Easergy MiCOM P24x
(P241, P242 & P243)

Rotating Machine Protection Relay

P24x/EN M/G73

Software Version	D1
Hardware Suffix	L (P241) & M (P242/P243)
Issue Date	05/2017

Technical Manual

Schneider Electric

Note The technical manual for this device gives instructions for its installation, commissioning, and operation. However, the manual cannot cover all conceivable circumstances or include detailed information on all topics. In the event of questions or specific problems, do not take any action without proper authorization. Contact the appropriate Schneider Electric technical sales office and request the necessary information.
Any agreements, commitments, and legal relationships and any obligations on the part of Schneider Electric including settlements of warranties, result solely from the applicable purchase contract, which is not affected by the contents of the technical manual.
This device MUST NOT be modified. If any modification is made without the express permission of Schneider Electric, it will invalidate the warranty, and may render the product unsafe.

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Date:	05/2017
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.
Hardware suffix:	L (P241) & M (P242 & P243)
Software version:	D1
Connection diagrams:	10P241xx (xx = 01 to 02) 10P242xx (xx = 01) 10P243xx (xx = 01)

SAFETY INFORMATION

CHAPTER SI

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Notes:

1 INTRODUCTION

This document and the relevant equipment documentation provide full information on safe handling, installation, testing, commissioning and operation of this equipment. This document also includes reference to typical equipment label markings.

Documentation for equipment ordered from Schneider Electric is dispatched separately from manufactured goods and may not be received at the same time as the equipment. Therefore this guide is provided to ensure that printed information which may be present on the equipment is fully understood by the recipient.

The technical data in this document provides typical information and advice, which covers a variety of different products. You must also refer to the Technical Data section of the relevant product publication(s) as this includes additional information which is specific to particular equipment.

Warning	**Before carrying out any work on the equipment, you should be familiar with the contents of the Safety Information chapter/Safety Guide SFTY/5L M/L11 or later issue, the Technical Data chapter and the ratings on the equipment rating label.**

You also need to make reference to the external connection diagram(s) before the equipment is installed, commissioned or serviced.

Language-specific, self-adhesive User Interface labels are provided in a bag for some equipment.

The manuals within the MiCOM P40 range include notices, which contain safety-related information. These are ranked in terms of their importance (from high to low) as follows:

DANGER	**THIS INDICATES AN IMMINENTLY HAZARDOUS SITUATION WHICH, IF NOT AVOIDED, WILL RESULT IN DEATH OR SERIOUS INJURY.**

WARNING	**This indicates an potentially hazardous situation which, if not avoided, can result in death or serious injury.**

Caution	**This indicates an potentially hazardous situation which, if not avoided, can result in minor or moderate injury.**

Important	**This indicates an potentially hazardous situation which, if not avoided, can result in equipment damage.**

Note	*This indicates an explanation or gives information which is useful to know, but which is not directly concerned with any of the above.*

These may appear with relevant Symbols (possibly electrical hazard, safety alert, disposal concern, etc) to denote the nature of the notice.

These notices appear at the relevant place in the remainder of this manual.

2 HEALTH AND SAFETY

The information in this part of the equipment documentation is intended to ensure that equipment is properly installed and handled in order to maintain it in a safe condition.

People

Schneider Electric assume that everyone who will be associated with installing, testing, commissioning, operating or working on the equipment (and any system to which it may be connected) will be completely familiar with the contents of the Safety Information chapter and the Safety Guide. We also assume that everyone working with the equipment (and any connected systems) will have sufficient qualifications, knowledge and experience of electrical systems. We also assume that they will work with a complete understanding of the equipment they are working on and the health and safety issues of the location in which they are working. All people must be able to perform tasks in accordance with accepted safety engineering practices. They must also be suitably authorised to energize and de-energize equipment and to isolate, ground (earth) and label it. Given the risks of working on electrical systems and the environments in which they may be located, they must be trained in the care and use of safety apparatus in accordance with safety engineering practices; and they should be trained in emergency first aid procedures.

Receipt, Handling, Storage and Unpacking Relays

Although relays are of a robust construction, we recommend that you become familiar with the Installation chapter, as this describes important issues associated with receiving, handling, storage and unpacking relays.

Planning

We recommend that a detailed plan is developed before equipment is installed into a location, to make sure that all of the work can be done safely. Such a plan needs to determine how relevant equipment can be isolated from the electrical supply in such as way that there is no possibility of accidental contact with any electrical live equipment, wiring or busbars. It also needs to take into account the requirements for people to work with tools/equipment a safe distance away from any hazards. The plan also needs to be aware of the risk of falling devices; such as equipment being knocked over, units being accidentally dropped or protruding units being knocked out of rack-mounted cabinets. Safety shoes are recommended, as well as other protective clothing such as safety hats and gloves.

Live and Stored Voltages

When electrical equipment is in operation, dangerous voltages will be present in certain parts of the equipment. Even if electrical power is no longer being supplied, some items of equipment may retain enough electrical energy inside them to pose a potentially serious risk of electrocution or damage to other equipment.

Important	**Remember that placing equipment in a “test” position does not normally isolate it from the power supply or discharge any stored electrical energy.**

Warnings and Barricades

Everyone must observe all warning notices. This is because the incorrect use of equipment, or improper use may endanger personnel and equipment and also cause personal injury or physical damage.

Unauthorized entry should also be prevented with suitably marked fixed barricades which will notify people of any dangers and screen off work areas.

People should not enter electrical equipment cubicles or cable troughs until it has been confirmed that all equipment/cables have been isolated and de-energised.

Electrical Isolation

Before working in the terminal strip area, all equipment which has the potential to provide damaging or unsafe levels of electrical energy must be isolated. You will need to isolate and de-energize the specific item of equipment which is being worked on.

Depending on the location, you may also need to isolate and de-energize other items which are electrically connected to it as well as those which are close enough to pose a risk of electrocution in the event of accidental physical or electrical contact.

Remember too that, where necessary, both load and line sides should be de-energized.

Before you make contact with any equipment use an approved voltage detection device to reduce the risk of electric shock.

Risk of Accidental Contact or Arc Flash

Be aware of the risk of accidental contact with hands, long hair, tools or other equipment; and be aware of the possibility of the increased risk of arc flash from areas of high voltage.

Always wear appropriate shock and arc flash personal protective equipment while isolating and de-energizing electrical equipment and until a de-energized state is confirmed.

Temporary Protection

Consider the use of temporary protective Earthing Clamps. This is required to establish and maintain de-energization when electrical equipment operates at greater than 1000 volts or there is potential for back-feed at any voltage.

Temporary protective earthing can be accomplished by installing cables designed for that purpose or by the use of intrinsic earthing clamp equipment. Temporary protective earthing clamp equipment must be able to carry maximum fault current available and have an impedance low enough to cause the applicable protective device to operate.

Restoring Power

To reduce the risks, the work plan should have a check list of things which must be completed and checks made before electrical power can be restored.

Be aware of the risk that electrical systems may have power restored to them at a remote location (possibly by the customer or a utility company). You should consider the use of lockouts so that the electrical system can be restored only when you unlock it. In any event, you should be aware of and be part of the process which determines when electrical power can be restored; and that people working on the system have control over when power is restored.

Inspect and test the electrical equipment to ensure it has been restored to a “safe” condition prior re-energizing. Replace all devices, doors and covers before turning on the power to any device.

Qualified Personnel

Proper and safe operation of the equipment depends on appropriate shipping and handling, proper storage, installation and commissioning, and on careful operation, maintenance and servicing. For this reason only qualified personnel may work on or operate the equipment.

Qualified personnel are individuals who:

- Are familiar with the installation, commissioning, and operation of the equipment and of the system to which it is being connected
- Are able to safely perform switching operations in accordance with accepted safety engineering practices and are authorized to energize and de-energize equipment and to isolate, ground, and label it
- Are trained in the care and use of safety apparatus in accordance with safety engineering practices
- Are trained in emergency procedures (first aid)

Documentation

The equipment documentation gives instructions for its installation, commissioning, and operation. However, the manuals cannot cover all conceivable circumstances or include detailed information on all topics. In the event of questions or specific problems, do not take any action without proper authorization. Contact the appropriate Schneider Electric technical sales office and request the necessary information.

3 SYMBOLS AND LABELS ON THE EQUIPMENT

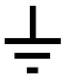
For safety reasons the following symbols and external labels, which may be used on the equipment or referred to in the equipment documentation, should be understood before the equipment is installed or commissioned.

3.1 Symbols

Caution: refer to equipment documentation

Caution: risk of electric shock

Protective Conductor (*Earth) terminal



Functional/Protective Conductor (*Earth) terminal

Note	*This symbol may also be used for a Protective Conductor (Earth) Terminal if that terminal is part of a terminal block or sub-assembly e.g. power supply.*

***CAUTION**	**The term “Earth” used throughout this technical manual is the direct equivalent of the North American term “Ground”.**

3.2 Labels

See Safety Guide (SFTY/5L M) for typical equipment labeling information.

4 INSTALLING, COMMISSIONING AND SERVICING

Manual Handling

Plan carefully, identify any possible hazards and determine whether the load needs to be moved at all. Look at other ways of moving the load to avoid manual handling. Use the correct lifting techniques and Personal Protective Equipment to reduce the risk of injury.

Many injuries are caused by:

- Lifting heavy objects
- Lifting things incorrectly
- Pushing or pulling heavy objects
- Using the same muscles repetitively

Follow the Health and Safety at Work, etc Act 1974, and the Management of Health and Safety at Work Regulations 1999.

Equipment Connections

Personnel undertaking installation, commissioning or servicing work for this equipment should be aware of the correct working procedures to ensure safety.

The equipment documentation should be consulted before installing, commissioning, or servicing the equipment.

Terminals exposed during installation, commissioning and maintenance may present a hazardous voltage unless the equipment is electrically isolated.

The clamping screws of all terminal block connectors, for field wiring, using M4 screws shall be tightened to a nominal torque of 1.3 Nm.

Equipment intended for rack or panel mounting is for use on a flat surface of a Type 1 enclosure, as defined by Underwriters Laboratories (UL).

Any disassembly of the equipment may expose parts at hazardous voltage, also electronic parts may be damaged if suitable ElectroStatic voltage Discharge (ESD) precations are not taken.

If there is unlocked access to the rear of the equipment, care should be taken by all personnel to avoid electric shock or energy hazards.

Caution	*Voltage and current connections shall be made using insulated crimp terminations to ensure that terminal block insulation requirements are maintained for safety.*

Watchdog (self-monitoring) contacts are provided in numerical relays to indicate the health of the device. Schneider Electric strongly recommends that these contacts are hardwired into the substation's automation system, for alarm purposes.

To ensure that wires are correctly terminated the correct crimp terminal and tool for the wire size should be used.

The equipment must be connected in accordance with the appropriate connection diagram.

Protection Class I Equipment

- **Before energizing the equipment it must be earthed using the protective conductor terminal, if provided, or the appropriate termination of the supply plug in the case of plug connected equipment.**
- The protective conductor (earth) connection must not be removed since the protection against electric shock provided by the equipment would be lost.

- When the protective (earth) conductor terminal (PCT) is also used to terminate cable screens, etc., it is essential that the integrity of the protective (earth) conductor is checked after the addition or removal of such functional earth connections. For M4 stud PCTs the integrity of the protective (earth) connections should be ensured by use of a locknut or similar.

The recommended minimum protective conductor (earth) wire size is 2.5 mm² (3.3 mm² for North America) unless otherwise stated in the technical data section of the equipment documentation, or otherwise required by local or country wiring regulations.

The protective conductor (earth) connection must be low-inductance and as short as possible.

All connections to the equipment must have a defined potential. Connections that are pre-wired, but not used, should preferably be grounded when binary inputs and output relays are isolated. When binary inputs and output relays are connected to common potential, the pre-wired but unused connections should be connected to the common potential of the grouped connections.

Pre-Energization Checklist

Before energizing the equipment, the following should be checked:

- Voltage rating/polarity (rating label/equipment documentation)
- CT circuit rating (rating label) and integrity of connections
- Protective fuse rating
- Integrity of the protective conductor (earth) connection (where applicable)
- Voltage and current rating of external wiring, applicable to the application

Accidental Touching of Exposed Terminals

If working in an area of restricted space, such as a cubicle, where there is a risk of electric shock due to accidental touching of terminals which do not comply with IP20 rating, then a suitable protective barrier should be provided.

Equipment Use

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Removal of the Equipment Front Panel/Cover

Removal of the equipment front panel/cover may expose hazardous live parts, which must not be touched until the electrical power is removed.

UL and CSA/CUL Listed or Recognized Equipment

To maintain UL and CSA/CUL Listing/Recognized status for North America the equipment should be installed using UL or CSA Listed or Recognized parts for the following items: connection cables, protective fuses/fuseholders or circuit breakers, insulation crimp terminals and replacement internal battery, as specified in the equipment documentation.

For external protective fuses a UL or CSA Listed fuse shall be used. The Listed type shall be a Class J time delay fuse, with a maximum current rating of 15 A and a minimum d.c. rating of 250 Vd.c., for example type AJT15.

Where UL or CSA Listing of the equipment is not required, a high rupture capacity (HRC) fuse type with a maximum current rating of 16 Amps and a minimum d.c. rating of 250 Vd.c. may be used, for example Red Spot type NIT or TIA.

Equipment Operating Conditions

The equipment should be operated within the specified electrical and environmental limits. This includes humidity as well as temperature limits.

Current Transformer Circuits

Do not open the secondary circuit of a live CT since the high voltage produced may be lethal to personnel and could damage insulation. Generally, for safety, the secondary of the line CT must be shorted before opening any connections to it.

For most equipment with ring-terminal connections, the threaded terminal block for current transformer termination has automatic CT shorting on removal of the module. Therefore external shorting of the CTs may not be required, the equipment documentation should be checked to see if this applies.

For equipment with pin-terminal connections, the threaded terminal block for current transformer termination does NOT have automatic CT shorting on removal of the module.

External Resistors, including Voltage Dependent Resistors (VDRs)

Where external resistors, including Voltage Dependent Resistors (VDRs), are fitted to the equipment, these may present a risk of electric shock or burns, if touched.

Battery Replacement

Where internal batteries are fitted they should be replaced with the recommended type and be installed with the correct polarity to avoid possible damage to the equipment, buildings and persons.

Insulation and Dielectric Strength Testing

Insulation testing may leave capacitors charged up to a hazardous voltage. At the end of each part of the test, the voltage should be gradually reduced to zero, to discharge capacitors, before the test leads are disconnected.

Insertion of Modules and PCB Cards

Modules and PCB cards must not be inserted into or withdrawn from the equipment whilst it is energized, since this may result in damage.

Insertion and Withdrawal of Extender Cards

Extender cards are available for some equipment. If an extender card is used, this should not be inserted or withdrawn from the equipment whilst it is energized. This is to avoid possible shock or damage hazards. Hazardous live voltages may be accessible on the extender card.

External Test Blocks and Test Plugs

Great care should be taken when using external test blocks and test plugs such as the Easergy Test Block, Easergy Test Plug and MiCOM P99x types, as hazardous voltages may be accessible when using these. CT shorting links must be in place before the insertion or removal of Easergy test plugs, to avoid potentially lethal voltages.

**Note:*	*When a MiCOM P992 Test Plug is inserted into the MiCOM P991 Test Block, the secondaries of the line CTs are automatically shorted, making them safe.*

Fiber Optic Communication

Where fiber optic communication devices are fitted, these use laser light. These laser-light sources should not be viewed directly, as they can cause permanent damage to eyesight. Optical power meters should be used to determine the operation or signal level of the device.

Cleaning

The equipment may be cleaned using a lint free cloth dampened with clean water, when no connections are energized. Contact fingers of test plugs are normally protected by petroleum jelly, which should not be removed.

5 DE-COMMISSIONING AND DISPOSAL

De-Commissioning

The supply input (auxiliary) for the equipment may include capacitors across the supply or to earth. To avoid electric shock or energy hazards, after completely isolating the supplies to the equipment (both poles of any dc supply), the capacitors should be safely discharged via the external terminals prior to de-commissioning.

Disposal

It is recommended that incineration and disposal to water courses is avoided. The equipment should be disposed of in a safe manner. Any equipment containing batteries should have them removed before disposal, taking precautions to avoid short circuits. Particular regulations within the country of operation, may apply to the disposal of the equipment.

6 TECHNICAL SPECIFICATIONS FOR SAFETY

Unless otherwise stated in the equipment technical manual, the following data is applicable.

6.1 Protective Fuse Rating

The recommended maximum rating of the external protective fuse for equipments is 16A, High Rupture Capacity (HRC) Red Spot type NIT, or TIA, or equivalent. Unless otherwise stated in equipment technical manual, the following data is applicable. The protective fuse should be located as close to the unit as possible.

DANGER **CTs must NOT be fused since open circuiting them may produce lethal hazardous voltages.**

6.2 Protective Class

IEC 60255-27: 2005	Class I (unless otherwise specified in the equipment documentation).
EN 60255-27: 2006	This equipment requires a protective conductor (earth) connection to ensure user safety.

6.3 Installation Category

IEC 60255-27: 2013	Installation Category III (Overvoltage Category III)
EN 60255-27: 2014	Distribution level, fixed installation.

Equipment in this category is qualification tested at 5 kV peak, 1.2/50 µs, 500 Ω, 0.5 J, between all supply circuits and earth and also between independent circuits.

6.4 Environment

The equipment is intended for indoor installation and use only. If it is required for use in an outdoor environment then it must be mounted in a specific cabinet of housing which will enable it to meet the requirements of IEC 60529 with the classification of degree of protection IP54 (dust and splashing water protected).

Pollution Degree	Pollution Degree 2 Compliance is demonstrated by reference to safety standards.
Altitude	Operation up to 2000m

INTRODUCTION

CHAPTER 1

Date:	05/2017
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.
Hardware suffix:	L (P241) & M (P242 & P243)
Software version:	D1
Connection diagrams:	10P241xx (xx = 01 to 02) 10P242xx (xx = 01) 10P243xx (xx = 01)

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FIGURES

TABLES

Notes:

1 DOCUMENTATION STRUCTURE

This manual provides a functional and technical description of this MiCOM device, and gives a comprehensive set of instructions for it’s use and application. A summary of the different chapters of this manual is given here:

	Description	Chapter Code
	Safety Information A guide to the safe handling, commissioning and testing of equipment. This provides typical information and advice which covers a range of MiCOM Px4x products. It explains how to work with equipment safely.	**Px4x/EN SI**
1	**Introduction** A guide to the MiCOM range of relays and the documentation structure. General safety aspects of handling Electronic Equipment are discussed with particular reference to relay safety symbols. Also a general functional overview of the relay and brief application summary is given.	**P24x/EN IT**
2	**Technical Data** Technical data including setting ranges, accuracy limits, recommended operating conditions, ratings and performance data. Compliance with norms and international standards is quoted where appropriate.	**P24x/EN TD**
3	**Getting Started** A guide to the different user interfaces of the IED describing how to start using it. This chapter provides detailed information regarding the communication interfaces of the IED, including a detailed description of how to access the settings database stored within the IED.	**P24x/EN GS**
4	**Settings** List of all relay settings, including ranges, step sizes and defaults, together with a brief explanation of each setting.	**P24x/EN ST**
5	**Operation** A comprehensive and detailed functional description of all protection and non-protection functions.	**P24x/EN OP**
6	**Application Notes** This section includes a description of common power system applications of the relay, calculation of suitable settings, some typical worked examples, and how to apply the settings to the relay.	**P24x/EN AP**
7	**Using the PSL Editor** This provides a short introduction to using the PSL Editor application.	**Px4x/EN SE**
8	**Programmable Logic** Overview of the Programmable Scheme Logic (PSL) and a description of each logical node. This chapter includes the factory default and an explanation of typical applications.	**P24x/EN PL**
9	**Measurements and Recording** Detailed description of the relays recording and measurements functions including the configuration of the event and disturbance recorder and measurement functions.	**P24x/EN MR**
10	**Product Design** Overview of the operation of the relay’s hardware and software. This chapter includes information on the self-checking features and diagnostics of the relay.	**P24x/EN PD**
11	**Commissioning** Instructions on how to commission the relay, comprising checks on the calibration and functionality of the relay.	**P24x/EN CM**
12	**Test and Setting Records** This is a list of the tests made and the settings stored on the MiCOM IED.	**P24x/EN RC**
13	**Maintenance** A general maintenance policy for the relay is outlined.	**Px4x/EN MT**

	Description	Chapter Code
14	**Troubleshooting** Advice on how to recognize failure modes and the recommended course of action. Includes guidance on whom within Schneider Electric to contact for advice.	**Px4x/EN TS**
15	**SCADA Communications** This chapter provides an overview regarding the SCADA communication interfaces of the relay. Detailed protocol mappings, semantics, profiles and interoperability tables are not provided within this manual. Separate documents are available per protocol, available for download from our website.	**P24x/EN SC**
16	**Installation** Recommendations on unpacking, handling, inspection and storage of the relay. A guide to the mechanical and electrical installation of the relay is provided, incorporating earthing recommendations.	**Px4x/EN IN**
17	**Connection Diagrams** A list of connection diagrams, which show the relevant wiring details for this relay.	**P24x/EN CD**
18	**Cyber Security** An overview of cyber security protection (to secure communication and equipment within a substation environment). Relevant cyber security standards and implementation are described too.	**Px4x/EN CS**
19	**Dual Redundant Ethernet Board** Information about how MiCOM products can be equipped with Dual Redundant Ethernet Boards (DREBs) and the different protocols which are available. Also covers how to configure and commission these types of boards.	**Pxxx/EN REB**
20	**Parallel Redundancy Protocol (PRP) Notes** Includes an introduction to Parallel Redundancy Protocols (PRP) and the different networks PRP can be used with. Also includes details of PRP and MiCOM functions.	**Pxxx/EN PR**
21	**High-availability Seamless Redundancy (HSR)** Introduction to the High-availability Seamless Redundancy (HSR); and how it is implemented on MiCOM-based products manufactured by Schneider Electric.	**Pxxx/EN HS**
22	**Version History (of Firmware and Service Manual)** This is a history of all hardware and software releases for this product.	**P24x/EN VH**
	Symbols and Glossary List of common technical terms, abbreviations and symbols found in this documentation.	**Px4x/EN SG**

Some of these chapters are *Specific* to a particular MiCOM product. Others are *Generic* – meaning that they cover more than one MiCOM product. The generic chapters have a Chapter Code which starts with Px4x.

2 INTRODUCTION

About MiCOM Range

MiCOM is a comprehensive solution capable of meeting all electricity supply requirements. It comprises a range of components, systems and services from Schneider Electric.

Central to the MiCOM concept is flexibility. MiCOM provides the ability to define an application solution and, through extensive communication capabilities, integrate it with your power supply control system.

The components within MiCOM are:

- P range protection relays
- C range control products
- M range measurement products for accurate metering and monitoring
- S range versatile PC support and substation control packages

MiCOM products include extensive facilities for recording information on the state and behaviour of the power system using disturbance and fault records. They can also provide measurements of the system at regular intervals to a control centre enabling remote monitoring and control to take place.

For up-to-date information, please see:

www.schneider-electric.com

Note	*During 2011, the International Electrotechnical Commission classified the voltages into different levels (IEC 60038). The IEC defined LV, MV, HV and EHV as follows: LV is up to 1000V. MV is from 1000V up to 35 kV. HV is from 110 kV or 230 kV. EHV is above 230 KV.* *There is still ambiguity about where each band starts and ends. A voltage level defined as LV in one country or sector, may be described as MV in a different country or sector. Accordingly, LV, MV, HV and EHV suggests a possible range, rather than a fixed band. Please refer to your local Schneider Electric office for more guidance.*

3 PRODUCT SCOPE

The MiCOM P241/P242/P243 universal motor protection relays have been developed and designed for the protection of medium sized to large rotating machines, both synchronous and Induction. The MiCOM P243 can also offer motor differential protection, providing the neutral star point of the machine is accessible, in addition to the features of the P241/P242. The P242/P243 also includes 10 function keys for integral scheme or operator control functionality and tri-color (red/yellow/green) LEDs.

3.1 Functional Overview

The relay contains a wide variety of protection functions which are summarized below:

Device No	PROTECTION FUNCTIONS OVERVIEW	P24x
87	Three-phase machine differential protection is provided to detect stator phase faults. The differential protection can be selected as percentage biased or high impedance.	P243
50/51	Four non-directional overcurrent protection stages are provided for protection against three-phase and phase-earth short circuit faults. Stage 1 and 2 may be set Inverse Definite Minimum Time (IDMT) or Definite Time (DT); stages 3 and 4 may be set DT only.	P241 / P242 / P243
50N/51N	Two stages of earth fault protection are provided for stator earth faults. Each stage can be set to either non-directional or directional forward. Stage 1 can be set Inverse Definite Minimum Time (IDMT) or Definite Time (DT). Stage 2 can be set Definite Time (DT) only. The earth fault current can be detected using internally derived current from the 3 phases.	P241 / P242 / P243
50N/51N/67N	Two stages of sensitive earth fault protection are provided. Each stage can be set to either non-directional or directional forward. Stage 1 can be set Inverse Definite Minimum Time (IDMT) or Definite Time (DT). `Stage 2 can be set to Definite Time (DT) only. The earth fault current is detected by using current measured from a sensitive current input.	P241 / P242 / P243
32N/64N	The sensitive earth fault element can also be configured as a wattmetric element suitable for Petersen Coil earthed systems. This form of protection uses the same sensitive earth fault directional characteristic but with a current, voltage and residual power threshold.	P241 / P242 / P243
32R	One stage of reverse power protection is provided, which measures active power to detect power flow from the motor to the system when the busbar is lost.	P241 / P242 / P243
37	Two stages of under power are used to detect a loss of load due to a shaft failure or a pump running unprimed. This feature is disabled during starting.	P241 / P242 / P243
40	A two stage offset mho definite time impedance element is provided to detect failure of the machine excitation. A power factor alarm element is also available to offer more sensitive protection.	P241 / P242 / P243
49	Thermal overload protection based on I1 and I2 is provided to protect the stator/rotor against overloading due to balanced and unbalanced currents. Both alarm and trip stages are provided.	P241 / P242 / P243
46	Two negative phase sequence overcurrent elements are provided to detect a phase failure or unbalanced load. Stage 1 can be set Definite Time (DT) only and Stage 2 can be set Inverse Definite Minimum Time (IDMT) only.	P241 / P242 / P243
55	Two stages (lag and Lead) of power factor protection are provided for out-of-step protection on synchronous machines. Both stages can be set to Definite Time (DT) only. Requires breaker status (52a) to operate.	P241 / P242 / P243

Device No	PROTECTION FUNCTIONS OVERVIEW	P24x
59N	Residual overvoltage protection is available for stator earth fault protection where there is an isolated or high impedance earth. The residual voltage can be measured from a residual voltage input or can be calculated from the three phase to neutral voltage measurements. Two independent stages of protection are provided for each measured neutral voltage input and also for the calculated value, Stage 1 can be selected as either Inverse Definite Minimum Time (IDMT) or Definite Time (DT). Stage 2 can be selected as Definite Time (DT) only.	P241 / P242 / P243
27	A 2 stage undervoltage protection element, phase to phase measuring is provided. Stage 1 may be selected as either IDMT or DT and stage 2 is DT only.	P241 / P242 / P243
59	A 2 stage overvoltage protection element, phase to phase measuring is provided. Both stages can be selected as DT only.	P241 / P242 / P243
47	One stage of 3 phase voltage check is provided when VT connect mode is 3VT or 2VT with Residual. Input voltage magnitudes are monitored to ensure they are correct before allowing the machine to start. Input voltage rotation is also checked by monitoring negative phase sequence voltage > positive phase sequence voltage.	P241 / P242 / P243
81U	2 stages of definite time underfrequency protection are provided to protect machines against loss of supply. This feature is disabled during starting.	P241 / P242 / P243
48/51LR	A starting current detector and a starting time delay protects the motor from excessively long starts. This protection function is activated either by the 52a contact, the starting current or both the 52a contact and the starting current.	P241 / P242 / P243
14	Where the motor stall withstand time may be shorter than the starting time, a digital input is provided to accommodate a speed switch to distinguish between start and stall.	P241 / P242 / P243
50S	A stall during running is given by a current exceeding the programmed current threshold following a successful start.	P241 / P242 / P243
66	For the number of starts limitation protection a separate count of “hot” and “cold” starts is maintained by the relay using the data held in the motor thermal replica. Starting is blocked if the permitted number of starts is exceeded by the use of a time between starts timer.	P241 / P242 / P243
27 (remanent)	Used to detect when the rotor has completely stopped, in order to allow re-starting of the motor. Operation can be triggered by either a remanant voltage threshold or by a time delay.	P241 / P242 / P243
RTD	10 RTDs (PT100) are provided to monitor the temperature accurately in the windings and bearings of the machine. Each RTD has an instantaneous alarm and definite time trip stage.	Option P241 / P242 / P243
50BF	A 2 stage circuit breaker failure function is provided.	P241 / P242 / P243
VTS	Voltage transformer supervision is provided (1, 2 & 3 phase fuse failure detection) to prevent mal-operation of voltage dependent protection elements upon loss of a VT input signal.	P241 / P242 / P243
CTS	Current transformer supervision is provided to prevent mal-operation of current dependent protection elements upon loss of a CT input signal. CTS is provided for both sets of 3 phase CTs in the P243 relay.	P241 / P242 / P243
CLIO	4 analog (or current loop) inputs are provided for transducers (vibration, tachometers etc.). Each input has a definite time trip and alarm stage. Each input can be independently selected as 0-1/0-10/0-20/4-20 mA. 4 analogue (or current loop) outputs are provided for the analogue measurements in the relay. Each output can be independently selected as 0-1/0-10/0-20/4-20 mA.	Option P241 / P242 / P243

Device No	PROTECTION FUNCTIONS OVERVIEW	P24x
	A facility is provided using an offline graphical programmable curve tool. This enables the user to configure a customized multiples of a current setting versus operating time curve and an associated reset curve. Two pairs of configurable operate-reset curves are made available to the user, one pair for thermal and one pair for overcurrent or sensitive/derived earth fault protection. The curves can be defined as a number of curve points or a user defined formula. The curves can then be downloaded to the relay and can also be extracted from the relay. The user programmable curves are available for Thermal, first and second stage overcurrent, first stage sensitive earth fault and first stage derived earth fault protection functions. To find out how to use the tool, see the Px4x/EN UPCT/A11 document.	P241 / P242 / P243
	A facility is provided to maintain correct operation of all the protection functions even when the motor is running in a reverse direction. This is achieved through user configurable settings available in two setting groups.	P241 / P242 / P243
	A facility is provided to check the three phase voltages to ensure both correct phase rotation and sufficient supply voltage prior to permitting motor starting.	P241 / P242 / P243
	Programmable function keys	10 (P242 / P243)
	Programmable LEDs (tri-color P242/P243, red P241).	18 (P242 / P243) 8 (P241)
	Digital inputs (model and order option dependent).	8 to 16
	Output relays (order option)	7 to 16
	Front communication port (EIA(RS)232)	P241 / P242 / P243
	Rear communication port (KBUS/EIA(RS)485). The following communications protocols are supported; Courier, MODBUS and IEC 870-5-103 (VDEW).	P241 / P242 / P243
	Rear communication port (Fiber Optic). The following communications protocols are supported; Courier, MODBUS, and IEC 870-5-103 (VDEW).	Option P241 / P242 / P243
	Second rear communication port (EIA(RS)232/EIA(RS)485). Courier protocol.	Option P241 / P242 / P243
	Rear IEC 61850 Ethernet communication port.	Option P241 / P242 / P243
	Redundant IEC 61850 Ethernet communication port.	Option P241 / P242 / P243
	Time synchronization port (IRIG-B modulated/un-modulated).	Option P241 / P242 / P243

Table 1 - Functional overview

The relay supports these relay management functions as well as the ones shown above.

- Measurement of all instantaneous & integrated values
- Circuit breaker, status & condition monitoring
- Programmable Scheme Logic (PSL)
- Trip circuit and coil supervision (using PSL)
- Alternative setting groups (model dependent)
- Programmable function keys (model dependent)
- Control inputs
- Programmable allocation of digital inputs and outputs
- Sequence of event recording
- Comprehensive disturbance recording (waveform capture)
- Fault recording
- Fully customizable menu texts
- Power-up diagnostics and continuous self-monitoring of relay
- Commissioning test facilities
- Real time clock/time synchronization - time synchronization possible from IRIG-B input, opto input or communications
- Password protection
- Read only mode

3.2 Application Overview

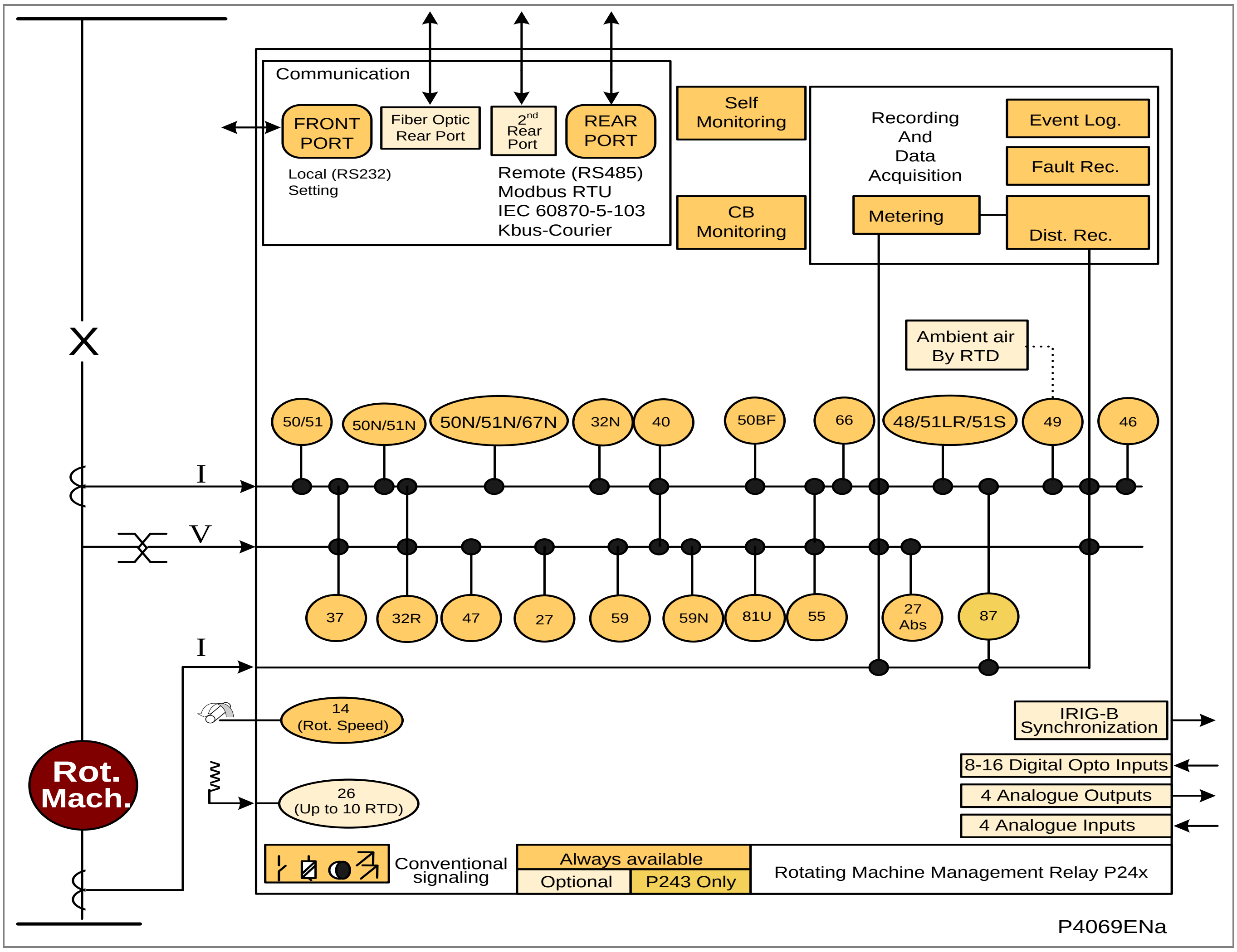

Figure 1 - Functional diagram

3.3 Ordering Options

Information required with order:

- P241 Motor Protection Relay
- P242 Motor Protection Relay
- P243 Motor Protection Relay

Note	*The following Cortec tables list the options available as of the date shown of this documentation. The most up-to-date Cortec versions of these tables can be found on our web site (www.schneider-electric.com). It may not be possible to select ALL of the options shown in this chart within a single item of equipment.*

3.3.1 P241 Motor Protection Relay

P241 Motor Protection Relay	**P241**
Vx Aux Rating	
24-32 Vdc	9
48-110 Vdc	2
110-250 Vdc, 100-240 Vac	3
In/Vn rating	
In=1 A/5 A, Vn=100/120 V	1
Hardware options	
Standard version	1
IRIG-B only (Modulated)	2
Fiber Optic Rear Comms Port	3
IRIG-B (Modulated) & Fiber Optic Rear Comms Port	4
Second Rear Comms. Board	7
IRIG-B (Modulated) plus Second Rear Comms Board	8
Redundant Ethernet (100Mbit/s) PRP or HSR and Dual IP, 2 LC ports + 1 RJ45 port + Modulated/Un-modulated IRIG-B	Q
Redundant Ethernet (100Mbit/s) PRP or HSR and Dual IP, 3 RJ45 ports + Modulated/Un-modulated IRIG-B	R
Ethernet (100Mbit/s), 1 RJ45 port + Modulated/Un-modulated IRIG-B	S
Product specific	
Size 40TE Case, 8 Logic Inputs + 7 Relay Outputs	A
Size 40TE Case, 8 Logic Inputs + 7 Relay Outputs + RTDs	B
Size 40TE Case, 8 Logic Inputs + 7 Relay Outputs + CLIO	C
Size 40TE Case, 12 Logic Inputs + 11 Relay Outputs	E
Protocol options	
K-bus	1
Modbus	2
IEC 60870-5-103 (VDEW)	3
Mounting	
Panel Mounting	M
Language	
Multilingual – English, French, German, Spanish	0
Multilingual – English, French, German, Russian	5
Multilingual – English, French, Chinese	C
Software issue	
Unless specified the latest version will be delivered	D1
Settings file	
Default	8
Customer specific	9
Design suffix	
Phase 3 CPU	L
Phase 2 CPU	J

3.3.2 P242 Motor Protection Relay

P242 Motor Protection Relay	P242
Vx Aux Rating	
24-32 Vdc	9
48-110 Vdc	2
110-250 Vdc, 100-240 Vac	3
In/Vn rating	
In=1 A/5 A, Vn=100/120 V	1
Hardware options	
Standard version	1
IRIG-B only (Modulated)	2
Fiber Optic Rear Comms Port	3
IRIG-B (Modulated) & Fiber Optic Rear Comms Port	4
Second Rear Comms. Board	7
IRIG-B (Modulated) plus Second Rear Comms Board	8
Redundant Ethernet (100Mbit/s) PRP or HSR and Dual IP, 2 LC ports + 1 RJ45 port + Modulated/Un-modulated IRIG-B	Q
Redundant Ethernet (100Mbit/s) PRP or HSR and Dual IP, 3 RJ45 ports + Modulated/Un-modulated IRIG-B	R
Ethernet (100Mbit/s), 1 RJ45 port + Modulated/Un-modulated IRIG-B	S
Product specific	
16 Logic Inputs & 16 Relay Outputs	A
16 Logic Inputs & 16 Relay Outputs + RTDs	B
16 Logic Inputs & 16 Relay Outputs + CLIO	C
16 Logic Inputs & 16 Relay Outputs + RTDs & CLIO	D
Protocol options	
IEC 61850 Edition 1/2 and Courier via rear K-Bus/RS485 with simple password management - CSL0	6
IEC 61850 Edition 1/2 and Courier via rear K-Bus/RS485 with advanced Cyber Security Security Administration Tool - CSL1	G
Mounting	
Panel Mounting	M
Language	
Multilingual – English, French, German, Spanish	0
Multilingual – English, French, German, Russian	5
Multilingual – English, French, Chinese	C
Software issue	
Unless specified the latest version will be delivered	D1
Settings file	
Default	8
Customer specific	9
Design suffix	
Extended Phase 3 CPU	M
Extended Phase 2 CPU	K

3.3.3 P243 Motor Protection Relay

P243 Motor Protection Relay	**P243**
Vx Aux Rating	
24-32 Vdc	9
48-110 Vdc	2
110-250 Vdc, 100-240 Vac	3
In/Vn rating	
In=1 A/5 A, Vn=100/120 V	1
Hardware options	
Standard version	1
IRIG-B only (Modulated)	2
Fiber Optic Rear Comms Port	3
IRIG-B (Modulated) & Fiber Optic Rear Comms Port	4
Second Rear Comms. Board	7
IRIG-B (Modulated) plus Second Rear Comms Board	8
Redundant Ethernet (100Mbit/s) PRP or HSR and Dual IP, 2 LC ports + 1 RJ45 port + Modulated/Un-modulated IRIG-B	Q
Redundant Ethernet (100Mbit/s) PRP or HSR and Dual IP, 3 RJ45 ports + Modulated/Un-modulated IRIG-B	R
Ethernet (100Mbit/s), 1 RJ45 port + Modulated/Un-modulated IRIG-B	S
Product specific	
16 Logic inputs & 16 Relay Outputs	A
16 Logic inputs & 16 Relay Outputs + RTDs	B
16 Logic inputs & 16 Relay Outputs + CLIO	C
16 Logic inputs & 16 Relay Outputs + RTDs & CLIO	D
Protocol options	
IEC 61850 Edition 1/2 and Courier via rear K-Bus/RS485 with simple password management – CLS0	6
IEC 61850 Edition 1/2 and Courier via rear K-Bus/RS485 with advanced Cyber Security (Security Administration Tool) - CSL1	G
Mounting	
Panel Mounting	M
Rack Mounting	N
Language	
Multilingual – English, French, German, Spanish	0
Multilingual – English, French, German, Russian	5
Multilingual – English, French, Chinese	C
Software issue	
Unless specified the latest version will be delivered	D1
Settings file	
Default	8
Customer specific	9
Design suffix	
Extended Phase 3 CPU	M
Extended Phase 2 CPU	K

Notes:

TECHNICAL DATA

CHAPTER 2

Date:	05/2017
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.
Hardware suffix:	L (P241) & M (P242 & P243)
Software version:	D1
Connection diagrams:	10P241xx (xx = 01 to 02) 10P242xx (xx = 01) 10P243xx (xx = 01)

CONTENTS

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Notes:

1 MECHANICAL SPECIFICATIONS

1.1 Design

Modular MiCOM Px40 platform relay, P241 in 40TE case, P242 in 60TE case, P243 in 80TE case.

Mounting is front of panel flush mounting or 19“ rack mounted (ordering options).

1.2 Enclosure Protection

Per IEC 60529:

- IP 52 Protection (front panel) against dust and dripping water.
- IP 50 Protection for the rear and sides of the case against dust.
- IP 10 Product safety protection for the rear due to live connections on the terminal block.

1.3 Weight

P241 (40TE):	7.3kg
P242 (60TE):	9.2kg (with RTD, CLIO cards)
P243 (80TE):	11.5kg (with RTD, CLIO cards)

2 TERMINALS

2.1 AC Current and Voltage Measuring Inputs

Located on heavy duty (black) terminal block:
Threaded M4 terminals, for ring terminal connection.
CT inputs have integral safety shorting, upon removal of the terminal block.

2.2 General Input/Output Terminals

For power supply, opto inputs, output contacts and RP1, COM1 and optional COM2 rear communications.
Located on general purpose (grey) blocks:
Threaded M4 terminals, for ring lug/terminal connection.

2.3 Case Protective Earth Connection

Two rear stud connections, threaded M4.
Must be earthed (grounded) using the protective (earth) conductor for safety, minimum earth wire size $2.5mm^2$.

2.4 Front Port Serial PC Interface

EIA(RS)-232 DCE, 9 pin D-type female connector Socket SK1.
Courier protocol for interface to MiCOM S1 Studio software.
Isolation to SELV/ELV (Safety/Extra Low Voltage) level / PEB (Protective Equipotential Bonded).
Maximum cable length 15m.

2.5 Front Download/Monitor Port

EIA(RS)-232, 25 pin D-type female connector Socket SK2.
For firmware and menu text downloads.
Isolation to SELV/PEB level.

2.6 Rear Communications Port (RP1)

EIA(RS)-485 signal levels, two wire connections located on general purpose block, M4 screw.
For screened twisted pair cable, multidrop, 1000 m max.
For Courier (K-Bus), IEC-60870-5-103 (not for P746/P849), MODBUS (not for P14x/P445/P44x/P54x/P547/P746/P841/P849) or DNP3.0 protocol (not for P24x/P746/P849) (ordering options).
Isolation to SELV (Safety Extra Low Voltage) level. Ethernet (copper and fibre).

2.7 Optional Second Rear Communication Port (RP2)

EIA(RS)-232, 9 pin D-type female connector, socket SK4.
Courier protocol: K-Bus, EIA(RS)-232, or EIA(RS)485 connection.
Isolation to SELV level.
Maximum cable length 15m.

- PEB = Protective equipotential bonded
- SELV = Safety/Separated extra low voltage

Both PEB and SELV circuits are safe to touch after a single fault condition.

2.8 Optional Rear IRIG-B Interface Modulated or Un-Modulated

BNC plug
Isolation to SELV level.
50 ohm coaxial cable.

2.9 Optional Rear Fiber Connection for SCADA/DCS

BFOC 2.5 -(ST)-interface for multi-mode glass fiber type 62.5, as for IEC 874-10.
850nm short-haul fibers, one Tx and one Rx. For Courier, IEC-60870-5-103, MODBUS or DNP3.0 (but, see different ordering options for each model).

2.10 Optional Rear Ethernet Connection for IEC 61850

2.10.1 10BaseT/100BaseTX Communications

Interface in accordance with IEEE802.3 and IEC 61850

Isolation:	1.5 kV
Connector type:	RJ45
Cable type:	Screened Twisted Pair (STP)
Max. cable length:	100 m

2.10.2 100 Base FX Interface

Interface in accordance with IEEE802.3 and IEC 61850

Wavelength:	1310 nm
Fiber:	multi-mode 50/125 µm or 62.5/125 µm
Connector type:	ST/LC Connector Optical Interface (depending on model)

2.11 Optional Rear Redundant Ethernet Connection for IEC 61850

2.11.1 100 Base FX Interface

Interface in accordance with IEEE802.3 and IEC 61850

Wavelength:	1310 nm
Fiber:	multi-mode 50/125 µm or 62.5/125 µm
Connector type:	ST/LC Connector Optical Interface (depending on model)

2.12 Fiber Defect Connector (Watchdog Relay)

Connector (3 terminals):	2 NC contacts
Rated voltage:	250 V
Continuous current:	5 A
Short duration current:	30 A for 3 s

2.13 Breaking Capacity

Breaking capacity:

DC: 50 W resistive
DC: 25 W inductive (L/R = 40 ms)
AC: 1500 VA resistive (cos ϕ = unity)
AC: 1500 VA inductive (cos ϕ = 0.5)

Subject to maxima of 5 A and 250 V

3 RATINGS

3.1 AC Measuring Inputs

Nominal frequency: 50 and 60 Hz (settable)
Operating range: 45 to 65Hz

3.2 AC Current

Nominal current (In): 1 and 5 A dual rated.
(1 A and 5 A inputs use different transformer tap connections, check correct terminals are wired).

Nominal burden:

< 0.04 VA at In, <40 mΩ (0-30 In) In = 1 A
< 0.01 VA at In, <8 mΩ (0-30 In) In = 5 A

Thermal withstand:

Continuous 4 In
For 10 s: 30 In
For 1 s; 100 In

Standard: linear to 64 In (non-offset AC current).
Sensitive: linear to 2 In (non-offset AC current).

Caution	***Separate terminals are provided for the 1A and 5A windings, with the neutral input of each winding sharing one terminal.***

3.3 AC Voltage

Nominal voltage (Vn): 100 to 120 V phase-phase
Nominal burden per phase: < 0.02 VA rms at 110/√3 V
Thermal withstand: Continuous 2 Vn for 10 s: 2.6 Vn linear to 200 V.

4 POWER SUPPLY

4.1 Auxiliary Voltage (Vx)

Three ordering options:
(i) Vx: 24 to 32 Vdc
(ii) Vx: 48 to 110 Vdc,
(iii) Vx: 110 to 250 Vdc, and 100 to 240 Vac (rms).

4.2 Operating Range

(i) 19 to 38Vdc (dc only for this variant)

(ii) 37 to 150V (dc only for this variant)

(iii) 87 to 300V (dc), 80 to 265 V (ac).

With a tolerable ac ripple of up to 15% for a dc supply, per EN / IEC 60255-11, EN / IEC 60255-26.

4.3 Nominal Burden

Quiescent burden: 11W or 24 VA. (Extra 1.25 W when fitted with second rear communications board).

Additions for energized binary inputs/outputs:

For each opto input:

0.09 W (24 to 54 V)

0.12 W (110/125 V)

0.19 W (220/250 V)

For each energized output relay: 0.13W

4.4 Power-Up Time

Time to power up < 11 s.

4.5 Power Supply Interruption

Per IEC 60255-11, EN / IEC 60255-26

The relay will withstand a 20 ms interruption in the DC auxiliary supply, without de-energizing.

Per IEC 61000-4-11, EN / IEC 60255-26

The relay will withstand a 20 ms interruption in an AC auxiliary supply, without de-energizing.

4.6 Battery Backup

Front panel mounted.
Type ½ AA, 3.6 V Lithium Thionyl Chloride (SAFT advanced battery reference LS14250).
Battery life (assuming relay energized for 90% time) >10 years.

4.7 Field Voltage Output

Regulated 48 Vdc
Current limited at 112 mA maximum output
The operating range shall be 40 V to 60 V with an alarm raised at <35 V

4.8 Digital (“Opto”) Inputs

Universal opto inputs with programmable voltage thresholds (24/27, 30/34, 48/54, 110/125, 220/250 V). May be energized from the 48 V field voltage, or the external battery supply.

Rated nominal voltage:	24 to 250 Vdc
Operating range:	19 to 265 Vdc
Withstand:	300 Vdc, 300 Vrms.

Peak current of opto input when energized is 3.5 mA (0-300 V)

Nominal pick-up and reset thresholds:

Pick-up approx 70% of battery nominal set

Reset approx 66% of battery nominal set

Nominal battery 24/27:	60 - 80% DO/PU
(logic 0) <16.2	(logic 1) >19.2
Nominal battery 24/27:	50 - 70% DO/PU
(logic 0) <12.0	(logic 1) >16.8
Nominal battery 30/34:	60 - 80% DO/PU
(logic 0) <20.4	(logic 1) >24.0
Nominal battery 30/34:	50 - 70% DO/PU
(logic 0) <15.0	(logic 1) >21.0
Nominal battery 48/54:	60 - 80% DO/PU
(logic 0) <32.4	(logic 1) >38.4
Nominal battery 48/54:	50 - 70% DO/PU
(logic 0) <24.0	(logic 1) >33.6
Nominal battery 110/125:	60 - 80% DO/PU
(logic 0) <75.0	(logic 1) >88.0
Nominal battery 110/125:	50 - 70% DO/PU
(logic 0) <55.0	(logic 1) >77.0
Nominal battery 220/250:	60 - 80% DO/PU
(logic 0) <150.0	(logic 1) >176.0
Nominal battery 220/250:	50 - 70% DO/PU
(logic 0) <110	(logic 1) >154

Recognition time:

<2 ms with long filter removed.
<10 ms with half cycle ac immunity filter on.

5 OUTPUT CONTACTS

5.1 Standard Contacts

General purpose relay outputs for signaling, tripping and alarming:

Continuous Carry Ratings (Not Switched):

Maximum continuous current:	10 A (UL: 8 A)
Short duration withstand carry:	30 A for 3 s or 250A for 30ms
Rated voltage:	300 V

Make & Break Capacity:

DC:	50 W resistive	
DC:	62.5 W inductive	(L/R = 50 ms)
AC:	2500 VA resistive	(cos ϕ = unity)
AC:	2500 VA inductive	(cos ϕ = 0.7)

Make, Carry:

30 A for 3 secs, dc resistive, 10,000 operations (subject to the above limits of make/break capacity and rated voltage)

Make, Carry & Break:

30 A for 200 ms, ac resistive, 2,000 operations (subject to the above limits of make/break capacity & rated voltage)
4A for 1.5 secs, dc resistive, 10,000 operations (subject to the above limits of make/break capacity & rated voltage)
0.5 A for 1 sec, dc inductive, 10,000 operations (subject to the above limits of make/break capacity & rated voltage)
10 A for 1.5 secs, ac resistive/inductive, 10,000 operations (subject to the above limits of make/break capacity & rated voltage)

Durability:

Loaded contact:	10 000 operations minimum
Unloaded contact:	100 000 operations minimum
Operate Time	Less than 5 ms
Reset Time	Less than 5 ms

5.2 Watchdog Contacts

Non-programmable contacts for relay healthy or relay fail indication:

Breaking capacity: DC: 30 W resistive
DC: 15 W inductive (L/R = 40 ms)
AC: 375 VA inductive (cos ϕ = 0.7)

5.3 IRIG-B 12X Interface (Modulated)

External clock synchronization to IRIG standard 200-98, format B12x
Input impedance 6 kΩ at 1000 Hz
Modulation ratio: 3:1 to 6:1
Input signal, peak-peak: 200 mV to 20 V

5.4 IRIG-B 00X Interface (Un-modulated)

External clock synchronization to IRIG standard 200-98, format B00X.
Input signal TTL level
Input impedance at dc 10 kΩ

6 ENVIRONMENTAL CONDITIONS

6.1 Ambient Temperature Range

Per EN 60068-2-1 & EN / IEC 60068-2-2
Operating temperature range: -25°C to +55°C (or -13°F to +131°F)
Storage and transit: -25°C to +70°C (or -13°F to +158°F)

6.2 Ambient Humidity Range

Per EN /IEC 60068-2-78:
56 days at 93% relative humidity and +40 °C
Per EN / IEC 60068-2-14
5 cycles, -25°C to +55 °C
1°C / min rate of change
Per EN / IEC 60068-2-30
Damp heat cyclic, six (12 + 12) hour cycles, +25 to +55°C

6.3 Corrosive Environments

Per EN / IEC 60068-2-60, Part 2, Test Ke, Method (class) 3
Industrial corrosive environment/poor environmental control, mixed gas flow test.
21 days at 75% relative humidity and +30°C
Exposure to elevated concentrations of H_2S, (100 ppb), NO_2, (200 ppb) & Cl_2 (20 ppb).
Per EN / IEC 60068-2-52 Salt mist (7 days)
Per EN / IEC 60068-2-43 for H_2S (21 days), 15 ppm
Per EN / IEC 60068-2-42 for SO_2 (21 days), 25 ppm

7 TYPE TESTS

7.1 Insulation

Per EN / IEC 60255-27:
Insulation resistance > 100 MΩ at 500 Vdc
(Using only electronic/brushless insulation tester).

7.2 Creepage Distances and Clearances

Per EN / IEC 60255-27:
Pollution degree 3, Overvoltage category **III**,

7.3 High Voltage (Dielectric) Withstand

(EIA RS-232 ports excepted and normally-open contacts of output relays excepted).

(i) As for IEC 60255-27: 2005 (incorporating corrigendum March 2007):

2 kV rms AC, 1 minute:
Between all independent circuits.
Between independent circuits and case earth (ground).
1 kV rms AC for 1 minute, across open watchdog contacts.
1 kV rms AC for 1 minute, across open contacts of changeover output relays.
1 kV rms AC for 1 minute for all D-type EIA(RS)-232 or EIA(RS)-485 ports between the communications port terminals and protective (earth) conductor terminal.

(ii) As for ANSI/IEEE C37.90-1989 (reaffirmed 1994):

1.5 kV rms AC for 1 minute, across open contacts of normally open output relays.
1k V rms AC for 1 minute, across open watchdog contacts.
1k V rms AC for 1 minute, across open contacts of changeover output relays.

7.4 Impulse Voltage Withstand Test

Per IEC 60255-27: 2005
Front time: 1.2 µs, Time to half-value: 50 µs,
Peak value: 5 kV, 0.5 J
Between all terminals, and all terminals and case earth.

8 ELECTROMAGNETIC COMPATIBILITY (EMC)

8.1 1 MHz Burst High Frequency Disturbance Test

As for EN / IEC 60255-22-1, Class III,

Common-mode test voltage:	2.5 kV,
Differential test voltage:	1.0 kV,
Test duration:	2 s,
Source impedance:	200 Ω

(EIA(RS)-232 ports excepted).

8.2 100 kHz Damped Oscillatory Test

EN / IEC 61000-4-18:	Level 3
Common mode test voltage:	2.5 kV
Differential mode test voltage:	1 kV

8.3 Immunity to Electrostatic Discharge

Per IEC 60255-22-2: 1996, Class 4,
15 kV discharge in air to user interface, display, communication port and exposed metalwork.
8 kV point contact discharge to any part of the front of the product.

8.4 Electrical Fast Transient or Burst Requirements

Per IEC 60255-22-4: 2002 and EN 61000-4-4: 2004.

Test severity:	Class III and IV:
Amplitude:	2 kV, burst frequency 5kHz (Class III),
Amplitude:	4 kV, burst frequency 2.5kHz (Class IV). Applied directly to auxiliary supply, and applied to all other inputs. (EIA RS232 ports excepted).
Amplitude:	4 kV, burst frequency 5kHz (Class IV). Applied directly to auxiliary supply.

8.5 Surge Withstand Capability

As for IEEE/ANSI C37.90.1: 2002:
4 kV fast transient and 2.5 kV oscillatory applied directly across each output contact, optically isolated input, and power supply circuit.
4 kV fast transient and 2.5 kV oscillatory applied common mode to communications, IRIG-B.

8.6 Surge Immunity Test

EIA(RS)232 ports excepted.
Per IEC 61000-4-5: 2005 Level 4.

Time to half-value:	1.2/50 µs.
Amplitude:	4 kV between all groups and protective (earth) conductor terminal.
Amplitude:	2 kV between terminals of each group.

8.7 Conducted/Radiated Immunity

For RTDs used for tripping applications the conducted and radiated immunity performance is guaranteed only when using totally shielded RTD cables (twisted leads).

8.8 Immunity to Radiated Electromagnetic Energy

IEC 60255-22-3: 2000, Class III:

Test field strength, frequency band 80 to 1000 MHz:	10 V/m,
Test using AM:	1 kHz / 80%,
Spot tests at:	80, 160, 450, 900 MHz

IEEE/ANSI C37.90.2: 2004:

25MHz to 1000MHz, zero and 100% square wave modulated.
Field strength of 35V/m.

8.9 Radiated Immunity from Digital Communications

As for EN / IEC61000-4-3, Level 4:
Test field strength, frequency band 800 to 960 MHz,
and 1.4 to 2.0 GHz: 30 V/m, Test using AM: 1 kHz/80%.

8.10 Radiated Immunity from Digital Radio Telephones

As for EN / IEC 61000-4-3: 10 V/m, 900 MHz and 1.89 GHz.

8.11 Immunity to Conducted Disturbances Induced by Radio Frequency Fields

As for EN / IEC 61000-4-6, Level 3, Disturbing test voltage: 10 V.

8.12 Power Frequency Magnetic Field Immunity

As for EN / IEC 61000-4-8, Level 5,
100 A/m applied continuously, 1000 A/m applied for 3 s.
As for EN / IEC 61000-4-9, Level 5,
1000 A/m applied in all planes.
As for EN / IEC 61000-4-10, Level 5,
100 A/m applied in all planes at 100 kHz and 1 MHz with a burst duration of 2 s.

8.13 Conducted Emissions

EN 55022: 1998: Class A:

0.15 - 0.5 MHz, 79 dBμV (quasi peak) 66 dBμV (average)
0.5 – 30 MHz, 73 dBμV (quasi peak) 60 dBμV (average).

8.14 Radiated Emissions

EN 55022: 1998: Class A:

30 – 230 MHz, 40 dBμV/m at 10 m measurement distance
230 – 1 GHz, 47 dBμV/m at 10 m measurement distance.

9 EU DIRECTIVES

9.1 EMC Compliance

2004/108/EC:
Compliance to the European Commission Directive on EMC is demonstrated using a Technical File. Product Specific Standards were used to establish conformity:
EN 50263: 2000

9.2 Product Safety

Per 2006/95/EC:

Compliance to the European Commission Low Voltage Directive (LVD) is demonstrated using a Technical File. A product-specific standard was used to establish conformity.

EN 60255-27

9.3 R&TTE Compliance

Radio and Telecommunications Terminal Equipment (R&TTE) directive 99/5/EC.

Compliance demonstrated by compliance to both the EMC directive and the Low voltage directive, down to zero volts.

Applicable to rear communications ports.

9.4 ATEX Compliance

ATEX Potentially Explosive Atmospheres directive 94/9/EC, for equipment.
The equipment is compliant with Article 1(2) of European directive 94/9/EC.

It is approved for operation outside an ATEX hazardous area. It is however approved for connection to Increased Safety, “Ex e”, motors with rated ATEX protection, Equipment Category 2, to ensure their safe operation in gas Zones 1 and 2 hazardous areas.

II (2) G

Caution	**Equipment with this marking is not itself suitable for operation within a potentially explosive atmosphere.**

Compliance demonstrated by Notified Body certificates of compliance.

Note	*Programmable IDMT curves shall not be used for ATEX applications. ATEX marked models are only approved for use with a fixed IDMT curve.*

10 MECHANICAL ROBUSTNESS

10.1 Vibration Test

Per EN / IEC 60255-21-1	Response Class 2 Endurance Class 2

10.2 Shock and Bump

Per EN / IEC 60255-21-2	Shock response Class 2 Shock withstand Class 1 Bump Class 1

10.3 Seismic Test

Per EN / IEC 60255-21-3:	Class 2

11 THIRD PARTY COMPLIANCES

11.1 Underwriters Laboratory (UL)

File Number: E202519
(Complies with Canadian and US requirements).

Original Issue Date: 21-04-2005

11.2 Energy Networks Association (ENA)

Certificate Number: 104 Issue 2
Assessment Date: 16-04-2004

12 PROTECTION FUNCTIONS

12.1 Thermal Overload

Accuracy

Setting accuracy:	±5%
Reset:	97% of thermal setting ±5%
Thermal alarm Pick-up:	Calculated trip time ±5% or 40 ms whichever is greater
Thermal overload Pick-up:	Calculated trip time ±5% or 40 ms whichever is greater
Cooling time accuracy:	±5% of theoretical Repeatability: <2.5%

12.2 4-Stage Non-Directional Short-Circuit Protection

Accuracy

Pick-up:	Setting ±5%
Drop-off:	0.95 x Setting ±5%
Minimum trip level (IDMT):	1.05 x Setting ±5%
IDMT characteristic shape:	±5% or 40 ms whichever is greater*
IEEE reset:	±5% or 50 ms whichever is greater
DT operation:	±2% or 50 ms whichever is greater
DT Reset:	±5%
Characteristic UK:	IEC 6025-3…1998
Characteristic US:	IEEE C37.112…1996

* Under reference conditions

12.3 Sensitive Directional Earth Fault

12.3.1 SEF

Accuracy

Pick-up:	Setting ±5%
Drop-off:	0.95 x Setting ±5%
IDMT trip level elements:	1.05 x Setting ±5%
IDMT characteristic shape:	±5% or 40 ms whichever is greater
IEEE reset:	±5% or 40 ms whichever is greater
DT operation:	±2% or 40 ms whichever is greater
DT reset:	±5%
Repeatability:	<2.5%

12.3.2 Wattmetric SEF

Accuracy

P = 0W Pick-up:	PO> ±5%
P > 0W Pick-up:	P> ±5%
P = 0W Drop-off:	(0.95 x ISEF>) ±5%
P > 0W Drop-off:	0.9 x P> ±5%
Boundary accuracy:	±5% with 1° hysteresis
Repeatability:	<2.5%

12.3.3 Polarizing Quantities

Accuracy

Operating boundary Pick-up:	±2° of RCA ±90°
Hysteresis:	<3°
ISEF>Vnpol Pick-up:	Setting ±10%
ISEF>Vnpol Drop-off:	0.9 x Setting or 0.7V (whichever is greater) ±10%

12.4 2-Stage Negative Phase Sequence Overcurrent

Accuracy

I2>Pick-up:	Setting ±5%
I2> Drop-off:	0.95 x Setting ±5%
Vpol Pick-up:	Setting ±5%
Vpol Drop-off:	0.95 x Setting ±5%
DT operation:	±2% or 40 ms whichever is greater
IDMT operation:	±5% or 40 ms whichever is greater

12.5 3-Phase Voltage Check

Accuracy

I2>Pick-up:	Setting ±5%
I2> Drop-off:	0.95 x Setting ±5%
Vpol Pick-up:	Setting ±5%
Vpol Drop-off:	0.95 x Setting ±5%
DT operation:	±2% or 40 ms whichever is greater
IDMT operation:	±5% or 40 ms whichever is greater

12.6 2-Stage Directional/Non-Directional Derived Earth Fault

Accuracy

Pick-up:	Setting ±5%
Drop-off:	0.95 x Setting ±5%
IDMT trip level elements:	1.05 x Setting ±5%
IDMT characteristic shape:	±5% or 40 ms whichever is greater
IEEE reset:	±5% or 40 ms whichever is greater
DT operation:	±2% or 40 ms whichever is greater
DT reset:	±5%
Repeatability:	2.5%

Zero Polarizing

Operating pick-up:	±2%º of RCA ±90%
Hysteresis:	<3º
VN > Pick-up:	Setting ±10%
VN > Drop-off:	0.9 x Setting ±10%

Negative Polarizing

Operating Pick-up:	±2% of RCA ±90%
Hysteresis:	<3º
V2 > Pick-up:	Setting ±10%
V2 > Drop-off:	0.9 x Setting ±10%
I2 > Pick up:	Setting ±10%
I2 > Drop-off:	0.9 x Setting ±10%

12.7 Stall Protection

Pick-up: Setting ±5%

12.8 Timer

Accuracy

Timers: ±2% or 40 ms whichever is greater
Reset time: <30 ms

12.9 Motor Differential Protection

Accuracy

Pick-up: Formula ±5%
Drop-off: 95% of setting ±5%
Operating time: <30 ms for currents applied at 4x pickup level or greater
Repeatability: <7.5%
Disengagement time: <40 ms

12.10 Neutral Displacement/Residual Overvoltage

Accuracy

DT/IDMT Pick-up: Setting ±5%
Drop-off: 0.95 x Setting ±5%
IDMT characteristic shape: ±5% or 40 ms whichever is greater
DT operation: ±2% 40 ms whichever is greater
Instantaneous operation: <55 ms
Reset: <35 ms
Repeatability: <1%

12.11 Loss of Load

Accuracy

Pick-up: Setting ±5% or 2 W
Drop-off: 0.95 of setting ±5%
Angle variation Pick-up: Expected pick-up angle ±2 degree
Angle variation Drop-off: Expected drop-off angle ±2.5 degree
Operating time: ±2% or 40 ms whichever is greater
Repeatability: <5%
Disengagement time: <50 ms
tRESET: ±5%
Instantaneous operating time: <50 ms

12.12 Out of Step

Pick-up: Setting ±5%
DT operation: ±2% or 40 ms whichever is greater

12.13 Reverse Power

Accuracy

Pick-up:	Setting ±5% or 2 W
Drop-off:	0.95 of setting ±5%
Angle variation Pick-up:	Expected pick-up angle ±2 degree
Angle variation Drop-off:	Expected drop-off angle ±2.5 degree
Operating time:	±2% or 40 ms whichever is greater
Repeatability:	<5%
Disengagement time:	<50 ms
tRESET:	±5%
Instantaneous operating time:	<50 ms

12.14 Anti-Backspin

Pick-up:	Setting ±5%
DT operation:	±2% or 40 ms whichever is greater
Repeatability:	<1%

12.15 Field Failure

Accuracy

Mho characteristic Pick-up:	Characteristic shape ±5%
Linear characteristic Pick-up:	Characteristic shape ±10%
Mho characteristic Drop-off:	105% of setting ±5%
Linear characteristic Drop-off:	105% of setting ±10%
Operating time:	±2% or 60 ms whichever is greater
Repeatability:	<1%
Disengagement time:	<50 ms

13 SUPERVISION FUNCTIONS

13.1 Voltage Transformer Supervision (VTS) (Fuse Failure)

Accuracy

Fast block operation:	<25 ms
Fast block reset:	<30 ms
Time delay: Setting	±2% or 20 ms whichever is greater

13.2 Current Transformer Supervision (CTS)

Accuracy

IN > Pick-up:	Setting ±5%
VN < Pick-up:	Setting ±5%
IN > Drop-off:	0.9 x Setting ±5%
VN < Drop-off:	(1.05 x Setting) ±5% or 1 V whichever is greater
CTS block operation:	< 1 cycle
CTS reset:	< 35 ms

13.3 Analogue Input (Current Loop Input)

CLIO Inputs

Range 1: Disabled / 0 - 1 mA / 0 - 10 mA / 0 - 20 mA / 4 - 20 mA

Unit 1:

Unit	Range
None	-32.5 k...50 k
A	0...100 k
V	0...20 k
Hz	0...100
W	-1.41 G...1.41 G
Var	-1.41 G...1.41 G
VA	0...1.41 G
°C	-40...400
F	-40...752
%	0...150
s	0...300

Minimum 1:	As above for unit range
Maximum 1:	As above for unit range
Function 1:	Disabled/Enabled
Alarm Set 1:	As above for unit range
Alarm Delay 1:	0…300 s
Trip Set 1:	As above for unit range
Trip Delay 1:	0…300 s
Drop-off Time:	0.1…300

CLI2/3/4 as CLI1

13.4 Analogue Output (Current Loop Output)

CLIO Outputs

Range 1: 0 - 1 mA / 0 - 10 mA / 0 - 20 mA / 4 - 20 mA
ANALOG OUTPUT 1: As shown below*
Minimum 1: Range, step size and unit corresponds to the selected parameter
Maximum 1: Same as Minimum 1
ANALOG OUTPUT2/3/4 as ANALOG OUTPUT1
ANALOG Output Parameters

Current Magnitude: IA Magnitude / IB Magnitude / IC Magnitude / IN Measured Mag
0.00…100 kA
Phase Currents: IA RMS / IB RMS / IC RMS / In RMS
0.00…100 kA
P-N Voltage Magnitude: VAN Magnitude / VBN Magnitude / VCN Magnitude
0.0…20 kV
RMS Phase P-N Voltages: VAN RMS / VBN RMS / VCN RMS
0.0…20 kV
P-P Voltage Magnitude: VAB Magnitude / VBC Magnitude / VCA Magnitude
0.0…20 kV
RMS Phase P-P Voltages: VAB RMS / VBC RMS / VCA RMS
0.0…20 kV

Frequency: 0.00…100.0 Hz
3 Phase Watts: -10 MW…10 MW
3 Phase Vars: -10 MVar…10 MVar
3 Phase VA: -10 MVA…10 MVA
3Ph Power Factor: -1…1
RTD 1-10: -40°C…400.0°C
Number of Hottest RTD: 1..10
Thermal State: 0-150
Time to Thermal Trip: 0…300 s
Time to Next Start: 0…300 s

13.5 Plant Supervision

13.6 CB State Monitoring Control and Condition Monitoring

Accuracy

Timers: ±2% or 20 ms whichever is greater
Broken current accuracy: ±5%

13.7 IEC 61850 Ethernet Data

Transmitter Optical Characteristics – 100 base FX interface

(T_A = 0°C to 70°C, V_{CC} = 4.75 V to 5.25 V)

Parameter	Sym	Min.	Typ.	Max	Unit
Output Optical Power BOL: 62.5/125 µm, NA = 0.275 Fiber EOL	P_{OUT}	–19 –20	–16.8	–14	dBm avg.
Output Optical Power BOL: 50/125 µm, NA = 0.20 Fiber EOL	P_{OUT}	–22.5 –23.5	–20.3	–14	dBm avg.
Optical Extinction Ratio				10 –10	% dB
Output Optical Power at Logic “0” State	P_{OUT} (“0”)			–45	dBm avg.
BOL – Beginning of life EOL – End of life					

Transmitter Optical Characteristics – 100 base FX interface

Receiver Optical Characteristics – 100 base FX interface
(T_A = 0°C to 70°C, V_{CC} = 4.75 V to 5.25 V)

Parameter	Sym	Min.	Typ.	Max.	Unit
Input Optical Power Minimum at Window Edge	P_{IN} Min. (W)		–33.5	–31	dBm avg.
Input Optical Power Minimum at Eye Center	P_{IN} Min. (C)		–34.5	–31.8	dBm avg.
Input Optical Power Maximum	P_{IN} Max.	–14	–11.8		dBm avg.

Receiver Optical Characteristics – 100 base FX interface

Note	The 10BaseFL connection will no longer be supported as IEC 61850 does not specify this interface

14 PROGRAMMABLE SCHEME LOGIC

Output conditioner timer:	Setting ±2% or 50 ms whichever is greater
Dwell conditioner timer:	Setting ±2% or 50 ms whichever is greater
Pulse conditioner timer:	Setting ±2% or 50 ms whichever is greater

15 VOLTAGE PROTECTION

15.1 Undervoltage

Accuracy

DT Pick-up:	Setting ±5%
IDMT Pick-up:	(0.95 x Setting) ±5%
Drop-off:	1.05 x Setting ±5%
IDMT characteristic shape:	±5% or 40 ms whichever is greater
DT operation:	±2% or 20 ms whichever is greater
Reset:	<75 ms
Repeatability:	<1%

15.2 Overvoltage

Accuracy

DT Pick-up:	Setting ±5%
IDMT Pick-up:	Setting ±5%
Drop-off:	0.95 x Setting ±5%
IDMT characteristic shape:	±5% or 40 ms whichever is greater
DT operation:	±2% or 20 ms whichever is greater
Reset:	<75 ms
Repeatability:	<1%

15.3 Underfrequency

Accuracy

Pick-up:	Setting ±0.01 Hz
Drop-off:	(Setting +0.025 Hz) ±0.01 Hz
DT operation:	±2% or 40 ms whichever is greater*

* The operating time will also include a time for the relay to frequency track (20 Hz/second)

15.4 Resistive Temperature Detectors (RTDs)

Accuracy

Pick-up:	Setting ±1°C
Drop-off:	(Setting -1°C)
Operating time:	±2% or <1.1 s

15.5 CB Fail

15.5.1 Timer

Accuracy

Timers:	±2% or 40 ms whichever is greater
Reset time:	<30 ms

15.6 Undercurrent

Accuracy

Pick-up:	±10% or 25 mA whichever is greater
Operating time:	< 12 ms (Typical <10 ms)
Reset:	< 15 ms (Typical < 10 ms)

15.7 CB State Monitoring Control and Condition Monitoring

Accuracy

Timers:	±2% or 20 ms whichever is greater
Broken current accuracy:	±5%

15.8 Programmable Scheme Logic (PSL)

Output conditioner timer:	Setting ±2% or 50 ms whichever is greater
Dwell conditioner timer:	Setting ±2% or 50 ms whichever is greater
Pulse conditioner timer:	Setting ±2% or 50 ms whichever is greater

16 MEASUREMENTS AND RECORDING FACILITIES

16.1 Measurements

Current:	0.05… 3 In
Accuracy:	±1.0% of reading
Voltage:	0.05…2 Vn
Accuracy:	±1.0% of reading
Power (W):	0.2…2 Vn 0.05…3 In
Accuracy:	±5.0% of reading at unity power factor
Reactive Power (Vars):	0.2…2 Vn, 0.05…3 In
Accuracy:	±5.0% of reading at zero power factor
Apparent Power (VA):	0.2…2 Vn 0.05…3 In
Accuracy:	±5% of reading
Energy (Wh):	0.2…2 Vn 0.2…3 In
Accuracy:	±5% of reading at zero power factor
Energy (Varh):	0.2…2 Vn 0.2…3 In
Accuracy:	±5% of reading at zero power factor
Phase accuracy:	0°…360°
Accuracy:	±0.5°
Frequency:	45…65 Hz
Accuracy:	±0.025 Hz

16.2 IRIG-B and Real Time Clock

Performance

Year 2000:	Compliant
Real time accuracy:	< ±1 second / day
External clock synchronisation:	Conforms to IRIG standard 200-98, format B

Features

Real time 24 hour clock settable in hours, minutes and seconds
Calendar settable from January 1994 to December 2092
Clock and calendar maintained via battery after loss of auxiliary supply
Internal clock synchronization using IRIG-B Interface for IRIG-B signal is BNC

16.3 Current Loop Input and Outputs

Accuracy

Current loop input accuracy:	±1% of full scale
CLI drop-off threshold:	0.95 x setting ±5% of full scale
CLI sampling interval:	50 ms
CLI instantaneous operating time:	< 250 ms
CLI DT operating time:	±2% setting or 200 ms whichever is the greater
CLO conversion interval:	50 ms
CLO latency:	< 0.27 s depending on CLO output parameter's internal refresh rate - (0.2 s)
Current loop output accuracy:	±0.5% of full scale
Repeatability:	<5%

CLI - Current Loop Input (Analog Input)
CLO - Current Loop Output (Analog Output)

16.3.1 Other Specifications

CLI load resistance 0-1 mA: < 4 kΩ
CLI load resistance 0-1 mA/0-20 mA/4 20 mA: <300 Ω
Isolation between common input channels: zero
Isolation between input channels and case earth/other circuits: 2 kV rms for 1 minute
CLO compliance voltage 0-1 mA/0 10 mA: 10 V
CLO compliance voltage 0-20 mA/4 20 mA: 8.8 V
Isolation between common output channels: zero
Isolation between output channels and case earth/other circuits: 2 kV rms for 1 minute

16.4 Disturbance Records

Accuracy

Magnitude and relative phases: ±5% of applied quantities
Duration: ±2%
Trigger Position: ±2% (minimum 100ms)
Record length: 50 records each 1.5 s duration (75 s total memory) with 8 analog channels and 32 digital channels (Courier, MODBUS), 8 records each 3 s (50 Hz) or 2.5 s (60 Hz) duration (IEC 60870-5-103).

16.5 Event, Fault & Maintenance Records

Maximum 512 events in a cyclic memory
Maximum 5 fault records
Maximum 10 maintenance records
Accuracy
Event time stamp resolution: 1 ms

17 SETTINGS, MEASUREMENTS AND RECORDS LIST

17.1 Settings List

Global Settings (System Data)

Language:	English/French/German/Spanish
Frequency:	50/60 Hz
IEC61850 Edition	Edition1 or Edition 2
ETH COMM Mode	Dual IP, PRP or HSR

17.2 Circuit Breaker Control (CB Control)

CB Control by:	Disabled / Local / Remote / Local + Remote / Opto / Opto + Local / Opto + Remote / Opto + Rem + Local
Close Pulse Time:	0.1…5 sec
Trip Pulse Time:	0.1…5 sec
Man Close Delay:	0.0…60 sec

17.3 Date and Time

IRIG-B Sync:	Disabled/Enabled
Battery Alarm:	Disabled/Enabled

17.4 Configuration

Setting Group:	Select via Menu or Select via Optos
Active Settings:	Group 1/2
Setting Group 1:	Disabled/Enabled
Setting Group 2:	Disabled/Enabled
Thermal Overload:	Disabled/Enabled
Short Circuit:	Disabled/Enabled
Sensitive E/F:	Disabled/Enabled
Neg. Seq. O/C:	Disabled/Enabled
3PH Volt Check:	Disabled/Enabled
Derived E/F:	Disabled/Enabled
Stall Detection:	Disabled/Enabled
Differential:	Disabled/Enabled
Residual O/V NVD:	Disabled/Enabled
Limit Nb Starts:	Disabled/Enabled
Loss of Load:	Disabled/Enabled
Out of Step:	Disabled/Enabled
Reverse Power:	Disabled/Enabled
Anti-Backspin:	Disabled/Enabled
Field Failure:	Disabled/Enabled
Volt Protection:	Disabled/Enabled
Under Frequency:	Disabled/Enabled
RTD Inputs:	Disabled/Enabled
CB Fail:	Disabled/Enabled
Supervision	Disabled/Enabled
System Config:	Invisible/Visible
Input Labels:	Invisible/Visible
Output Labels:	Invisible/Visible
RTD Labels:	Invisible/Visible
CT & VT Ratios:	Invisible/Visible

Record Control	Invisible/Visible
Disturb Recorder:	Invisible/Visible
Measure't Setup:	Invisible/Visible
Comms Settings:	Invisible/Visible
Commission Tests:	Invisible/Visible
Setting Values:	Primary/Secondary
Control Inputs:	Invisible/Visible
CLIO Inputs:	Disabled/Enabled (does not apply to P44y, P54x or P841)
CLIO Outputs:	Disabled/Enabled (does not apply to P44y, P54x or P841)
Ctrl I/P Config:	Invisible/Visible
Ctrl I/P Labels:	Invisible/Visible
Direct Access:	Disabled/Enabled/Hotkey
IEC GOOSE:	Invisible/Visible (does not apply to P44y, P54x or P841)
Function Keys:	Invisible/Visible
LCD Contrast:	0…31

17.5 CT and VT Ratios

Main VT Primary:	100...1000000 V
Main VT Sec'y:	80...140 V
Phase CT Primary:	1A…30 kA
Phase CT Sec'y:	1A/5 A
SEF CT Primary:	1A…30 kA
SEF CT Sec'y:	1A/5 A
VT Connecting Mode:	3 VT / 2 VT + Residual / 2 VT + Vremanent (Vremanent phase-phase)
NVD VT Primary	100...1000000V
NVD VT Secondary	80...140 V

17.6 Sequence of Event Recorder (Record Control)

Alarm Event:	No/Yes
Relay O/P Event:	No/Yes
Opto Input Event:	No/Yes
General Event:	No/Yes
Fault Rec Event:	No/Yes
Maint Rec Event:	No/Yes
Protection Event:	No/Yes
Flt Rec Extended:	Disabled/Enabled (where available)
DDB 31 - 0:	(up to):
DDB 1022 - 992:	Binary function link strings, selecting which DDB signals will be

stored as events, and which will be filtered out.

17.7 Oscillography (Disturbance Recorder)

Duration:	0.10…10.50 s
Trigger Position:	0.0…100.0%
Trigger Mode:	Single/Extended
Analog Channel 1:	(up to):
Analog Channel 8	(depending on model):

Disturbance channels selected from: VA/VB/VC/IA/IB/IC/IA-2/IB-2/IC-2/IN/ VAB/VCB/VN/VRM (*depending on model*)

Digital Input 1: (up to):
Digital Input 32:
Selected binary channel assignment from any DDB status point within the relay (opto input, output contact, alarms, starts, trips, controls, logic…).
Input 1 Trigger: No Trigger/Trigger Edge -/+ (Low to High)/Trigger Edge +/- (High to Low) (up to):
Input 32 Trigger: No Trigger/Trigger Edge -/+ / Trigger Edge +/-

17.8 Measured Operating Data (Measure't Setup)

Default Display:	3Ph + N Current / 3Ph Voltage / Power / Date and Time / Description / Plant Reference / Frequency / Thermal State
Local Values:	Primary/Secondary
Remote Values:	Primary/Secondary
Measurement Ref:	VA/VB/VC/IA/IB/IC
Demand Interval:	1…99 mins
Alarm Fix Demand:	Invisible/Visible
3 Phase Watt Thresh:	1 In……120 In W
3 Phase Var Thresh:	1 In……120 In VAr
Alarm Energies:	Invisible/Visible
W Fwd Thresh:	1 In……1000 In Wh
W Rev Thresh:	1 In……1000 In Wh
Var Fwd Thresh:	1 In……1000 In VArh
Var Rev Thresh:	1 In……1000 In VArh
Motor Hour Run >1:	Disable/Enable
Motor Hour Run >1:	1…9999 Hours
Motor Hour Run >2:	Disable/Enable
Motor Hour Run >2:	1…9999 Hours
Remote 2 Values:	Primary/Secondary

17.9 Communications

RP1 Protocol:	Courier / IEC60870-5-103 / Modbus	
RP1 Address:	(Courier or IEC870-5-103):	0…255
RP1 Address:	(MODBUS):	1…247
RP1 InactivTimer:	1…30mins	
RP1 Baud Rate:	(IEC 870-5-103):	9600/19200 bits/s
RP1 Baud Rate:	(MODBUS, Courier):	9600/19200/38400 bits/s
RP1 Parity:	Odd/Even/None (MODBUS)	
RP1 Meas Period:	1…60s (IEC870-5-103)	
RP1 PhysicalLink:	Copper (EIA(RS)485/K bus) or Fiber Optic	
RP1 Time Sync:	Disabled/Enabled	
MODBUS IEC Timer:	Standard/Reverse	
RP1 CS103Blocking:	Disabled / Monitor Blocking / Command Blocking	
RP1 Port Config:	(Courier): K Bus / EIA485 (RS485)	
RP1 Comms Mode:	(Courier): IEC 60870 FT1.2 / IEC 60870 10-Bit No parity	

> *Note* *If RP1 Port Config is K Bus the baudrate is fixed at 64 kbits/s*

MAC Addr 1:	This is set during manufacturing process as the MAC Address for Interface 1
MAC Addr 2:	This is set during manufacturing process as the MAC Address for Interface 2
Redundancy Conf:	The redundant agency device configuration is used for the SNMP server.
MAC Address:	Set during manufacturing process as the MAC address 3 for redundant agency device .
IP Address:	A default IP address is 169.254.2.zzz, zzz = mod (The last byte of MAC3, 128) + 1.
Subnet Mask:	0.0.0.0
Gateway:	0.0.0.0

17.10 Optional Additional Second Rear Communication (Rear Port2 (RP2))

RP2 Protocol: Courier (fixed)
RP2 Port Config: Courier over EIA(RS)232 / Courier over EIA(RS)485 / K-Bus
RP2 Comms. Mode: IEC60870 FT1.2 Frame / 10-Bit NoParity
RP2 Address: 0…255
RP2 InactivTimer: 1…30 mins
RP2 Baud Rate: 9600 / 19200 / 38400 bits/s

Note	*If RP2 Port Config is K Bus the baud rate is fixed at 64 kbits/s*

17.11 Optional Ethernet Port

NIC Tunl Timeout: 1...30 mins
NIC Link Report: Alarm/Event/None
NIC Link Timeout: 0.1...60 s

17.12 Commission Tests

Monitor bit 1: (up to): Monitor bit 8: Binary function link strings, selecting which DDB signals have their status visible in the Commissioning menu, for test purposes
Test Mode: Disabled Test Mode Blocked Contacts
Test Pattern: Configuration of which output contacts are to be energized when the contact test is applied
Static Test Mode: Disabled/Enabled

17.13 Circuit Breaker Condition Monitoring (CB Monitor Setup)

Broken I^: 1.0…2.0
I^ Maintenance: Alarm Disabled/Enabled
I^ Maintenance: 1…25000
No. CB Ops Maint: Alarm Disabled/Enabled
No. CB Ops Maint: 1…10000
CB Time Maint: Alarm Disabled/Enabled
CB Time Maint: 0.005…0.500 s

17.14 Opto Coupled Binary Inputs (Opto Config)

Global Nominal V: 24 – 27 V / 30 – 34 V / 48 – 54 V / 110 – 125 V / 220 – 250 V

Custom Opto Input 1: (up to):

Opto Input #. (# = max. opto no. fitted):

Custom options allow independent thresholds to be set for each opto, from the same range as above.

Opto Filter Control: Binary function link string, selecting which optos have an extra 1/2 cycle noise filter, and which do not.

Characteristics: Standard 60% - 80% / 50% - 70%

Time stamping accuracy: ±1 msec

17.15 Control Inputs into PSL (Ctrl. I/P Config.)

Hotkey Enabled: Binary function link string, selecting which of the control inputs are driven from Hotkeys.
Control Input 1 (up to): Control Input 32: Latched/Pulsed
Ctrl Command 1 (up to): Ctrl Command 32: On/Off / Set/Reset / In/Out / Enabled/Disabled

17.16 Function Keys

Fn. Key Status 1 (up to) 10:	Disable / Lock / Unlock / Enable
Fn. Key 1 Mode (up to) 10:	Toggled/Normal
Fn. Key 1 Label (up to) 10:	User defined text string to describe the function of the particular function key.

17.17 IED Configurator

Switch Conf. Bank:	No Action/Switch Banks
IP Address 1	0.0.0.0. The default IP address is encoded from the MAC address. 169.254.0.xxx, xxx = mod (The last byte of MAC1, 128) + 1.
Subnet Mask 1	255.255.255.0
Gateway 1	169.254.0.250
IP Address 2	0.0.0.0. The default IP address is encoded from the MAC address. 169.254.1.yyy, yyy = mod (The last byte of MAC2, 128) + 1.
Subnet Mask 2	255.255.255.0
Gateway 2	169.254.1.250

17.18 IEC 61850 GOOSE

GoEna:	0x0000000000000000(bin)... 0x1111111111111111(bin)
Pub.Simul.Goose:	0x0000000000000000(bin)... 0x1111111111111111(bin)
Sub.Simul.Goose:	No/Yes

17.19 Control Input User Labels (Ctrl. I/P labels)

Control Input 1:	User defined text string
(up to):	to describe the function
Control Input 32:	of the particular control input

18 SETTINGS IN MULTIPLE GROUPS

Note	*All settings here onwards apply for setting groups # = 1 to 2.*

19 PROTECTION FUNCTIONS (IN MULTIPLE GROUPS)

Note	*All settings here onwards apply for setting groups # = 1 to 2.*

19.1 System Config.

Phase Sequence: Standard ABC / Reverse ACB

19.2 Thermal

Ith Current Set:	0.2 In…1.5 In
K Coefficient:	0…10
Thermal Const T1:	1min…180min
Thermal Const T2:	1min…360min
Thermal Const Tr:	1min…999min
Thermal Trip:	Disabled/Enabled
Thermal Alarm:	Disabled/Enabled
Alarm Threshold:	0.2%…100%
Thermal Lockout:	Disabled/Enabled
Lockout Thresh:	0.2…100%
Inh Trip Dur St:	Disabled/Enabled

19.3 4-Stage Non-Directional Short Circuit Protection

Phase O/C: Sub Heading

I>1 Function: Disabled / DT / IEC S Inverse / IEC V Inverse / IEC E Inverse / UK LT Inverse / UK Rectifier / RI / IEEE M Inverse / IEEE V Inverse / IEEE E Inverse / US Inverse / US ST Inverse

I>1 Current Set:	0.2…15 In
I>1 Time Delay:	0.040…100.00 s
I>1 TMS:	0.025…1.200
I>1 Time Dial:	0.01…100.00
I>1 K (RI):	0.10…10.00
I>1 Reset Char:	DT/Inverse
I>1 tRESET:	0.00…100.00 s
I>2 as I>1	
I>3 Status:	Disabled/Enabled
I>3 Current Set:	0.20…15.00 In
I>3 Time Delay:	0.040…100.00 s
I>4 as I>3	

19.4 IDMT Curves

Inverse Time (IDMT) Characteristic

IDMT characteristics are selectable from a choice of four IEC/UK and five IEEE/US curves as shown in the table below.

The IEC/UK IDMT curves conform to the following formula:

$$t = T \times \left(\frac{K}{(I/Is)^{\alpha} - 1} + L \right)$$

The IEEE/US IDMT curves conform to the following formula:

$$t = TD \times \left(\frac{K}{(I/Is)^{\alpha} - 1} + L \right)$$

Where:

	t	= Operation time
	K	= Constant
	I	= Measured current
	Is	= Current threshold setting
	α	= Constant
	L	= ANSI/IEEE constant (zero for IEC/UK curves)
	T	= Time Multiplier Setting for IEC/UK curves
	TD	= Time Dial Setting for IEEE/US curves

19.5 IDMT Characteristics

IDMT Curve description	Standard	K Constant	α Constant	L Constant
Standard Inverse	IEC	0.14	0.02	0
Very Inverse	IEC	13.5	1	0
Extremely Inverse	IEC	80	2	0
Long Time Inverse	UK	120	1	0
Rectifier	UK	45900	5.6	0
Moderately Inverse	IEEE	0.0515	0.02	0.114
Very Inverse	IEEE	19.61	2	0.491
Extremely Inverse	IEEE	28.2	2	0.1217
Inverse	US-C08	5.95	2	0.18
Short Time Inverse	US-C02	0.16758	0.02	0.11858

The IEC extremely inverse curve becomes definite time at currents greater than 20 x setting. The IEC standard, very and long time inverse curves become definite time at currents greater than 30 x setting. The rectifier curve becomes definite time at currents greater than 8 x settings.

The definite time part of the IEC inverse time characteristics at currents greater than 20x and 30x setting are only relevant for currents in the operating range of the relay. The operating range of the P241/P242/P243 current inputs is 0 - 64In for the standard current inputs and is 0 - 2In for the sensitive current input.

The RI curve (electromechanical) has been included in the first and second stage characteristic setting options for Phase Overcurrent and both Earth Fault (i.e. Earth Fault 1 and Earth Fault 2 where available) protections. The curve is represented by the following equation (where t is in seconds and K is adjustable from 0.1 to 10 in steps of 0.05).

$$t = K \times \left(\frac{1}{0.339 - \left(0.236 / M\right)} \right) \text{ in seconds}$$

M = I/Is

For all IEC/UK curves, the reset characteristic is definite time only.

For all IEEE/US curves, the reset characteristic can be selected as either inverse curve or definite time.

The definite time can be set (as defined in IEC) to zero. Range 0 to 100 seconds in steps of 0.01 seconds.

The Inverse Reset characteristics are dependent upon the selected IEEE/US IDMT curve as shown in the table below.

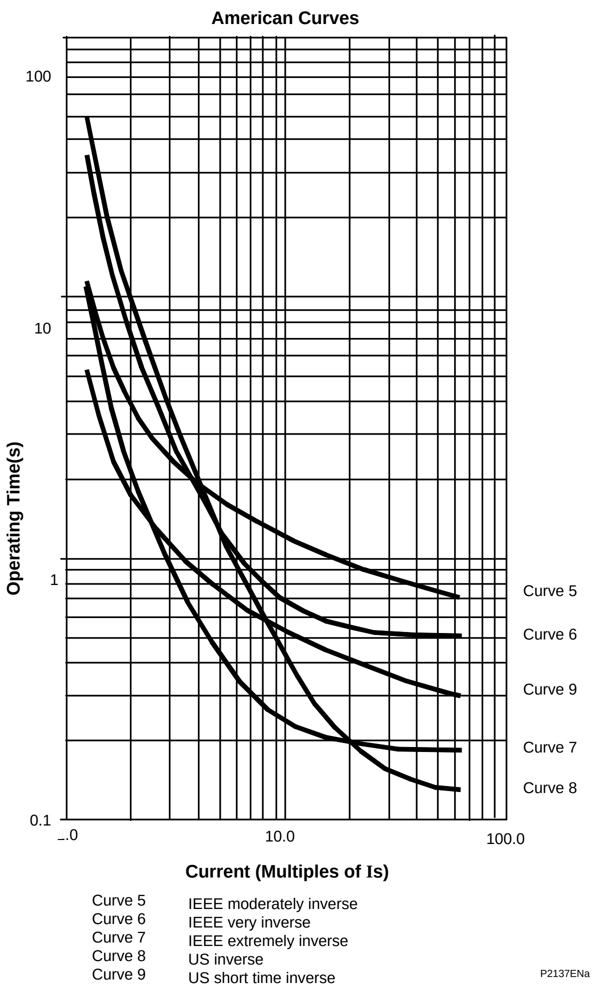
All inverse reset curves conform to the following formula:

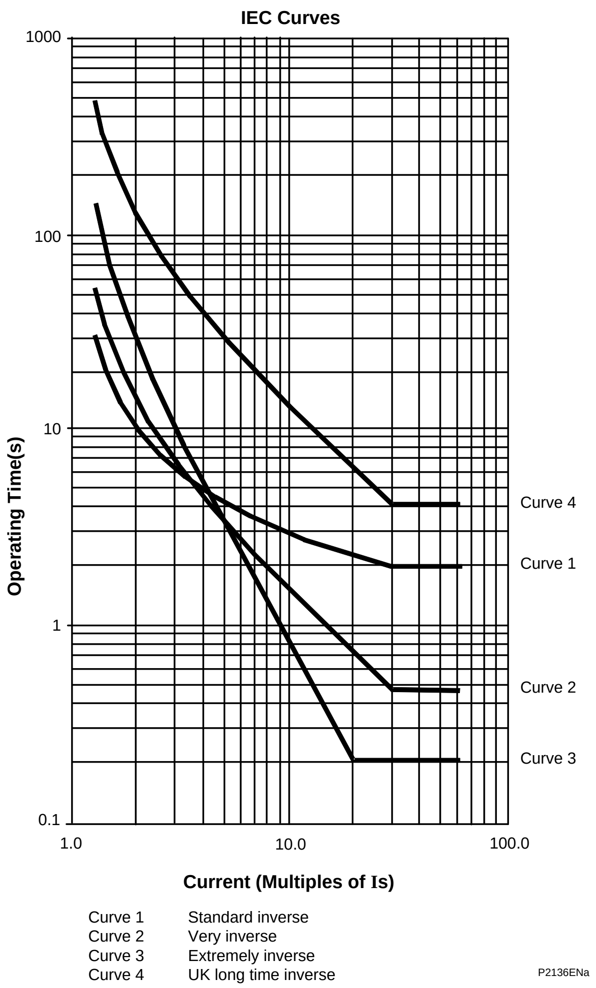
$$tRESET = \frac{TD \times S}{(1 - M^2)} \text{ in seconds}$$

Where:

TD = Time dial setting for IEEE curves
S = Constant
M = I/Is

Curve description	Standard	S
Moderately inverse	IEEE	4.85
Very inverse	IEEE	21.6
Extremely inverse	IEEE	29.1
Inverse	US	5.95
Short time inverse	US	2.261





19.6 Earth Fault

ISEF>1 Function: Disabled / DT / IEC S Inverse / IEC V Inverse / IEC E Inverse / UK LT Inverse / UK Rectifier / IEEE M Inverse / IEEE V Inverse / IEEE E Inverse / US Inverse / US ST Inverse
ISEF>1 Direction: Non-Directional / Directional Fwd
ISEF>1 Current: 0.005In…1In
ISEF>1 T Delay: 0.04…200.0 s
ISEF>1 TMS: 0.025…1.2
ISEF>1 Time Dial: 0.5…15
ISEF>1 Reset Chr: DT/Inverse
ISEF>1 tReset: 0…100 s
ISEF>2 Function: Disabled/Enabled
ISEF>2 Direction: Non-Directional/Directional Fwd
ISEF>2 Current Set: 0.005In…1In
ISEF>2 T Delay: 0.04…200 s
ISEF> Char Angle: -180°…+180°
ISEF> VN Pol Set: 0.5…25 V

19.7 Earth Fault Wattmetric

PO> Function: Disabled/Enabled
PO> Current Set: 0.005 In…1 In
PO> Voltage Set: 0.5…80 V
PO> Coeff K Set: 1…10
PO> Char Angle: -180°…+180°
PO> Time Delay: 0.04…100 s

19.8 Negative Sequence Overcurrent

I2>1 Status: Disabled/DT
I2>1 Current Set: 0.05…0.8 In
I2>1 Time Delay: 0.04…200 s
I2>2 Status: Disabled/IMDT
I2>2 Current Set: 0.05…0.8 In
I2>2 TMS: 0.07…2

19.9 3-Phase Voltage Check

Start Low V Set: 0.1 Vn…1.0 Vn

19.10 Derived Earth Fault

IN>1 Function:	Disabled / DT / IEC S Inverse / IEC V Inverse / IEC E Inverse / UK LT Inverse / UK Rectifier / IEEE M Inverse / IEEE V Inverse / IEEE E Inverse / US Inverse / US ST Inverse
IN>1 Direction:	Non-Directional / Directional Fwd
IN>1 Current Set:	0.08In…32 In
IN>1 T Delay:	0.04…100 s
IN>1 TMS:	0.025…1.2
IN>1 Time Dial:	0.5…15
IN>1 Reset Chr:	DT/Inverse
IN>1 tReset:	0…100 s
IN>2 Function:	Disabled/DT
IN>2 Direction:	Non-Directional / Directional Fwd
IN>2 Current:	0.08 In…32 In
IN>2 T Delay:	0.04…100 s
IN> Char Angle:	-180°…+180°
IN> Type Pol Type:	Zero Sequence / Neg Sequence
IN> VN Pol Set:	0.5…25 V
IN> V2pol Set:	0.5…25 V
IN2> I2pol Set:	0.002 In…0.8 In

19.11 Stall Detection

Prolonged Start:	Disabled/Enabled
Start Criteria:	52a or I or 52a + I
Starting Current:	1*Ith…5*Ith
Prol Start time:	1…200 s
Stall Rotor Strt:	Disabled/Enabled
Stall Detection:	Disabled/Enabled
Stall Setting:	1*Ith…5*Ith
Stall Time:	0.1…60 s
Reacceleration:	Disabled/Enabled
Reacc Low Voltage Setting:	50…120 V

19.12 Motor Differential Protection

Diff Function:	Disabled / Percentage Bias / High Impedance
Diff Is1:	0.05…0.50 In
Diff k1:	0…20%
Diff Is2:	1…5.0 In
Diff k2:	20…150.00%

19.13 Residual O/V NVD

VN>1 Function:	Disabled or DT or IDMT
VN>1 Voltage Set:	0.5….80 V
VN>1 Time Delay:	0.04…100 s
VN>1 TMS:	0.05…100
VN>2 Status:	Disabled/DT
VN>2 Voltage Set:	0.5…80 V
VN>2 Time Delay:	0.04…100 s

19.14 Limit Nb Starts

Hot Start status:	Disabled/Enabled
Hot start Nb:	1…5
Cold Start Stat:	Disabled/Enabled
Cold start Nb:	1…5
Supervising Time:	10…120 min
T Betw St Status:	Disabled/Enabled
Time betw start:	1…120 min
Inhib Start Ttime:	1…120 min

19.15 Loss of Load

P<1 Status:	Disabled/DT
P<1 Power Set:	1*In …120*In W
P<1 Time Delay:	0.04…100s
P<2 Status:	Disabled/DT
P<2 Power Set:	1*In …120*In W
P<2 Time Delay:	0.04…100 s
P< Drop-off Time	0.05…300 s

19.16 Out of Step (Power Factor)

PF< Status Lead:	Disabled/DT
Power Fact lead:	0.1…0.9
PF< Lead TD:	0.05…100 s
PF< Status Llag:	Disabled/DT
Power Fact Lag:	0.1…0.9
PF< Lag TD:	0.05…100 s
PF< Drop-off time:	0.05…300 s

19.17 Reverse Power

Rev P< Power Set:	1*In…120*In W
Rev P< Time Delay:	0.04…100 s
Rev P< Drop-of Ti:	0.05…300 s

19.18 Anti-Backspin

VRem Anti-backs:	1…120 V
Anti-backs Delay:	1…7200 s

19.19 Field Failure

FFail Alm Status:	Disabled/Enabled
FFail Alm Angle:	15°…75°
FFail Alm Delay:	0.00…100.0 s
FFail 1 Status:	Disabled/Enabled
FFail 1 -Xa1:	0…40.0/InΩ
FFail 1 Xb1:	25…325.0/InΩ
FFail 1 Time Delay:	0…100 s
FFail 1 DO Timer:	0…100 s
FFail 2 as FFail1	

19.20 Voltage Protection

19.20.1 Undervoltage

V<1 Function:	Disabled or DT or IDMT
V<1 Voltage Set:	15…120 V
V<1 Time Delay:	0.04…7200 s
V<1 TMS:	0.5…100
V<2 Status:	Disabled/DT
V<2 Voltage Set:	15…120V
V<2 Time Delay:	0.04…100 s
Inhib During St:	Disabled/DT

19.20.2 Overvoltage

V>1 Status:	Disabled/DT
V>1 Voltage Set:	50…200 V
V>1 time Delay:	0.04…7200 s
V>2 Status:	Disabled/DT
V>2 Voltage Set:	50…200 V
V>2 Time Delay:	0.04…7200 s

19.21 Underfrequency

F<1 Status:	Disabled/DT
F<1 Setting:	45…65 Hz
F<1 Time Delay:	0.1…100 s
F<2 Status:	Disabled/DT
F<2 Setting:	45…65 Hz
F<2 Time Delay:	0.1…100 s

19.22 RTD Protection

Select RTD: Bit 0 - Select RTD 1, Bit 1 - Select RTD 2 to Bit 9 - Select RTD 10
Binary function link string, selecting which RTDs (1 - 10) are enabled.

RTD 1 Alarm Set:	0°C to 200°C
RTD 1 Alarm Dly:	0 s to 100 s
RTD 1 Trip Set:	0°C to 200°C
RTD 1 Trip Dly:	0 s to 100 s

RTD2/3/4/5/6/7/8/9/10 the same as RTD1

Ext. Temp. Influence:	Disabled/DT
Ext. Temp. RTD:	1…10
Ext. RTD Back-up:	1…10
Type RTD:	PT100 or Ni100 or Ni120
RTD Unit:	Celsius or Fahrenheit

19.23 CB Fail

CB Fail 1 Status:	Disabled/Enabled
CB Fail 1 Timer:	0.00…10.00 s
CB Fail 2 Status:	Disabled/Enabled
CB Fail 2 Timer:	0.00…10.00 s
CBF Non I Reset:	I< Only / CB Open & I< / Prot Reset & I<
CBF Ext Reset:	I< Only / CB Open & I < / Prot Reset & I<
I< Current Set:	0.02…3.200 In

20 MEASUREMENTS LIST

20.1 Measurements 1

Iφ Magnitude	
Iφ Phase Angle	Per phase (φ = A, B, C) current measurements
IN Derived Mag	
IN Derived Angle	
ISEF Magnitude	
ISEF Angle	
I1 magnitude	
I2 magnitude	
I0 Magnitude	
Iφ RMS	Per phase (φ = A, B, C) RMS current measurements
Vφ-φ Magnitude	
Vφ-φ Phase Angle	
Vφ Magnitude	
Vφ Phase Angle	All phase-phase and phase-neutral voltages (φ = A, B, C, N).
Vr Antibacks Mag	
V1 Magnitude	
V2 Magnitude	
Vφ RMS	
Vφ-φ RMS	All phase-phase and phase-neutral voltages (φ = A, B, C, AB, BC, CA).
Frequency	
Ratio I2/I1	
IA2 Magnitude	
IA2 Angle	
IB2 Magnitude	
IB2 Angle	
IC2 Magnitude	
IC2 Angle	
IA Differential	
IB Differential	
IC Differential	
IA Bias	
IB Bias	
IC Bias	

20.2 Measurements 2

3 Phase Watts	
3 Phase VArs	
3 Phase VA	
Zero Seq Power	
3Ph Power Factor	
3Ph WHours Fwd	
3Ph WHours Rev	
3Ph VArHours Fwd	
3Ph VArHours Rev	
Reset Energies:	No/Yes
3Ph W Fix Demand	
3Ph VArs Fix Dem	
3Ph W Peak Dem	
3Ph VAr Peak Dem	
Reset Demand:	No/Yes
3Ph I Maximum	

3Ph V Maximum
Reset Maximum I/V: No/Yes

20.3 Measurements 3 (Model Specific)

Thermal Load
Thermal State
Time to Th Trip
Reset Th State: No/Yes
RTD#1 Temperature to RTD#10 Temperature
Nb of Hot St Allow
Nb of Cold St Allow
Time to Next St
Emergency Rest: No/Yes
Last Start Time
Last St Current
Nb of Starts
Reset Nb of St: No/Yes
Nb Emergency Rst
Reset Nb Em Rst: No/Yes
Nb of Reaccelerat
Reset Nb of Reacc: No/Yes
Motor Run Time
Reset Motor Run T: No/Yes
RTD open Cct
RTD Short Cct
RTD Data Error
Reset RTD Flags: No/Yes
Nb Hottest RTD
Hottest RTD Temp
Reset Max RTD Temp: No/Yes
Analog Input 1
Analog Input 2
Analog Input 3
Analog Input 4

20.4 Measurements 4 (Model Specific)

Nb Control trips
Nb Thermal Trip
Nb Trip I> 1
Nb Trip I> 2
Nb Trip I> 3
Nb Trip I> 4
Nb Trip ISEF>1
Nb Trip ISEF>2
Nb Trip IN>1
Nb Trip IN>2
Nb Trip I2>1
Nb Trip I2> 2
Nb Trip P0>
Nb Trip V<1
Nb Trip V<2
Nb Trip F<1
Nb Trip F<2
Nb F.Fail1 Trip
Nb F.Fail2 Trip
Nb Trip P<1
Nb Trip P<2

Nb Trip PF< Lead
Nb Trip PF< Lag
Nb Trip Rev P
Nb Trip V> 1
Nb Trip V> 2
Nb Trip VN>1
Nb Trip VN>2
Nb Prolong St
Nb Lock Rot-sta
Nb Lock-Rot-run
Nb Trip RTD#1…
Nb Trip RTD#10
Nb Trip Diff
Nb A Input 1Trip
Nb A Input 2Trip
Nb A Input 3Trip
Nb A Input 4Trip
Nb FFail1 Trip
Nb FFail2 Trip
Nb Trip I>3
Nb Trip I>4
Reset Trip Stat: No/Yes

20.5 CB Condition

CB Operations
Total Iφ Broken
Cumulative breaker interruption duty on a per phase basis (φ = A, B, C).
CB Operate Time
Reset CB Data: No/Yes

21 LABELS

21.1 Opto Input Labels

Opto Input 1…16: OPTO 1…OPTO 16
User defined text string to describe the function of the particular opto input.

21.2 Output Labels

Relay 1…16: RELAY 1…RELAY 16
User defined text string to describe the function of the particular relay output contact.

21.3 RTD Labels

RTD 1-10: RTD1 to RTD10
User-defined text string to describe the function of the particular RTD.

21.4 CLIO Labels

CLIO Input 1...4: ANALOG INPUT 1...ANALOG INPUT 4
CLIO Output 1...4: ANALOG OUTPUT 1...ANALOG OUTPUT 4
User defined text string to describe the function of the particular analog input/output.

21.5 Control Input Labels

Control Input 1 (up to): Control Input 32:	User defined text string to describe the function of the particular control input.
Settable Control Input 1 (up to): Settable Control Input 32:	User defined text string to describe the function of the particular settable control input.

21.6 Virtual Input Labels

Virtual Input 1 to Virtual Input 64.
User-defined text string to describe the function of the particular virtual input.

21.7 Virtual Output Labels

Virtual Output 1 to Virtual Output 32.
User-defined text string to describe the function of the particular virtual output.

21.8 SR/MR User Alarm Labels

SR User Alarm 1 to SR User Alarm 16:
User-defined text string to describe the function of the particular self-reset user alarm.
MR User Alarm 17 to MR User Alarm 32:
User-defined text string to describe the function of the particular manual reset user alarm.

GETTING STARTED

CHAPTER 3

Date:	05/2017
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.
Hardware suffix:	L (P241) & M (P242 & P243)
Software version:	D1
Connection diagrams:	10P241xx (xx = 01 to 02) 10P242xx (xx = 01) 10P243xx (xx = 01)

CONTENTS

TABLES

FIGURES

1 Introduction to the Relay

⚠ **Warning** **Before carrying out any work on the equipment, you should be familiar with the contents of the Safety Information chapter/Safety Guide SFTY/5L M/L11 or later issue, the Technical Data chapter and the ratings on the equipment rating label.**

1.1 User Interfaces and Menu Structure

The settings and functions of the MiCOM protection relay can be accessed both from the front panel keypad and LCD, and via the front and rear communication ports. Information on each of these methods is given in this section to describe how to start using the relay.

1.2 Front Panel

The following figure shows the front panel of the relay; the hinged covers at the top and bottom of the front panel are shown open. An optional transparent front cover physically protects the front panel. With the cover in place, access to the user interface is read-only. Removing the cover allows access to the relay settings and does not compromise the protection of the product from the environment.

When editing relay settings, full access to the relay keypad is needed. To remove the front cover:

1. Open the top and bottom covers, then unclip and remove the transparent cover. If the lower cover is secured with a wire seal, remove the seal.
2. Using the side flanges of the transparent cover, pull the bottom edge away from the relay front panel until it is clear of the seal tab.
3. Move the cover vertically down to release the two fixing lugs from their recesses in the front panel.

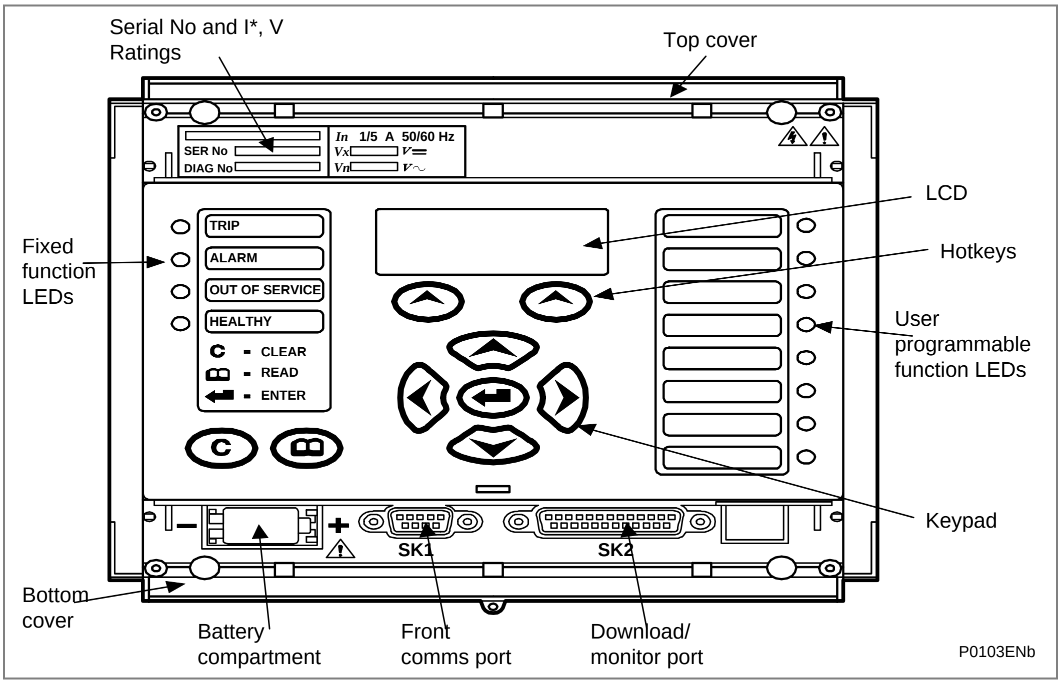


Figure 1 - Relay front view (40TE case for P241)

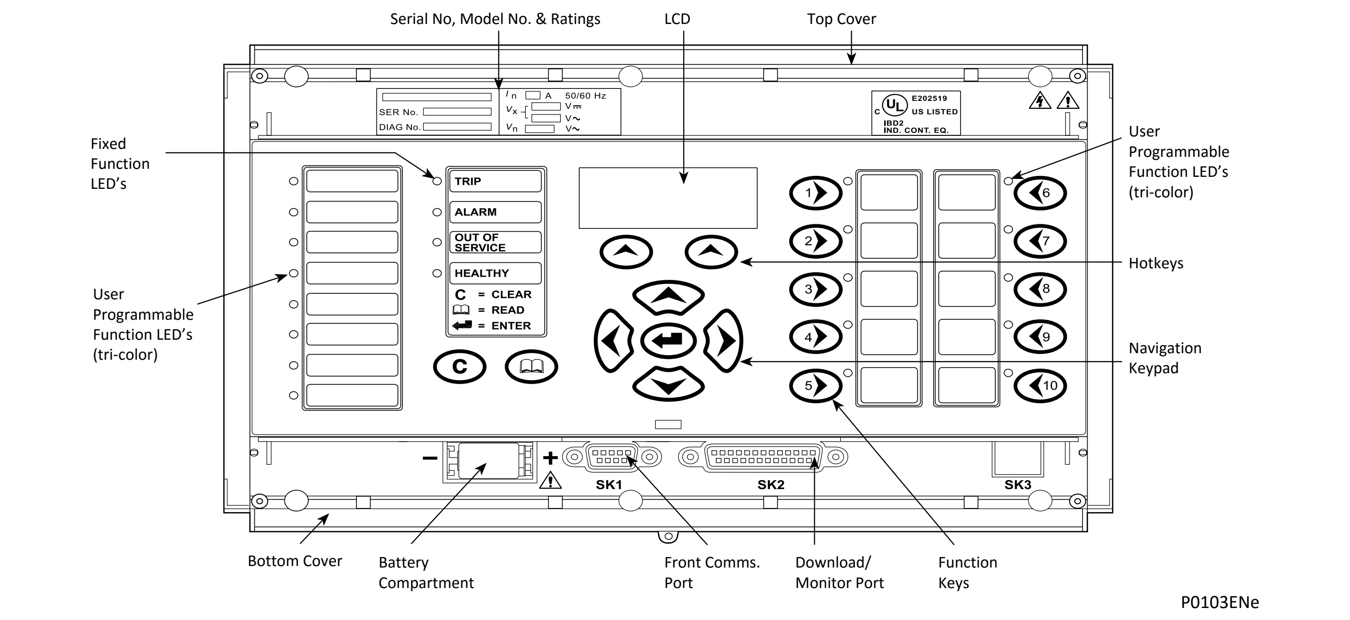


Figure 2 - Relay front view (P242/P243)

The front panel of the relay includes the following, as shown in the previous figure:

- a 16-character by 3-line alphanumeric Liquid Crystal Display (LCD)
- a 19-key keypad comprising:
  - 4 arrow keys (◁ ▷ △ and ▽), an enter key (↵), a clear key (C), a read key (📖), 2 hot keys (◁) and 10 (① – ⑩) programmable function keys

Note	Unlike the P242/P243, the P241 has a 9-key keypad instead of a 19-key keypad and no programmable function keys.

Function Key Functionality (P242/P243 only):

- The relay front panel has control keys with programmable LEDs for local control. Factory default settings associate specific relay functions with these 10 direct-action keys and LEDs, e.g. Enable or Disable the auto-recloser function. Using programmable scheme logic, the user can change the default functions of the keys and LEDs to fit specific needs.
- Hotkey functionality:
  - **SCROLL** starts scrolling through the various default displays.
  - **STOP** stops scrolling the default display.

For control of setting groups, control inputs and circuit breaker operation:

- 22 LEDs (P242/P243), 12 LEDs (P241); 4 fixed function LEDs, 8 tri-color (P242/P243), 8 red (P241) programmable function LEDs on the left hand side of the front panel and 10 tri-color programmable function LEDs on the right hand side associated with the function keys (P242/P243)

Under the top hinged cover:

- The relay serial number, and the relay's current and voltage rating information

Under the bottom hinged cover:

- Battery compartment to hold the 1/2 AA size battery which is used for memory back-up for the real time clock, event, fault and disturbance records
- A 9-pin female D-type front port for communication with a PC locally to the relay (up to 15m distance) via an EIA(RS)232 serial data connection
- A 25-pin female D-type port providing internal signal monitoring and high speed local downloading of software and language text via a parallel data connection

1.3 LED Indications

1.3.1 Fixed Function

The Fixed Function LEDs on the left-hand side of the front panel show these conditions:

- **Trip (Red)** indicates that the relay has issued a trip signal. It is reset when the associated fault record is cleared from the front display.
- **Alarm (Yellow)** flashes when the relay has registered an alarm. This may be triggered by a fault, event or maintenance record. The LED will flash until the alarms have been accepted (read), after which the LED will change to constant illumination, and will extinguish, when the alarms have been cleared.
- **Out of Service** (Yellow) is ON when the relay is not fully operational.
- **Healthy (Green)** indicates that the relay is in correct working order, and should be on at all times. It will be extinguished if the relay's self-test facilities show that there is an error with the relay's hardware or software. The state of the healthy LED is reflected by the watchdog contact at the back of the relay.

To improve the visibility of the settings via the front panel, the LCD contrast can be adjusted using the "LCD Contrast" setting in the CONFIGURATION column. This should only be necessary in very hot or cold ambient temperatures.

1.3.2 Programmable LEDs

There are differences between the P241 and the P242/P243 relays in the LED colours, input connection and functions.

- The P241 has red LEDs and does not have any programmable LEDs which are physically associated with the function keys.
- The P242/P243 device has programmable LEDs which are tri-color. The P242/P243 also has 10 programmable LEDs which are physically associated with the function keys.

All the programmable LEDs are tri-colour and can be programmed to show red, yellow or green depending on the requirements. The eight programmable LEDs on the left are suitable for programming alarm indications. The 10 programmable LEDs associated with the function keys, are used to show the status of the key's function. The default behaviour and mappings for each of the programmable LEDs are as shown in this table:

Default Mappings for the P241			
LED No	**LED input connection/text**	**Latched**	**P241 LED function indication**
1	LED 1 Red	No	Opto Input 1 (CB Closed, 52a)
2	LED 2 Red	No	Opto Input 2 (CB Open, 52b)
3	LED 3 Red	No	Opto Input 3 (Speed Switch)
4	LED 4 Red	No	Start in Progress
5	LED 5 Red	No	Re-acceleration in Progress
6	LED 6 Red	No	Start Successful
7	LED 7 Red	No	Re-acceleration Low Voltage Detected
8	LED 8 Red	No	Start Protection (Number of hot/cold starts, time between starts), Thermal Trip, 3Ph Volt Alarm

Table 1 - P241 default mappings for programmable LEDs

Default Mappings for the P242/P243			
LED No	**LED input connection/text**	**Latched**	**P242/3 LED function indication**
1	LED 1 Green	No	Opto Input 1 (CB Closed, 52a)
1	LED 1 Red	No	Opto Input 2 (CB Open, 52b)
2	LED 2 Not Used		

Default Mappings for the P242/P243			
LED No	**LED input connection/text**	**Latched**	**P242/3 LED function indication**
3	LED 3 Yellow	No	Opto Input 3 (Speed Switch)
4	LED 4 Yellow	No	Start in Progress
5	LED 5 Yellow	No	Re-acceleration in Progress
6	LED 6 Green	No	Start Successful
7	LED 7 Yellow	No	Re-acceleration Low Voltage Detected
8	LED 8 Red	No	Start Protection (Number of hot/cold starts, time between starts), Thermal Trip, 3Ph Volt Alarm
9	FnKey LED1 (Yellow)	N/A	Emergency Restart
10	FnKey LED2 (Yellow)	N/A	Trip
11	FnKey LED3 (Yellow)	N/A	Close
12	FnKey LED4	N/A	Not Used
13	FnKey LED5 (Red)	N/A	Setting Group
14	FnKey LED6	N/A	Not Used
15	FnKey LED7	N/A	Not Used
16	FnKey LED8 (Yellow)	N/A	Reset Thermal
17	FnKey LED9 (Yellow)	N/A	Reset Latches
18	FnKey LED10 (Yellow)	N/A	Disturbance Recorder Trigger

Table 2 - P242/P243 default mappings for programmable LEDs

1.4 Relay Rear Panel

Examples of the rear panel of the relay are shown in the following figure. All current and voltage signals, digital logic input signals and output contacts are connected at the rear of the relay. Also connected at the rear is the twisted pair wiring for the rear EIA(RS)485 communication port; the IRIG-B time synchronising input is optional, the Ethernet rear communication board with copper and fiber optic connections or the second communication are optional.

Refer to the wiring diagrams in the 'Connection Diagrams' chapter for further details.

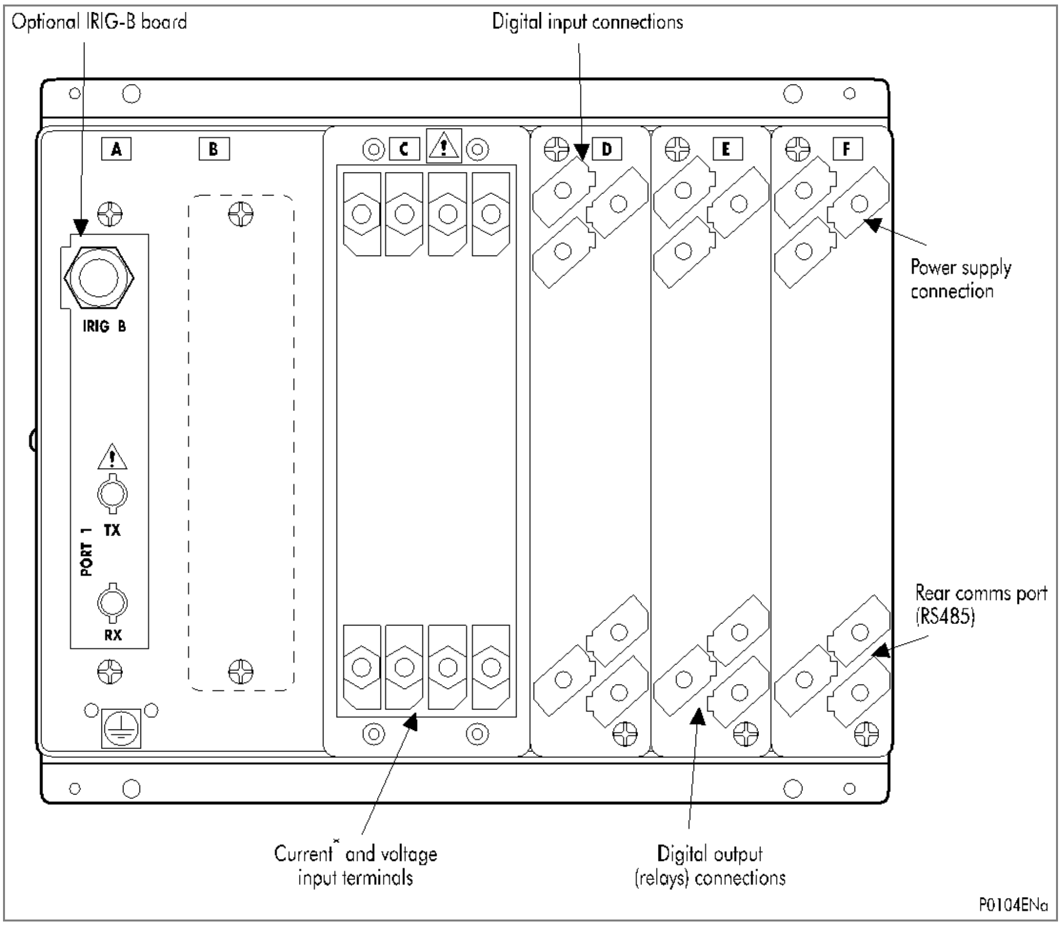


Figure 3 - Relay rear view

1.5 Relay Connection and Power-Up

Before powering-up the relay, confirm that the relay power supply voltage and nominal ac signal magnitudes are appropriate for your application. The relay serial number, and the relay's current and voltage rating, power rating information can be viewed under the top hinged cover. The relay is available in the auxiliary voltage versions shown in this table:

Nominal Ranges		Operative Ranges	
dc	ac	dc	ac
24 – 32 V dc	-	19 - 38 V dc	-
48 – 110 V dc	-	37 - 150 V dc	-
110 – 250 V dc **	100 – 240 V ac rms **	87 - 300 V dc	80 - 265 V ac
** rated for ac or dc operation			

Table 3 - Nominal and Operative dc and ac Ranges

Please note that the label does not specify the logic input ratings. These relays are fitted with universal opto isolated logic inputs that can be programmed for the nominal battery voltage of the circuit of which they are a part. See 'Universal Opto input' in the Product Design (Firmware) section for more information on logic input specifications.

Note *The opto inputs have a maximum input voltage rating of 300V dc at any setting.*

Once the ratings have been verified for the application, connect external power capable of delivering the power requirements specified on the label to perform the relay familiarization procedures. Previous diagrams show the location of the power supply terminals - please refer to the ***Installation*** and ***Connection Diagrams*** chapters for all the details, ensuring that the correct polarities are observed in the case of dc supply.

2 USER INTERFACES AND SETTINGS OPTIONS

The relay has three user interfaces:

- The front panel user interface via the LCD and keypad
- The front port which supports Courier communication
- The rear port which supports one protocol of either Courier, MODBUS or IEC 60870-5-103. The protocol for the rear port must be specified when the relay is ordered
- Second rear port (option) which supports Courier communication

The measurement information and relay settings that can be accessed from the interfaces are summarized in the following table.

	Keypad or LCD	Courier	MODBUS	IEC870-5-103	DNP3.0	IEC61850
Display & modification of all settings	Yes	Yes	Yes			
Digital I/O signal status	Yes	Yes	Yes	Yes		
Display/extraction of measurements	Yes	Yes	Yes	Yes		
Display/extraction of fault records	Yes	Yes	Yes	Yes		
Extraction of disturbance records		Yes	Yes	Yes		
Programmable scheme logic settings		Yes				
Reset of fault & alarm records	Yes	Yes	Yes	Yes		
Clear event & fault records	Yes	Yes	Yes			
Time synchronization		Yes	Yes	Yes		
Control commands	Yes	Yes	Yes	Yes		

Table 4 - Measurement information and relay settings

3 MENU STRUCTURE

The relay's menu is arranged in a table. Each setting in the menu is referred to as a cell, and each cell in the menu may be accessed using a row and column address. The settings are arranged so that each column contains related settings, for example all the disturbance recorder settings are contained within the same column. As shown in the following diagram, the top row of each column contains the heading that describes the settings contained within that column. Movement between the columns of the menu can only be made at the column heading level.

A complete list of all of the menu settings is given in the Relay Menu Database (*P24x/EN MD*).

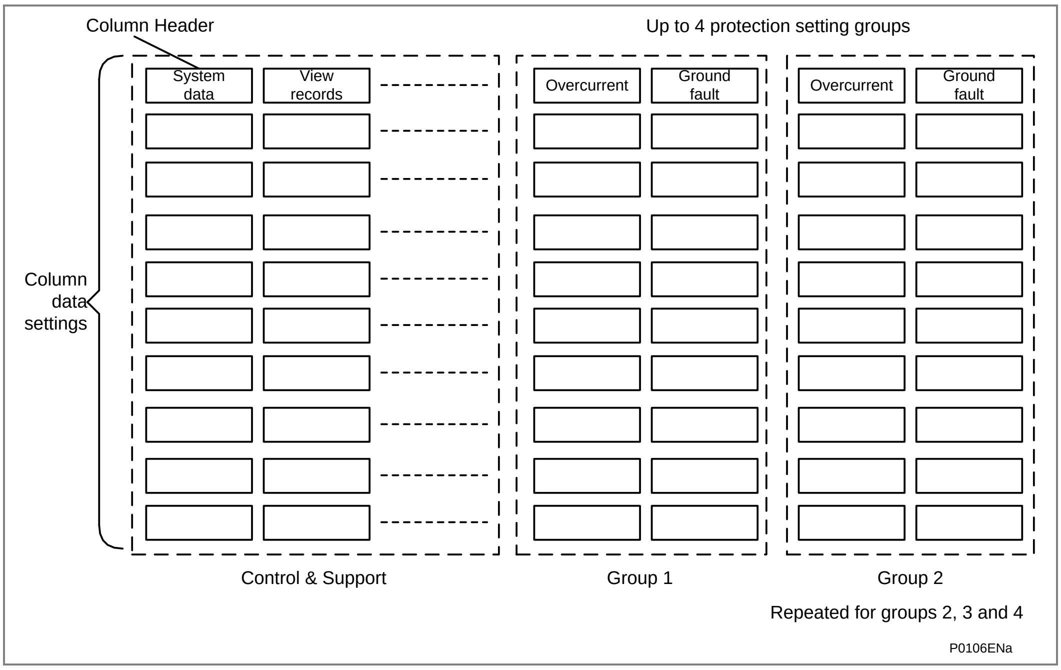


Figure 4 - Menu structure

The settings in the menu fall into one of these categories:

- Protection Settings
- Disturbance Recorder settings
- Control and Support (C&S) settings.

Different methods are used to change a setting depending on which category the setting falls into.

- C&S settings are stored and used by the relay immediately after they are entered.
- For either protection settings or disturbance recorder settings, the relay stores the new setting values in a temporary 'scratchpad'. It activates all the new settings together, but only after it has been confirmed that the new settings are to be adopted. This technique is employed to provide extra security, and so that several setting changes that are made within a group of protection settings will all take effect at the same time.

3.1 Protection Settings

The protection settings include the following items:

- Protection element settings
- Scheme logic settings

There are four groups of protection settings (only two groups for the P24x), with each group containing the same setting cells. One group of protection settings is selected as the active group, and is used by the protection elements.

3.2 Disturbance Recorder Settings

The Disturbance Recorder (DR) settings include the record duration and trigger position, selection of analogue and digital signals to record, and the signal sources that trigger the recording.

3.3 Control and Support Settings

The control and support settings include:

- Relay configuration settings
- Open/close circuit breaker (may vary according to relay type or model)
- CT & VT ratio settings
- Reset LEDs
- Active protection setting group
- Password & language settings
- Communications settings
- Measurement settings
- Event & fault record settings
- User interface settings
- Commissioning settings
- Circuit breaker control & monitoring settings (may vary according to relay type or model)

4 CYBER SECURITY

4.1 Cyber Security Settings

A detailed description of Schneider Electric Cyber Security features is provided in the *Cyber Security* chapter.

Important	**We would strongly recommend that you understand the contents of the Cyber Security chapter before you use any cyber security features or make any changes to the settings.**

Each MiCOM P40 IED includes a large number of possible settings. These settings are very important in determining how the device works.

A detailed description of the settings is given in the *Cyber Security* chapter.

4.2 Products with Cyber Security Features

For products with cyber security features, the menu structure contains four levels of access, three of which are password-protected. These are summarized below:

Level	Meaning	Read Operation	Write Operation
0	Read Some Write Minimal	SYSTEM DATA column: Description Plant Reference Model Number Serial Number S/W Ref. Access Level Security Feature SECURITY CONFIG column: User Banner Attempts Remain Blk Time Remain Fallback PW level Security Code (UI only)	Password Entry LCD Contrast (UI only)
1	Read All Write Few	All data and settings are readable. Poll Measurements	All items writeable at level 0. Level 1 Password setting Select Event, Main and Fault (upload) Extract Events (e.g. via MiCOM S1 Studio)
2	Read All Write Some	All data and settings are readable. Poll Measurements	All items writeable at level 1. Setting Cells that change visibility (Visible/Invisible). Setting Values (Primary/Secondary) selector Commands: Reset Indication Reset Demand Reset Statistics Reset CB Data / counters Level 2 Password setting
3	Read All Write All	All data and settings are readable. Poll Measurements	All items writeable at level 2. Change all Setting cells Operations: Extract and download Setting file. Extract and download PSL Extract and download MCL61850 (IED Config - IEC61850) Extraction of Disturbance Recorder Courier/Modbus Accept Event (auto event extraction, e.g. via A2R) Commands: Change Active Group setting Close / Open CB Change Comms device address. Set Date & Time Switch MCL banks / Switch Conf. Bank in UI (IED Config - IEC61850) Enable / Disable Device ports (in SECURITY CONFIG column) Level 3 password setting

Note *Applicable to Software Versions prior to H1.*
For further details, see the Cyber Security chapter.

Table 5 - Access levels (with cyber security features)

4.3 Password Management

Level management, including password description, management and recovery, is fully described in the *Cyber Security* chapter.

Each of the Password may be any length between 0 and 8 characters long which can contain any ASCII character in the range ASCII code 33 (21 Hex) to ASCII code 122 (7A Hex) inclusive. The factory default passwords are blank for Level 1 and AAAA for Levels 2 and 3. Each password is user-changeable once it has been correctly entered. Entry of the password is achieved either by a prompt when a setting change is attempted, or by moving to the ‘Password’ cell in the ‘System data’ column of the menu. The level of access is independently enabled for each interface, that is to say if level 2 access is enabled for the rear communication port, the front panel access will remain at level 0 unless the relevant password is entered at the front panel. The access level enabled by the password entry will time-out independently for each interface after a period of inactivity and revert to the default level. If the passwords are lost an emergency password can be supplied - contact Schneider Electric with the relay’s serial number and security code (relays with Cyber Security features). The current level of access enabled for an interface can be determined by examining the 'Access level' cell in the 'System data' column, the access level for the front panel User Interface (UI), can also be found as one of the default display options.

5 RELAY CONFIGURATION

The relay is a multi-function device that supports numerous different protection, control and communication features. To simplify the setting of the relay, there is a configuration settings column which can be used to enable or disable many of the functions of the relay. The settings associated with any function that is disabled are made invisible, i.e. they are not shown in the menu. To disable a function change the relevant cell in the '**Configuration'** column from '**Enabled'** to '**Disabled'**.

The configuration column controls which of the protection settings groups is selected as active through the '**Active settings**' cell. A protection setting group can also be disabled in the configuration column, provided it is not the present active group. Similarly, a disabled setting group cannot be set as the active group.

The column also allows all of the setting values in one group of protection settings to be copied to another group.

To do this firstly set the 'Copy from' cell to the protection setting group to be copied, then set the 'Copy to' cell to the protection group where the copy is to be placed. The copied settings are initially placed in the temporary scratchpad, and will only be used by the relay following confirmation.

To restore the default values to the settings in any protection settings group, set the 'Restore defaults' cell to the relevant group number. Alternatively it is possible to set the 'Restore defaults' cell to 'All settings' to restore the default values to all of the relay's settings, not just the protection groups' settings. The default settings will initially be placed in the scratchpad and will only be used by the relay after they have been confirmed. Note that restoring defaults to all settings includes the rear communication port settings, which may result in communication via the rear port being disrupted if the new (default) settings do not match those of the master station.

6 FRONT PANEL USER INTERFACE (KEYPAD AND LCD)

When the keypad is exposed it provides full access to the menu options of the relay, with the information displayed on the LCD.

The ⊲, ⊳, ⊼ and ⊻ keys which are used for menu navigation and setting value changes include an auto-repeat function that comes into operation if any of these keys are held continually pressed. This can speed up both setting value changes and menu navigation; the longer the key is held depressed, the faster the rate of change or movement becomes.

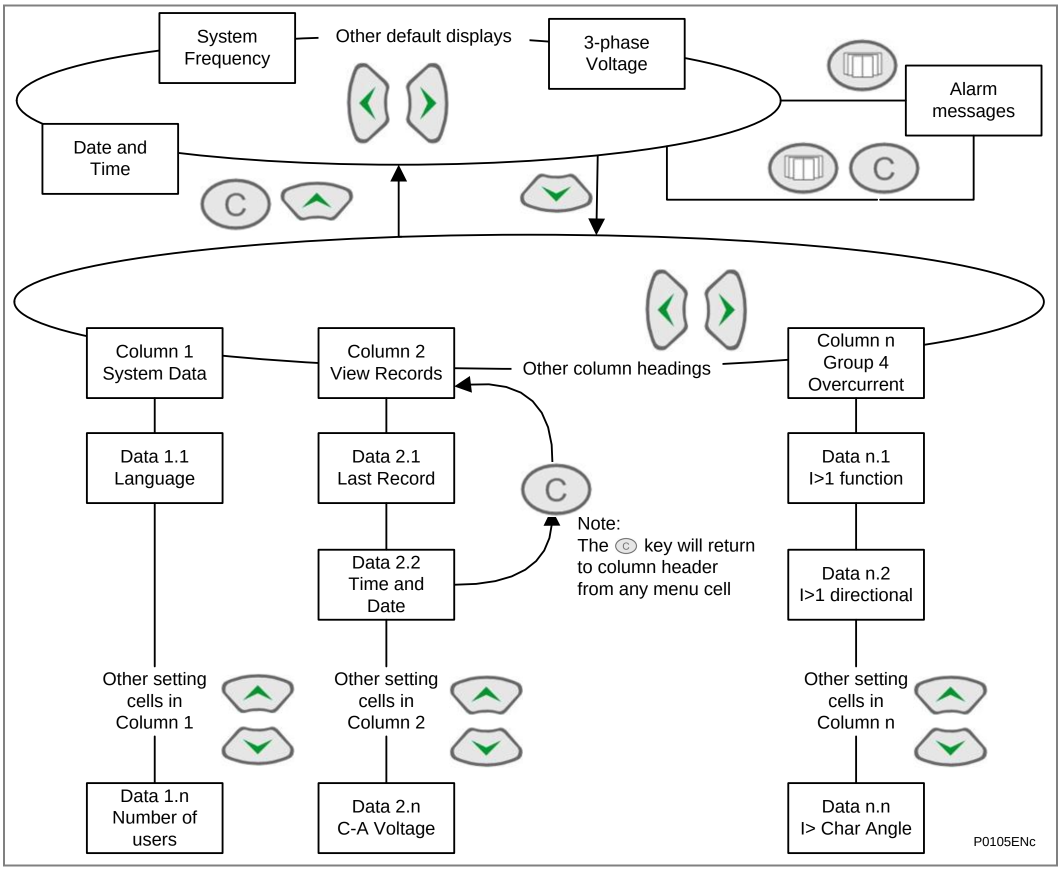


Figure 5 - Front panel user interface

6.1 Default Display and Menu Time-Out

The front panel menu has a default display. To change the default display selection requires password level 3 and the following items can be selected by using the ◄ and ► keys:

- User Banner
- Date and time
- Relay description (user defined)
- Plant reference (user defined)
- System frequency
- 3-phase voltage
- 3-phase and neutral current
- Power
- Access permissions

If the user has got level 3 (or enters a level 3 password when prompted as above), then the IED will then inform the user that to move to another default display will make the IED non-NERC compliant, as follows:

```
DISPLAY NOT-NERC
COMPLIANT. OK?
```

'Enter' will move the default display to the next one, 'Cancel' will leave the display at the user banner display. The confirmation for non-NERC compliance will only be asked when moving off the user banner display. The request for level 3 password will always be asked for any change to the default display selection if the current level is not already 3.

Whenever the relay has an uncleared alarm (such as fault record, protection alarm, or control alarm) the default display is replaced by the following display.

```
Alarms/Faults
Present
```

Enter the menu structure of the relay from the default display, even if the display shows the **Alarms/Faults present** message.

6.2 Navigating Menus and Browsing Settings

Use the four arrow keys to browse the menu, following the menu structure shown above.

1. Starting at the default display, press the ▼ key to show the first column heading.
2. Use the ◄ and ► keys to select the required column heading.
3. Use the ▼ and ▲ keys to view the setting data in the column.
4. To return to the column header, either hold the ▲ key down or press the clear key Ⓒ once. It is only possible to move across columns at the column heading level.
5. To return to the default display, press the ▲ key or the clear key Ⓒ from any of the column headings. If you use the auto-repeat function of the ▲ key, you cannot go straight to the default display from one of the column cells because the auto-repeat stops at the column heading.
6. Press the ▲ key again to go to the default display.

6.3 Navigating the Hotkey Menu

To access the hotkey menu from the default display:

1. Press the key directly below the **HOTKEY** text on the LCD.
2. Once in the hotkey menu, use the ◄ and ► keys to scroll between the available options, then use the hotkeys to control the function currently displayed.
   If neither the ◄ or ► keys are pressed within 20 seconds of entering a hotkey sub menu, the relay reverts to the default display.
3. Press the clear key Ⓒ to return to the default menu from any page of the hotkey menu.

The layout of a typical page of the hotkey menu is as follows:

- The top line shows the contents of the previous and next cells for easy menu navigation
- The center line shows the function
- The bottom line shows the options assigned to the direct access keys

The functions available in the hotkey menu are listed in the following sections.

6.3.1 Setting Group Selection

The user can either scroll using <<NXT GRP>> through the available setting groups or <<SELECT>> the setting group that is currently displayed.

When the SELECT button is pressed a screen confirming the current setting group is displayed for 2 seconds before the user is prompted with the <<NXT GRP>> or <<SELECT>> options again. The user can exit the sub menu by using the left and right arrow keys.

For more information on setting group selection refer to “Setting group selection” section in the Operation chapter.

6.3.2 Control Inputs - User Assignable Functions

The number of control inputs (user assignable functions – USR ASS) represented in the hotkey menu is user configurable in the “CTRL I/P CONFIG” column. The chosen inputs can be SET/RESET using the hotkey menu.

For more information refer to the “Control Inputs” section in the Operation chapter.

6.3.3 CB Control

The CB control functionality varies from one Px40 relay to another. For a detailed description of the CB control via the hotkey menu refer to the “Circuit Breaker Control” section of the Setting chapter.

The CB control functionality varies from one Px40 relay to another (e.g. CB control via the hotkey menu is not included in the P241/P242/P243).

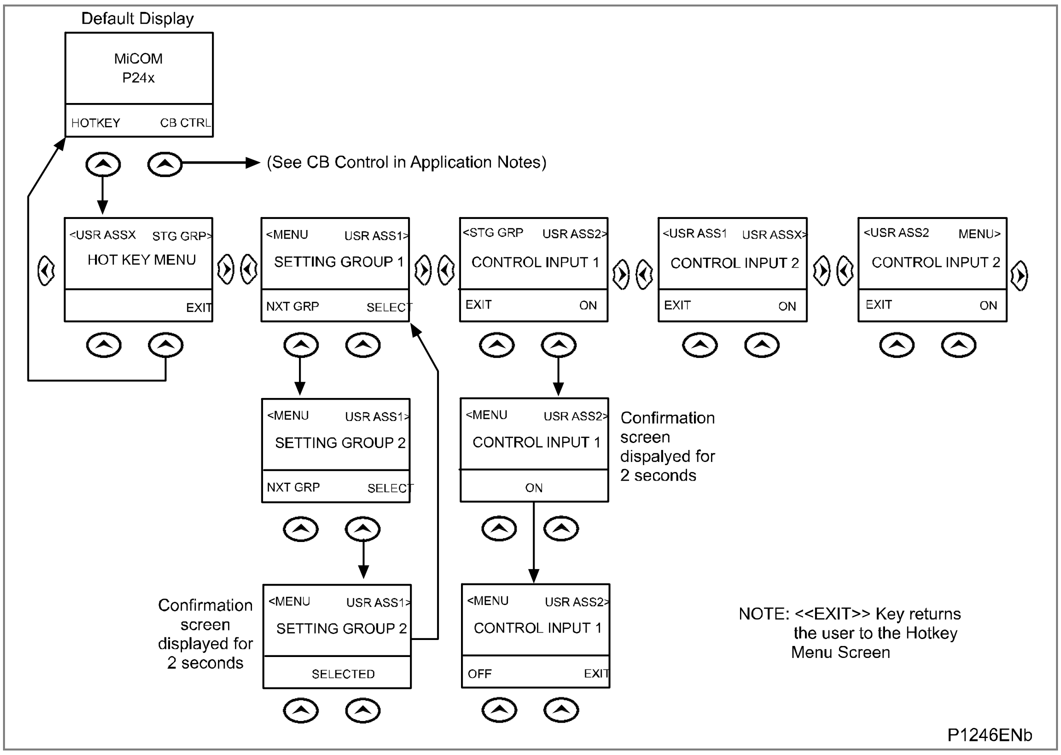


Figure 6 - Hotkey menu navigation

6.4 How to Login

The password entry method varies slightly between CSL0 and CSL1 Versions.

6.4.1 Local Default Access

In CSL0 models the user can access the relay menu without the need to login.
In CSL1 models this can be enabled/disabled using SAT.
If the Local Default Access is enabled, the user may login to the front panel with associated roles.

See Table 6 for the applied cases.

6.4.2 Auto Login

Auto login means the user will login the IED automatically and no need to select the user name and enter the password. In this case, the user will be authorized with relevant rights. The auto login will be applied in these cases:

<table>
<tr><th>CS Version</th><th>Interface</th><th>RBAC/PW Cases</th><th>Login Process</th></tr>
<tr><td rowspan="3">CSL1</td><td rowspan="2">Front panel</td><td>Factory RBAC</td><td>Auto login with EngineerLevel</td></tr>
<tr><td>Customized RBAC</td><td>Local Default Access Enabled: Login with Local Default Access
Local Default Access Disabled: Login with Prompt User List</td></tr>
<tr><td>Courier Interface</td><td>All cases</td><td>Login with Prompt User List</td></tr>
<tr><td rowspan="4">CSL0</td><td rowspan="2">Front panel</td><td>Factory RBAC</td><td>Auto login with EngineerLevel</td></tr>
<tr><td>Password changed</td><td>EngineerLevel password is “AAAA” or is disabled/blank: Auto login with EngineerLevel
OperatorLevel password is “AAAA” or is disabled/blank: Auto login with OperatorLevel
EngineerLevel and OperatorLevel password changed: Auto login with ViewerLevel Access</td></tr>
<tr><td rowspan="2">Courier Interface</td><td>Factory RBAC</td><td>Auto login with EngineerLevel</td></tr>
<tr><td>Password changed</td><td>EngineerLevel password is “AAAA” or is disabled/blank: Auto login with EngineerLevel
OperatorLevel password is “AAAA” or is disabled/blank: Auto login with OperatorLevel
EngineerLevel and OperatorLevel password changed: Login with Prompt User List</td></tr>
</table>

Table 6 - Auto Login process

For more details about the Factory RBAC, please refer to the Cyber Security chapter.

6.4.3 Login with Prompt User List

This login process will happen if:

- The Auto login process is not applied.
- Or high authorization is required for the current operation.

In this case, the IED will prompt the user list, and the user needs to select proper user name and enter the password to login.

6.5 Reading and Clearing of Alarm Messages and Fault Records

One or more alarm messages appear on the default display and the yellow alarm LED flashes. The alarm messages can either be self-resetting or latched, in which case they must be cleared manually.

1. To view the alarm messages, press the read key . When all alarms have been viewed but not cleared, the alarm LED change from flashing to constantly ON and the latest fault record appears (if there is one).
2. Scroll through the pages of the latest fault record, using the key. When all pages of the fault record have been viewed, the following prompt appears.

```
Press clear to
reset alarms
```

3. To clear all alarm messages, press . To return to the display showing alarms or faults present, and leave the alarms uncleared, press .
4. Depending on the password configuration settings, you may need to enter a password before the alarm messages can be cleared. See the ***How to Access the IED/Relay*** section.
5. When all alarms are cleared, the yellow alarm LED switches OFF; also the red trip LED switches OFF if it was switched ON after a trip.
6. To speed up the procedure, enter the alarm viewer using the key, then press the key. This goes straight to the fault record display. Press again to move straight to the alarm reset prompt, then press again to clear all alarms.

6.6 Setting Changes

1. To change the value of a setting, go to the relevant cell in the menu, then press the enter key to change the cell value. A flashing cursor on the LCD shows the value can be changed. If a password is required to edit the cell value, a password prompt appears.
2. To change the setting value, press the or keys. If the setting to be changed is a binary value or a text string, select the required bit or character to be changed using the and keys.
3. Press to confirm the new setting value or the clear key to discard it. The new setting is automatically discarded if it is not confirmed in 15 minutes.
4. For protection group settings and disturbance recorder settings, the changes must be confirmed before they are used by the relay.
5. To do this, when all required changes have been entered, return to the column heading level and press the key. Before returning to the default display, the following prompt appears.

```
Update settings?
Enter or clear
```

6. Press to accept the new settings or press to discard the new settings.

Note	*If the menu time-out occurs before the setting changes have been confirmed, the setting values are also discarded.*

Control and support settings are updated immediately after they are entered, without the **Update settings**? prompt.

6.7 How to Logout

6.7.1 How to Logout at the IED

For security consideration, it would be better to “logout' the IED once the configuration done. You can do this by going up to the default display. When you are at the default display and you press the ‘Cancel’ button, you may be prompted to log out with the following display:

```
ENTER TO LOGOUT
CLEAR TO CANCEL
```

You will be asked this question if you are logged in.

If you confirm, the following message is displayed for 2 seconds:

```
LOGGED OUT
User Name
```

If you decide not to log out (i.e. you cancel), the following message is displayed for 2 seconds.

```
LOGOUT CANCELLED
User Name
```

Note	*The MiCOM IED runs a timer, which logs the user out after a period of inactivity. For more details, refer to the Inactivity Timer section.*

6.7.2 How to Logout at MiCOM S1 Studio

- Right-click on the device name and select Log Off.
- In the Log Off confirmation dialog click Yes.

7 FRONT COMMUNICATION PORT USER INTERFACE

The front communication port is provided by a 9-pin female D-type connector located under the bottom hinged cover. It provides EIA(RS)232 serial data communication and is intended for use with a PC locally to the relay (up to 15m distance) as shown in the following diagram. This port supports the Courier communication protocol only. Courier is the communication language developed by Schneider Electric to allow communication with its range of protection relays. The front port is particularly designed for use with the relay settings program Easergy Studio (MiCOM S1 Studio) (Windows 2000, Windows XP or Windows Vista based software package).

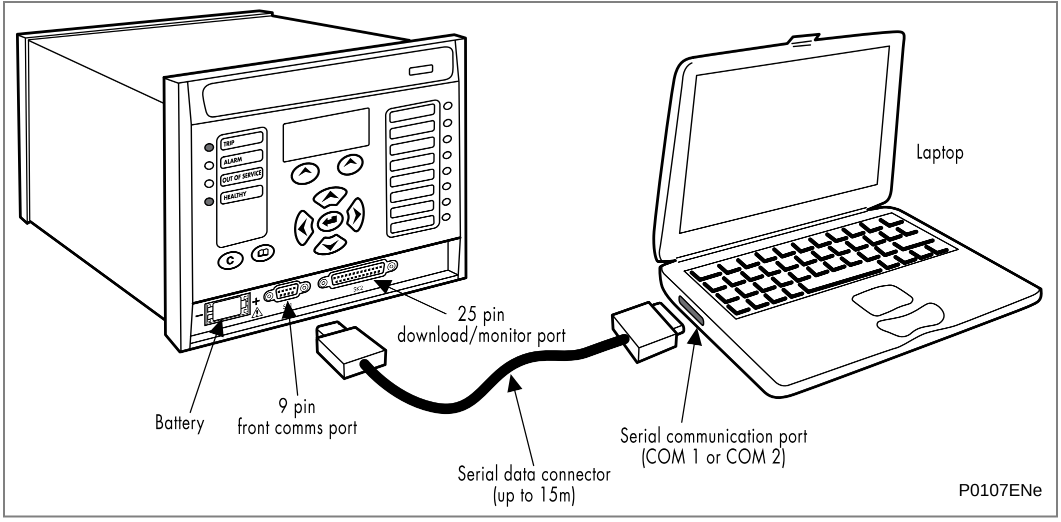


Figure 7 - Front port connection

The IED is a Data Communication Equipment (DCE) device. The pin connections of the 9-pin front port are as follows:

Pin no.	Description
2	Tx Transmit data
3	Rx Receive data
5	0V Zero volts common

Table 7 - Relay Serial Port Connections

None of the other pins are connected in the relay. The relay should be connected to the serial port of a PC, usually called COM1 or COM2. PCs are normally Data Terminal Equipment (DTE) devices which have a serial port pin connection as below (if in doubt check your PC manual):

Pin	25 Way	9 Way	Description
Pin no. 2	3	2	Rx Receive data
Pin no. 3	2	3	Tx Transmit data
Pin no. 5	7	5	0V Zero volts common

Table 8 - PC Serial Port Connections

For successful data communication, the Tx pin on the relay must be connected to the Rx pin on the PC, and the Rx pin on the relay must be connected to the Tx pin on the PC, as shown in the diagram. Therefore, providing that the PC is a DTE with pin connections as given above, a ‘straight through’ serial connector is required, i.e. one that connects pin 2 to pin 2, pin 3 to pin 3, and pin 5 to pin 5.

Note	*A common cause of difficulty with serial data communication is connecting Tx to Tx and Rx to Rx. This could happen if a ‘cross-over’ serial connector is used, i.e. one that connects pin 2 to pin 3, and pin 3 to pin 2, or if the PC has the same pin configuration as the relay.*

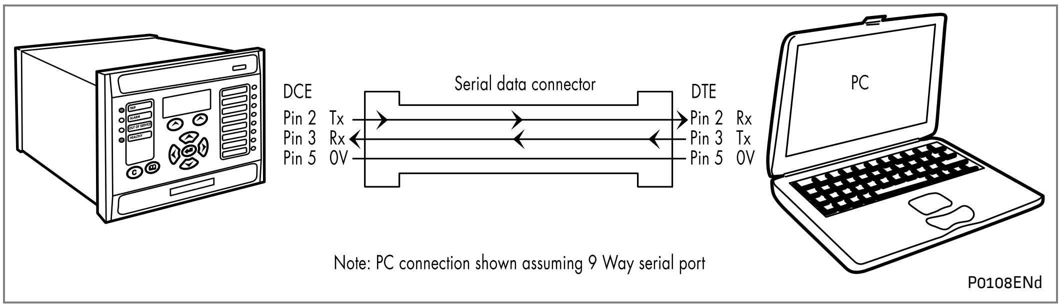


Figure 8 - PC - relay signal connection

Having made the physical connection from the relay to the PC, the PCs communication settings must be configured to match those of the relay. The relays communication settings for the front port are fixed as shown below:

Protocol	Baud rate	Courier address	Message format
Courier	19,200 bits/s	1	11 bit - 1 start bit, 8 data bits, 1 parity bit (even parity), 1 stop bit

Table 9 - Communication settings for front port

7.1 Relay Front Port Settings

The inactivity timer for the front port is set at 15 minutes. This controls how long the relay will maintain its password access on the front port. If no messages are received on the front port for 15 minutes then any password access that has been enabled will be revoked.

7.2 Front Courier Port

The front EIA(RS)232 9-pin port supports the Courier protocol for one to one communication.

Note	*The front port is actually compliant to EIA(RS)574; the 9-pin version of EIA(RS)232, see www.tiaonline.org.*

The front port is designed for use during installation and commissioning/maintenance and is not suitable for permanent connection. Since this interface will not be used to link the relay to a substation communication system, some of the features of Courier are not implemented. These are as follows:

- Automatic Extraction of Event Records:
    - Courier Status byte does not support the Event flag
    - Send Event/Accept Event commands are not implemented
- Automatic Extraction of Disturbance Records:
    - Courier Status byte does not support the Disturbance flag
- Busy Response Layer: Courier Status byte does not support the Busy flag, the only response to a request will be the final data
- Fixed Address: The address of the front courier port is always 1, the Change Device address command is not supported.
- Fixed Baud Rate: 19200 bps

Note	*Although automatic extraction of event and disturbance records is not supported, this data can be manually accessed using the front port.*

8 EASERGY STUDIO (MICOM S1 STUDIO) COMMUNICATIONS BASICS

Note MiCOM S1 Studio has been renamed as Easergy Studio.

The EIA(RS)232 front communication port is particularly designed for use with the relay settings program Easergy Studio (MiCOM S1 Studio). Easergy Studio (MiCOM S1 Studio) is the universal MiCOM IED Support Software and provide users a direct and convenient access to all stored data in any MiCOM IED using the EIA(RS)232 front communication port.

Easergy Studio (MiCOM S1 Studio) provides full access to MiCOM Px10, Px20, Px30, Px40 and Mx20 measurements units.

The Easergy Studio (MiCOM S1 Studio) product is updated periodically. These updates provide support for new features (such as allowing you to manage new MiCOM products, as well as using new software releases and hardware suffixes). The updates may also include fixes. **Accordingly, we strongly advise customers to use the latest Schneider Electric version of Easergy Studio (MiCOM S1 Studio).**

8.1 PC Requirements

The minimum and recommended hardware requirements for Easergy Studio (MiCOM S1 Studio) (v7.0.0) are shown below. These include the Studio application and other tools which are included: UPCT, P746 RHMI, P74x Topology Tool:

Minimum requirements:				
Platform	**Processor**	**RAM**	**HDD (Note 1 & 3)**	**HDD (Note 2 & 3)**
Windows XP x86	1 GHz	512 MB	900 MB	1.5 GB
Windows 7 x86	1 GHz	1 GB	900 MB	1.9 GB
Windows 7 x64	1 GHz	2 GB	900 MB	2.1 GB
Windows Server 2008 x86 Sp1	1 GHz	512 MB	900 MB	1.7 GB

Recommended requirements:				
Platform	**Processor**	**RAM**	**HDD (Note 1 & 3)**	**HDD (Note 2 & 3)**
Windows XP x86	1 GHz	1 GB	900 MB	1.5 GB
Windows 7 x86	1 GHz	2 GB	900 MB	1.9 GB
Windows 7 x64	1 GHz	4 GB	900 MB	2.1 GB
Windows Server 2008 x86 Sp1	1 GHz	4 GB	900 MB	1.7 GB

Note 1 Operating system with Windows Updates updated on 2015/05.

Note 2 Operating system without Windows Updates installed.

Note 3 Both configurations do not include Data Models HDD requirements. Data Models typically need from 1 GB to 15 GB of hard disk space.

Screen resolution for minimum requirements: Super VGA (800 x 600).
Screen resolution for recommended requirements: XGA (1024x768) and higher.
Easergy Studio (MiCOM S1 Studio) must be started with Administrator privileges.

Easergy Studio (MiCOM S1 Studio) Additional components

The following components are required to run Easergy Studio (MiCOM S1 Studio) and are installed by its installation package.

Component Type	Component
Package	.NET Framework 2.0 SP 1 (x64)
Package	.NET Framework 2.0 SP 1 (x86)
Package	.NET Framework 4.0 Client (x64)
Package	.NET Framework 4.0 Client (x86)
Package	Visual C++ 2005 SP1 Redistributable Package (x86)
Package	Visual C++ 2008 SP1 Redistributable Package (x86)
Merge modules	DAO 3.50
Merge modules	MFC 6.0
Merge modules	MFC Unicode 6.0
Merge modules	Microsoft C Runtime Library 6.0
Merge modules	Microsoft C++ Runtime Library 6.0
Merge modules	Microsoft Component Category Manager Library
Merge modules	Microsoft Data Access Components 2.8 (English)
Merge modules	Microsoft Jet Database Engine 3.51 (English)
Merge modules	Microsoft OLE 2.40 for Windows NT and Windows 95
Merge modules	Microsoft Visual Basic Virtual Machine 6.0
Merge modules	MSXML 4.0 - Windows 9x and later
Merge modules	MSXML 4.0 - Windows XP and later
Merge modules	Visual C++ 8.0 MFC (x86) WinSXS MSM
Merge modules	Visual C++ 8.0 MFC.Policy (x86) WinSXS MSM

8.2 Connecting to the Relay using Easergy Studio (MiCOM S1 Studio)

This section is a quick start guide to using Easergy Studio (MiCOM S1 Studio) and assumes this is installed on your PC. See the Easergy Studio (MiCOM S1 Studio) program online help for more detailed information.

1. Make sure the EIA(RS)232 serial cable is properly connected between the port on the front panel of the relay and the PC.
2. To start MiCOM S1 Studio, select **Programs** > **Schneider Electric** > **MiCOM S1 Studio** > **MiCOM S1 Studio**.
3. Click the **Quick Connect** tab and select **Create a New System**.
4. Check the **Path to System file** is correct, then enter the name of the system in the **Name** field. To add a description of the system, use the **Comment** field.
5. Click **OK**.
6. Select the device type.
7. Select the communications port, and open a connection with the device.
8. Once connected, select the language for the settings file, the device name, then click **Finish**. The configuration is updated.
9. In the **Studio Explorer** window, select **Device** > **Supervise Device**… to control the relay directly. (User Login necessary)

Note	*In case MiCOM S1 Studio is connecting to relay in Ed.2 mode via Rear Port, please set the "Response Time" to "20000" ms in connection parameters during the Quick Connect operation for normal communication.*

8.3 Off-Line Use of Easergy Studio (MiCOM S1 Studio)

Easergy Studio (MiCOM S1 Studio) can also be used as an off-line tool to prepare settings, without access to the relay.

1. If creating a new system, in the Studio Explorer, select **create new** system. Then right-click the new system and select **New substation**.
2. Right-click the new substation and select **New voltage level**.
3. Then right-click the new voltage level and select **New bay**.
4. Then right-click the new bay and select **New device**.

   You can add a device at any level, whether it is a system, substation, voltage or bay.
5. Select a device type from the list, then enter the relay type. Click **Next**.
6. Enter the full model number and click **Next**.
7. Select the **Language** and **Model**, then click **Next**.
8. If the IEC61850 protocol is selected, and an Ethernet board with hardware option Q, R or S is selected, select IEC 61850 Edition:
   IEC 61850 Edition 2 Mode or
   IEC 61850 Edition 1 Compatible Mode.
9. Enter a unique device name, then click **Finish**.
10. Right-click the **Settings** folder and select **New File**. A default file **000** is added.
11. Right-click file **000** and select click **Open**. You can then edit the settings. See the Easergy Studio (MiCOM S1 Studio) program online help for more information.

9 USER PROGRAMMABLE CURVE TOOL (UPCT)

The User Programmable Curve Tool (UPCT) allows the creation of user defined curves and flexible download and upload of these curves into/from the MiCOM Px4x relays. This tool can be used to create user programmable over current operating and reset curves. For example, its user friendly Graphical User Interface (GUI) allows easy creation and visualization of curves either by inputting a formula or data points.

9.1 Supporting Software Versions

The UPCT is supported for the following products:

Relay Type	Product	Software Version
Feeder Management relays	P14x	46 onwards
Motor Protection relays	P24x	57 onwards

Table 10 - UPCT supported products

9.2 Application Advantages of User-Programmable Curves

- Provide specific protection characteristics of Customer schemes
- Match more closely to the withstand characteristics for electrical equipment than standard curves.
- Provide compatibility with older relays and different manufacturers relays for retrofit / refurbishment.
- Data can be exported for protection grading and testing purposes.

9.3 Main Features and Overview of User Configurable Curve Tool

- Allows the user to create new configuration curve files or edit existing curve files
- Allows the user to enter a defined number of curve points (up to 256 points) or a user defined formula.
- Allows the user to create and save multiple formulae
- Allows the user defined curve to be associated with a predefined curve Px4x template.
- Allows interpolation between curve points
- Allows the user to save curve formulae in XML format and configured curve points in CSV format, suitable for download into the relay.
- Enables easy upload of the curve data from the relay.
- Allows the user to input formula constants with user defined values
- Allows the user to set a Definite Minimum Time (DMT) in the formula defined curves
- Graphically displays curves with zoom, pan User and point on curve facilities.
- Color coding of multiple curves enables effective comparison
- Allows the user to print curves or save curves in a range of standard image formats.

Please refer to the User Programmable Curve Tool Guide (Px4x/EN UPCT) for more information.

SETTINGS

CHAPTER 4

Date:	05/2017
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.
Hardware suffix:	L (P241) & M (P242 & P243)
Software version:	D1
Connection diagrams:	10P241xx (xx = 01 to 02) 10P242xx (xx = 01) 10P243xx (xx = 01)

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TABLES

1 INTRODUCTION

The IED must be configured to the system and the application by means of appropriate settings.

The sequence in which the settings are listed and described in this chapter will be the protection setting, control and configuration settings and the disturbance recorder settings.

The IED is supplied with a factory-set configuration of default settings.

Important	**The following tables provide information about the different settings for this range of MiCOM products. Unless otherwise stated in these tables, the settings apply to the whole range of products covered by this manual. Where a setting applies to anything other than the whole range, the individual products to which it applies are listed accordingly.**

2 RELAY SETTINGS

The IED is a multi-function device that supports numerous different control and communication features. The settings associated with any function that is disabled are made invisible; i.e. they are not shown in the menu. To disable a function change the relevant cell in the '**Configuration'** column from '**Enabled'** to '**Disabled'**.

To simplify the setting of the IED, there is a configuration settings column, used to enable or disable many of the IED functions. The aim of the configuration column is to allow general configuration from a single point in the menu.

The configuration column controls which of the four settings groups is selected as active through the '**Active settings**' cell. A setting group can also be disabled in the configuration column, provided it is not the present active group. Similarly, a disabled setting group cannot be set as the active group.

The column also allows all of the setting values in one group of settings to be copied to another group.

To do this firstly set the '**Copy from**' cell to the setting group to be copied, then set the '**Copy to**' cell to the group where the copy is to be placed. The copied settings are initially placed in the temporary scratchpad, and will only be used by the IED following confirmation.

2.1 Default Settings Restore

To restore the default values to the settings in any protection settings group, set the 'restore defaults' cell to the relevant group number. Alternatively, it is possible to set the 'restore defaults' cell to 'all settings' to restore the default values to all of the IEDs settings, not just the protection groups' settings. The default settings will initially be placed in the scratchpad and will only be used by the IED after they have been confirmed.

Important	***Restoring defaults to all settings includes the rear communication port settings, which may result in communication via the rear port being disrupted if the new (default) settings do not match those of the master station.***

Important	***If you restore settings, the settings for the IEC 61850 Edition and the Communications Mode will not be restored, even if "Restore All Settings" is set.***

3 CONFIGURATION MENU

Courier Text	Col	Row	Default Setting	Available Setting
Description				
CONFIGURATION	09	00		
This column contains all the general configuration options				
Restore Defaults	09	01	No Operation	0 = No Operation, 1 = All Settings, 2 = Setting Group 1, 3 = Setting Group 2, 4 = Setting Group 3, 5 = Setting Group 4
etting to restore a setting group to factory default settings. To restore the default values to the settings in any Group settings, set the 'restore defaults' cell to the relevant Group number. Alternatively it is possible to set the 'restore defaults' cell to 'all settings' to restore the default values to all of the IED's settings, not just the Group settings. The default settings will initially be placed in the scratchpad and will only be used by the IED after they have been confirmed by the user. Note: Restoring defaults to all settings includes the rear communication port settings, which may result in communication via the rear port being disrupted if the new (default) settings do not match those of the master station.				
Setting Group	09	02	Select via Menu	0 = Select via Menu or 1 = Select via Opto
Allows setting group changes to be initiated via Opto Input or via Menu				
Active Settings	09	03	Group 1	0 = Group 1, 1 = Group 2
Selects the active setting group.				
Save Changes	09	04	No Operation	0 = No Operation, 1 = Save, 2 = Abort
Saves all IED settings.				
Copy From	09	05	Group 1	0 = Group 1, 1 = Group 2
Allows displayed settings to be copied from a selected setting group				
Copy To	09	06	No Operation	0 = No Operation, 1 = Group 1, 2 = Group 2
Allows displayed settings to be copied from a selected setting group				
Setting Group 1	09	07	Enabled	0 = Disabled or 1 = Enabled
Enables or disables Group 1 settings. If the setting is disabled from the configuration, then all associated settings and signals are hidden, with the exception of this setting.				
Setting Group 2	09	08	Disabled	0 = Disabled or 1 = Enabled
Enables or disables Group 2 settings. If the setting is disabled from the configuration, then all associated settings and signals are hidden, with the exception of this setting.				
Thermal Overload	09	0B	Enabled	0 = Disabled or 1 = Enabled
To enable (activate) or disable (turn off) the Thermal protection function.				
Short Circuit	09	0C	Enabled	0 = Disabled or 1 = Enabled
To enable (activate) or disable (turn off) the Short Circuit function.				
Sensitive E/F	09	0D	Enabled	0 = Disabled or 1 = Enabled
To enable (activate) or disable (turn off) the Earth fault Protection function.				
Neg Seq O/C	09	0E	Enabled	0 = Disabled or 1 = Enabled
To enable (activate) or disable (turn off) the Neg. Seq. O/C function.				
3Ph Volt.Check	09	0F	Disabled	0 = Disabled or 1 = Enabled
To enable (activate) or disable (turn off) the Voltage system Checking function.				
Derived E/F	09	10	Disabled	0 = Disabled or 1 = Enabled
To enable (activate) or disable (turn off) the Earth fault derived Protection function.				
Stall Detection	09	14	Enabled	0 = Disabled or 1 = Enabled
Differential	09	15	Disabled	0 = Disabled or 1 = Enabled
To enable (activate) or disable (turn off) the Differential protection function.				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Residual O/V NVD	09	16	Disabled	0 = Disabled or 1 = Enabled
To enable (activate) or disable (turn off) the Differential protection function.				
Limit nb Starts	09	17	Enabled	0 = Disabled or 1 = Enabled
To enable (activate) or disable (turn off) the Residual O/V NVD function.				
Loss of Load	09	18	Disabled	0 = Disabled or 1 = Enabled
To enable (activate) or disable (turn off) the Loss of Load function.				
Out of Step	09	19	Disabled	0 = Disabled or 1 = Enabled
To enable (activate) or disable (turn off) the Out of step Protection function.				
Reverse power	09	1A	Disabled	0 = Disabled or 1 = Enabled
To enable (activate) or disable (turn off) the Reverse power function.				
Antibackspin	09	1B	Disabled	0 = Disabled or 1 = Enabled
To enable (activate) or disable (turn off) the Anti-Backspin protection function.				
Field Failure	09	1C	Disabled	0 = Disabled or 1 = Enabled
To enable (activate) or disable (turn off) the Field Failure protection function.				
Volt Protection	09	1D	Enabled	0 = Disabled or 1 = Enabled
To enable (activate) or disable (turn off) the Volt Protection function.				
Under Frequency	09	1E	Disabled	0 = Disabled or 1 = Enabled
To enable (activate) or disable (turn off) the Under Frequency function.				
RTD Inputs	09	1F	Disabled	0 = Disabled or 1 = Enabled
To enable (activate) or disable (turn off) the RTD Inputs function.				
CB Fail	09	20	Disabled	0 = Disabled or 1 = Enabled
To enable (activate) or disable (turn off) the CB Fail function.				
Supervision	09	21	Disabled	0 = Disabled or 1 = Enabled
To enable (activate) or disable (turn off) the Supervision function.				
System Config	09	24	Invisible	0 = Invisible, 1 = Visible
Sets the System Config menu visible further on in the IED setting menu.				
Input Labels	09	25	Visible	0 = Invisible, 1 = Visible
Sets the Input Labels menu visible further on in the IED setting menu.				
Output Labels	09	26	Visible	0 = Invisible, 1 = Visible
Sets the Output Labels menu visible further on in the IED setting menu.				
RTD Labels	09	27	Visible	0 = Invisible, 1 = Visible
Sets the RTD Labels menu visible further on in the IED setting menu.				
CT & VT Ratios	09	28	Visible	0 = Invisible, 1 = Visible
Sets the Current & Voltage Transformer Ratios menu visible further on in the IED settings menu.				
Record Control	09	29	Visible	0 = Invisible, 1 = Visible
Sets the Event Recorder menu visible further on in the IED setting menu.				
Disturb Recorder	09	2A	Visible	0 = Invisible, 1 = Visible
Sets the Disturbance Recorder menu visible further on in the IED settings menu.				
Measure't Setup	09	2B	Visible	0 = Invisible, 1 = Visible
Sets the Measurement Setup menu visible further on in the IED settings menu.				
Comms Settings	09	2C	Visible	0 = Invisible, 1 = Visible
Sets the Communications Settings menu visible further on in the IED settings menu. These are the settings associated with the 1st and 2nd rear communications ports				
Commission Tests	09	2D	Visible	0 = Invisible, 1 = Visible

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Sets the Commissioning Tests menu visible further on in the IED settings menu.				
Setting Values	09	2E	Secondary	0 = Primary, 1 = Secondary
This affects all protection settings that are dependent upon CT and VT ratios. All subsequent settings input must be based in terms of this reference.				
Control Inputs	09	2F	Visible	0 = Invisible, 1 = Visible
Activates the Control Input status and operation menu further on in the IED setting menu.				
CLIO Inputs	09	30	Disabled	0 = Disabled or 1 = Enabled
To enable (activate) or disable (turn off) the CILO Inputs function.				
CLIO Outputs	09	31	Disabled	0 = Disabled or 1 = Enabled
To enable (activate) or disable (turn off) the CILO Outputs function.				
CLIO Labels	09	32	Invisible	0 = Invisible, 1 = Visible
Sets the CLIO Labels menu visible further on in the IED setting menu.				
Ctrl I/P Config	09	35	Visible	0 = Invisible, 1 = Visible
Sets the Control Input Configuration menu visible further on in the IED setting menu.				
Ctrl I/P Labels	09	36	Visible	0 = Invisible, 1 = Visible
Sets the Control Input Labels menu visible further on in the IED setting menu.				
Direct Access	09	39	Enabled	0 = Disabled or 1 = Enabled
Defines whether direct access is allowed or not. The front direct access keys that are used as a short cut function of the menu may be: Disabled – No function visible on the LCD. Enabled – All control functions mapped to the Hotkeys and Control Trip/Close are available. Not available on Chinese version relays.				
Function Key	09	50	Visible	0 = Invisible, 1 = Visible
Sets the Function Key menu visible further on in the IED setting menu.				
VIR I/P Labels	09	70	Invisible	0 = Invisible, 1 = Visible
Sets the VIR I/P Labels menu visible further on in the IED setting menu.				
VIR O/P Labels	09	80	Invisible	0 = Invisible, 1 = Visible
Sets the VIR O/P Labels menu visible further on in the IED setting menu.				
USR ALARM LABELS	09	90	Invisible	0 = Invisible, 1 = Visible
Sets the User Alarm Labels menu visible further on in the IED setting menu.				
RP2 Read Only	09	FC	Disabled	0 = Disabled or 1 = Enabled
Enable Remote Read Only Mode on RP2 courier communication protocol. Visible when hardware options are: 7, 8, E or F.				
NIC Read Only	09	FD	Disabled	0 = Disabled or 1 = Enabled
Enable Remote Read Only Mode on the Network Interface card (IEC 61850 tunneled courier). Visible when comms options are: 6&G – IEC61850 with 1st Rear Courier				
LCD Contrast	09	FF	11	From 0 to 31 step 1
Sets the LCD contrast.				

Table 1 - General configuration settings

4 GROUPED PROTECTION SETTINGS

The grouped protection settings include all the following items that become active once enabled in the configuration column of the relay menu database:

- Protection Element Settings.
- Programmable Scheme Logic (PSL).

There are four groups of protection settings, with each group containing the same setting cells. One group of protection settings is selected as the active group, and is used by the protection elements. The settings for group 1 are shown. The settings are discussed in the same order in which they are displayed in the menu.

4.1 System Config

This function applies to the following products: P241/P242/P243

- A facility is provided in the relay to maintain correct operation of all the protection functions even when the motor is running in a reverse phase sequence. This is achieved through user configurable settings available for the two setting groups.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
GROUP 1 SYSTEM CONFIG	49	00		
This column contains settings for System Configuration				
Phase Sequence	49	01	Standard ABC	0 = Standard ABC or 1 = Reverse ACB
The Phase Sequence setting applies to a power system that has a permanent phase sequence of either ABC or ACB.				

Table 2 - System configuration settings

4.2 Thermal Overload Protection

The thermal overload function within the relay uses a multiple time constant thermal replica. This replica takes into account the overheating generated by the negative phase sequence current in the motor.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
GROUP 1 THERMAL OVERLOAD	30	00		
This column contains settings for Thermal Overload				
Ith Current Set	30	01	1*In A	From 0.2*In A to 1.5*In A step 0.01*In A
Thermal overload current setting.				
K Coefficient	30	02	3	From 0 to 10 step 1
Negative sequence current heating factor.				
Thermal Const T1	30	03	20 min	From 1 min to 180 min step 1 min
Thermal constant in overload condition				
Thermal Const T2	30	04	1 min	From 1 min to 360 min step 1 min
Thermal constant in starting condition, Unit = min				
Cooling Const Tr	30	05	1 min	From 1 min to 999 min step 1 min
Thermal constant in cooling condition, Unit = min				
Thermal Trip	30	06	Enabled	0 = Disabled, 1 = Enabled
Enalbes or disables tripping of the relay if the thermal setting is exceeded.				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Thermal Alarm	30	07	Enabled	0 = Disabled, 1 = Enabled
Enables or disables the setting of an alarm threshold for the thermal state.				
Alarm Threshold	30	08	0.9	From 20% to 100% step 1%
Alarm Threshold in % of thermal state				
Thermal Lockout	30	09	Enabled	0 = Disabled, 1 = Enabled
Enables or disables the lockout of a restart if the thermal state exceeds a threshold.				
Lockout Thresh.	30	0A	0.4	From 20% to 100% step 1%
Thermal state setting for the thermal lockout protection (in percentage).				
Inh.Trip dur St.	30	0B	Disabled	0 = Disabled, 1 = Enabled
Inhibits a trip during the start sequence of the motor. The thermal state will not be greater than 90% during the start sequence.				
Thermal Overload	30	0C	Thermal Model	0 = Thermal Model, 1 = User Curve Th.
Choice of default Thermal Model or a user pre-programmed operate thermal curve which has been downloaded to the relay using the programmable curve tool. There are 4 Curve Characteristics that can be sent to the relay from the Programmable Curve Tool - Curve 1, Curve 2, Curve 3 and Curve 4. Curve 3 is defined as the thermal operate curve.				
Reset	30	0D	Usr Curv Th. Rst	0 = Thermal Model, 1 = User Curve Th. Rst
Choice of default Thermal Model or a user pre-programmed reset thermal curve which has been downloaded to the relay using the programmable curve tool. There are 4 Curve Characteristics that can be sent to the relay from the Programmable Curve Tool - Curve 1, Curve 2, Curve 3 and Curve 4. Curve 4 is defined as the thermal reset curve.				

Table 3 - Thermal over load protection settings

4.3 Short Circuit Protection

The short circuit protection included in the relay provides four-stage non-directional three-phase overcurrent protection with independent time delay characteristics. All overcurrent settings apply to all three phases but are independent for each of the four stages.

The first two stages of overcurrent protection have time-delayed characteristics which are selectable between Inverse Definite Minimum Time (IDMT), Definite Time (DT) and User Curve. The third and fourth stages have DT characteristics only.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
GROUP 1 SHORT CIRCUIT	31	00		
This column contains settings for Short Circuit				
I>1 Function	31	01	IEC S Inverse	Disabled, DT, IEC S Inverse, IEC V Inverse, IEC E Inverse, UK LT Inverse, UK Rectifier, RI, IEEE M Inverse, IEEE V Inverse, IEEE E Inverse, US Inverse, US ST Inverse, User Curve.
Tripping characteristic for the first stage overcurrent protection. There are 4 User Curve Characteristics that can be sent to the relay from the Programmable Curve Tool - Curve 1, Curve 2, Curve 3 and Curve 4. Curve 1 is defined as the Short Circuit or Sensitive E/F or Derived Earth Fault operate curve. Curve 2 is defined as the Short Circuit or Sensitive E/F or Derived Earth Fault reset curve. When the User Curve1 is chosen as operate curve, its corresponding reset curve is automatically chosen as the one assigned in the User Programmable Curve Tool.				
I>1 Current Set	31	02	7.5*In A	From 0.2*In A to 15*In A step 0.1*In A
Pick-up setting for first stage overcurrent protection.				
I>1 Time Delay	31	03	100ms	From 40ms to 100s step 10ms
Operating time-delay setting for the definite time setting if selected for first stage element.				
I>1 TMS	31	04	1	From 25 to 1.2 step 25
Time multiplier setting to adjust the operating time of the IEC IDMT characteristic.				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
I>1 Time Dial	31	05	7	From 10 to 100 step 1
Time multiplier setting to adjust the operating time of the IEEE/US IDMT and User curves.				
I>1 k (RI)	31	06	1	From 100 to 10 step 50
Time multiplier setting to adjust the operating time for the RI curve.				
I>1 Reset Chr	31	07	DT	DT or IDMT
Setting to determine the type of reset/release characteristic of the IEEE/US curves.				
I>1 tRESET	31	08	0s	From 0s to 100s step 10ms
Reset/release time setting for definite time reset characteristic.				
I>2 Function	31	11	Disabled	Disabled, DT, IEC S Inverse, IEC V Inverse, IEC E Inverse, UK LT Inverse, UK Rectifier, RI, IEEE M Inverse, IEEE V Inverse, IEEE E Inverse, US Inverse, US ST Inverse, User Curve.
Tripping characteristic for the first stage overcurrent protection. There are 4 User Curve Characteristics that can be sent to the relay from the Programmable Curve Tool - Curve 1, Curve 2, Curve 3 and Curve 4. Curve 1 is defined as the Short Circuit or Sensitive E/F or Derived Earth Fault operate curve. Curve 2 is defined as the Short Circuit or Sensitive E/F or Derived Earth Fault reset curve. When the User Curve1 is chosen as operate curve, its corresponding reset curve is automatically chosen as the one assigned in the User Programmable Curve Tool.				
I>2 Current Set	31	12	7.5*In A	From 0.2*In A to 15*In A step 0.1*In A
Pick-up setting for second stage overcurrent protection.				
I>2 Time Delay	31	13	100ms	From 40ms to 100s step 10ms
Operating time-delay setting for the definite time setting if selected for second stage element.				
I>2 TMS	31	14	1	From 25 to 1.2 step 25
Time multiplier setting to adjust the operating time of the IEC IDMT characteristic.				
I>2 Time Dial	31	15	7	From 10 to 100 step 1
Time multiplier setting to adjust the operating time of the IEEE/US IDMT and User curves.				
I>2 k (RI)	31	16	1	From 100 to 10 step 50
Time multiplier setting to adjust the operating time for the RI curve.				
I>2 Reset Chr	31	17	DT	DT or IDMT
Setting to determine the type of reset/release characteristic of the IEEE/US curves.				
I>2 tRESET	31	18	0s	From 0s to 100s step 10ms
Reset/release time setting for definite time reset characteristic.				
I>3 Function	31	21	Disabled	Disabled or DT
Enable or disables the third stage overcurrent protection.				
I>3 Current Set	31	22	15*In A	From 0.2*In A to 15*In A step 0.1*In A
Pick-up setting for third stage overcurrent protection.				
I>3 Time Delay	31	23	40ms	From 40ms to 100s step 10ms
Operating time-delay setting for third stage overcurrent protection.				
I>4 Function	31	31	Disabled	Disabled or DT
Enable or disables the fourth stage overcurrent protection.				
I>4 Current Set	31	32	15*In A	From 0.2*In A to 15*In A step 0.1*In A
Pick-up setting for fourth stage overcurrent protection.				
I>4 Time Delay	31	33	40ms	From 40ms to 100s step 10ms
Operating time-delay setting for fourth stage overcurrent protection.				

Table 4 - Short circuit protection settings

4.4 Sensitive Earth Fault Protection

The Sensitive Earth Fault (SEF) protection included in the relay two stages of directional/non-directional, SEF protection. The SEF element can also be configured as a wattmetric earth fault element.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
GROUP 1 SENSITIVE E/F	32	00		
This column contains settings for Sensitive Earth Fault				
ISEF>1 Function	32	01	IEC S Inverse	Disabled, DT, IEC S Inverse, IEC V Inverse, IEC E Inverse, UK LT Inverse, IEEE M Inverse, IEEE V Inverse, IEEE E Inverse, US Inverse, US ST Inverse, User Curve.
Selection of the first stage sensitive earth fault element. There are 4 User Curve Characteristics that can be sent to the relay from the Programmable Curve Tool - Curve 1, Curve 2, Curve 3 and Curve 4. Curve 1 is defined as the Short Circuit or Sensitive E/F or Derived Earth Fault operate curve. Curve 2 is defined as the Short Circuit or Sensitive E/F or Derived Earth Fault reset curve. When the User Curve1 is chosen as operate curve, its corresponding reset curve is automatically chosen as the one assigned in the User Programmable Curve Tool.				
ISEF>1 Direction	32	02	Non-Directional	Non Directional or Directional FWD
Selection of the directional first stage sensitive earth fault element.				
ISEF>1 Current	32	03	0.2*In(SEF) A	From 0.005*In(SEF) A to 1*In(SEF) A step 0.001*In(SEF) A
Current setting for the first stage sensitive earth fault element.				
ISEF>1 T. Delay	32	04	1s	From 40ms to 200s step 10ms
Definite Time setting for first stage sensitive earth fault element if ISEF>1 Function is selected as DT.				
ISEF>1 TMS	32	05	1	0.025 to 1.2 step 0.025
Setting for the time multiplier to adjust the operating time of the IEC IDMT characteristic.				
ISEF>1 Time Dial	32	06	7	.01 to 100 step .01
Setting for the time multiplier to adjust the operating time of the IEEE/US IDMT curves.				
ISEF>1 Reset Chr	32	07	DT	DT or IDMT
Setting to determine the type of reset/release characteristic of the IEEE/US curves.				
ISEF>1 tRESET	32	08	0s	0s to 100s step 10ms
Reset time setting for first stage sensitive earth fault element if ISEF>1 Function is set as Inverse Definite Minimum Time (IDMT).				
ISEF>2 Function	32	09	Disabled	Disabled or DT
Enables or disables the second stage sensitive overcurrent element.				
ISEF>2 Direction	32	0A	Non Directional	Non Directional or Directional FWD
Selection of the directional second stage sensitive earth fault element.				
ISEF>2 Current	32	0B	0.2*In(SEF) A	0.005*In(SEF) A to 1*In(SEF) A step 0.001*In(SEF) A
Current setting for the second stage sensitive earth fault element.				
ISEF>2 T. Delay	32	0C	1s	40ms to 200s step 10ms
Definite Time (DT) setting for the second stage sensitive earth fault element.				
GROUP 1 ISEF DIRECTIONAL	32	0D		
Menu Sub-heading				
ISEF> Char Angle	32	0E	-45º	From -180º to 180º step 1º
Characteristic angle for the sensitive earth fault directional element.				
ISEF> VNpol Set	32	0F	5*Vn(NVD) V	From 0.5*Vn(NVD) V to 25*Vn(NVD) V step 0.5*Vn(NVD) V
Minimum voltage reference setting for the sensitive earth fault directional element.				
WATTMETRIC SEF	32	10		

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Menu Sub-heading				
P0> Function	32	11	Disabled	Disabled, Enabled
Enables or Disables the Wattmetric sensitive directional earth fault element.				
P0> Current Set	32	12	0.2*In(SEF) A	From 0.005*In(SEF) A to 1*In(SEF) A step 0.001*In(SEF) A
Current setting for the Wattmetric sensitive directional earth fault element.				
P0> Voltage Set	32	13	5*Vn(NVD) V	From 0.5*Vn(NVD) V to 80*Vn(NVD) V step 0.5*Vn(NVD) V
Voltage setting for the Wattmetric sensitive directional earth fault element.				
P0> Coeff. K Set	32	14	1	1 to 10 step 1
Power Threshold setting for the Wattmetric sensitive directional earth fault element.				
P0> Char Angle	32	15	0º	From -180º to 180º step 1º
Characteristic angle setting for the Wattmetric sensitive directional earth fault element.				
P0> Time Delay	32	16	200ms	From 40ms to 100s step 10ms
Time Delay setting for the Wattmetric sensitive directional earth fault element.				
ISEF> VTS Block	32	20	00(bin)	Bit 00 ISEF>1 VTS Block, Bit 01 ISEF>2 VTS Block
Setting that determines whether VT supervision logic signals blocks the sensitive earth fault stage. When the relevant bit is set to 1, operation of VTS will block the stage if directionalized, when set to 0 the function will be settled to Non-directional.				

Table 5 - Sensitive earth fault protection settings

4.5 Negative Sequence Overcurrent

The Negative Sequence Overcurrent protection included in the relay provides 2 stages of NPS. The first stage can be selected as Definite Time (DT) only and the second stage can be selected as Inverse Definite Minimum Time (IDMT) only.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
GROUP 1 NEG SEQ O/C	33	00		
This column contains settings for Negative Sequence Overcurrent				
I2>1 Status	33	01	DT	Disabled or DT
Enables or Disables the first stage negative sequence overcurrent (NPS) element.				
I2>1 Current Set	33	02	0.3*In A	From 0.05*In A to 0.8*In A step 0.025*In A
Current setting for the first stage negative sequence overcurrent (NPS) element.				
I2>1 time Delay	33	03	200ms	From 40ms to 200s step 10ms
Definite Time (DT) setting for the first stage negative sequence overcurrent (NPS) element.				
I2>2 Status	33	04	Disabled	Disabled or IDMT
Enables or Disables the second stage negative sequence overcurrent (NPS) element.				
I2>2 Current Set	33	05	0.5*In A	From 0.05*In A to 0.8*In A step 0.025*In A
Current setting for the second stage negative sequence overcurrent (NPS) element.				
I2>2 TMS	33	06	1	From 0.7 to 2 step 0.025
Time Multiplier Setting (TMS) for the second stage negative sequence overcurrent (NPS) element.				

Table 6 - Negative sequence overcurrent protection settings

4.6 Three-Phase Voltage Check

This function applies to the following products: P241/P242/P243

- The three-phase voltage check function included in the relay provides a single low voltage threshold setting, which ensures both correct phase rotation (V1 > V2) and sufficient supply voltage prior to permitting motor starting.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
GROUP 1 3PH VOLT.CHECK	34	00		
This column contains settings for 3-Phase Voltage Check				
Start Low V Set	34	01	100*Vn V	From 10*Vn V to 120*Vn V step 1*Vn V
Phase-Neutral Low Voltage threshold setting.				
V< Measur't Mode	34	02	Phase-Phase	0 = Phase-Phase or 1 = Phase-Neutral
The measurement mode of under voltage protection. This cell is available from version C7.A.				

Table 7 - Three phase voltage check setting

4.7 Derived Earth Fault

This function applies to the following products: P241/P242/P243

- The Derived Earth Fault function within the relay provides 2 stages of derived directional earth fault protection. Stage 1 can be set Definite Time (DT) or Inverse Definite Minimum Time (IDMT) or User Curve and stage 2 can be set Definite Time (DT) only.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
GROUP 1 DERIVED E/F	35	00		
This column contains settings for Derived Earth Fault				
IN>1 Function	35	01	IEC S Inverse	Disabled, DT, IEC S Inverse, IEC V Inverse, IEC E Inverse, UK LT Inverse, IEEE M Inverse, IEEE V Inverse, IEEE E Inverse, US Inverse, US ST Inverse, User Curve.
Selection of the first stage derived earth fault element. There are 4 User Curve Characteristics that can be sent to the relay - Curve 1, Curve 2, Curve 3 and Curve 4. Curve 1 is defined as the Short Circuit or Sensitive E/F or Derived Earth Fault operate curve. Curve 2 is defined as the Short Circuit or Sensitive E/F or Derived Earth Fault reset curve. When the User Curve1 is chosen as operate curve, its corresponding reset curve is automatically chosen as the one assigned in the User Programmable Curve Tool.				
IN>1 Direction	35	02	Non Directional	Non Directional or Directional FWD
Selection of the directional first stage derived earth fault element.				
IN>1 Current	35	03	0.2*In A	From 0.08*In A to 32*In A step 0.01*In A
Current setting for the first stage derived earth fault element.				
IN>1 T. Delay	35	04	1s	From 40ms to 100s step 10ms
Definite Time setting for first stage derived earth fault element if IN>1 Function is selected as DT.				
IN>1 TMS	35	05	1	From 0.025 to 1.2 step 0.025
Setting for the time multiplier to adjust the operating time of the IEC IDMT characteristic.				
IN>1 Time Dial	35	06	7	From 10ms to 100s step 10ms
Setting for the time multiplier to adjust the operating time of the IEEE/US IDMT curves.				
IN>1 Reset Chr	35	07	DT	DT or IDMT
Setting to determine the type of reset/release characteristic of the IEEE/US curves.				
IN>1 tRESET	35	08	0s	From 0s to 100s step 10ms

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Reset time setting for first stage derived earth fault element if IN>1 Function is set as Inverse Definite Minimum Time (IDMT).				
IN>2 Function	35	09	Disabled	Disabled or DT
Enables or Disables the second stage derived earth fault element.				
IN>2 Direction	35	0A	Non Directional	Non Directional or Directional FWD
Selection of the directional second stage derived earth fault element.				
IN>2 Current	35	0B	0.2*In A	From 0.08*In A to 32*In A step 0.01*In A
Current setting for the second stage derived earth fault element.				
IN>2 T. Delay	35	0C	1s	From 40ms to 100s step 10ms
Definite Time (DT) setting for the second stage derived earth fault element.				
IN DIRECTIONAL	35	0D		
Sub-heading				
IN> Char Angle	35	0E	-45º	From -180º to 180º step 1º
Characteristic angle for the derived earth fault directional element.				
IN> pol. Type	35	0F	Zero Sequence	Zero sequence, Neg sequence
Selection of polarization type depending on VT connection used.				
IN> VNpol Set	35	10	5*Vn(NVD) V	From 0.5*Vn(NVD) V to 25*Vn(NVD) V step 0.5*Vn(NVD) V
Minimum voltage reference setting for the derived earth fault directional element.				
IN> V2pol Set	35	11	5*Vn V	From 0.5*Vn V to 25*Vn V step 0.5*Vn V
Minimum Negative sequence Voltage reference setting for the derived earth fault directional element. P241 and P242 only.				
IN> I2pol Set	35	12	0.08*In A	From 0.002*In A to 0.8*In A step 0.001*In A
Minimum Negative sequence current reference setting for the derived earth fault directional element.				
IN> VTS Blocking	35	20	00(bin)	Bit 00 IN>1 VTS Block, Bit 01 IN>2 VTS Block
Setting that determines whether VT supervision logic signals blocks the derived earth fault stage. When the relevant bit is set to 1, operation of VTS will block the stage if directionalized, when set to 0 the function will be settled to Non-directional.				

Table 8 - Derived earth fault protection settings

4.8 Stall Detection

The Stall detection in the relay is available for protection of the motor during the starting sequence.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
GROUP 1 STALL DETECTION	39	00		
This column contains settings for Stall Detection				
Prolonged Start	39	01	Enabled	Disabled, Enabled
Enables or disables the detection of a prolonged start.				
Start Criteria	39	02	52a	52a, I or 52a + I
Selects the detection method of a motor start. Options are change of state of Circuit Breaker (52a), exceeding the start current threshold or both.				
Starting Current	39	03	3*In A	From 0.2*In A to 7.5*In A step 0.1*In A
Starting current setting. A normal start will be detected if the current falls below this threshold within the prolonged start time setting. Setting in multiples of Ith Thermal Overload setting.				
Prol. Start Time	39	04	5s	From 1s to 200s step 1s

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Starting supervision time. The motor current has to fall below the starting current threshold within this time for a normal start to be detected.				
Stall Rotor-strt	39	05	Disabled	Disabled or Enabled
Enables or disables the locked rotor during starting element. Used in conjunction with the speed switch input if the starting time is greater than the safe stall time.				
Stall Detection	39	06	Enabled	Disabled or Enabled
Enables or disables the stall detection element.				
Stall Setting	39	07	3*In A	From 1*In A to 5*In A step 0.5*In A
Stall current setting.				
Stall Time	39	08	2s	From 100ms to 60s step 100ms
Stall Time Delay setting.				
Reacceleration	39	09	Disabled	Disabled or Enabled
Enables or disables the reacceleration of the motor following a reduction in system voltage.				
Reac. Low V Set	39	0A	100*Vn V	From 50*Vn V to 120*Vn V step 1*Vn V
Undervoltage setting for the reacceleration element (Ph-Ph).				

Table 9 - Stall protection settings

4.9 Motor Differential Protection (P243 only)

The differential protection included in the relay may be configured to operate as either a high impedance or biased differential element.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
GROUP 1 DIFFERENTIAL	3A	00		
This column contains settings for Differential				
Diff Function	3A	01	Percentage bias	Disabled, Percentage Bias, High Impedance
P243 only. Setting to select the function of the differential protection element.				
Diff Is1	3A	02	0.1*In A	From 0.05*In A to 0.5*In A step 0.01*In A
P243 only. Minimum differential operating current of the low impedance biased characteristic. Also, the pick-up setting of the high impedance differential protection.				
Diff k1	3A	03	0	From 0% to 20% step 5%
P243 only. Slope angle setting for the first slope of the low impedance biased characteristic.				
Diff Is2	3A	04	1.2*In A	From 1*In A to 5*In A step 0.1*In A
P243 only. The bias current operating threshold for the second slope, low impedance characteristic.				
Diff k2	3A	05	1.5	From 20% to 150% step 10%
P243 only. Slope angle setting for the second slope of the low impedance biased characteristic.				

Table 10 - Differential protection settings

4.10 Residual Overvoltage (Neutral Voltage Displacement)

The Neutral Voltage Displacement (NVD) element within the relay is of two-stage design, each stage having separate voltage and time delay settings. Stage 1 may be set to operate on either an IDMT or DT characteristic, whilst stage 2 may be set to DT only.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
GROUP 1 RES O/V NVD	3B	00		
This column contains settings for Residential Overvoltage NVD				
VN>1 Function	3B	02	Disabled	Disabled, DT or IDMT
Selection of the first stage residual overvoltage (NVD) element.				
VN>1 Voltage Set	3B	03	5*Vn(NVD) V	From 0.5*Vn(NVD) V to 80*Vn(NVD) V step 0.5*Vn(NVD) V
Voltage setting for the first stage residual overvoltage (NVD) element.				
VN>1 Time Delay	3B	04	5s	From 40ms to 100s step 10ms
Definite Time (DT) setting for the first stage residual overvoltage (NVD) element if VN>1 Function is set as DT.				
VN>1 TMS	3B	05	1	From 0.05 to 100 step 0.05
Time Multiplier Setting for the first stage residual overvoltage (NVD) element if VN>1 Function is set as IDMT.				
VN>2 Status	3B	07	Disabled	Disabled or DT
Enables or disables the second stage residual overvoltage (NVD).				
VN>2 Voltage Set	3B	08	10*Vn(NVD) V	From 0.5*Vn(NVD) V to 80*Vn(NVD) V step 0.5*Vn(NVD) V
Voltage setting for the second stage residual overvoltage (NVD) element.				
VN>2 Time Delay	3B	09	10s	From 40ms to 100s step 10ms
Definite Time (DT) setting for the second stage residual overvoltage (NVD) element.				

Table 11 - Residual overvoltage protection settings

4.11 Limit Number of Starts Protection

The start protection within the relay supervises the maximum allowable number of starts, hot or cold, that the motor is permitted for. The relay distinguishes between a hot start or a cold start by using the data held in the motor thermal replica. Starting is blocked if the permitted number of starts is exceeded by the use of a time between starts timer.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
GROUP 1 LIMIT NB STARTS	3C	00		
This column contains settings for Limit No. of Starts				
Hot Start Status	3C	01	Disabled	Disabled or Enabled
Enables or disables the setting of a maximum number of hot starts before a relay issues an alarm.				
Hot Start Nb.	3C	02	1	1 to 5 step 1
Maximum number of hot starts allowed before starting of the motor is inhibited.				
Cold Start Stat.	3C	03	Disabled	Disabled or Enabled
Enables or disables the setting of a maximum number of cold starts before a relay issues an alarm.				
Cold Start Nb.	3C	04	2	1 to 5 step 1
Maximum number of cold starts allowed before starting of the motor is inhibited.				
Supervising Time	3C	05	10s	From 10s to 120s step 1s
Supervising period for the number of hot and cold starts.				
T.Betw.St.Status	3C	06	Disabled	Disabled or Enabled
Enables or disables the setting of a minimum time between motor starts.				
Time Betwe Start	3C	07	2s	From 1s to 120s step 1s

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Minimum time period setting allowable between each motor start.				
Inhib.Start Time	3C	08	10s	From 1s to 120s step 1s
Inhibition time setting. If the maximum number of starts (hot or cold) is reached, this time delay will start and inhibit a new start before it ends.				

Table 12 - Limit number of start protection settings

4.12 Loss of Load (Under Power)

The Loss of Load protection within the relay uses 2 underpower elements to detect a loss of load due to a shaft failure or a pump running unprimed. Both stages are selectable to Definite Time (DT). This feature is only enabled when the circuit breaker is closed, therefore it requires a 52a CB auxiliary contact mapped to an opto input to monitor the breaker status.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
GROUP 1 LOSS OF LOAD	3D	00		
This column contains settings for Loss of Load				
P<1 Status	3D	01	DT	Disabled or DT
Enables or disables the first stage underpower element.				
P<1 Power Set	3D	02	1*Vn*In W	From 1*Vn*In W to 120*Vn*In step 1*Vn*In
First stage underpower threshold.				
P<1 Time Delay	3D	03	200ms	From 40ms to 100s step 10ms
Definite Time (DT) setting for first stage underpower element.				
P<2 Status	3D	11	Disabled	Disabled or DT
Enables or disables the second stage underpower element.				
P<2 Power Set	3D	12	1*Vn*In W	From 1*Vn*In W to 120*Vn*In step 1*Vn*In
Second stage undrepower threshold.				
P<2 Time Delay	3D	13	200ms	From 40ms to 100s step 10ms
Definite Time (DT) setting for second stage underpower element.				
P< Drop-of Time	3D	20	5s	From 5s to 300s step 50ms
Time delay on drop-off to ensure inhibition during motor starting.				

Table 13 - Loss of load protection settings

4.13 Out-of-Step Protection (Under Power Factor)

The relay provides power factor protection on synchronous machines by monitoring the 3 phase power factor. Both Lead and Lag elements are settable to Definite Time (DT). This feature is only enabled when the circuit breaker is closed, therefore it requires a 52 a CB auxiliary contact mapped to an opto input to monitor the breaker status.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
GROUP 1 OUT OF STEP	3E	00		
This column contains settings for Out of Step				
PF< Status Lead	3E	01	DT	Disabled or DT

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Enables or disables the lead level element of the under power factor protection.				
Power Fact. Lead	3E	02	0.9	From 0.1 to 0.9 step 0.1
Power Factor setting for the lead level element.				
PF< Lead TD	3E	03	50ms	From 50ms to 100s step 10ms
Time delay setting associated with the lead level element of the under power factor protection.				
PF< Status Lag	3E	11	Disabled	Disabled or DT
Enables or disables the lag level element of the under power factor protection.				
Power Fact. Lag	3E	12	0.9	From 0.1 to 0.9 step 0.1
Power Factor setting for the lag level element.				
PF< Lag TD	3E	13	50ms	From 50ms to 100s step 10ms
Time delay setting associated with the lag level element of the under power factor protection.				
PF< Drop-of time	3E	20	7s	From 50ms to 300s step 50ms
Time delay on drop-off to ensure inhibition during motor starting.				

Table 14 - Out of step protection settings

4.14 Reverse Power

The relay provides reverse power protection which is used to detect the reverse flow of power due to a synchronous motor feeding a fault. This feature is only enabled when the circuit breaker is closed, therefore it requires a 52 a CB auxiliary contact mapped to an opto input to monitor the breaker status.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
GROUP 1 REVERSE POWER	3F	00		
This column contains settings for Reverse Power				
Rev.P< Power Set	3F	02	1*Vn*In W	From 1*Vn*In W to 120*Vn*In W step 1*Vn*In W
Setting for the reverse power stage.				
Rev.P<Time Delay	3F	03	200ms	From 40ms to 100s step 10ms
Time delay associated with the reverse power stage.				
Rev.P<Drop-of Ti	3F	20	5s	From 50ms to 300s step 50ms
Time delay on drop-off to ensure inhibition during motor starting.				

Table 15 - Reverse power protection settings

4.15 Anti-Backspin Protection

Courier Text	Col	Row	Default Setting	Available Setting
Description				
GROUP 1 ANTI-BACKSPIN	40	00		
This column contains settings for Anti Backspin				
VRem Antibacks	40	01	10*Vn V	From 1*Vn V to 120*Vn V step 1*Vn V
Setting of the remanent phase-phase voltage element.				
Anti-backs delay	40	02	3000s	From 1s to 7200s step 1s

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Time delay setting associated with the remanent voltage anti-backspin protection.				

Table 16 - Anti-Backspin protection settings

4.16 Field Failure Protection

The field failure protection included in the relay provides two impedance based stages of protection and a leading power factor alarm element.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
GROUP 1 FIELD FAILURE	41	00		
This column contains settings for Field Failure				
FFail Alm Status	41	01	Disabled	Disabled, Enabled
Enables or disables the Field Failure Alarm function.				
FFail Alm Angle	41	02	15º	From 15º to 75º step 1º
Pick-up setting for field failure alarm angle (leading power factor angle).				
FFail Alm Delay	41	03	5s	From 0s to 100s step 10ms
Operating time-delay setting of the field failure alarm.				
FFail1 Status	41	04	Enabled	Disabled, Enabled
Enables or disables the first stage field failure protection function.				
FFail1 -Xa1	41	05	20*Vn/In Ω	0 Ω to 40*Vn/In Ω step 0.5*Vn/In Ω
Negative reactance offset setting of first stage field failure impedance protection.				
FFail1 Xb1	41	06	220*Vn/In Ω	25*Vn/In Ω to 325*Vn/In Ω step 1*Vn/In Ω
Diameter setting of circular impedance characteristic of first stage field failure protection.				
FFail1 TimeDelay	41	07	5s	From 0s to 100s step 10ms
Operating time-delay setting of the field failure first stage protection.				
FFail1 DO Timer	41	08	0s	From 0s to 100s step 10ms
Drop-off time-delay setting of the first stage field failure protection.				
FFail2 Status	41	09	Disabled	Disabled, Enabled
Enables or disables the second stage field failure protection function.				
FFail2 -Xa2	41	0A	20*Vn/In Ω	0 Ω to 40*Vn/In Ω step 0.5*Vn/In Ω
Negative reactance offset setting of second stage field failure impedance protection.				
FFail2 Xb2	41	0B	110*Vn/In Ω	25*Vn/In Ω to 325*Vn/In Ω step 1*Vn/In Ω
Diameter setting of circular impedance characteristic of second stage field failure protection.				
FFail2 TimeDelay	41	0C	0s	From 0s to 100s step 10ms
Operating time-delay setting of the field failure second stage protection.				
FFail2 DO Timer	41	0D	0s	From 0s to 100s step 10ms
Drop-off time-delay setting of the second stage field failure protection.				

Table 17 - Field failure protection settings

4.17 Voltage Protection

The undervoltage and overvoltage protection included within the relay both consist of two independent stages. The Undervoltage protection stage 1 can be set to Inverse Definite Minimum Time (IDMT) and the second stage can be set to Definite Time (DT). This feature is only enabled when the circuit breaker is closed, therefore it requires a 52a CB auxiliary contact mapped to an opto input to monitor the breaker status.

The overvoltage protection stage 1 and stage 2 can be set to Definite Time (DT) only.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
GROUP 1 VOLT PROTECTION	42	00		
This column contains settings for Voltage Protection				
UNDER VOLTAGE	42	01		
sub-heading				
V< Measur't Mode	42	02	Phase-Neutral	Phase-Phase or Phase-Neutral
The measurement mode of under voltage protection. This cell is available from version C7.A.				
V<1 Function	42	04	Disabled	Disabled, DT or IDMT
Selection of first stage undervoltage element.				
V<1 Voltage Set	42	05	93*Vn V	From 15*Vn V to 120*Vn V step 1*Vn V
Setting of the first stage undervoltage element.				
V<1 Time Delay	42	06	500ms	From 40ms to 7200s step 10ms
Definite Time (DT) setting for the first stage undervoltage element if V<1 Function is set as DT.				
V<1 TMS	42	07	1	0.05 to 100 step 0.05
Time Multiplier Setting of first stage undervoltage element if V<1 Function is set as IDMT.				
V<2 Status	42	09	Disabled	Disabled or DT
Selection of second stage undervoltage element.				
V<2 Voltage Set	42	0A	60*Vn V	From 15*Vn V to 120*Vn V step 1*Vn V
Setting of the second stage undervoltage element.				
V<2 Time Delay	42	0B	250ms	From 40ms to 100s step 10ms
Definite Time (DT) setting for the first stage undervoltage element if V<1 Function is set as DT.				
Inhib.During St.	42	0C	Disabled	Disabled or Enabled
Inhibits a trip during the start sequence of the motor. The thermal state will not be greater than 90% during the start sequence.				
OVERVOLTAGE	42	0D		
sub-heading				
V> Measur't Mode	42	0E	Phase-Neutral	Phase-Phase or Phase-Neutral
The measurement mode of over voltage protection. This cell is available from version C7.A.				
V>1 Status	42	10	Disabled	Disabled or DT
Enable or disables the first stage overvoltage element.				
V>1 Voltage Set	42	11	132*Vn V	From 50*Vn V to 200*Vn V step 1*Vn V
Setting of the first stage overvoltage element.				
V>1 Time Delay	42	12	10s	From 40ms to 7200s step 10ms
Definite Time (DT) setting for the first stage overvoltage element.				
V>2 Status	42	14	DT	Disabled or DT
Enable or disables the second stage overvoltage element.				
V>2 Voltage Set	42	15	140*Vn V	From 50*Vn V to 200*V1 step 1*Vn V
Setting of the second stage overvoltage element.				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
V>2 Time Delay	42	16	5s	From 40ms to 7200s step 10ms
Definite Time (DT) setting for the second stage overvoltage element.				

Table 18 - Under/Overvoltage protection settings

4.18 Underfrequency Protection

The relay includes 2 stages of underfrequency protection to protect synchronous machine against loss of AC supply. Each stage can be selected as Definite Time (DT). This feature is only enabled when the circuit breaker is closed, therefore it requires a 52a CB auxiliary contact mapped to an opto input to monitor the breaker status.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
GROUP 1 UNDER FREQUENCY	43	00		
This column contains settings for Under Frequency				
F<1 Status	43	02	Disabled	Disabled or IDMT
Enables or disables the first stage underfrequency element.				
F<1 Setting	43	03	49 Hz	45 Hz to 65 Hz step 0.05 Hz
Pick-up setting for the first stage underfrequency element.				
F<1 Time Delay	43	04	100ms	From 100ms to 100s step 100ms
Operating time-delay setting for the definite time first stage underfrequency element.				
F<2 Status	43	05	Disabled	Disabled or IDMT
Enables or disables the second stage underfrequency element.				
F<2 Setting	43	06	48 Hz	45 Hz to 65 Hz step 0.05 Hz
Pick-up setting for the second stage underfrequency element.				
F<2 Time Delay	43	07	100ms	From 100ms to 100s step 100ms
Operating time-delay setting for the definite time second stage underfrequency element.				

Table 19 - Underfrequency protection settings

4.19 Resistor Temperature Device (RTD)

The relay provides temperature protection from 10 PT100/Ni100/Ni120 Resistor Temperature Devices (RTD). Each RTD has a Definite Time (DT) trip and alarm stage.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
GROUP 1 RTD PROTECTION	44	00		
This column contains settings for RTD Protection				
Select RTD	44	01	0000000000(bin)	Bit 00 RTD Input 1 to Bit 09 RTD Input 10
10 bit setting to enable or disable the 10 RTDs. For each bit 1 = Enabled, 0 = Disabled.				
RTD 1 Alarm Set	44	03	80	From 0 to 400 step 1
Temperature setting for this alarm element.				
RTD 1 Alarm Dly	44	04	0s	From 0s to 100s step 1s
Operating time delay setting for this alarm element.				
RTD 1 Trip Set	44	05	100	From 0 to 400 step 1

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Temperature setting for this trip element.				
RTD 1 Trip Dly	44	06	0s	From 0s to 100s step 1s
Operating time delay setting for this alarm element.				
RTD 2 Alarm Set	44	08	80	From 0 to 400 step 1
Temperature setting for this alarm element.				
RTD 2 Alarm Dly	44	09	0s	From 0s to 100s step 1s
Operating time delay setting for this alarm element.				
RTD 2 Trip Set	44	0A	100	From 0 to 400 step 1
Temperature setting for this trip element.				
RTD 2 Trip Dly	44	0B	0s	From 0s to 100s step 1s
Operating time delay setting for this alarm element.				
RTD 3 Alarm Set	44	0D	80	From 0 to 400 step 1
Temperature setting for this alarm element.				
RTD 3 Alarm Dly	44	0E	0s	From 0s to 100s step 1s
Operating time delay setting for this alarm element.				
RTD 3 Trip Set	44	0F	100	From 0 to 400 step 1
Temperature setting for this trip element.				
RTD 3 Trip Dly	44	10	0s	From 0s to 100s step 1s
Operating time delay setting for this alarm element.				
RTD 4 Alarm Set	44	12	80	From 0 to 400 step 1
Temperature setting for this alarm element.				
RTD 4 Alarm Dly	44	13	0s	From 0s to 100s step 1s
Operating time delay setting for this alarm element.				
RTD 4 Trip Set	44	14	100	From 0 to 400 step 1
Temperature setting for this trip element.				
RTD 4 Trip Dly	44	15	0s	From 0s to 100s step 1s
Operating time delay setting for this alarm element.				
RTD 5 Alarm Set	44	17	80	From 0 to 400 step 1
Temperature setting for this alarm element.				
RTD 5 Alarm Dly	44	18	0s	From 0s to 100s step 1s
Operating time delay setting for this alarm element.				
RTD 5 Trip Set	44	19	100	From 0 to 400 step 1
Temperature setting for this trip element.				
RTD 5 Trip Dly	44	1A	0s	From 0s to 100s step 1s
Operating time delay setting for this alarm element.				
RTD 6 Alarm Set	44	1C	80	From 0 to 400 step 1
Temperature setting for this alarm element.				
RTD 6 Alarm Dly	44	1D	0s	From 0s to 100s step 1s
Operating time delay setting for this alarm element.				
RTD 6 Trip Set	44	1E	100	From 0 to 400 step 1
Temperature setting for this trip element.				
RTD 6 Trip Dly	44	1F	0s	From 0s to 100s step 1s
Operating time delay setting for this alarm element.				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
RTD 7 Alarm Set	44	21	80	From 0 to 400 step 1
Temperature setting for this alarm element.				
RTD 7 Alarm Dly	44	22	0s	From 0s to 100s step 1s
Operating time delay setting for this alarm element.				
RTD 7 Trip Set	44	23	100	From 0 to 400 step 1
Temperature setting for this trip element.				
RTD 7 Trip Dly	44	24	0s	From 0s to 100s step 1s
Operating time delay setting for this alarm element.				
RTD 8 Alarm Set	44	26	80	From 0 to 400 step 1
Temperature setting for this alarm element.				
RTD 8 Alarm Dly	44	27	0s	From 0s to 100s step 1s
Operating time delay setting for this alarm element.				
RTD 8 Trip Set	44	28	100	From 0 to 400 step 1
Temperature setting for this trip element.				
RTD 8 Trip Dly	44	29	0s	From 0s to 100s step 1s
Operating time delay setting for this alarm element.				
RTD 9 Alarm Set	44	2B	80	From 0 to 400 step 1
Temperature setting for this alarm element.				
RTD 9 Alarm Dly	44	2C	0s	From 0s to 100s step 1s
Operating time delay setting for this alarm element.				
RTD 9 Trip Set	44	2D	100	From 0 to 400 step 1
Temperature setting for this trip element.				
RTD 9 Trip Dly	44	2E	0s	From 0s to 100s step 1s
Operating time delay setting for this alarm element.				
RTD 10 Alarm Set	44	30	80	From 0 to 400 step 1
Temperature setting for this alarm element.				
RTD 10 Alarm Dly	44	31	0s	From 0s to 100s step 1s
Operating time delay setting for this alarm element.				
RTD 10 Trip Set	44	32	100	From 0 to 400 step 1
Temperature setting for this trip element.				
RTD 10 Trip Dly	44	33	0s	From 0s to 100s step 1s
Operating time delay setting for this alarm element.				
Ext.Temp.Influen	44	34	Disabled	Disabled or DT
Enables or disables the adaptation of the thermal replica according to the external ambient temperature measurement.				
Ext. Temp. RTD	44	35	1	1 to 10 step 1
RTD which will be used to adapt the thermal replica for the external ambient temperature.				
Ext. RTD Back-Up	44	36	2	1 to 10 step 1
Back-up RTD which will be used to adapt the thermal replica for the external ambient temperature.				
RTD Type	44	50	PT100	PT100, Ni100, Ni120
Type of RTD.				
RTD Unit	44	51	Celsius	Celsius or Fahrenheit
Unit of RTD temperature measurement.				

Table 20 - RTD protection settings

4.20 Circuit Breaker Fail

This function consists of a two-stage Circuit Breaker (CB) fail function initiated by:

- Current-based or Voltage-based protection elements
- External protection elements.

For current-based protection, the reset condition is based on undercurrent operation to determine that the CB has opened. For the non-current based protection, the reset criteria may be selected by means of a setting for determining a CB Failure condition.

It is common practice to use low set undercurrent elements in protection relays to indicate that circuit breaker poles have interrupted the fault or load current, as required.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
GROUP 1 CB FAIL	45	00		
This column contains settings for Circuit Breaker Failure				
CB FAIL	45	01		
Sub-heading				
CB Fail 1 Status	45	02	Enabled	Enabled or Disabled
Enables or disables the first stage of the circuit breaker function.				
CB Fail 1 Timer	45	03	300ms	From 0s to 10s step 10ms
Circuit breaker fail timer setting for stage 1 for which the initiating condition must be valid.				
CB Fail 2 Status	45	04	Disabled	Enabled or Disabled
Enables or disables the second stage of the circuit breaker function.				
CB Fail 2 Timer	45	05	400ms	From 0s to 10s step 10ms
Circuit breaker fail timer setting for stage 2 for which the initiating condition must be valid.				
CBF Non I Reset	45	06	CB open & I<	I< Only, CB Open & I<, Prot. Reset & I<
Setting which determines the elements that will reset the circuit breaker fail time for non current based protection functions (e.g. voltage, frequency) initiating circuit breaker fail conditions.				
CBF Ext Reset	45	07	CB open & I<	I< Only, CB Open & I<, Prot. Reset & I<
Setting which determines the elements that will reset the circuit breaker fail time for external protection functions initiating circuit breaker fail conditions.				
UNDER CURRENT	45	08		
Sub-heading				
I< Current Set	45	09	0.05*In A	From 0.02*In A to 3.2*In A step 0.01*In A
Circuit breaker fail phase fault undercurrent setting. This undercurrent element is used to reset the CB failure function initiated from the internal or external protection (Any Trip and Ext Trip signals).				

Table 21 - CBF protection settings

4.21 Current Loop Inputs and Outputs (CLIO)

Four analog or current loop (analog) inputs are provided for transducers with ranges of ~ 0 - 1 mA, 0 - 10 mA, 0 - 20 mA or 4 - 20 mA. The analog inputs can be used for various transducers such as vibration monitors, tachometers and pressure transducers. Associated with each input there are two protection stages, one for alarm and one for trip. Each stage can be individually enabled or disabled and each stage has a definite time delay setting. The Alarm and Trip stages operate when the input value rises above the Alarm/Trip threshold.

Four current loop (analog) outputs are provided with ranges of 0 - 1 mA, 0 - 10 mA, 0 - 20 mA or 4 - 20 mA which can alleviate the need for separate transducers. These may be used to feed standard moving coil ammeters for analog indication of certain measured quantities or into a SCADA using an existing analog RTU.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
GROUP 1 CLIO INPUTS	46	00		
This column contains settings for CLIO Inputs				
Range 1	46	01	Disabled	Disabled, 0 - 1 mA, 0 - 10 mA, 0 - 20 mA, 4 - 20 mA
Enables or disables the current loop (transducer) input 1 element.				
Unit 1	46	02	None	None, A, V, Hz, W, Var, VA, °C, F, %, s
Current loop 1 input unit type.				
Minimum 1	46	03	0	A list of parameters are shown in the table below.
Current loop input 1 minimum setting. Defines the lower range of the physical or electrical quantity measured by the transducer.				
Maximum 1	46	04	100	A list of parameters are shown in the table below.
Current loop input 1 maximum setting. Defines the upper range of the physical or electrical quantity measured by the transducer.				
Function 1	46	05	Disabled	Disabled or Enabled
Enables or disables the current loop (transducer) input 1 alarm and trip stages.				
Alarm Set 1	46	06	0	A list of parameters are shown in the Current Loops Inputs Units and Setting Ranges table
Pick-up setting for the current loop input 1 alarm element.				
Alarm Delay 1	46	07	0s	From 0s to 300s step 1s
Operating time-delay setting of current loop input 1 alarm element.				
Trip Set 1	46	08	0	A list of parameters are shown in the Current Loops Inputs Units and Setting Ranges table
Pick-up setting for the current loop input 1 trip element.				
Trip Delay 1	46	09	0s	From 0s to 300s step 1s
Operating mode of the current loop input 1 trip element.				
Range 2	46	11	Disabled	Disabled, 0 - 1 mA, 0 - 10 mA, 0 - 20 mA, 4 - 20 mA
Enables or disables the current loop (transducer) input 2 element.				
Unit 2	46	12	None	None, A, V, Hz, W, Var, VA, °C, F, %, s
Current loop 2 input unit type.				
Minimum 2	46	13	0	A list of parameters are shown in the table below.
Current loop input 2 minimum setting. Defines the lower range of the physical or electrical quantity measured by the transducer.				
Maximum 2	46	14	0	A list of parameters are shown in the table below.
Current loop input 2 maximum setting. Defines the upper range of the physical or electrical quantity measured by the transducer.				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Function 2	46	15	Disabled	Disabled or Enabled
Enables or disables the current loop (transducer) input 2 alarm and trip stages.				
Alarm Set 2	46	16	0	A list of parameters are shown in the Current Loops Inputs Units and Setting Ranges table
Pick-up setting for the current loop input 2 alarm element.				
Alarm Delay 2	46	17	0s	From 0s to 300s step 1s
Operating time-delay setting of current loop input 2 alarm element.				
Trip Set 2	46	18	0	A list of parameters are shown in the Current Loops Inputs Units and Setting Ranges table
Pick-up setting for the current loop input 2 trip element.				
Trip Delay 2	46	19	0s	From 0s to 300s step 1s
Operating mode of the current loop input 2 trip element.				
Range 3	46	21	Disabled	Disabled, 0 - 1 mA, 0 - 10 mA, 0 - 20 mA, 4 - 20 mA
Enables or disables the current loop (transducer) input 3 element.				
Unit 3	46	22	None	None, A, V, Hz, W, Var, VA, °C, F, %, s
Current loop 3 input unit type.				
Minimum 3	46	23	0	A list of parameters are shown in the table below.
Current loop input 3 minimum setting. Defines the lower range of the physical or electrical quantity measured by the transducer.				
Maximum 3	46	24	0	A list of parameters are shown in the table below.
Current loop input 3 maximum setting. Defines the upper range of the physical or electrical quantity measured by the transducer.				
Function 3	46	25	Disabled	Disabled or Enabled
Enables or disables the current loop (transducer) input 3 alarm and trip stages.				
Alarm Set 3	46	26	0	A list of parameters are shown in the Current Loops Inputs Units and Setting Ranges table
Pick-up setting for the current loop input 3 alarm element.				
Alarm Delay 3	46	27	0s	From 0s to 300s step 1s
Operating time-delay setting of current loop input 3 alarm element.				
Trip Set 3	46	28	0	A list of parameters are shown in the Current Loops Inputs Units and Setting Ranges table
Pick-up setting for the current loop input 3 trip element.				
Trip Delay 3	46	29	0s	From 0s to 300s step 1s
Operating mode of the current loop input 3 trip element.				
Range 4	46	31	Disabled	Disabled, 0 - 1 mA, 0 - 10 mA, 0 - 20 mA, 4 - 20 mA
Enables or disables the current loop (transducer) input 4 element.				
Unit 4	46	32	None	None, A, V, Hz, W, Var, VA, °C, F, %, s
Current loop 4 input unit type.				
Minimum 4	46	33	0	A list of parameters are shown in the table below.
Current loop input 4 minimum setting. Defines the lower range of the physical or electrical quantity measured by the transducer.				
Maximum 4	46	34	0	A list of parameters are shown in the table below.
Current loop input 4 maximum setting. Defines the upper range of the physical or electrical quantity measured by the transducer.				
Function 4	46	35	Disabled	Disabled or Enabled
Enables or disables the current loop (transducer) input 4 alarm and trip stages.				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Alarm Set 4	46	36	0	A list of parameters are shown in the Current Loops Inputs Units and Setting Ranges table
Pick-up setting for the current loop input 4 alarm element.				
Alarm Delay 4	46	37	0s	From 0s to 300s step 1s
Operating time-delay setting of current loop input 4 alarm element.				
Trip Set 4	46	38	0	A list of parameters are shown in the Current Loops Inputs Units and Setting Ranges table
Pick-up setting for the current loop input 4 trip element.				
Trip Delay 4	46	39	0s	From 0s to 300s step 1s
Operating mode of the current loop input 4 trip element.				
Drop-of time	46	40	5s	From 100ms to 300s step 100ms
Drop-off time delay of the current loop inputs 1/2/3/4.				

Table 22 - Current loop inputs and outputs settings

Analog (Current loop) input units and setting ranges are shown below

Analog input unit	Setting range		Step size
	Min.	Max.	
A	0	100 k	1
V	0	20 k	1
Hz	0	100	1
W	-1.41 G	1.41 G	1
VAr	-1.41 G	1.41 G	1
VA	0	1.41 G	1
°C	-40	400	1
F	-40	752	1
%	0	150	0.1
s	0	300	0.1
None	-32.5 k	50 k	0.1

Table 23 - Current loop inputs units and setting ranges

The CLIO output conversion task runs every 50 ms and the refresh interval for the output measurements is nominally 200 ms.

Current loop output parameters are shown in the following table:

Current loop output parameter	Abbreviation	Units	Range	Step	Default min.	Default max.
Current Magnitude	IA Magnitude IB Magnitude IC Magnitude IN Magnitude	A	0 to 100 k	1	0	100
RMS Phase Currents	IA RMS IB RMS IC RMS IN RMS	A	0 to 100 k	1	0	100
P-N voltage Magnitude	VAN Magnitude VBN Magnitude VCN Magnitude VN Magnitude	V	0 to 20 k	1	0	100
RMS Phase-N Voltages	VAN RMS VBN RMS VCN RMS	V	0 to 20 k	1	0	100
P-P Voltage Magnitude	VAB Magnitude VBC Magnitude VCA Magnitude	V	0 to 20 k	1	0	100

Current loop output parameter	Abbreviation	Units	Range	Step	Default min.	Default max.
RMS Phase-Phase Voltages	VAB RMS Magnitude VBC RMS Magnitude VCA RMS Magnitude	V	0 to 20 k	1	0	100
Frequency	Frequency	Hz	0 to 100	1	0	100
3 Ph Active Power	Three-Phase Watts	W	-10 M to 30 M	1	0	100
3 Ph Reactive Power	Three-Phase Vars	Var	-10 M to 30 M	1	0	100
3 Ph Apparent Power	Three-Phase VA	VA	-10 M to 30 M	1	0	100
3 Ph Power Factor	3Ph Power Factor	-	-1 to 1	0.01	0	1
RTD Temperatures	RTD 1 RTD 2 RTD 3 RTD 4 RTD 5 RTD 6 RTD 7 RTD 8 RTD 9 RTD 10	°C	-40°C to 400°C	1°C	0°C	100°C
Nb of hottest RTD	Nb Hottest RTD		1-10	1	1	10
Thermal State	Thermal State	%	0-150	0.1	0	100
Time to Thermal Trip	Time to Thermal Trip	Sec	0-300	0.1	0	100
Time to next start	Time to Next Start	Sec	0-300	0.1	0	100

Table 24 - Current loop outputs units and setting range

Note 1	*The current loop (Analog) outputs are refreshed every 200 ms.*
Note 2	*The polarity of Watts, Vars and power factor is affected by the Measurements Mode setting.*
Note 3	*These settings are for nominal 1 A and 100/120 V versions only. For other nominal versions they need to be multiplied accordingly.*
Note 4	*All current loop (Analog) output measurements are in primary values.*

4.22 Supervision (VTS and CTS)

The VTS feature in the relay operates when it detects a Negative Phase Sequence (NPS) voltage when there is no NPS current. This gives operation for the loss of one or two-phase voltages. Stability of the VTS function is assured during system fault conditions by the presence of the NPS current. The use of negative sequence quantities ensures correct operation even where three-limb or V-connected VTs are used.

If all 3-phase voltages to the relay are lost, there are no NPS quantities to operate the VTS function, and the 3-phase voltages collapse. If this is detected without a corresponding change in any of the phase current signals (which would indicate a fault), a VTS condition is raised. In practice, the relay detects superimposed current signals, which are changes in the current applied to the relay.

If a VT is inadvertently left isolated before line energization, voltage-dependent elements may operate incorrectly. The previous VTS element detected 3-phase VT failure due to the absence of all three phase voltages with no corresponding change in current. However, on line energization there is a change in current, for example, due to load or line charging current. An alternative method of detecting 3-phase VT failure is therefore required on line energization.

The absence of measured voltage on all three phases on line energization can be as a result of two conditions. The first is a 3-phase VT failure and the second is a close-up 3-phase fault. The first condition would require blocking of the voltage dependent function and the second would require tripping. To differentiate between these two conditions an overcurrent level detector (VTS I> Inhibit) is used to prevent a VTS block from being issued if it operates. This element should be set in excess of any non-fault based currents on line energization (load, line charging current, transformer inrush current if applicable) but below the level of current produced by a close-up 3-phase fault. If the line is closed where a 3-phase VT failure is present, the overcurrent detector does not operate and a VTS block is applied. Closing onto a 3-phase fault results in operation of the overcurrent detector and prevents a VTS block from being applied.

The CT supervision feature operates on detection of derived zero sequence current, in the absence of corresponding derived zero sequence voltage that would normally accompany it.

The CT supervision can be set to operate from the residual voltage measured at the VNEUTRAL input (VN1 input) or the residual voltage derived from the three phase-neutral voltage inputs as selected by the 'CTS Vn Input' setting.

There are two stages of CT supervision CTS-1 and CTS-2. CTS-1 supervises the CT inputs to IA, IB, IC which are used by the biased differential protection and all the power, impedance and overcurrent based protection functions. CTS-2 supervises the CT inputs to IA-2, IB-2, IC-2 which are used by the biased or high impedance differential or interturn protection in the P243. The CTS-2 independent enabled/disabled setting is to prevent CTS-2 from giving unnecessary alarms when the Generator Differential is disabled. For interturn faults, some utilities may isolate the faulted winding section and return the generator to service, therefore producing unbalanced phase currents. Under these circumstances the CTS-2 may also need to be disabled or de-sensitized to prevent a false alarm and a false block.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
GROUP 1 VT SUPERVISION	48	00		
This column contains settings for Supervision				
VT SUPERVISION	48	01		
Sub-heading				
VTS Time Delay	48	02	5s	From 1s to 10s step 100ms
Operating time-delay setting of the VTS element upon detection of a voltage supervision condition.				
VTS I2 & I0 Inh	48	03	0.05*In A	From 0.05*In A to 0.5*In A step 0.01*In A
This NPS overcurrent setting is used to inhibit the voltage transformer supervision in the event of a fault occurring on the system with negative sequence current above this setting.				
Detect 3P	48	04	Disabled	Enabled or Disabled
3 phase under voltage setting to set whether detecting voltage on 3 phases.				
Threshold 3P	48	05	30*Vn V	From 10*Vn V to 70*Vn V step 1*Vn V
3 phase under voltage level setting. This setting is used to indicate a close up 3 phase fault or a 3 phase VT failure condition.				
Delta I>	48	06	0.1*In A	From 0.1*In A to 5*In A step 0.01*In A
Delta (superimposed) phase current setting. This setting is used to distinguish between a close up 3 phase fault and a 3 phase VT failure condition under load conditions. For a close up 3 phase fault there will be a loss of 3 phase voltage but there will be a delta change in the measured current. For a 3 phase VT failure where there will a loss of 3 phase voltage but no delta change in the measured current.				
VTS I> Inhibit	48	07	10s	From 100ms to 32s step 100ms
This overcurrent setting is used to inhibit the voltage transformer supervision in the event of a loss of all 3 phase voltages caused by a close up 3 phase fault occurring on the system following closure of the CB to energize the line.				
CT SUPERVISION	48	10		
Sub-heading				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
CTS1 Status	48	11	Disabled	Enabled or Disabled
Enables or disables the current transformer supervision 1 element.				
CTS1 VN< Inhibit	48	12	5*Vn V	From 1*Vn V to 22*Vn V step 1*Vn V
Residual/neutral voltage setting to inhibit the CTS1 element.				
CTS1 IN> Set	48	13	0.2*In A	From 0.08*In A to 4*In A step 0.01*In A
Residual/neutral current setting for a valid current transformer supervision condition for CTS1.				
CTS1 Time Delay	48	14	5s	From 0s to 10s step 1s
Operating time-delay setting of CTS1.				
CTS2 Status	48	21	Disabled	Enabled or Disabled
Enables or disables the current transformer supervision 1 element. P243 only.				
CTS2 VN< Inhibit	48	22	5*Vn V	From 1*Vn V to 22*Vn V step 1*Vn V
Residual/neutral voltage setting to inhibit the CTS1 element. P243 only.				
CTS2 IN> Set	48	23	0.2*In A	From 0.08*In A to 4*In A step 0.01*In A
Residual/neutral current setting for a valid current transformer supervision condition for CTS1. P243 only.				
CTS2 Time Delay	48	24	5s	From 0s to 10s step 1s
Operating time-delay setting of CTS1. P243 only.				

Table 25 - VTS and CTS protection settings

4.23 Input Labels

The column **GROUP x INPUT LABELS** is used to individually label each opto input that is available in the relay. The text is restricted to 16 characters and is available if 'Input Labels' are set visible under CONFIGURATION column.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
GROUP 1 INPUT LABELS	4A	00		
This column contains settings for Opto Input Labels				
Opto Input 1	4A	01	OPTO 1	From 32 to 234 step 1
Text label to describe each individual opto input. This text will be displayed in the programmable scheme logic and event record description of the opto input.				
Opto Input 2	4A	02	OPTO 2	From 32 to 234 step 1
Text label to describe each individual opto input. This text will be displayed in the programmable scheme logic and event record description of the opto input.				
Opto Input 3	4A	03	OPTO 3	From 32 to 234 step 1
Text label to describe each individual opto input. This text will be displayed in the programmable scheme logic and event record description of the opto input.				
Opto Input 4	4A	04	OPTO 4	From 32 to 234 step 1
Text label to describe each individual opto input. This text will be displayed in the programmable scheme logic and event record description of the opto input.				
Opto Input 5	4A	05	OPTO 5	From 32 to 234 step 1
Text label to describe each individual opto input. This text will be displayed in the programmable scheme logic and event record description of the opto input.				
Opto Input 6	4A	06	OPTO 6	From 32 to 234 step 1

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Text label to describe each individual opto input. This text will be displayed in the programmable scheme logic and event record description of the opto input.				
Opto Input 7	4A	07	OPTO 7	From 32 to 234 step 1
Text label to describe each individual opto input. This text will be displayed in the programmable scheme logic and event record description of the opto input.				
Opto Input 8	4A	08	OPTO 8	From 32 to 234 step 1
Text label to describe each individual opto input. This text will be displayed in the programmable scheme logic and event record description of the opto input.				
Opto Input 9	4A	09	OPTO 9	From 32 to 234 step 1
P242 and P243 only. Text label to describe each individual opto input. This text will be displayed in the programmable scheme logic and event record description of the opto input.				
Opto Input 10	4A	0A	OPTO 10	From 32 to 234 step 1
P242 and P243 only. Text label to describe each individual opto input. This text will be displayed in the programmable scheme logic and event record description of the opto input.				
Opto Input 11	4A	0B	OPTO 11	From 32 to 234 step 1
P242 and P243 only. Text label to describe each individual opto input. This text will be displayed in the programmable scheme logic and event record description of the opto input.				
Opto Input 12	4A	0C	OPTO 12	From 32 to 234 step 1
P242 and P243 only. Text label to describe each individual opto input. This text will be displayed in the programmable scheme logic and event record description of the opto input.				
Opto Input 13	4A	0D	OPTO 13	From 32 to 234 step 1
P242 and P243 only. Text label to describe each individual opto input. This text will be displayed in the programmable scheme logic and event record description of the opto input.				
Opto Input 14	4A	0E	OPTO 14	From 32 to 234 step 1
P242 and P243 only. Text label to describe each individual opto input. This text will be displayed in the programmable scheme logic and event record description of the opto input.				
Opto Input 15	4A	0F	OPTO 15	From 32 to 234 step 1
P242 and P243 only. Text label to describe each individual opto input. This text will be displayed in the programmable scheme logic and event record description of the opto input.				
Opto Input 16	4A	10	OPTO 16	From 32 to 234 step 1
P242 and P243 only. Text label to describe each individual opto input. This text will be displayed in the programmable scheme logic and event record description of the opto input.				

Table 26 - Input labels settings

4.24 Output Labels

The column **GROUP x OUTPUT LABELS** is used to individually label each output relay that is available in the relay. The text is restricted to 16 characters and is available if 'Output Labels' are set visible under CONFIGURATION column.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
GROUP 1 OUTPUT LABELS	4B	00		
This column contains settings for Relay Output Labels				
Relay 1	4B	01	RELAY 1	From 32 to 234 step 1
Text label to describe each individual relay output contact. This text will be displayed in the programmable scheme logic and event record description of the relay output contact.				
Relay 2	4B	02	RELAY 2	From 32 to 234 step 1

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Text label to describe each individual relay output contact. This text will be displayed in the programmable scheme logic and event record description of the relay output contact.				
Relay 3	4B	03	RELAY 3	From 32 to 234 step 1
Text label to describe each individual relay output contact. This text will be displayed in the programmable scheme logic and event record description of the relay output contact.				
Relay 4	4B	04	RELAY 4	From 32 to 234 step 1
Text label to describe each individual relay output contact. This text will be displayed in the programmable scheme logic and event record description of the relay output contact.				
Relay 5	4B	05	RELAY 5	From 32 to 234 step 1
Text label to describe each individual relay output contact. This text will be displayed in the programmable scheme logic and event record description of the relay output contact.				
Relay 6	4B	06	RELAY 6	From 32 to 234 step 1
Text label to describe each individual relay output contact. This text will be displayed in the programmable scheme logic and event record description of the relay output contact.				
Relay 7	4B	07	RELAY 7	From 32 to 234 step 1
Text label to describe each individual relay output contact. This text will be displayed in the programmable scheme logic and event record description of the relay output contact.				
Relay 8	4B	08	RELAY 8	From 32 to 234 step 1
P242 and P243 only. Text label to describe each individual relay output contact. This text will be displayed in the programmable scheme logic and event record description of the relay output contact.				
Relay 9	4B	09	RELAY 9	From 32 to 234 step 1
P242 and P243 only. Text label to describe each individual relay output contact. This text will be displayed in the programmable scheme logic and event record description of the relay output contact.				
Relay 10	4B	0A	RELAY 10	From 32 to 234 step 1
P242 and P243 only. Text label to describe each individual relay output contact. This text will be displayed in the programmable scheme logic and event record description of the relay output contact.				
Relay 11	4B	0B	RELAY 11	From 32 to 234 step 1
P242 and P243 only. Text label to describe each individual relay output contact. This text will be displayed in the programmable scheme logic and event record description of the relay output contact.				
Relay 12	4B	0C	RELAY 12	From 32 to 234 step 1
P242 and P243 only. Text label to describe each individual relay output contact. This text will be displayed in the programmable scheme logic and event record description of the relay output contact.				
Relay 13	4B	0D	RELAY 13	From 32 to 234 step 1
P242 and P243 only. Text label to describe each individual relay output contact. This text will be displayed in the programmable scheme logic and event record description of the relay output contact.				
Relay 14	4B	0E	RELAY 14	From 32 to 234 step 1
P242 and P243 only. Text label to describe each individual relay output contact. This text will be displayed in the programmable scheme logic and event record description of the relay output contact.				
Relay 15	4B	0F	RELAY 15	From 32 to 234 step 1
P242 and P243 only. Text label to describe each individual relay output contact. This text will be displayed in the programmable scheme logic and event record description of the relay output contact.				
Relay 16	4B	10	RELAY 16	From 32 to 234 step 1
P242 and P243 only. Text label to describe each individual relay output contact. This text will be displayed in the programmable scheme logic and event record description of the relay output contact.				

Table 27 - Output labels settings

4.25 RTD Labels

Courier Text	Col	Row	Default Setting	Available Setting
Description				
GROUP 1 RTD LABELS	4C	00		
This column contains settings for RTD Labels				
RTD 1	4C	01	RTD 1	From 32 to 234 step 1
Text label to describe each individual RTD. This text will be displayed in the Measurements 3 menu and fault records for the description of the RTDs.				
RTD 2	4C	02	RTD 2	From 32 to 234 step 1
Text label to describe each individual RTD. This text will be displayed in the Measurements 3 menu and fault records for the description of the RTDs.				
RTD 3	4C	03	RTD 3	From 32 to 234 step 1
Text label to describe each individual RTD. This text will be displayed in the Measurements 3 menu and fault records for the description of the RTDs.				
RTD 4	4C	04	RTD 4	From 32 to 234 step 1
Text label to describe each individual RTD. This text will be displayed in the Measurements 3 menu and fault records for the description of the RTDs.				
RTD 5	4C	05	RTD 5	From 32 to 234 step 1
Text label to describe each individual RTD. This text will be displayed in the Measurements 3 menu and fault records for the description of the RTDs.				
RTD 6	4C	06	RTD 6	From 32 to 234 step 1
Text label to describe each individual RTD. This text will be displayed in the Measurements 3 menu and fault records for the description of the RTDs.				
RTD 7	4C	07	RTD 7	From 32 to 234 step 1
Text label to describe each individual RTD. This text will be displayed in the Measurements 3 menu and fault records for the description of the RTDs.				
RTD 8	4C	08	RTD 8	From 32 to 234 step 1
Text label to describe each individual RTD. This text will be displayed in the Measurements 3 menu and fault records for the description of the RTDs.				
RTD 9	4C	09	RTD 9	From 32 to 234 step 1
Text label to describe each individual RTD. This text will be displayed in the Measurements 3 menu and fault records for the description of the RTDs.				
RTD 10	4C	0A	RTD 10	From 32 to 234 step 1
Text label to describe each individual RTD. This text will be displayed in the Measurements 3 menu and fault records for the description of the RTDs.				

Table 28 - RTD labels settings

4.26 Analog Input Labels

Courier Text	Col	Row	Default Setting	Available Setting
Description				
GROUP 1 CLIO LABELS	4D	00		
This column contains settings for CLIO Labels				
CLIO Input 1	4D	01	ANALOG INPUT 1	From 32 to 234 step 1
Text label to describe each individual current loop/analogue input. This text will be displayed in the Measurements 3 menu and fault records for the description of the current loop/analogue inputs.				
CLIO Input 2	4D	02	ANALOG INPUT 2	From 32 to 234 step 1

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Text label to describe each individual current loop/analogue input. This text will be displayed in the Measurements 3 menu and fault records for the description of the current loop/analogue inputs.				
CLIO Input 3	4D	03	ANALOG INPUT 3	From 32 to 234 step 1
Text label to describe each individual current loop/analogue input. This text will be displayed in the Measurements 3 menu and fault records for the description of the current loop/analogue inputs.				
CLIO Input 4	4D	04	ANALOG INPUT 4	From 32 to 234 step 1
Text label to describe each individual current loop/analogue input. This text will be displayed in the Measurements 3 menu and fault records for the description of the current loop/analogue inputs.				
CLIO Output 1	4D	11	ANALOG OUTPUT 1	From 32 to 234 step 1
Text label to describe each individual current loop/analogue output This text will be displayed in the Measurements 3 menu and fault records for the description of the current loop/analogue inputs.				
CLIO Output 2	4D	12	ANALOG OUTPUT 2	From 32 to 234 step 1
Text label to describe each individual current loop/analogue output This text will be displayed in the Measurements 3 menu and fault records for the description of the current loop/analogue inputs.				
CLIO Output 3	4D	13	ANALOG OUTPUT 3	From 32 to 234 step 1
Text label to describe each individual current loop/analogue output This text will be displayed in the Measurements 3 menu and fault records for the description of the current loop/analogue inputs.				
CLIO Output 4	4D	14	ANALOG OUTPUT 4	From 32 to 234 step 1
Text label to describe each individual current loop/analogue output This text will be displayed in the Measurements 3 menu and fault records for the description of the current loop/analogue inputs.				

Table 29 - Current loop analog input label settings

5 CONTROL AND SUPPORT SETTINGS

The control and support settings are part of the main menu and are used to configure the global configuration for the relay. It includes submenu settings as shown here.

- Relay function configuration settings
- Open/close circuit breaker
- CT & VT ratio settings
- Reset LEDs
- Active protection setting group
- Password & language settings
- Circuit breaker control & monitoring settings
- Communications settings
- Measurement settings
- Event & fault record settings
- User interface settings
- Commissioning settings

5.1 System Data

This menu provides information for the device and general status of the relay.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
SYSTEM DATA	00	00		
This column contains general system settings				
Language	00	01	English	English, French, German, Italian, Spanish, Chinese (UI only)
The default language used by the device. Selectable as English, French, German, Spanish, Italian and Chinese. Chinese is UI only.				
Description	00	04	MiCOM P24x	32 to 234 step 1
Editable 16-character description of the unit				
Plant Reference	00	05	MiCOM	32 to 234 step 1
Plant description: Can be edited				
Model Number	00	06	Model Number	<Model number>
Displays the model number. This can not be edited				
Serial Number	00	08	Serial Number	<Serial number>
Displays the serial number. This can not be edited.				
Frequency	00	09	50 Hz	50Hz or 60 Hz
Sets the main frequency				
Comms Level	00	0A	2	<conformance level displayed>
Displays the conformance of the relay to the Courier Level 2 comms				
Relay Address	00	0B	255 1 1	0 to 255 step 1 (Courier) 1 to 247 step 1 (Modbus) 0 to 254 step 1 (CS103)
Sets the first rear port relay address. Build = Courier (Address available via LCD) Build = Modbus (Address available via LCD) Build = CS103 (Address available via LCD)				
Plant Status	00	0C		Not Settable
Displays the circuit breaker plant status.				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Control Status	00	0D		Not Settable
Not used				
Active Group	00	0E	1	Not Settable
Displays the active settings group				
CB Trip/Close	00	10	No Operation	0 = No Operation, 1 = Trip, 2 = Close
Supports trip and close commands if enabled in the Circuit Breaker Control menu.				
Software Ref. 1	00	11		<Software Ref. 1>
Displays the relay software version including protocol and relay model.				
Software Ref. 2	00	12		<Software Ref. 2>
Relay Ethernet card software reference. Visible when Ethernet card fitted.				
NIC Platform Ref	00	14		<NIC platform reference>
Displays the relay NIC platform reference. Visible when Ethernet card fitted.				
IEC61850 Edition	00	15	2	1 or 2
Selects IEC 61850 Editions, Edition 1 or Edition 2. This setting can only be changed via HMI and the changes will cause the Ethernet board to reboot.				
ETH COMM Mode	00	16	Dual IP	Dual IP, PRP, HSR
Sets the redundancy protocol. This setting can only be changed via the HMI and the changes will cause the Ethernet board to reboot.				
Opto I/P Status	00	20		Not Settable
Display the status of the available opto inputs fitted.				
Relay O/P Status	00	21		Not Settable
Displays the status of the first 32 output relays.				
Alarm Status 1	00	22		Not Settable
This menu cell displays the status of the first 32 alarms as a binary string. 1 indicates an ON state and 0 an OFF state. Includes fixed and user settable alarms.				
Alarm Status 1	00	50		Not Settable
This menu cell displays the status of the first 32 alarms as a binary string. 1 indicates an ON state and 0 an OFF state. Includes fixed and user settable alarms.				
Alarm Status 2	00	51		Not Settable
This menu cell displays the status of the second 32 alarms as a binary string.1 indicates an ON state and 0 an OFF state.				
Alarm Status 3	00	52		Not Settable
This menu cell displays the status of the third 32 alarms as a binary string. 1 indicates an ON state and 0 an OFF state. Assigned specifically for platform alarms.				
Usr Alarm Status	00	53		Not Settable
This menu cell displays the status of the 32 user alarms as a binary string. 1 indicates an ON state and 0 an OFF state.				
Access Level	00	D0	ENGINEER	Not Settable
Display the Role(s) of the current logged in user, if no one logged in, it shall be "NONE".				
New Eng.Level PW	00	D3		ASCII 33 to 122
Allows user to change password for EngineerLevel. Visible on UI only.				
New Op.Level PW	00	D4		ASCII 33 to 122
Allows user to change password for OperatorLevel. Visible on UI only.				
Security Feature	00	DF	3	Not Settable
Displays the level of cyber security inmplemented.				
Password	00	E1		<Password>
Used to send encrypted password. Not visible on UI				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Encryption Salt	00	E5		<Encryption Salt>
Random data used with encrypted password. Not visible on UI				
Enter username	00	F1		<User Name>
User selection for login. Not visible on UI				
Number of users	00	F2		Not Settable
Shows the number of users configured within the relays RBAC				
New UI pwd	00	F3		<Second Simple Password>
Hidden cell reserved for second password modification. Not in use currently.				
New password	00	F4		<Encrpted Password>
Allow password change if engineer or operator logged in and CSL0 model. Not visible on UI.				

Table 30 - System data

5.2 View Records

This menu provides information on fault and maintenance records. The relay records the last five fault records and the last ten maintenance records.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
VIEW RECORDS	01	00		
This column contains event, fault and maintenance records				
Select Event	01	01	0	From 0 to 511 step 1
This selects the required event record from all the possible ones that may be stored. A value of 0 corresponds to the latest event, with the maximum value the oldest.				
Event Type	01	02		Not Settable
Indicates type of event				
Time & Date	01	03		Not Settable
Time & Date Stamp for the event given by the internal Real Time Clock.				
Event Text	01	04		Not Settable
Up to 16 Character description of the Event (refer to following sections).				
Event Value	01	05		Not Settable
Up to 32 Bit Binary Flag or integer representative of the Event (refer to following sections).				
Select Fault	01	06	0	From 0 to 4 step 1
This selects the required fault record from the possible 5 that may be stored. A value of 0 corresponds to the latest fault and so on.				
Start Elements	01	07		Not Settable
Displays the status of the first 32 start signals.				
Trip Elements(1)	01	08		Not Settable
Displays the status of the first 32 trip signals.				
Trip Elements(2)	01	09		Not Settable
Displays the status of the second 32 trip signals.				
Fault Alarms	01	0C		Not Settable
Displays the status of the fault alarm signals.				
Active Group	01	0D		Not Settable
Displays the active setting group when fault occurred.				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Time Stamp	01	0E		Not Settable
Displays fault time and date.				
System Frequency	01	0F		Not Settable
Displays the system frequency				
IA	01	17		Not Settable
Measured parameter				
IB	01	18		Not Settable
Measured parameter				
IC	01	19		Not Settable
Measured parameter				
VAB	01	1A		Not Settable
Measured parameter				
VBC	01	1B		Not Settable
Measured parameter				
VCA	01	1C		Not Settable
Measured parameter				
IN Derived	01	1D		Not Settable
Measured parameter				
I0 Sensitive	01	1E		Not Settable
Measured parameter				
Thermal State	01	1F		Not Settable
Measured parameter				
I2 Magnitude	01	22		Not Settable
Measured parameter				
3Ph Power Factor	01	23		Not Settable
Measured parameter				
Zero Seq Power	01	24		Not Settable
Measured parameter				
VN Magnitude	01	25		Not Settable
Measured parameter				
3 Phase Watts	01	26		Not Settable
Measured parameter				
RTD1 Temperature	01	2A		Not Settable
Measured parameter				
RTD2 Temperature	01	2B		Not Settable
Measured parameter				
RTD3 Temperature	01	2C		Not Settable
Measured parameter				
RTD4 Temperature	01	2D		Not Settable
Measured parameter				
RTD5 Temperature	01	2E		Not Settable
Measured parameter				
RTD6 Temperature	01	2F		Not Settable

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Measured parameter				
RTD7 Temperature	01	30		Not Settable
Measured parameter				
RTD8 Temperature	01	31		Not Settable
Measured parameter				
RTD9 Temperature	01	32		Not Settable
Measured parameter				
RTD10 Temperatur	01	33		Not Settable
Measured parameter				
IA-2	01	34		Not Settable
Measured parameter				
IB-2	01	35		Not Settable
Measured parameter				
IC-2	01	36		Not Settable
Measured parameter				
IA Differential	01	37		Not Settable
Measured parameter				
IB Differential	01	38		Not Settable
Measured parameter				
IC Differential	01	39		Not Settable
Measured parameter				
IA Bias	01	3A		Not Settable
Measured parameter				
IB Bias	01	3B		Not Settable
Measured parameter				
IC Bias	01	3C		Not Settable
Measured parameter				
Analog Input 1	01	3D		Not Settable
Measured parameter				
Analog Input 2	01	3E		Not Settable
Measured parameter				
Analog Input 3	01	3F		Not Settable
Measured parameter				
Analog Input 4	01	40		Not Settable
Measured parameter				
Select Maint	01	F0	0	From 0 to 9 step 1
This selects the required maintenance report from those stored. A value of 0 corresponds to the latest report and so on.				
Maint Text	01	F1		Not Settable
Up to 16 Character description of the occurrence (refer to following sections).				
Maint Type	01	F2		Not Settable
These cells are numbers representative of the occurrence. They form a specific error code which should be quoted in any related correspondence to Report Data.				
Maint Data	01	F3		Not Settable

Courier Text	Col	Row	Default Setting	Available Setting
Description				
These cells are numbers representative of the occurrence. They form a specific error code which should be quoted in any related correspondence to Report Data.				
Evt Iface Source	01	FA		Not Settable
Interface on which the event was logged				
Evt Access Level	01	FB		Not Settable
Any security event that indicates that it came from an interface action, such as disabling a port, will also record the access level of the interface that initiated the event. This will be recorded in the 'Event State' field of the event.				
Evt Extra Info	01	FC		Not Settable
This cell provides supporting information for the event and can vary between the different event types.				
Evt Unique Id	01	FE		Not Settable
Each event will have a unique event id. The event id is a 32 bit unsigned integer that is incremented for each new event record and is stored in the record in battery-backed memory (BBRAM). The current event id must be non-volatile so as to preserve it du				
Reset Indication	01	FF	No	0=No 1=Yes
This serves to reset the trip LED indications provided that the relevant protection element has reset, to reset all LED and relays latched in the PSL, and to reset the latched alarms.				

Table 31 - View records settings

5.3 Measurements 1

This menu provides measurement information.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
MEASUREMENTS 1	02	00		
This column contains measurement parameters				
IA Magnitude	02	01		Not Settable
IA Magnitude				
IA Phase Angle	02	02		Not Settable
IA Phase Angle				
IB Magnitude	02	03		Not Settable
IB Magnitude				
IB Phase Angle	02	04		Not Settable
IB Phase Angle				
IC Magnitude	02	05		Not Settable
IC Magnitude				
IC Phase Angle	02	06		Not Settable
IC Phase Angle				
IN Derived Mag	02	09		Not Settable
IN Derived Mag				
IN Derived Angle	02	0A		Not Settable
IN Derived Angle				
IN Magnitude	02	0B		Not Settable
IN Magnitude				
IN Angle	02	0C		Not Settable

Courier Text	Col	Row	Default Setting	Available Setting
Description				
IN Angle				
I1 Magnitude	02	0D		Not Settable
I1 Magnitude				
I2 Magnitude	02	0E		Not Settable
I2 Magnitude				
I0 Magnitude	02	0F		Not Settable
I0 Magnitude				
IA RMS	02	10		Not Settable
IA RMS				
IB RMS	02	11		Not Settable
IB RMS				
IC RMS	02	12		Not Settable
IC RMS				
IN RMS	02	13		Not Settable
IN RMS				
VAB Magnitude	02	14		Not Settable
VAB Magnitude				
VAB Phase Angle	02	15		Not Settable
VAB Phase Angle				
VBC Magnitude	02	16		Not Settable
VBC Magnitude				
VBC Phase Angle	02	17		Not Settable
VBC Phase Angle				
VCA Magnitude	02	18		Not Settable
VCA Magnitude				
VCA Phase Angle	02	19		Not Settable
VCA Phase Angle				
VAN Magnitude	02	1A		Not Settable
VAN Magnitude				
VAN Phase Angle	02	1B		Not Settable
VAN Phase Angle				
VBN Magnitude	02	1C		Not Settable
VBN Magnitude				
VBN Phase Angle	02	1D		Not Settable
VBN Phase Angle				
VCN Magnitude	02	1E		Not Settable
VCN Magnitude				
VCN Phase Angle	02	1F		Not Settable
VCN Phase Angle				
VN Magnitude	02	20		Not Settable
VN Magnitude				
VN Phase Angle	02	21		Not Settable
VN Angle				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Vr Antibacks Mag	02	22		Not Settable
Vr Antibacks Mag				
V1 Magnitude	02	24		Not Settable
V1 Magnitude				
V2 Magnitude	02	25		Not Settable
V2 Magnitude				
VA RMS Magnitude	02	27		Not Settable
VAN RMS				
VB RMS Magnitude	02	28		Not Settable
VBN RMS				
VC RMS Magnitude	02	29		Not Settable
VCN RMS				
VAB RMS	02	2A		Not Settable
VAB RMS				
VBC RMS	02	2B		Not Settable
VBC RMS				
VCA RMS	02	2C		Not Settable
VCA RMS				
Frequency	02	2D		Not Settable
Frequency				
Ratio I2/I1	02	2E		Not Settable
Ratio I2/I1				
IA-2 Magnitude	02	30		Not Settable
IA2 Magnitude				
IA-2 Phase Angle	02	31		Not Settable
IA2 Phase Angle				
IB-2 Magnitude	02	32		Not Settable
IB2 Magnitude				
IB-2 Phase Angle	02	33		Not Settable
IB2 Phase Angle				
IC-2 Magnitude	02	34		Not Settable
IC2 Magnitude				
IC-2 Phase Angle	02	35		Not Settable
IC2 Phase Angle				
IA Differential	02	36		Not Settable
IA Differential Magnitude				
IB Differential	02	37		Not Settable
IB Differential Magnitude				
IC Differential	02	38		Not Settable
IC Differential Magnitude				
IA Bias	02	39		Not Settable
IA Bias Magnitude				
IB Bias	02	3A		Not Settable

Courier Text	Col	Row	Default Setting	Available Setting
Description				
IB Bias Magnitude				
IC Bias	02	3B		Not Settable
IC Bias Magnitude				

Table 32 - Measurement 1 menu

5.4 Measurements 2

This menu provides measurement information.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
MEASUREMENTS 2	03	00		
This column contains measurement parameters				
3 Phase Watts	03	0A		Not Settable
3 Phase Watts				
3 Phase VArs	03	0B		Not Settable
3 Phase VArs				
3 Phase VA	03	0C		Not Settable
3 Phase VA				
Zero Seq Power	03	0D		Not Settable
Zero Seq Power				
3Ph Power Factor	03	0E		Not Settable
3Ph Power Factor				
3Ph WHours Fwd	03	12		Not Settable
3 Phase Watt - Hours (Forward)				
3Ph WHours Rev	03	13		Not Settable
3 Phase Watts - Hours (Reverse)				
3Ph VArHours Fwd	03	14		Not Settable
3 Phase VAr - Hours (Forward)				
3Ph VArHours Rev	03	15		Not Settable
3 Phase VAr - Hours (Reverse)				
Reset Energies	03	16	No	0 = No or 1 = Yes
Reset Energies				
3Ph W Fix Dem	03	17		Not Settable
3 Phase Watts - Fixed Demand				
3Ph VArs Fix Dem	03	18		Not Settable
3 Phase VArs - Fixed Demand				
3Ph W Peak Dem	03	20		Not Settable
3 Phase Watts - Peak Demand				
3Ph VArs PeakDem	03	21		Not Settable
3 Phase VArs - Peak Demand				
Reset Demand	03	25	No	0 = No or 1 = Yes
Reset Demand				
3Ph I Maximum	03	26		Not Settable

Courier Text	Col	Row	Default Setting	Available Setting
Description				
3 Ph I Maximum				
3Ph V Maximum	03	27		
3 Ph V Maximum				
Reset max. I / V	03	28	No	0 = No or 1 = Yes
Reset Max I/V				

Table 33 - Measurement 2 menu

5.5 Measurements 3 (Product Specific Measurements)

This menu provides measurement information.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
MEASUREMENTS 3	04	00		
This column contains measurement parameters				
Thermal Load	04	01		Not Settable
Load as ratio of full load				
Thermal State	04	02		Not Settable
Thermal state				
Time to Th. Trip	04	03		Not Settable
Time to Th trip				
Reset Th. State	04	04	No	0 = No or 1 = Yes
Send reset thermal state command				
RTD 1	04	05		Not Settable
RTD#1 Temperature				
RTD 2	04	06		Not Settable
RTD#2 Temperature				
RTD 3	04	07		Not Settable
RTD#3 Temperature				
RTD 4	04	08		Not Settable
RTD#4 Temperature				
RTD 5	04	09		Not Settable
RTD#5 Temperature				
RTD 6	04	0A		Not Settable
RTD#6 Temperature				
RTD 7	04	0B		Not Settable
RTD#7 Temperature				
RTD 8	04	0C		Not Settable
RTD#8 Temperature				
RTD 9	04	0D		Not Settable
RTD#9 Temperature				
RTD 10	04	0E		Not Settable
RTD#10 Temperature				
Nb.Hot St.Allow.	04	0F		Not Settable

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Nb hot St Allow				
Nb.Cold St.Allow	04	10		Not Settable
Nb Cold St Allow				
Time to Next St.	04	11		Not Settable
Time to Next St				
Emergency Rest.	04	12	No	0 = No or 1 = Yes
Send Energency Restart Command				
Last Start Time	04	13		Not Settable
Last start time				
Last St. Current	04	14		Not Settable
Last St current				
Nb. of Starts	04	15		Not Settable
Nb of starts				
Reset Nb of St.	04	16	No	0 = No or 1 = Yes
Send Reset Number of Starts Command				
Nb Emergency Rst	04	17		Not Settable
Nb Emergency Rst				
Reset Nb.Em.Rst.	04	18	No	0 = No or 1 = Yes
Send Reset Number of Energency Restarts Command				
Nb.Reaccelerat.	04	19		Not Settable
Nb Reacc				
Reset Nb.Reacc.	04	1A	No	0 = No or 1 = Yes
Send Reset Number of Reacceleration Command				
Motor Run. Time	04	1B		Not Settable
Motor Run Time				
Reset Mot.Run.T.	04	1C	No	0 = No or 1 = Yes
Send Reset Motor Run Time Command				
RTD Open Cct	04	1D		Not Settable
RTD Open Cct				
RTD Short Cct	04	1E		Not Settable
RTD Short Cct				
RTD Data Error	04	1F		Not Settable
RTD data error				
Reset RTD Flags	04	20	No	0 = No or 1 = Yes
Set Reset RTD flags Command				
Nb Hotest RTD	04	21		Not Settable
Nb Hottest RTD				
Hotest RTD Temp.	04	22		Not Settable
Hottest RTD Temp				
Reset Max RTD T.	04	23		0 = No or 1 = Yes
Send Reset Max RTD Temperature Command				
ANALOG INPUT 1	04	24		Not Settable
Analog Input 1				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
ANALOG INPUT 2	04	25		Not Settable
Analog Input 2				
ANALOG INPUT 3	04	26		Not Settable
Analog Input 3				
ANALOG INPUT 4	04	27		Not Settable
Analog Input 4				

Table 34 - Measurement 3 menu

5.6 Measurements 4 (Product Specific Measurements)

This menu provides measurement information.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
MEASUREMENTS 4	05	00		
This column contains measurement parameters				
Nb.Control Trips	05	01		Not Settable
Nb Control trips				
Nb. Thermal Trip	05	02		Not Settable
Nb Thermal Trip				
Nb. Trip I>1	05	03		Not Settable
Nb Trip I > 1				
Nb. Trip I>2	05	04		Not Settable
Nb Trip I > 2				
Nb. Trip ISEF>1	05	05		Not Settable
Nb Trip ISEF > 1				
Nb. Trip ISEF>2	05	06		Not Settable
Nb Trip ISEF > 2				
Nb. Trip IN>1	05	07		Not Settable
Nb Trip IN > 1				
Nb. Trip IN>2	05	08		Not Settable
Nb Trip IN > 2				
Nb. Trip I2>1	05	09		Not Settable
Nb Trip I2 > 1				
Nb. Trip I2>2	05	0A		Not Settable
Nb Trip I2 > 2				
Nb. Trip P0>	05	0B		Not Settable
Nb Trip P0 >				
Nb. Trip V<1	05	0C		Not Settable
Nb Trip V < 1				
Nb. Trip V<2	05	0D		Not Settable
Nb Trip V < 2				
Nb. Trip F<1	05	0E		Not Settable
Nb Trip F < 1				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Nb. Trip F<2	05	0F		Not Settable
Nb Trip F < 2				
Nb. Trip P<1	05	10		Not Settable
Nb Trip P < 1				
Nb. Trip P<2	05	11		Not Settable
Nb Trip P < 2				
Nb.Trip PF<Lead	05	12		Not Settable
Nb Trip PF < Lead				
Nb.Trip PF< Lag	05	13		Not Settable
Nb Trip PF < Lag				
Nb. Trip Rev. P	05	14		Not Settable
Nb Trip Rev P >				
Nb. Trip V>1	05	15		Not Settable
Nb Trip V > 1				
Nb. Trip V>2	05	16		Not Settable
Nb Trip V > 2				
Nb.Trip NVD VN > 1	05	17		Not Settable
Nb Trip NVD VN > 1				
Nb.Trip NVD VN > 2	05	18		Not Settable
Nb Trip NVD VN > 2				
Nb. Prolong. St.	05	19		Not Settable
Nb Prolong St				
Nb.Lock Rot-sta.	05	1A		Not Settable
Nb Lock Rot-Sta				
Nb.Lock.Rot-run	05	1B		Not Settable
Nb Lock rotor-run				
Nb. Trip RTD 1	05	1C		Not Settable
Nb Trip RTD#1				
Nb. Trip RTD 2	05	1D		Not Settable
Nb Trip RTD#2				
Nb. Trip RTD 3	05	1E		Not Settable
Nb Trip RTD#3				
Nb. Trip RTD 4	05	1F		Not Settable
Nb Trip RTD#4				
Nb. Trip RTD 5	05	20		Not Settable
Nb Trip RTD#5				
Nb. Trip RTD 6	05	21		Not Settable
Nb Trip RTD#6				
Nb. Trip RTD 7	05	22		Not Settable
Nb Trip RTD#7				
Nb. Trip RTD 8	05	23		Not Settable
Nb Trip RTD#8				
Nb. Trip RTD 9	05	24		Not Settable

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Nb Trip RTD#9				
Nb. Trip RTD 10	05	25		Not Settable
Nb Trip RTD#10				
Nb. Diff Trip	05	26		Not Settable
Nb Trip Diff				
Nb.A.Input 1Trip	05	27		Not Settable
Nb A Input1 Trip				
Nb.A.Input 2Trip	05	28		Not Settable
Nb A Input2 Trip				
Nb.A.Input 3Trip	05	29		Not Settable
Nb A Input3 Trip				
Nb.A.Input 4Trip	05	2A		Not Settable
Nb A Input4 Trip				
Nb. FFail1 Trip	05	2B		Not Settable
Nb FFail1 Trip				
Nb. FFail2 Trip	05	2C		Not Settable
Nb FFail2 Trip				
Nb. Trip I>3	05	2D		Not Settable
Nb Trip I > 3				
Nb. Trip I>4	05	2E		Not Settable
Nb Trip I > 4				
Reset Trip Stat.	05	40	No	No or Yes
Reset Trip Stat				

Table 35 - Measurement 4 menu

5.7 Circuit Breaker Condition

Courier Text	Col	Row	Default Setting	Available Setting
Description				
CB CONDITION	06	00		
This column contains CB Condition Monitoring Measured Parameters				
CB Operations	06	01		Not Settable
Number of Circuit Breaker Operations				
Total IA Broken	06	02		Not Settable
Broken Current A Phase				
Total IB Broken	06	03		Not Settable
Broken Current B Phase				
Total IC Broken	06	04		Not Settable
Broken Current C Phase				
CB Operate Time	06	05		Not Settable
Circuit Breaker operating time				
Reset CB Data	06	06	No	No or Yes

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Reset CB Data				

Table 36 - Circuit breaker condition menu

5.8 Circuit Breaker Control

The P241/P242/P243 relays include settings to reset CB condition monitoring lockout alarms and set the type of CB auxiliary contacts that will be used to indicate the CB position.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
CB CONTROL	07	00		
This column controls the circuit Breaker Control configuration				
CB Control by	07	01	Disabled	0=Disabled 1=Local 2=Remote 3=Local+Remote 4=Opto 5=Opto+Local 6=Opto+Remote 7=Opto+Rem+Local
Close Pulse Time	07	02	500ms	From 100ms to 5s step 100ms
Close Pulse Time				
Trip Pulse Time	07	03	500ms	From 100ms to 5s step 100ms
Trip Pulse Time				
Man Close Delay	07	05	1s	From 0s to 60s step 1s
Manual Close Delay				

Table 37 - Circuit breaker control settings

5.9 Date and Time

Displays the date and time as well as the battery condition.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
DATE AND TIME	08	00		
This column contains Date and Time settings				
Date/Time	08	01		Not Settable
Displays the IED’s current date and time.				
Date	08	02		<Date>
Front Panel Menu only				
Time	08	03		<Time>
Front Panel Menu only				
IRIG-B Sync	08	04	Disabled	0 = Disabled or 1 = Enabled
Enable IRIG-B time synchronization.				
IRIG-B Status	08	05		Not Settable
Displays the status of IRIG-B				
Battery Status	08	06		Not Settable
Displays whether the battery is healthy or not				
Battery Alarm	08	07	Enabled	0 = Disabled or 1 = Enabled

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Enables or disables battery alarm. The battery alarm needs to be disabled when a battery is removed or not used				
SNTP Status	08	13		Not Settable
IEC61850 or DNP3.0 over Ethernet versions only. Displays information about the SNTP time synchronization status				
LocalTime Enable	08	20	Fixed	0 = Disabled, 1 = Fixed or 2 = Flexible
Setting to turn on/off local time adjustments. Disabled - No local time zone will be maintained. Time synchronization from any interface will be used to directly set the master clock and all displayed (or read) times on all interfaces will be based on the master clock with no adjustment. Fixed - A local time zone adjustment can be defined using the LocalTime offset setting and all interfaces will use local time except SNTP time synchronization and IEC 61850 timestamps. Flexible - A local time zone adjustment can be defined using the LocalTime offset setting and each interface can be assigned to the UTC zone or local time zone with the exception of the local interfaces which will always be in the local time zone and IEC 61850/SNTP which will always be in the UTC zone.				
LocalTime Offset	08	21	0 min	From -720 min to 720 min step 15 min
Setting to specify an offset of -12 to +12 hrs in 15 minute intervals for local time zone. This adjustment is applied to the time based on the master clock which is UTC/GMT				
DST Enable	08	22	Enabled	0 = Disabled or 1 = Enabled
Setting to turn on/off daylight saving time adjustment to local time.				
DST Offset	08	23	60 min	From 30 min to 60 min step 30 min
Setting to specify daylight saving offset which will be used for the time adjustment to local time.				
DST Start	08	24	Last	0 = First, 1 = Second, 2 = Third, 3 = Fourth or 4 = Last
Setting to specify the week of the month in which daylight saving time adjustment starts				
DST Start Day	08	25	Sunday	0 = Sunday, 1 = Monday, 2 = Tuesday, 3 = Wednesday, 4 = Thursday, 5 = Friday or 6 = Saturday
Setting to specify the day of the week in which daylight saving time adjustment starts				
DST Start Month	08	26	March	0 = January, 1 = February, 2 = March, 3 = April, 4 = May, 5 = June, 6 = July, 7 = August, 8 = September, 9 = October, 10 = November or 11 = December
Setting to specify the month in which daylight saving time adjustment starts				
DST Start Mins	08	27	60 min	From 0 min to 1425 min step 15 min
Setting to specify the time of day in which daylight saving time adjustment starts. This is set relative to 00:00 hrs on the selected day when time adjustment is to start				
DST End	08	28	Last	0 = First, 1 = Second, 2 = Third, 3 = Fourth or 4 = Last
Setting to specify the week of the month in which daylight saving time adjustment ends				
DST End Day	08	29	Sunday	0 = Sunday, 1 = Monday, 2 = Tuesday, 3 = Wednesday, 4 = Thursday, 5 = Friday or 6 = Saturday
Setting to specify the day of the week in which daylight saving time adjustment ends				
DST End Month	08	2A	October	0 = January, 1 = February, 2 = March, 3 = April, 4 = May, 5 = June, 6 = July, 7 = August, 8 = September, 9 = October, 10 = November or 11 = December
Setting to specify the month in which daylight saving time adjustment ends				
DST End Mins	08	2B	60 min	From 0 min to 1425 min step 15 min
Setting to specify the time of day in which daylight saving time adjustment ends. This is set relative to 00:00 hrs on the selected day when time adjustment is to end				
RP1 Time Zone	08	30	Local	0 = UTC or 1 = Local
Setting for the rear port 1 interface to specify if time synchronization received will be local or universal time co-ordinated				
RP2 Time Zone	08	31	Local	0 = UTC or 1 = Local
Setting for the rear port 2 interface to specify if time synchronization received will be local or universal time co-ordinated				
Tunnel Time Zone	08	33	Local	0 = UTC or 1 = Local

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Ethernet versions only for tunnelled courier. Setting to specify if time synchronization received will be local or universal time co-ordinated				

Table 38 - Date and time menu

5.10 CT and VT ratios

Courier Text	Col	Row	Default Setting	Available Setting
Description				
CT AND VT RATIOS	0A	00		
This column contains settings for Current and Voltage Transformer ratios				
Main VT Primary	0A	01	110V	From 100V to 1MV step 1V
Sets the main voltage transformer input primary voltage. Label Vn=Main VT Rating/110				
Main VT Sec'y	0A	02	110V	From 80V to 140V step 1V
Sets the main voltage transformer input secondary voltage. Multiplier M1=[0A01]/[0A02]				
Phase CT Primary	0A	07	1A	From 1A to 30kA step 1A
Sets the phase current transformer input primary current rating. In=Phase CT secondary rating.				
Phase CT Sec'y	0A	08	1A	From 1A to 5A step 4A
Sets the phase current transformer input secondary current rating. Multiplier M4=[0A07]/[0A08]				
SEF CT Primary	0A	0B	1A	From 1A to 30kA step 1A
Sets the SEF current transformer input primary current rating. Label In(SEF)=SEF CT secondary rating.				
SEF CT Secondary	0A	0C	1A	From 1A to 5A step 4A
Sets the SEF current transformer input secondary current rating. Multiplier M6=0A0B/0A0C				
VT Connect. Mode	0A	11	0	0 = 3VT, 1 = 2 VT + Residual, 2 = 2VT + VRemanent
To select VT connecting mode				
NVD VT Primary	0A	12	110V	From 100V to 1MV step 1V
Sets the Neutral Displacement voltage transformer input primary voltage. Vn(NVD)=Neutral Disp VT Rating/110 for 2VT + Residual VT connect mode otherwise Vn(NVD)=Main VT Rating/110				
NVD VT Secondary	0A	13	110V	From 80V to 140V step 1V
Sets the Neutral Displacement voltage transformer input secondary voltage. Multiplier M3=[0A12]/[0A13] for 2VT + Residual VT connect mode otherwise M3=[0A01]/[0A02]				

Table 39 - CT and VT ratio settings

5.11 Record Control

It is possible to disable the reporting of events from all interfaces that support setting changes. The settings that control the various types of events are in the Record Control column. The effect of setting each to disabled is as follows:

Courier Text	Col	Row	Default Setting	Available Setting
Description				
RECORD CONTROL	0B	00		
This column contains settings for Record Controls				
Clear Events	0B	01	No	0 = No or 1 = Yes
Selecting “Yes” will cause the existing event log to be cleared and an event will be generated indicating that the events have been erased.				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Clear Faults	0B	02	No	0 = No or 1 = Yes
Selecting “Yes” will cause the existing fault records to be erased from the relay.				
Clear Maint	0B	03	No	0 = No or 1 = Yes
Selecting “Yes” will cause the existing maintenance records to be erased from the relay.				
Alarm Event	0B	04	Enabled	0 = Disabled or 1 = Enabled
Disabling this setting means that no event is generated for alarms				
Relay O/P Event	0B	05	Enabled	0 = Disabled or 1 = Enabled
Disabling this setting means that no event will be generated for any change in logic output state.				
Opto Input Event	0B	06	Enabled	0 = Disabled or 1 = Enabled
Disabling this setting means that no event will be generated for any change in logic input state.				
General Event	0B	07	Enabled	0 = Disabled or 1 = Enabled
Disabling this setting means that no General Events are generated				
Fault Rec Event	0B	08	Enabled	0 = Disabled or 1 = Enabled
Disabling this setting means that no event will be generated for any fault that produces a fault record				
Maint Rec Event	0B	09	Enabled	0 = Disabled or 1 = Enabled
Disabling this setting means that no event will be generated for any occurrence that produces a maintenance record.				
Protection Event	0B	0A	Enabled	0 = Disabled or 1 = Enabled
Disabling this setting means that any operation of protection elements will not be logged as an event				
Clear Dist Recs	0B	30	No	0 = No or 1 = Yes
Selecting “Yes” will cause the existing disturbance records to be cleared and an event will be generated indicating that the disturbance records have been erased.				
Security Event	0B	31	Enabled	0 = Disabled or 1 = Enabled
Disabling this setting means that any operation of security elements will not be logged as an event				
DDB 31 - 0	0B	40	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 63 - 32	0B	41	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 95 - 64	0B	42	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 127 - 96	0B	43	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 159 - 128	0B	44	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 191 - 160	0B	45	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
DDB 223 - 192	0B	46	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 255 - 224	0B	47	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 287 - 256	0B	48	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 319 - 288	0B	49	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 351 - 320	0B	4A	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 383 - 352	0B	4B	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 415 - 384	0B	4C	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 447 - 416	0B	4D	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 479 - 448	0B	4E	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 511 - 480	0B	4F	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 543 - 512	0B	50	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 575 - 544	0B	51	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 607 - 576	0B	52	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 639 - 608	0B	53	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 671 - 640	0B	54	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 703 - 672	0B	55	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 735 - 704	0B	56	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 767 - 736	0B	57	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 799 - 768	0B	58	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 831 - 800	0B	59	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 863 - 832	0B	5A	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 895 - 864	0B	5B	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 927 - 896	0B	5C	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 959 - 928	0B	5D	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 991 - 960	0B	5E	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
DDB 1022 - 992	0B	5F	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1055 - 1024	0B	60	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1087 - 1056	0B	61	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1119 - 1088	0B	62	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1151 - 1120	0B	63	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1183 - 1152	0B	64	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1215 - 1184	0B	65	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1247 - 1216	0B	66	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1279 - 1248	0B	67	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1311 - 1280	0B	68	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1343 - 1312	0B	69	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1375 - 1344	0B	6A	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1407 - 1376	0B	6B	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1439 - 1408	0B	6C	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1471 - 1440	0B	6D	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1503 - 1472	0B	6E	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1535 - 1504	0B	6F	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1567 - 1536	0B	70	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1599 - 1568	0B	71	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1631 - 1600	0B	72	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1663 - 1632	0B	73	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1695 - 1664	0B	74	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1727 - 1696	0B	75	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1759 - 1728	0B	76	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1791 - 1760	0B	77	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
DDB 1823 - 1792	0B	78	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1855 - 1824	0B	79	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1887 - 1856	0B	7A	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1919 - 1888	0B	7B	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1951 - 1920	0B	7C	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1983 - 1952	0B	7D	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 2015 - 1984	0B	7E	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 2047 - 2016	0B	7F	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				

Table 40 - Record control menu

5.12 Disturbance Recorder Settings

The disturbance recorder settings include the record duration and trigger position, selection of analog and digital signals to record, and the signal sources that trigger the recording.

The precise event recorder column ("Disturb. Recorder" menu) is visible when the "Disturb recorder" setting ("Configuration" column) = "visible".

Courier Text	Col	Row	Default Setting	Available Setting
Description				
DISTURB RECORDER	0C	00		
This column contains settings for the Disturbance Recorder				
Duration	0C	01	1.5s	From 100ms to 10.5s step 10ms
This sets the overall recording time.				
TriggerPosition	0C	02	0.3	From 0% to 100% step 0.1%

Courier Text	Col	Row	Default Setting	Available Setting
Description				
This sets the trigger point as a percentage of the duration. For example, the default settings show that the overall recording time is set to 1.5 s with the trigger point being at 33.3% of this, giving 0.5 s pre-fault and 1s post fault recording times.				
TriggerMode	0C	03	Single	0 = Single or 1 = Extended
If set to single mode, if a further trigger occurs whilst a recording is taking place, the recorder will ignore the trigger. However, if this has been set to Extended, the post trigger timer will be reset to zero, thereby extending the recording time.				
AnalogChannel1	0C	04	VA	0 - VA, 1 - VB, 2 - VC, 3 - IA, 4 - IB, 5 - IC, 6 - IN, 7 - IA2, 8 - IB2, 9 - IC2, 10 - VAB, 11 - VBC, 12 - VN, 13 - VRM
Selects any available analogue input to be assigned to this channel.				
AnalogChannel2	0C	05	VB	0 - VA, 1 - VB, 2 - VC, 3 - IA, 4 - IB, 5 - IC, 6 - IN, 7 - IA2, 8 - IB2, 9 - IC2, 10 - VAB, 11 - VBC, 12 - VN, 13 - VRM
Selects any available analogue input to be assigned to this channel.				
AnalogChannel3	0C	06	VC	0 - VA, 1 - VB, 2 - VC, 3 - IA, 4 - IB, 5 - IC, 6 - IN, 7 - IA2, 8 - IB2, 9 - IC2, 10 - VAB, 11 - VBC, 12 - VN, 13 - VRM
Selects any available analogue input to be assigned to this channel.				
AnalogChannel4	0C	07	IA	0 - VA, 1 - VB, 2 - VC, 3 - IA, 4 - IB, 5 - IC, 6 - IN, 7 - IA2, 8 - IB2, 9 - IC2, 10 - VAB, 11 - VBC, 12 - VN, 13 - VRM
Selects any available analogue input to be assigned to this channel.				
AnalogChannel5	0C	08	IB	0 - VA, 1 - VB, 2 - VC, 3 - IA, 4 - IB, 5 - IC, 6 - IN, 7 - IA2, 8 - IB2, 9 - IC2, 10 - VAB, 11 - VBC, 12 - VN, 13 - VRM
Selects any available analogue input to be assigned to this channel.				
AnalogChannel6	0C	09	IC	0 - VA, 1 - VB, 2 - VC, 3 - IA, 4 - IB, 5 - IC, 6 - IN, 7 - IA2, 8 - IB2, 9 - IC2, 10 - VAB, 11 - VBC, 12 - VN, 13 - VRM
Selects any available analogue input to be assigned to this channel.				
AnalogChannel7	0C	0A	IN	0 - VA, 1 - VB, 2 - VC, 3 - IA, 4 - IB, 5 - IC, 6 - IN, 7 - IA2, 8 - IB2, 9 - IC2, 10 - VAB, 11 - VBC, 12 - VN, 13 - VRM
Selects any available analogue input to be assigned to this channel.				
AnalogChannel8	0C	0B	IN	0 - VA, 1 - VB, 2 - VC, 3 - IA, 4 - IB, 5 - IC, 6 - IN, 7 - IA2, 8 - IB2, 9 - IC2, 10 - VAB, 11 - VBC, 12 - VN, 13 - VRM
Selects any available analogue input to be assigned to this channel.				
DigitalInput1	0C	0C	Relay Label 01	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input1Trigger	0C	0D	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput2	0C	0E	Relay Label 02	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input2Trigger	0C	0F	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput3	0C	10	Relay Label 03	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input3Trigger	0C	11	Trigger L/H	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput4	0C	12	Relay Label 04	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input4Trigger	0C	13	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput5	0C	14	Relay Label 05	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input5Trigger	0C	15	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput6	0C	16	Relay Label 06	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input6Trigger	0C	17	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput7	0C	18	Relay Label 07	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input7Trigger	0C	19	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput8	0C	1A	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input8Trigger	0C	1B	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput9	0C	1C	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input9Trigger	0C	1D	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput10	0C	1E	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input10Trigger	0C	1F	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput11	0C	20	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input11Trigger	0C	21	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput12	0C	22	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input12Trigger	0C	23	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput13	0C	24	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input13Trigger	0C	25	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
DigitalInput14	0C	26	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input14Trigger	0C	27	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput15	0C	28	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input15Trigger	0C	29	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput16	0C	2A	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input16Trigger	0C	2B	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput17	0C	2C	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input17Trigger	0C	2D	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput18	0C	2E	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input18Trigger	0C	2F	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput19	0C	30	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input19Trigger	0C	31	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput20	0C	32	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input20Trigger	0C	33	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput21	0C	34	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input21Trigger	0C	35	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput22	0C	36	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input22Trigger	0C	37	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput23	0C	38	Unused	See Data Types - G32

Courier Text	Col	Row	Default Setting	Available Setting
Description				
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input23Trigger	0C	39	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput24	0C	3A	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input24Trigger	0C	3B	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput25	0C	3C	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input25Trigger	0C	3D	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput26	0C	3E	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input26Trigger	0C	3F	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput27	0C	40	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input27Trigger	0C	41	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput28	0C	42	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input28Trigger	0C	43	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput29	0C	44	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input29Trigger	0C	45	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput30	0C	46	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input30Trigger	0C	47	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput31	0C	48	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input31Trigger	0C	49	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput32	0C	4A	Unused	See Data Types - G32

Courier Text	Col	Row	Default Setting	Available Setting
Description				
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input32Trigger	0C	4B	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				

Table 41 - Disturbance record settings

5.13 Measurement Setup

Courier Text	Col	Row	Default Setting	Available Setting
Description				
MEASURE'T SETUP	0D	00		
This column contains settings for the measurement setup				
Default Display	0D	01	Banner	Not Settable
This displays the default display which is possible to change whilst at the default level using the arrow keys. Only visible on UI.				
Local Values	0D	02	Primary	0 = Primary, 1 = Secondary
Local Measurement Values.This setting controls whether measured values via the front panel user interface and the front courier port are displayed as primary or secondary quantities.				
Remote Values	0D	03	Primary	0 = Primary, 1 = Secondary
Remote Measurement Values.This setting controls whether measured values via the rear communication port are displayed as primary or secondary quantities.				
Measurement Ref	0D	04	VA	0 = VA, 1 = VB, 2 = VC, 3 = IA, 4 = IB, 5 = IC
Using this setting the phase reference for all angular measurements by the IED can be selected. This reference is for Measurements 1. Measurements 3 uses always IA local as a reference				
Demand Interval	0D	06	30min	From 1min to 99min step 1min
This setting defines the length of the fixed demand window				
Alarm Fix Dem.	0D	07	Invisible	0 = Invisible, 1 = Visible
Sets the Fixed demand alarm status to visible or invisible.				
3Ph W Thresh.	0D	08	50*Vn*In W	From 1*Vn*In W to 120*Vn*In W step 1*Vn*In W
Three phase threshold (in Watt)				
3Ph VAr Thresh.	0D	09	50*Vn*In VAr	From 1*Vn*In VAr to 120*Vn*In VAr step 1*Vn*In VAr
Three phase threshold (in Vars)				
Alarm Energies	0D	0A	Invisible	0 = Invisible, 1 = Visible
Sets the Alarm Energies to visible or invisible.				
W Fwd Thresh.	0D	0B	50*Vn*In Wh	From 1*Vn*In Wh to 1000*Vn*In Wh step 1*Vn*In Wh
W forward threshold (in Watt/h)				
W Rev Thresh.	0D	0C	50*Vn*In Wh	From 1*Vn*In Wh to 1000*Vn*In Wh step 1*Vn*In Wh
W Reverse threshold (in Watt/h)				
VAr Fwd Thresh.	0D	0D	50*Vn*In VArh	From 1*Vn*In VArh to 1000*Vn*In Varh step 1*Vn*In Varh
VAr Forward threshold (in Var/h)				
VAr Rev Thresh.	0D	0E	50*Vn*In VArh	From 1*Vn*In VArh to 1000*Vn*In Varh step 1*Vn*In Varh
VAr Reverse threshold (in Var/h)				
Motor Hour Run>1	0D	0F	Disabled	0 = Disabled, 1 = Enabled
Set Motor Hour Run >1 status.				
Motor Hour Run>1	0D	10	500hr	From 1 to 9999 step 1
Set Motor Hour Run>1 threshold (in h).				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Motor Hour Run>2	0D	11	Disabled	0 = Disabled, 1 = Enabled
Set Motor Hour Run >2 status.				
Motor Hour Run>2	0D	12	500hr	From 1 to 9999 step 1
Set Motor Hour Run>2 threshold (in h).				
Remote2 Values	0D	1B	Primary	0 = Primary or 1 = Secondary
The setting defines whether the values measured via the Second Rear Communication port are displayed in primary or secondary terms.				

Table 42 - Measurement setup settings

5.14 Communications

The communications settings apply to the rear communications ports only and will depend upon the particular protocol being used. Further details are given in the SCADA Communications chapter.

Depending on the values stored, the available settings may change too. The applicability of each setting is given in the description or available setting cell. These settings are available in the menu '**Communications'** column and are displayed.

These settings potentially cover a variety of different protocols and ports, including:

Courier Text	Col	Row	Default Setting	Available Setting
Description				
COMMUNICATIONS	0E	00		
This column contains general communications settings				
RP1 Protocol	0E	01		Not Settable
Indicates the communications protocol that will be used on the rear communications port.				
RP1 Address	0E	02	255 1 1	0 to 255 step 1 (Courier) 1 to 247 step 1 (Modbus) 0 to 254 step 1 (CS103)
Rear Port 1 Courier Protocol device address. This cell sets the unique address for the relay such that only one relay is accessed by master station software.				
RP1 Inactiv Timer	0E	03	15min	From 1min to 30min step 1min
Rear Port 1 Protocol inactivity timer. This cell controls how long the relay will wait without receiving any messages on the rear port before it reverts to its default state, including resetting any password access that was enabled.				
RP1 Baud Rate	0E	04	19200 bits/s	0=9600 bits/s 1=19200 bits/s 2=38400 bits/s (Modbus) 0=9600 bits/s 1=19200 bits/s (CS103)
Rear Port 1 Protocol serial bit/baud rate. This cell controls the communication speed between IED and master station. It is important that both IED and master station are set at the same speed setting.				
RP1 Parity	0E	05	None	0 = Odd, 1 = Even, 2 = None
Rear Port 1 Modbus/DNP 3.0 Protocol parity. This cell controls the parity format used in the data frames. It is important that both IED and master station are set with the same parity setting.				
Measure't Period	0E	06	10s	From 1s to 60s step 1s
Rear Port 1 IEC60870-5-103 Protocol measurment period. IEC60870-5-103 versions only. This cell controls the time interval that the IED will use between sending measurement data to the master station.				
Physical Link	0E	07	Copper	0 = Copper or 1 = Fibre Optic
Rear Port 1 Physical link selector. This cell defines whether an electrical EIA(RS) 485 or fiber optic connection is being used for communication between the master station and IED. This cell is only visible if a fibre optic board is fitted.				
Modbus IEC Time	0E	09	Standard	0=Standard IEC or 1=Reverse IEC

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Controls the format of the time-date G12 data type. Modbus Only. When ‘Standard IEC’ is selected the time format complies with IEC60870-5-4 requirements such that byte 1 of the information is transmitted first, followed by bytes 2 through to 7. If ‘Reverse’ is selected the transmission of information is reversed.				
RP1 CS103Blcking	0E	0A	Disabled	0 = Disabled, 1 = Monitor Blocking or 2 = Command Blocking
IEC60870-5-103 versions only. There are three settings associated with this cell: Disabled - No blocking selected. Monitor Blocking - When the monitor blocking DDB Signal is active high, either by energizing an opto input or control input, reading of the status information and disturbance records is not permitted. When in this mode the IED returns a “termination of general interrogation” message to the master station. Command Blocking - When the command blocking DDB signal is active high, either by energizing an opto input or control input, all remote commands will be ignored (i.e. CB Trip/Close, change setting group etc.). When in this mode the IED returns a “negative acknowledgement of command” message to the master station.				
RP1 Card Status	0E	0B		Not Settable
Rear Port 1 Courier Protocol Status. This cell indicates the status of the communication card.				
RP1 Port Config	0E	0C	K-Bus	0 = K-Bus or 1 = EIA485 (RS485)
Rear Port 1 Courier Protocol copper port configuration; K-Bus or EIA485. This cell defines whether an electrical KBus or EIA(RS)485 is being used for communication between the master station and relay.				
RP1 Comms Mode	0E	0D	IEC60870 FT1.2	0 = IEC60870 FT1.2 Frame or 1 = 10-bit no parity
Rear Port 1 Courier Protocol EIA485 mode. The choice is either IEC60870 FT1.2 for normal operation with 11-bit modems, or 10-bit no parity.				
RP1 Baud Rate	0E	0E	19200 bits/s	0 = 9600 bits/s, 1 = 19200 bits/s, 2 = 38400 bits/s
Rear Port 1 Courier Protocol EIA485 bit/baud rate. This cell controls the communication speed between relay and master station. It is important that both relay and master station are set at the same speed setting.				
ETH Protocol	0E	1F	IEC61850	Not Settable
Indicates the protocol used on the Network Interface Card. Visible when Ethernet card fitted				
MAC Addr 1	0E	22		This is a factory setting
Shows the MAC address of the 1st Ethernet port. Visible when Ethernet card fitted.				
MAC Addr 2	0E	23		This is a factory setting
Shows the MAC address of the 2nd Ethernet port. Visible when Ethernet card fitted.				
ETH Tunl Timeout	0E	64	15 min	From 1min to 30min step 1min
Duration of time to wait before an inactive tunnel to Easergy Studio is reset. Visible when Ethernet card fitted.				
Redundancy Conf	0E	70		
NIOS PARAMETERS. The redundant agency device configuration is used for SNMP server. This does not affect IEC61850 communications. Visible when redundant Ethernet card fitted and Comm Mode=PRP or HSR				
MAC Address	0E	71	NIOS MAC Addr	Not Settable
MAC address for the NIOS. The redundant agency device configuration is used for SNMP server. This does not affect IEC61850 communications. Visible when redundant Ethernet card fitted and Comm Mode=PRP or HSR				
IP Address	0E	72	0.0.0.0	<IP address of relay>
A default IP address which is encoded from MAC address 169.254.2.zzz, zzz = mod (The last byte of MAC address % 128 + 1) The redundant agency device configuration is used for SNMP server. This does not affect IEC61850 communications. Visible when redundant Ethernet card fitted and Comm Mode=PRP or HSR.				
Subnet Mask	0E	73	0.0.0.0	<Subnet mask of relay>
Subnet Mask for the NIOS. The redundant agency device configuration is used for SNMP server. This does not affect IEC61850 communications. Visible when redundant Ethernet card fitted and Comm Mode=PRP or HSR				
Gateway	0E	74	0.0.0.0	<Gateway address>
Gateway for the NIOS. The redundant agency device configuration is used for SNMP server. This does not affect IEC61850 communications. Visible when redundant Ethernet card fitted and Comm Mode=PRP or HSR				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
REAR PORT2 (RP2)	0E	80		
Visible when Rear Port 2 fitted.				
RP2 Protocol	0E	81	Courier	Not Settable
Rear Port 2 Protocol - "Courier". Indicates the communications protocol that will be used on the rear communications port.				
RP2 Card Status	0E	84		Not Settable
Rear Port 2 Courier Protocol Status				
RP2 Port Config	0E	88	EIA232 (RS232)	0 = EIA232 (RS232), 1 = EIA485 (RS485), 2 = K-Bus
Rear Port 2 Courier Protocol port configuration. This cell defines whether an electrical EIA(RS)232, EIA(RS)485 or KBus is being used for communication.				
RP2 Comms Mode	0E	8A	IEC60870 FT1.2	0 = IEC60870 FT1.2 Frame or 1 = 10-bit no parity
Rear Port 2 Courier Protocol EIA485 mode. The choice is either IEC60870 FT1.2 for normal operation with 11-bit modems, or 10-bit no parity.				
RP2 Address	0E	90	255	From 0 to 255 step 1
Rear Port 2 Courier Protocol device address. This cell sets the unique address for the relay such that only one relay is accessed by master station software.				
RP2 InactivTimer	0E	92	15min	From 1min to 30min step 1min
Rear Port 2 Courier Protocol inactivity timer. This cell controls how long the relay will wait without receiving any messages on the rear port before it reverts to its default state, including resetting any password access that was enabled.				
RP2 Baud Rate	0E	94	19200 bits/s	0 = 9600 bits/s, 1 = 19200 bits/s, 2 = 38400 bits/s
Rear Port 2 Courier Protocol EIA485 bit/baud rate. This cell controls the communication speed between relay and master station. It is important that both relay and master station are set at the same speed setting.				

Table 43 – Communications settings for various protocols

5.15 Commissioning Tests

To help minimising the time required to test MiCOM relays the relay provides several test facilities under the 'COMMISSION TESTS' menu heading.

There are menu cells which allow the status of the opto-isolated inputs, output relay contacts, internal Digital Data Bus (DDB) signals and user-programmable LEDs to be monitored. Additionally there are cells to test the operation of the output contacts, user-programmable LEDs.

This column is visible when the "Commission tests" setting ("Configuration" column) = "visible".

Courier Text	Col	Row	Default Setting	Available Setting
Description				
COMMISSION TESTS	0F	00		
This column contains commissioning test settings				
Opto I/P Status	0F	01		Not Settable
This menu cell displays the status of the available IED's opto-isolated inputs as a binary string, a '1' indicating an energized opto-isolated input and a '0' a de-energized one.				
Relay O/P Status	0F	02		Not Settable
This menu cell displays the status of the digital data bus (DDB) signals that result in energization of the available output relays as a binary string, a '1' indicating an operated state and '0' a non-operated state. When the 'Test Mode' cell is set to 'Enabled' the 'Relay O/P Status' cell does not show the current status of the output relays and hence can not be used to confirm operation of the output relays. Therefore it will be necessary to monitor the state of each contact in turn.				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Test Port Status	0F	03		Not Settable
This menu cell displays the status of the eight digital data bus (DDB) signals that have been allocated in the 'Monitor Bit' cells.				
LED Status	0F	04		Not Settable
8-bit binary string that indicates which of the LEDs are ON				
Monitor Bit 1	0F	05	Relay Label 01	All DDB Points
The eight 'Monitor Bit' cells allow the user to select the status of which digital data bus signals can be observed in the 'Test Port Status' cell or via the monitor/download port.				
Monitor Bit 2	0F	06	Relay Label 02	All DDB Points
The eight 'Monitor Bit' cells allow the user to select the status of which digital data bus signals can be observed in the 'Test Port Status' cell or via the monitor/download port.				
Monitor Bit 3	0F	07	Relay Label 03	All DDB Points
The eight 'Monitor Bit' cells allow the user to select the status of which digital data bus signals can be observed in the 'Test Port Status' cell or via the monitor/download port.				
Monitor Bit 4	0F	08	Relay Label 04	All DDB Points
The eight 'Monitor Bit' cells allow the user to select the status of which digital data bus signals can be observed in the 'Test Port Status' cell or via the monitor/download port.				
Monitor Bit 5	0F	09	Relay Label 05	All DDB Points
The eight 'Monitor Bit' cells allow the user to select the status of which digital data bus signals can be observed in the 'Test Port Status' cell or via the monitor/download port.				
Monitor Bit 6	0F	0A	Relay Label 06	All DDB Points
The eight 'Monitor Bit' cells allow the user to select the status of which digital data bus signals can be observed in the 'Test Port Status' cell or via the monitor/download port.				
Monitor Bit 7	0F	0B	Relay Label 07	All DDB Points
The eight 'Monitor Bit' cells allow the user to select the status of which digital data bus signals can be observed in the 'Test Port Status' cell or via the monitor/download port.				
Monitor Bit 8	0F	0C	Relay Label 08	All DDB Points
The eight 'Monitor Bit' cells allow the user to select the status of which digital data bus signals can be observed in the 'Test Port Status' cell or via the monitor/download port.				
Test Mode	0F	0D	Disable	0 = Disable, 1 = Test Mode, 2 = Blocked
The Test Mode menu cell is used to allow secondary injection testing to be performed on the IED without operation of the trip contacts. It also enables a facility to directly test the output contacts by applying menu controlled test signals. To select test mode the Test Mode menu cell should be set to 'Test Mode', which takes the IED out of service . It also causes an alarm condition to be recorded and the yellow 'Out of Service' LED to illuminate and an alarm message 'Prot'n. Disabled' is given. In IEC 60870-5-103 builds changes the Cause of Transmission, COT, to Test Mode. To enable testing of output contacts the Test Mode cell should be set to Blocked. This blocks the protection from operating the contacts and enables the test pattern and contact test functions which can be used to manually operate the output contacts. This mode also blocks maintenance, counters and freezes any information stored in the Circuit Breaker Condition column. Also in IEC 60870-5-103 builds changes the Cause of Transmission, COT, to Test Mode. Once testing is complete the cell must be set back to 'Disabled' to restore the IED back to service. In IEC61850 models using edition 2 mode, selecting Test Mode or Blocked will change the behaviour of all active logical nodes to test. The quality of all data will also indicate test.				
Test Pattern	0F	0E	0000000000000000 (bin)	0=Not Operated or 1=Operated
This cell is used to select the output relay contacts that will be tested when the 'Contact Test' cell is set to 'Apply Test'.				
Contact Test	0F	0F	No Operation	0 = No Operation, 1 = Apply Test, 2 = Remove Test

Courier Text	Col	Row	Default Setting	Available Setting
Description				
When the ‘Apply Test’ command in this cell is issued the contacts set for operation (set to ‘1’) in the ‘Test Pattern’ cell changestate. After the test has been applied the command text on the LCD will change to ‘No Operation’ and the contacts will remainin the Test State until reset issuing the ‘Remove Test’ command. The command text on the LCD will again revert to ‘No Operation’ after the ‘Remove Test’ command has been issued. Note: When the ‘Test Mode’ cell is set to ‘Enabled’ the ‘Relay O/P Status’ cell does not show the current status of the output relays and hence can not be used to confirm operation of the output relays. Therefore it will be necessary to monitor the state of each contact in turn.				
Test LEDs	0F	10	No Operation	0 = No Operation or 1 = Apply Test
When the ‘Apply Test’ command in this cell is issued, the eighteen user-programmable LEDs will illuminate for approximately 2 seconds before they extinguish and the command text on the LCD reverts to ‘No Operation’.				
Red LED Status	0F	16		Not Settable
This cell is an eighteen bit binary string that indicates which of the user-programmable LEDs on the IED are illuminated with the Red LED input active when accessing the IED from a remote location, a ‘1’ indicating a particular LED is lit and a ‘0’ not lit.				
Green LED Status	0F	17		Not Settable
This cell is an eighteen bit binary string that indicates which of the user-programmable LEDs on the IED are illuminated with the Green LED input active when accessing the IED from a remote location, a ‘1’ indicating a particular LED is lit and a ‘0’ not lit.				
DDB 31 - 0	0F	20		Not Settable
Displays the status of DDB signals				
DDB 63 - 32	0F	21		Not Settable
Displays the status of DDB signals				
DDB 95 - 64	0F	22		Not Settable
Displays the status of DDB signals				
DDB 127 - 96	0F	23		Not Settable
Displays the status of DDB signals				
DDB 159 - 128	0F	24		Not Settable
Displays the status of DDB signals				
DDB 191 - 160	0F	25		Not Settable
Displays the status of DDB signals				
DDB 223 - 192	0F	26		Not Settable
Displays the status of DDB signals				
DDB 255 - 224	0F	27		Not Settable
Displays the status of DDB signals				
DDB 287 - 256	0F	28		Not Settable
Displays the status of DDB signals				
DDB 319 - 288	0F	29		Not Settable
Displays the status of DDB signals				
DDB 351 - 320	0F	2A		Not Settable
Displays the status of DDB signals				
DDB 383 - 352	0F	2B		Not Settable
Displays the status of DDB signals				
DDB 415 - 384	0F	2C		Not Settable
Displays the status of DDB signals				
DDB 447 - 416	0F	2D		Not Settable
Displays the status of DDB signals				
DDB 479 - 448	0F	2E		Not Settable
Displays the status of DDB signals				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
DDB 511 - 480	0F	2F		Not Settable
Displays the status of DDB signals				
DDB 543 - 512	0F	30		Not Settable
Displays the status of DDB signals				
DDB 575 - 544	0F	31		Not Settable
Displays the status of DDB signals				
DDB 607 - 576	0F	32		Not Settable
Displays the status of DDB signals				
DDB 639 - 608	0F	33		Not Settable
Displays the status of DDB signals				
DDB 671 - 640	0F	34		Not Settable
Displays the status of DDB signals				
DDB 703 - 672	0F	35		Not Settable
Displays the status of DDB signals				
DDB 735 - 704	0F	36		Not Settable
Displays the status of DDB signals				
DDB 767 - 736	0F	37		Not Settable
Displays the status of DDB signals				
DDB 799 - 768	0F	38		Not Settable
Displays the status of DDB signals				
DDB 831 - 800	0F	39		Not Settable
Displays the status of DDB signals				
DDB 863 - 832	0F	3A		Not Settable
Displays the status of DDB signals				
DDB 895 - 864	0F	3B		Not Settable
Displays the status of DDB signals				
DDB 927 - 896	0F	3C		Not Settable
Displays the status of DDB signals				
DDB 959 - 928	0F	3D		Not Settable
Displays the status of DDB signals				
DDB 991 - 960	0F	3E		Not Settable
Displays the status of DDB signals				
DDB 1023 - 992	0F	3F		Not Settable
Displays the status of DDB signals				
DDB 1055 - 1024	0F	40		Not Settable
Displays the status of DDB signals				
DDB 1087 - 1056	0F	41		Not Settable
Displays the status of DDB signals				
DDB 1119 - 1088	0F	42		Not Settable
Displays the status of DDB signals				
DDB 1151 - 1120	0F	43		Not Settable
Displays the status of DDB signals				
DDB 1183 - 1152	0F	44		Not Settable

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Displays the status of DDB signals				
DDB 1215 - 1184	0F	45		Not Settable
Displays the status of DDB signals				
DDB 1247 - 1216	0F	46		Not Settable
Displays the status of DDB signals				
DDB 1279 - 1248	0F	47		Not Settable
Displays the status of DDB signals				
DDB 1311 - 1280	0F	48		Not Settable
Displays the status of DDB signals				
DDB 1343 - 1312	0F	49		Not Settable
Displays the status of DDB signals				
DDB 1375 - 1344	0F	4A		Not Settable
Displays the status of DDB signals				
DDB 1407 - 1376	0F	4B		Not Settable
Displays the status of DDB signals				
DDB 1439 - 1408	0F	4C		Not Settable
Displays the status of DDB signals				
DDB 1471 - 1440	0F	4D		Not Settable
Displays the status of DDB signals				
DDB 1503 - 1472	0F	4E		Not Settable
Displays the status of DDB signals				
DDB 1535 - 1504	0F	4F		Not Settable
Displays the status of DDB signals				
DDB 1567 - 1536	0F	50		Not Settable
Displays the status of DDB signals				
DDB 1599 - 1568	0F	51		Not Settable
Displays the status of DDB signals				
DDB 1631 - 1600	0F	52		Not Settable
Displays the status of DDB signals				
DDB 1663 - 1632	0F	53		Not Settable
Displays the status of DDB signals				
DDB 1695 - 1664	0F	54		Not Settable
Displays the status of DDB signals				
DDB 1727 - 1696	0F	55		Not Settable
Displays the status of DDB signals				
DDB 1759 - 1728	0F	56		Not Settable
Displays the status of DDB signals				
DDB 1791 - 1760	0F	57		Not Settable
Displays the status of DDB signals				
DDB 1823 - 1792	0F	58		Not Settable
Displays the status of DDB signals				
DDB 1855 - 1824	0F	59		Not Settable
Displays the status of DDB signals				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
DDB 1887 - 1856	0F	5A		Not Settable
Displays the status of DDB signals				
DDB 1919 - 1888	0F	5B		Not Settable
Displays the status of DDB signals				
DDB 1951 - 1920	0F	5C		Not Settable
Displays the status of DDB signals				
DDB 1983 - 1952	0F	5D		Not Settable
Displays the status of DDB signals				
DDB 2015 - 1984	0F	5E		Not Settable
Displays the status of DDB signals				
DDB 2047 - 2016	0F	5F		Not Settable
Displays the status of DDB signals				

Table 44 - Commissioning tests menu cells

5.16 Circuit Breaker Condition Monitor Setup

The Circuit Breaker condition monitoring includes features to monitor the CB condition such as the current broken, number of CB operations, number of CB operations in a set time and CB operating time. Alarms or a circuit breaker lockout can be raised for different threshold values.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
CB MONITOR SETUP	10	00		
This column contains Circuit Breaker monitoring parameters				
Broken I^	10	01	2	From 1 to 2 step 0.1
This sets the factor to be used for the cumulative I^ counter calculation that monitors the cumulative severity of the duty placed on the interrupter. This factor is set according to the type of Circuit Breaker used.				
I^ Maintenance	10	02	Disabled	0 = Disabled, 1 = Enabled
Setting which determines if an alarm will be raised or not when the cumulative I^ maintenance counter threshold is exceeded.				
I^ Maintenance	10	03	1000A	From 1A to 25kA step 1A
Setting that determines the threshold for the cumulative I^ maintenance counter monitors.				
No CB Ops Maint	10	06	Disabled	0 = Disabled, 1 = Enabled
Setting to activate the number of circuit breaker operations maintenance alarm.				
No CB Ops Maint	10	07	10	From 1 to 10000 step 1
Sets the threshold for number of circuit breaker operations maintenance alarm, indicating when preventative maintenance is due.				
CB Time Maint	10	0A	Disabled	0 = Disabled, 1 = Enabled
Setting to activate the circuit breaker operating time maintenance alarm.				
CB Time Maint	10	0B	100ms	From 5ms to 500ms step 1ms
Setting for the circuit operating time threshold which is set in relation to the specified interrupting time of the circuit breaker.				

Table 45 - Circuit breaker condition monitoring menu

5.17 Opto Configuration

Courier Text	Col	Row	Default Setting	Available Setting
Description				
OPTO CONFIG	11	00		
This column contains opto-input configuration settings				
Global Nominal V	11	01	24/27V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V, 4 = 220/250V, 5 = Custom
Sets the nominal battery voltage for all opto inputs by selecting one of the five standard ratings in the Global Nominal V settings. If Custom is selected then each opto input can individually be set to a nominal voltage value.				
Opto Input 1	11	02	24/27V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V, 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 40, depending on the IED and I/O configuration.				
Opto Input 2	11	03	24/27V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V, 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 40, depending on the IED and I/O configuration.				
Opto Input 3	11	04	24/27V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V, 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 40, depending on the IED and I/O configuration.				
Opto Input 4	11	05	24/27V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V, 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 40, depending on the IED and I/O configuration.				
Opto Input 5	11	06	24/27V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V, 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 40, depending on the IED and I/O configuration.				
Opto Input 6	11	07	24/27V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V, 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 40, depending on the IED and I/O configuration.				
Opto Input 7	11	08	24/27V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V, 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 40, depending on the IED and I/O configuration.				
Opto Input 8	11	09	24/27V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V, 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 40, depending on the IED and I/O configuration.				
Opto Input 9	11	0A	24/27V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V, 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 40, depending on the IED and I/O configuration.				
Opto Input 10	11	0B	24/27V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V, 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 40, depending on the IED and I/O configuration.				
Opto Input 11	11	0C	24/27V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V, 4 = 220/250V

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 40, depending on the IED and I/O configuration.				
Opto Input 12	11	0D	24/27V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V, 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 40, depending on the IED and I/O configuration.				
Opto Input 13	11	0E	24/27V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V, 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 40, depending on the IED and I/O configuration.				
Opto Input 14	11	0F	24/27V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V, 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 40, depending on the IED and I/O configuration.				
Opto Input 15	11	10	24/27V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V, 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 40, depending on the IED and I/O configuration.				
Opto Input 16	11	11	24/27V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V, 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 40, depending on the IED and I/O configuration.				
Opto Filter Cntl	11	50	1111111111111111(bin)	32-bit binary setting: 0=disable filtering or 1=enable filtering
Selects each of the first 32 inputs with a pre-set filter of ½ cycle that renders the input immune to induced noise on the wiring. The number of available bits depends on the I/O configuration.				
Characteristic	11	80	Standard 60%-80%	0 = Standard 60% to 80% or 1 = 50% to 70%
Selects the pick-up and drop-off characteristics of the opto's. Selecting the standard setting means they nominally provide a Logic 1 or On value for Voltages ≥80% of the set lower nominal voltage and a Logic 0 or Off value for the voltages ≤60% of the set higher nominal voltage.				

Table 46 - Opto inputs configuration settings

5.18 Control Inputs

The control inputs function as software switches that can be set or reset either locally or remotely. These inputs can be used to trigger any function that they are connected to as part of the PSL.

The setting is not visible if ‘Control Inputs’ are set invisible under the CONFIGURATION column.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
CONTROL INPUTS	12	00		
This column contains settings for the type of control input (32 in all)				
Ctrl I/P Status	12	01	00000000000000000000000000000000(bin)	32-bit binary setting: 0=Reset or 1=Set
Cell that is used to set (1) and reset (0) the selected Control Input by simply scrolling and changing the status of selected bits. This command will be then recognized and executed in the PSL. Alternatively, each of the 32 Control input can also be set and reset using the individual menu setting cells as follows:				
Control Input 1	12	02	No operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 1 set/ reset.				
Control Input 2	12	03	No operation	0 = No Operation, 1 = SET , 2 = RESET

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Setting to allow Control Inputs 2 set/ reset.				
Control Input 3	12	04	No operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 3 set/ reset.				
Control Input 4	12	05	No operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 4 set/ reset.				
Control Input 5	12	06	No operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 5 set/ reset.				
Control Input 6	12	07	No operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 6 set/ reset.				
Control Input 7	12	08	No operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 7 set/ reset.				
Control Input 8	12	09	No operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 8 set/ reset.				
Control Input 9	12	0A	No operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 9 set/ reset.				
Control Input 10	12	0B	No operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 10 set/ reset.				
Control Input 11	12	0C	No operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 11 set/ reset.				
Control Input 12	12	0D	No operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 12 set/ reset.				
Control Input 13	12	0E	No operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 13 set/ reset.				
Control Input 14	12	0F	No operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 14 set/ reset.				
Control Input 15	12	10	No operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 15 set/ reset.				
Control Input 16	12	11	No operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 16 set/ reset.				
Control Input 17	12	12	No operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 17 set/ reset.				
Control Input 18	12	13	No operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 18 set/ reset.				
Control Input 19	12	14	No operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 19 set/ reset.				
Control Input 20	12	15	No operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 20 set/ reset.				
Control Input 21	12	16	No operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 21 set/ reset.				
Control Input 22	12	17	No operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 22 set/ reset.				
Control Input 23	12	18	No operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 23 set/ reset.				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Control Input 24	12	19	No operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 24 set/ reset.				
Control Input 25	12	1A	No operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 25 set/ reset.				
Control Input 26	12	1B	No operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 26 set/ reset.				
Control Input 27	12	1C	No operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 27 set/ reset.				
Control Input 28	12	1D	No operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 28 set/ reset.				
Control Input 29	12	1E	No operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 30 set/ reset.				
Control Input 30	12	1F	No operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 30 set/ reset.				
Control Input 31	12	20	No operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 31 set/ reset.				
Control Input 32	12	21	No operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 32 set/ reset.				

Table 47 - Control inputs settings

5.19 Control Input Configuration

The control inputs function as software switches that can be set or reset either locally or remotely. These inputs can be used to trigger any function that they are connected to as part of the PSL.
This column is visible when the “Control I/P Config” setting (“Configuration” column) = “visible”.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
CTRL I/P CONFIG	13	00		
This column contains settings for the type of control input (32 in all)				
Hotkey Enabled	13	01	11111111111111111111111111111111 (bin)	32-bit binary setting: 0=Not accessible via Hotkey Menu or 1=Accessible via Hotkey Menu
Setting to allow the control inputs to be individually assigned to the Hotkey menu by setting ‘1’ in the appropriate bit in the Hotkey Enabled cell. The hotkey menu allows the control inputs to be set, reset or pulsed without the need to enter the CONTROL INPUTS column. Not available on Chinese version relays.				
Control Input 1	13	10	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either ‘latched’ or ‘pulsed’. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				
Ctrl Command 1	13	11	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
Control Input 2	13	14	Latched	0 = Latched or 1 = Pulsed

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Configures the control inputs as either 'latched' or 'pulsed'. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				
Ctrl Command 2	13	15	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
Control Input 3	13	18	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				
Ctrl Command 3	13	19	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
Control Input 4	13	1C	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				
Ctrl Command 4	13	1D	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
Control Input 5	13	20	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				
Ctrl Command 5	13	21	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
Control Input 6	13	24	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				
Ctrl Command 6	13	25	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
Control Input 7	13	28	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				
Ctrl Command 7	13	29	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
Control Input 8	13	2C	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Ctrl Command 8	13	2D	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
Control Input 9	13	30	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				
Ctrl Command 9	13	31	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
Control Input 10	13	34	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				
Ctrl Command 10	13	35	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
Control Input 11	13	38	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				
Ctrl Command 11	13	39	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
Control Input 12	13	3C	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				
Ctrl Command 12	13	3D	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
Control Input 13	13	40	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				
Ctrl Command 13	13	41	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
Control Input 14	13	44	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				
Ctrl Command 14	13	45	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
Control Input 15	13	48	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				
Ctrl Command 15	13	49	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
Control Input 16	13	4C	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				
Ctrl Command 16	13	4D	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
Control Input 17	13	50	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				
Ctrl Command 17	13	51	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
Control Input 18	13	54	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				
Ctrl Command 18	13	55	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
Control Input 19	13	58	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				
Ctrl Command 19	13	59	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
Control Input 20	13	5C	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				
Ctrl Command 20	13	5D	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
Control Input 21	13	60	Latched	0 = Latched or 1 = Pulsed

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Configures the control inputs as either 'latched' or 'pulsed'. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				
Ctrl Command 21	13	61	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
Control Input 22	13	64	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				
Ctrl Command 22	13	65	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
Control Input 23	13	68	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				
Ctrl Command 23	13	69	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
Control Input 24	13	6C	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				
Ctrl Command 24	13	6D	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
Control Input 25	13	70	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				
Ctrl Command 25	13	71	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
Control Input 26	13	74	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				
Ctrl Command 26	13	75	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
Control Input 27	13	78	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Ctrl Command 27	13	79	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
Control Input 28	13	7C	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either ‘latched’ or ‘pulsed’. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				
Ctrl Command 28	13	7D	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
Control Input 29	13	80	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either ‘latched’ or ‘pulsed’. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				
Ctrl Command 29	13	81	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
Control Input 30	13	84	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either ‘latched’ or ‘pulsed’. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				
Ctrl Command 30	13	85	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
Control Input 31	13	88	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either ‘latched’ or ‘pulsed’. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				
Ctrl Command 31	13	89	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
Control Input 32	13	8C	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either ‘latched’ or ‘pulsed’. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				
Ctrl Command 32	13	8D	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				

Table 48 - Control inputs configuration settings

5.20 Function Keys

Courier Text	Col	Row	Default Setting	Available Setting
Description				
FUNCTION KEYS	17	00		
This column contains the function key definitions				
Fn Key Status	17	01		Not Settable
Displays the status of each function key.				
Fn Key 1	17	02	Unlocked	0 = Disabled, 1 = Unlocked (Enabled), 2 = Locked
Setting to activate function key. The ‘Lock’ setting allows a function key output that is set to toggle mode to be locked in its current active state.				
Fn Key 1 Mode	17	03	Normal	0 = Normal or 1 = Toggled
Sets the function key in toggle or normal mode. In ‘Toggle’ mode, a single key press will set/latch the function key output as ‘high’ or ‘low’ in programmable scheme logic. This feature can be used to enable/disable IED functions. In the ‘Normal’ mode the function key output will remain ‘high’ as long as key is pressed.				
Fn Key 1 Label	17	04	Function Key 1	From 32 to 234 step 1
Allows the text of the function key to be changed to something more suitable for the application.				
Fn Key 2	17	05	Unlocked	0 = Disabled, 1 = Unlocked (Enabled), 2 = Locked
Same description as Fn Key 1				
Fn Key 2 Mode	17	06	Normal	0 = Normal or 1 = Toggled
Same description as Fn Key 1 Mode				
Fn Key 2 Label	17	07	Function Key 2	From 32 to 234 step 1
Same description as Fn Key 1 Label				
Fn Key 3	17	08	Unlocked	0 = Disabled, 1 = Unlocked (Enabled), 2 = Locked
Same description as Fn Key 1				
Fn Key 3 Mode	17	09	Normal	0 = Normal or 1 = Toggled
Same description as Fn Key 1 Mode				
Fn Key 3 Label	17	0A	Function Key 3	From 32 to 234 step 1
Same description as Fn Key 1 Label				
Fn Key 4	17	0B	Unlocked	0 = Disabled, 1 = Unlocked (Enabled), 2 = Locked
Same description as Fn Key 1				
Fn Key 4 Mode	17	0C	Normal	0 = Normal or 1 = Toggled
Same description as Fn Key 1 Mode				
Fn Key 4 Label	17	0D	Function Key 4	From 32 to 234 step 1
Same description as Fn Key 1 Label				
Fn Key 5	17	0E	Unlocked	0 = Disabled, 1 = Unlocked (Enabled), 2 = Locked
Same description as Fn Key 1				
Fn Key 5 Mode	17	0F	Normal	0 = Normal or 1 = Toggled
Same description as Fn Key 1 Mode				
Fn Key 5 Label	17	10	Function Key 5	From 32 to 234 step 1
Same description as Fn Key 1 Label				
Fn Key 6	17	11	Unlocked	0 = Disabled, 1 = Unlocked (Enabled), 2 = Locked
Same description as Fn Key 1				
Fn Key 6 Mode	17	12	Normal	0 = Normal or 1 = Toggled
Same description as Fn Key 1 Mode				
Fn Key 6 Label	17	13	Function Key 6	From 32 to 234 step 1
Same description as Fn Key 1 Label				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Fn Key 7	17	14	Unlocked	0 = Disabled, 1 = Unlocked (Enabled), 2 = Locked
Same description as Fn Key 1				
Fn Key 7 Mode	17	15	Normal	0 = Normal or 1 = Toggled
Same description as Fn Key 1 Mode				
Fn Key 7 Label	17	16	Function Key 7	From 32 to 234 step 1
Same description as Fn Key 1 Label				
Fn Key 8	17	17	Unlocked	0 = Disabled, 1 = Unlocked (Enabled), 2 = Locked
Same description as Fn Key 1				
Fn Key 8 Mode	17	18	Normal	0 = Normal or 1 = Toggled
Same description as Fn Key 1 Mode				
Fn Key 8 Label	17	19	Function Key 8	From 32 to 234 step 1
Same description as Fn Key 1 Label				
Fn Key 9	17	1A	Unlocked	0 = Disabled, 1 = Unlocked (Enabled), 2 = Locked
Same description as Fn Key 1				
Fn Key 9 Mode	17	1B	Normal	0 = Normal or 1 = Toggled
Same description as Fn Key 1 Mode				
Fn Key 9 Label	17	1C	Function Key 9	From 32 to 234 step 1
Same description as Fn Key 1 Label				
Fn Key 10	17	1D	Unlocked	0 = Disabled, 1 = Unlocked (Enabled), 2 = Locked
Same description as Fn Key 1				
Fn Key 10 Mode	17	1E	Normal	0 = Normal or 1 = Toggled
Same description as Fn Key 1 Mode				
Fn Key 10 Label	17	1F	Function Key 10	From 32 to 234 step 1
Same description as Fn Key 1 Label				

Table 49 - Function keys configuration settings

5.21 IED Configurator

Courier Text	Col	Row	Default Setting	Available Setting
Description				
IED CONFIGURATOR	19	00		
This column contains IED Configurator settings (IEC61850 builds)				
Switch Conf.Bank	19	05	No action	0 = No action or 1 = Switch banks
Setting which allows the user to switch between the current configuration, held in the Active Memory Bank (and partly displayed below), to the configuration sent to and held in the Inactive Memory Bank.				
Restore Conf.	19	0A	No action	0 = No action or 1 = Restore Conf.
Used to restore data from MCL(MiCOM Configuration Language)/CID (Configured IED Descriptor) file. This file is specific, containing a single devices IEC61850 configuration information, and used for transferring data to/from the MiCOM IED.				
Active Conf.Name	19	10		Not Settable
The name of the configuration in the Active Memory Bank, usually taken from the SCL file.				
Active Conf.Rev	19	11		Not Settable
Configuration Revision number of the configuration in the Active Memory Bank, usually taken from the SCL file.				
Inact.Conf.Name	19	20		Not Settable

Courier Text	Col	Row	Default Setting	Available Setting
Description				
The name of the configuration in the Inactive Memory Bank, usually taken from the SCL file.				
Inact.Conf.Rev	19	21		Not Settable
Configuration Revision number of the configuration in the Inactive Memory Bank, usually taken from the SCL file.				
IP PARAMETERS	19	30		Not Settable
IP PARAMETERS				
IP Address 1	19	31		Not Settable
Displays the unique network IP address that identifies the relay on interface 1. A default IP address is encoded from MAC address 169.254.0.xxx, xxx = mod (The last byte of MAC1, 128) + 1.				
Subnet Mask 1	19	32		Not Settable
Displays the sub-network mask for interface 1.				
Gateway 1	19	33		Not Settable
Displays the IP address of the gateway (proxy) that interface 1 is connected to.				
IP Address 2	19	34		Not Settable
Displays the unique network IP address that identifies the relay on interface 2. A default IP address is encoded from MAC address 169.254.0.xxx, xxx = mod (The last byte of MAC1, 128) + 1. Visible when redundant Ethernet card fitted.				
Subnet Mask 2	19	35		Not Settable
Displays the sub-network mask for interface 2. Visible when redundant Ethernet card fitted.				
Gateway 2	19	36		Not Settable
Displays the IP address of the gateway (proxy) that interface 2 is connected to. Visible when redundant Ethernet card fitted.				
SNTP PARAMETERS	19	40		Not Settable
SNTP PARAMETERS				
SNTP Server 1	19	41		Not Settable
Displays the IP address of the primary SNTP server.				
SNTP Server 2	19	42		Not Settable
Displays the IP address of the secondary SNTP server. Visible when Ethernet card fitted.				
IEC 61850 SCL	19	50		Not Settable
IEC 61850 SCL				
IED Name	19	51		Not Settable
IED name, which is the unique name on the IEC 61850 network for the IED, usually taken from the SCL (Substation Configuration Language for XML) file.				
IEC 61850 GOOSE	19	60		Not Settable
IEC 61850 GOOSE				
GoEna	19	70	0000000000000000(bin)	Bit 00=gcb01 GoEna to Bit 0F=gcb16 GoEna
Setting to enable GOOSE publisher settings.				
Pub.Simul.Goose	19	71	0000000000000000(bin)	Bit 00=gcb01 Sim Mode to Bit 0F=gcb16 Sim Mode
The Pub.Simul.GOOSE cell controls whether GOOSE are sent as Normal or Simulated GOOSE. When a GOOSE control block is set to Sim Mode its GOOSE is published as simulated. Simulated GOOSE are usually published by test equipment and this setting allows a test IED to be set up to simulate the IEDs in a substation.				
Sub.Simul.Goose	19	73	No	0 = No or 1 = Yes
In edition 2 mode when Sub.Simul.GOOSE is set to Yes the relay will look for simulated GOOSE. If a simulated GOOSE is found the relay will subscribe to it and will not respond to its normal GOOSE until Sub.Simul.GOOSE is set to No. Other GOOSE signals that are not being simulated will remain subscribing to normal GOOSE. In edition 1 mode the relay will respond to both normal and test GOOSE.				

Table 50 - IED configurator settings

5.22 Virtual Input Labels

Courier Text	Col	Row	Default Setting	Available Setting
Description				
VIR I/P LABELS	26	00		
This column contains settings for Virtual Input Labels				
Virtual Input 1	26	01	Virtual Input 1	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 2	26	02	Virtual Input 2	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 3	26	03	Virtual Input 3	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 4	26	04	Virtual Input 4	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 5	26	05	Virtual Input 5	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 6	26	06	Virtual Input 6	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 7	26	07	Virtual Input 7	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 8	26	08	Virtual Input 8	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 9	26	09	Virtual Input 9	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 10	26	0A	Virtual Input 10	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 11	26	0B	Virtual Input 11	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 12	26	0C	Virtual Input 12	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 13	26	0D	Virtual Input 13	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 14	26	0E	Virtual Input 14	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 15	26	0F	Virtual Input 15	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 16	26	10	Virtual Input 16	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 17	26	11	Virtual Input 17	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 18	26	12	Virtual Input 18	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 19	26	13	Virtual Input 19	From 32 to 234 step 1
Text label to describe each individual Virtual input				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Virtual Input 20	26	14	Virtual Input 20	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 21	26	15	Virtual Input 21	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 22	26	16	Virtual Input 22	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 23	26	17	Virtual Input 23	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 24	26	18	Virtual Input 24	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 25	26	19	Virtual Input 25	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 26	26	1A	Virtual Input 26	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 27	26	1B	Virtual Input 27	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 28	26	1C	Virtual Input 28	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 29	26	1D	Virtual Input 29	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 30	26	1E	Virtual Input 30	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 31	26	1F	Virtual Input 31	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 32	26	20	Virtual Input 32	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 33	26	21	Virtual Input 33	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 34	26	22	Virtual Input 34	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 35	26	23	Virtual Input 35	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 36	26	24	Virtual Input 36	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 37	26	25	Virtual Input 37	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 38	26	26	Virtual Input 38	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 39	26	27	Virtual Input 39	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 40	26	28	Virtual Input 40	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 41	26	29	Virtual Input 41	From 32 to 234 step 1

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Text label to describe each individual Virtual input				
Virtual Input 42	26	2A	Virtual Input 42	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 43	26	2B	Virtual Input 43	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 44	26	2C	Virtual Input 44	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 45	26	2D	Virtual Input 45	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 46	26	2E	Virtual Input 46	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 47	26	2F	Virtual Input 47	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 48	26	30	Virtual Input 48	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 49	26	31	Virtual Input 49	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 50	26	32	Virtual Input 50	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 51	26	33	Virtual Input 51	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 52	26	34	Virtual Input 52	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 53	26	35	Virtual Input 53	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 54	26	36	Virtual Input 54	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 55	26	37	Virtual Input 55	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 56	26	38	Virtual Input 56	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 57	26	39	Virtual Input 57	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 58	26	3A	Virtual Input 58	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 59	26	3B	Virtual Input 59	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 60	26	3C	Virtual Input 60	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 61	26	3D	Virtual Input 61	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 62	26	3E	Virtual Input 62	From 32 to 234 step 1
Text label to describe each individual Virtual input				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Virtual Input 63	26	3F	Virtual Input 63	From 32 to 234 step 1
Text label to describe each individual Virtual input				
Virtual Input 64	26	40	Virtual Input 64	From 32 to 234 step 1
Text label to describe each individual Virtual input				

Table 51 – V I/P Labels

5.23 Virtual Output Labels

Courier Text	Col	Row	Default Setting	Available Setting
Description				
VIR O/P LABELS	27	00		
This column contains settings for Virtual Output Labels				
Virtual Output 1	27	01	Virtual Output 1	From 32 to 234 step 1
Text label to describe each individual Virtual output				
Virtual Output 2	27	02	Virtual Output 2	From 32 to 234 step 1
Text label to describe each individual Virtual output				
Virtual Output 3	27	03	Virtual Output 3	From 32 to 234 step 1
Text label to describe each individual Virtual output				
Virtual Output 4	27	04	Virtual Output 4	From 32 to 234 step 1
Text label to describe each individual Virtual output				
Virtual Output 5	27	05	Virtual Output 5	From 32 to 234 step 1
Text label to describe each individual Virtual output				
Virtual Output 6	27	06	Virtual Output 6	From 32 to 234 step 1
Text label to describe each individual Virtual output				
Virtual Output 7	27	07	Virtual Output 7	From 32 to 234 step 1
Text label to describe each individual Virtual output				
Virtual Output 8	27	08	Virtual Output 8	From 32 to 234 step 1
Text label to describe each individual Virtual output				
Virtual Output 9	27	09	Virtual Output 9	From 32 to 234 step 1
Text label to describe each individual Virtual output				
Virtual Output10	27	0A	Virtual Output10	From 32 to 234 step 1
Text label to describe each individual Virtual output				
Virtual Output11	27	0B	Virtual Output11	From 32 to 234 step 1
Text label to describe each individual Virtual output				
Virtual Output12	27	0C	Virtual Output12	From 32 to 234 step 1
Text label to describe each individual Virtual output				
Virtual Output13	27	0D	Virtual Output13	From 32 to 234 step 1
Text label to describe each individual Virtual output				
Virtual Output14	27	0E	Virtual Output14	From 32 to 234 step 1
Text label to describe each individual Virtual output				
Virtual Output15	27	0F	Virtual Output15	From 32 to 234 step 1
Text label to describe each individual Virtual output				
Virtual Output16	27	10	Virtual Output16	From 32 to 234 step 1

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Text label to describe each individual Virtual output				
Virtual Output17	27	11	Virtual Output17	From 32 to 234 step 1
Text label to describe each individual Virtual output				
Virtual Output18	27	12	Virtual Output18	From 32 to 234 step 1
Text label to describe each individual Virtual output				
Virtual Output19	27	13	Virtual Output19	From 32 to 234 step 1
Text label to describe each individual Virtual output				
Virtual Output20	27	14	Virtual Output20	From 32 to 234 step 1
Text label to describe each individual Virtual output				
Virtual Output21	27	15	Virtual Output21	From 32 to 234 step 1
Text label to describe each individual Virtual output				
Virtual Output22	27	16	Virtual Output22	From 32 to 234 step 1
Text label to describe each individual Virtual output				
Virtual Output23	27	17	Virtual Output23	From 32 to 234 step 1
Text label to describe each individual Virtual output				
Virtual Output24	27	18	Virtual Output24	From 32 to 234 step 1
Text label to describe each individual Virtual output				
Virtual Output25	27	19	Virtual Output25	From 32 to 234 step 1
Text label to describe each individual Virtual output				
Virtual Output26	27	1A	Virtual Output26	From 32 to 234 step 1
Text label to describe each individual Virtual output				
Virtual Output27	27	1B	Virtual Output27	From 32 to 234 step 1
Text label to describe each individual Virtual output				
Virtual Output28	27	1C	Virtual Output28	From 32 to 234 step 1
Text label to describe each individual Virtual output				
Virtual Output29	27	1D	Virtual Output29	From 32 to 234 step 1
Text label to describe each individual Virtual output				
Virtual Output30	27	1E	Virtual Output30	From 32 to 234 step 1
Text label to describe each individual Virtual output				
Virtual Output31	27	1F	Virtual Output31	From 32 to 234 step 1
Text label to describe each individual Virtual output				
Virtual Output32	27	20	Virtual Output32	From 32 to 234 step 1
Text label to describe each individual Virtual output				

Table 52 – Virtual O/PLabels

5.24 USR Alarm Labels

Courier Text	Col	Row	Default Setting	Available Setting
Description				
USR ALARM LABELS	28	00		
This column contains settings for Virtual Output Labels				
SR User Alarm 1	28	01	SR User Alarm 1	From 32 to 234 step 1
Text label to describe each individual User Alarm				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
SR User Alarm 2	28	02	SR User Alarm 2	From 32 to 234 step 1
Text label to describe each individual User Alarm				
SR User Alarm 3	28	03	SR User Alarm 3	From 32 to 234 step 1
Text label to describe each individual User Alarm				
SR User Alarm 4	28	04	SR User Alarm 4	From 32 to 234 step 1
Text label to describe each individual User Alarm				
SR User Alarm 5	28	05	SR User Alarm 5	From 32 to 234 step 1
Text label to describe each individual User Alarm				
SR User Alarm 6	28	06	SR User Alarm 6	From 32 to 234 step 1
Text label to describe each individual User Alarm				
SR User Alarm 7	28	07	SR User Alarm 7	From 32 to 234 step 1
Text label to describe each individual User Alarm				
SR User Alarm 8	28	08	SR User Alarm 8	From 32 to 234 step 1
Text label to describe each individual User Alarm				
SR User Alarm 9	28	09	SR User Alarm 9	From 32 to 234 step 1
Text label to describe each individual User Alarm				
SR User Alarm 10	28	0A	SR User Alarm 10	From 32 to 234 step 1
Text label to describe each individual User Alarm				
SR User Alarm 11	28	0B	SR User Alarm 11	From 32 to 234 step 1
Text label to describe each individual User Alarm				
SR User Alarm 12	28	0C	SR User Alarm 12	From 32 to 234 step 1
Text label to describe each individual User Alarm				
SR User Alarm 13	28	0D	SR User Alarm 13	From 32 to 234 step 1
Text label to describe each individual User Alarm				
SR User Alarm 14	28	0E	SR User Alarm 14	From 32 to 234 step 1
Text label to describe each individual User Alarm				
SR User Alarm 15	28	0F	SR User Alarm 15	From 32 to 234 step 1
Text label to describe each individual User Alarm				
SR User Alarm 16	28	10	SR User Alarm 16	From 32 to 234 step 1
Text label to describe each individual User Alarm				
MR User Alarm 17	28	11	MR User Alarm 17	From 32 to 234 step 1
Text label to describe each individual User Alarm				
MR User Alarm 18	28	12	MR User Alarm 18	From 32 to 234 step 1
Text label to describe each individual User Alarm				
MR User Alarm 19	28	13	MR User Alarm 19	From 32 to 234 step 1
Text label to describe each individual User Alarm				
MR User Alarm 20	28	14	MR User Alarm 20	From 32 to 234 step 1
Text label to describe each individual User Alarm				
MR User Alarm 21	28	15	MR User Alarm 21	From 32 to 234 step 1
Text label to describe each individual User Alarm				
MR User Alarm 22	28	16	MR User Alarm 22	From 32 to 234 step 1
Text label to describe each individual User Alarm				
MR User Alarm 23	28	17	MR User Alarm 23	From 32 to 234 step 1

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Text label to describe each individual User Alarm				
MR User Alarm 24	28	18	MR User Alarm 24	From 32 to 234 step 1
Text label to describe each individual User Alarm				
MR User Alarm 25	28	19	MR User Alarm 25	From 32 to 234 step 1
Text label to describe each individual User Alarm				
MR User Alarm 26	28	1A	MR User Alarm 26	From 32 to 234 step 1
Text label to describe each individual User Alarm				
MR User Alarm 27	28	1B	MR User Alarm 27	From 32 to 234 step 1
Text label to describe each individual User Alarm				
MR User Alarm 28	28	1C	MR User Alarm 28	From 32 to 234 step 1
Text label to describe each individual User Alarm				
MR User Alarm 29	28	1D	MR User Alarm 29	From 32 to 234 step 1
Text label to describe each individual User Alarm				
MR User Alarm 30	28	1E	MR User Alarm 30	From 32 to 234 step 1
Text label to describe each individual User Alarm				
MR User Alarm 31	28	1F	MR User Alarm 31	From 32 to 234 step 1
Text label to describe each individual User Alarm				
MR User Alarm 32	28	20	MR User Alarm 32	From 32 to 234 step 1
Text label to describe each individual User Alarm				

Table 53 – Virtual O/PLabels

5.25 Control Input Labels

Courier Text	Col	Row	Default Setting	Available Setting
Description				
CTRL I/P LABELS	29	00		
This column contains settings for Control Input Labels				
Control Input 1	29	01	Control Input 1	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 2	29	02	Control Input 2	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 3	29	03	Control Input 3	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 4	29	04	Control Input 4	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 5	29	05	Control Input 5	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 6	29	06	Control Input 6	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Control Input 7	29	07	Control Input 7	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 8	29	08	Control Input 8	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 9	29	09	Control Input 9	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 10	29	0A	Control Input 10	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 11	29	0B	Control Input 11	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 12	29	0C	Control Input 12	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 13	29	0D	Control Input 13	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 14	29	0E	Control Input 14	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 15	29	0F	Control Input 15	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 16	29	10	Control Input 16	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 17	29	11	Control Input 17	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 18	29	12	Control Input 18	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 19	29	13	Control Input 19	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 20	29	14	Control Input 20	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 21	29	15	Control Input 21	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 22	29	16	Control Input 22	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Control Input 23	29	17	Control Input 23	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 24	29	18	Control Input 24	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 25	29	19	Control Input 25	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 26	29	1A	Control Input 26	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 27	29	1B	Control Input 27	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 28	29	1C	Control Input 28	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 29	29	1D	Control Input 29	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 30	29	1E	Control Input 30	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 31	29	1F	Control Input 31	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
Control Input 32	29	20	Control Input 32	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				

Table 54 - Control input label settings

5.26 PSL DATA Column

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Grp1 PSL Ref	B7	01		
Displays Group 1 PSL Reference				
Date/Time	B7	02		
This cell cell has no menu text. It will display the creating date and time of Group 1 PSL.				
PSL unique ID	B7	03		
Displays Group 1 PSL ID				
Grp2 PSL Ref	B7	11		
Displays Group 2 PSL Reference				
Date/Time	B7	12		
This cell cell has no menu text. It will display the creating date and time of Group 2 PSL.				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
PSL unique ID	B7	13		
Displays Group 2 PSL ID				

Table 55 - PSL data menu

OPERATION

CHAPTER 5

Date:	05/2017
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.
Hardware suffix:	L (P241) & M (P242 & P243)
Software version:	D1
Connection diagrams:	10P241xx (xx = 01 to 02) 10P242xx (xx = 01) 10P243xx (xx = 01)

CONTENTS

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FIGURES

TABLES

1 OPERATION OF INDIVIDUAL PROTECTION FUNCTIONS

The following sections detail the individual protection functions.

1.1 Motor Starting and Running (Stall Protection) (48/51LR/50S/14)

1.1.1 Stall Protection Description

Comprehensive features are available to protect the motor during the critical starting sequence. Measurements and diagnostics are also available, in order to help the user in the maintenance of the electrical process: for example, last start time and last start current can be displayed on the HMI of the relay.

1.1.1.1 Prolonged Start

Three criteria can be used to detect a motor start:

Single criteria: a change in the interrupting device position is detected, that is from open to close or detection of a starting current of more than the starting current threshold (start criteria is set to **52a** or **I** in the **STALL DETECTION** menu settings)

Extended criteria: a change in the interrupting device position is detected, along with the detection of a starting current of more than the starting current threshold, **52A+I**. Both criteria have to be present within a 90 ms time period.

Once a start has been detected, using one of these methods, and the current fails to fall below the current threshold before normal starting time threshold, a trip will be initialized.

A typical diagram for the detection of a successful start is shown in the following *Start successful* diagram, with the use of the extended criteria.

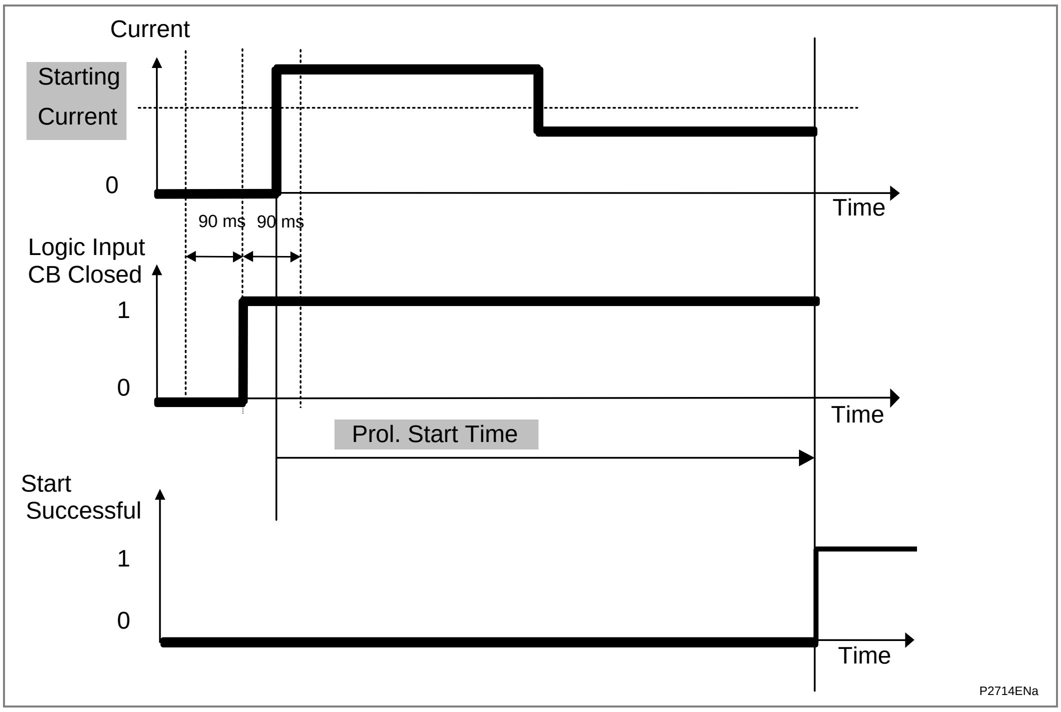


Figure 1 - Start successful

An alarm **Prolonged Start : DDB 299** will be generated if the current fails to fall below the starting current threshold before the end of the starting timer.

1.1.1.2 Locked Rotor during Starting – (Stall Time < Start Time)

For certain applications, such as motors driving high inertia loads, the stall withstand time may be safely exceeded during starting, without resulting in an over temperature condition within the motor. Consequently, since the stall withstand time is less than the start time, it is not possible to use time alone to distinguish between a start and a stall condition.

The P24x relay overcomes this problem by using a contact from a speed sensing device wired into a specified opto input (Speed Input: DDB 104) on the relay. Change of state of this contact indicates successful acceleration of the motor. If the **Phase Current** exceeds the value set in the **Starting Current** and the speed of the motor is equal to zero, the relay will trip following the programmed **Stall Time** (Stall Rotor-Strt: DDB 302).

The following *Locked rotor detection* diagram shows the principle of this feature:

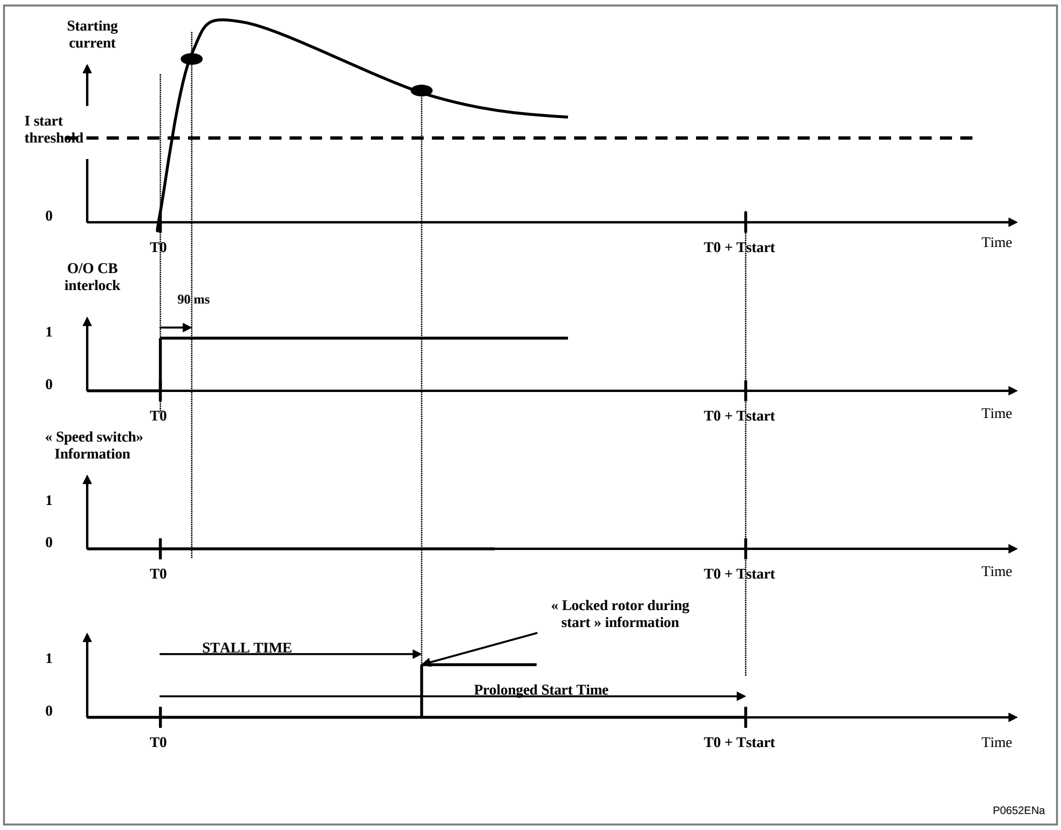


Figure 2 - Locked rotor detection

The **Stall Rot-Strt** setting must be enabled. In this case, after the detection of the start, both timers **Prol.Start Time** and **Stall Time** are running. A typical setting could be 5 s for the prolonged start timer and 1 s for the stall timer.

If the current falls below the starting current threshold or if the speed switch detects the rotation of the motor before the end of the Stall time, this feature will NOT generate a tripping order.

1.1.1.3 Stall During Running

A stall during running is given by a current exceeding the programmed current threshold, following a successful start. If the current fails to fall below the current threshold before the rotor stall time delay has elapsed, a trip will be initiated (Stall Rotor-run: DDB 301).

1.1.1.4 Re-Acceleration after a Reduction in System Voltage

The stall protection will be disabled, to allow for re-acceleration, if a low voltage condition exists on the system for a time in excess of 100 ms and if, on recovery of the voltage, the current exceeds the stalling current threshold within 5 seconds (Reac in Progress: DDB 300).

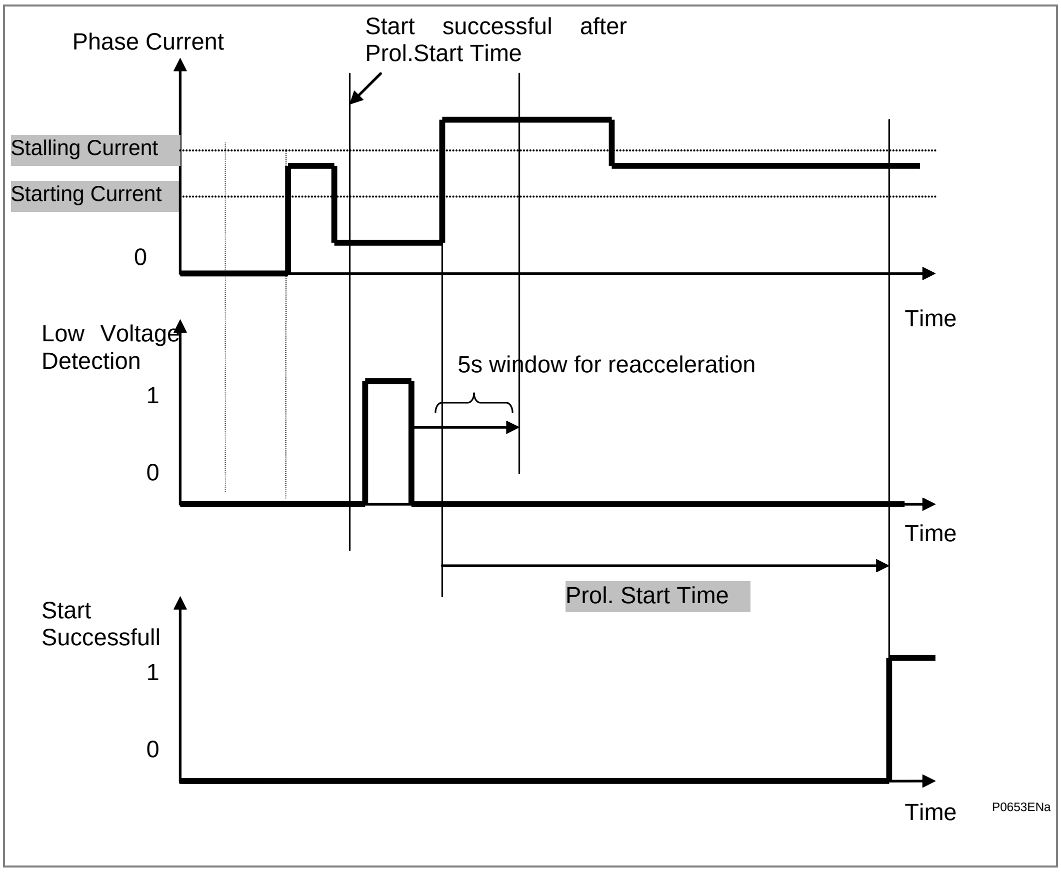


Figure 3 - Reacceleration detection

If the current fails to fall below the stalling current threshold before the end of the **Prol.Start Time**, the relay will generate a tripping order (Prolonged Start: DDB 299).

If the current exceeds the stalling current threshold after the 5 s window used for reacceleration criteria, the stall protection will be enabled.

This function is disabled during the starting period.

1.2 Number of Starts Limitation (66)

1.2.1 Starts Inhibition

Any motor has a restriction on the number of starts that are allowed in a defined period without the permitted winding temperatures being exceeded. The settings in the **Limit Nb Starts** protection menu monitors these starts.

Two types of starts are supervised:

- Hot Starts are defined by an initial thermal state greater than 50%
- Cold Starts are defined by an initial thermal state lower than 50%

The maximum allowable number of starts per period is an auto-reset inhibit function which monitors the number of motor starts in the set period. At the end of the supervising period the number of starts is decremented.

Note	*If User Curve is enabled in the Thermal Overload protection, the thermal state remains at 0% for as long as I_{eq} is less than Ith. As a consequence, the number of hot starts and cold starts protections should be disabled because they could give unexpected result*

First Diagram

The maximum number of starts within the **Supervising Time** has been reached, therefore, the **Inhib. Start Time** is initiated. The remaining time **Supervising Time - tn** is **greater** than the **Inhib. Start Time**, so the start inhibition remains for a duration equal to **Supervising time – tn.** Therefore, with the setting for Supervising Time of 60 mins and a tn of 8 mins for example, the inhibition time before a new start will be 52 mins.

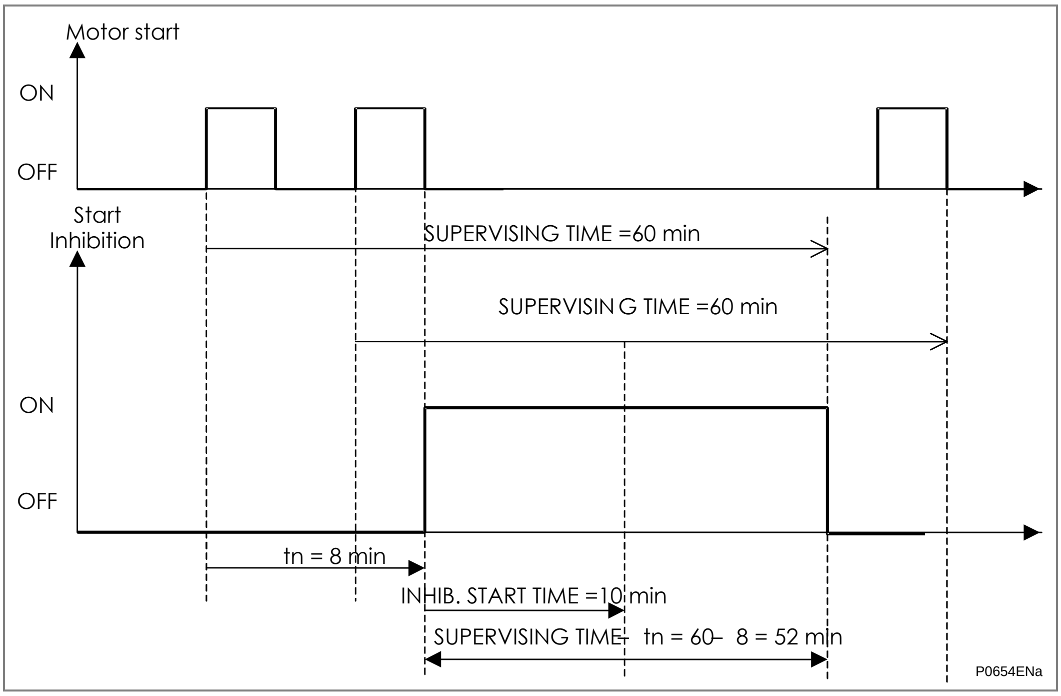


Figure 4 - Start inhibition example 1

Second Diagram

The maximum number of starts within the **Supervising Time** has been reached, therefore, the **Inhib. Start Time** is initiated. The remaining time **Supervising Time – tn** is shorter than the **Inhib. Start Time**, so the start inhibition remains for a duration equal to **Inhib. Start Time**. Therefore, with the setting for Supervising Time of 60 mins and a **tn** of 55 mins for example, the inhibition time before a new start will be 10 mins.

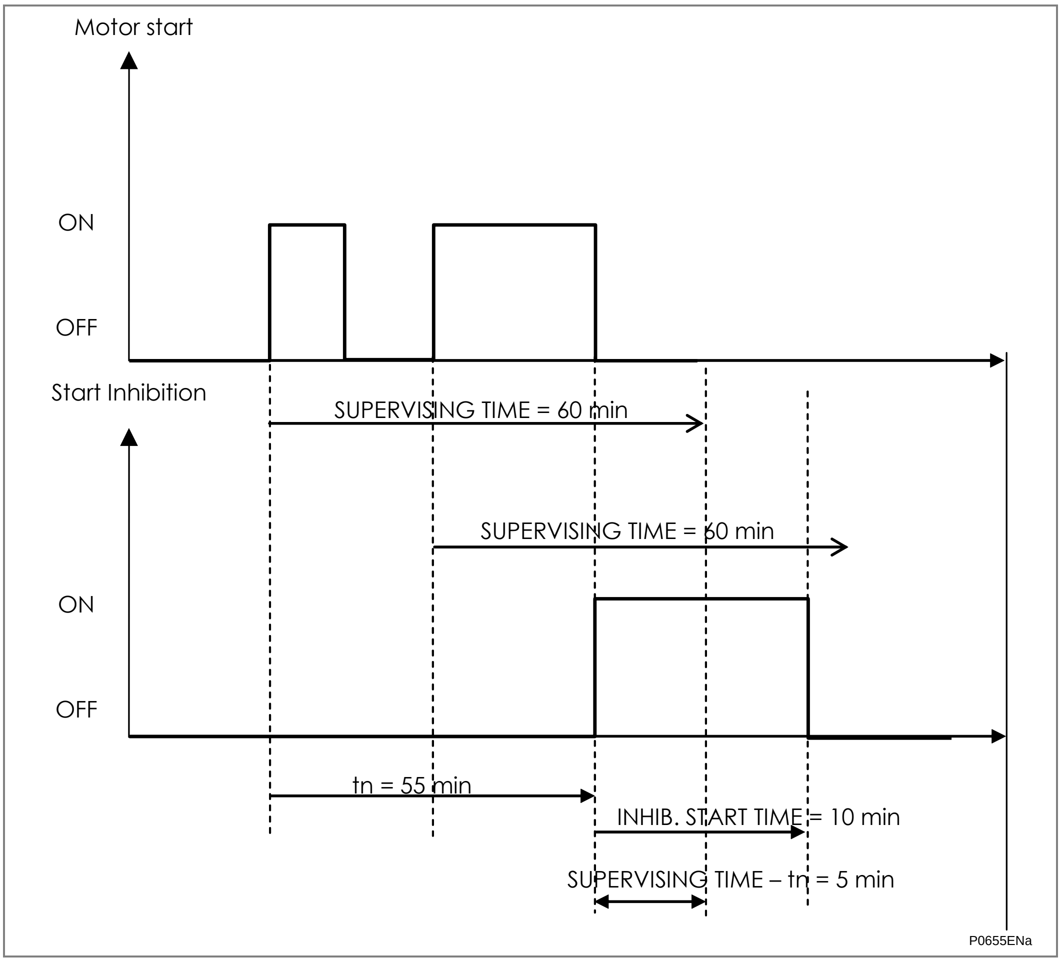


Figure 5 - Start inhibition example 2

The **Start Lockout** information (Hot Start Nb: DDB 181, Cold Start Nb: DDB 182) will be present until the end of the **Inhib.Start Time** or as long as the counter of the number of starts is equal to the maximum allowed starts.

1.2.2 Time between Starts

Immediately following a start, there is a start inhibit as soon as the interrupting device is opened, for a period equal to the remaining time of the **Time between start** settings.

The **Start Lockout** information (Time Between Start: DDB180) will be present until the end of the **Time Between Start**.

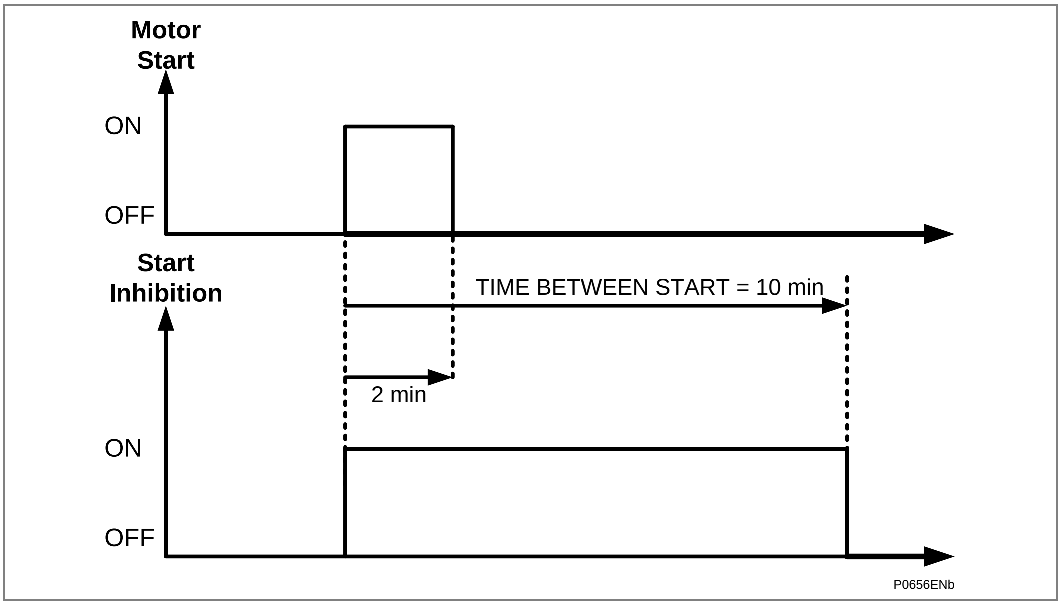


Figure 6 - Time between starts

1.3 Anti-Backspin Protection (27 Remanent)

1.3.1 Anti-Backspin Description

The anti-backspin function is mainly used for a motor with high inertia, or a synchronous motor in deceleration and is used to detect when the rotor has completely stopped, in order to allow re-starting of the motor.

The operation of this function depends on the parameter **VT connecting mode**: If this is set to **2 VT + Vremanent**, then the function uses an undervoltage with the connected Phase-Phase remanent voltage. If not, the function uses only a time delay.

As soon as the CB is opened, the delay setting **Anti-backs Delay** is started and the DDB signal **Antibkspin Alarm: DDB233** goes high.

Note	*When the 2 VT + Vremanent input is used, it must be connected to V_3 input on the relay by using a third VT while the first VT is connected to V_1 (V_{ab}) and the second VT connected to V_2 (V_{bc}) inputs on the relay (refer to the connection diagram in the Connection Diagrams chapter.*

Note	*Connection of remanent voltage to input V_3 on the relay disables measurement of V_a, V_b, V_c, and V_0. Hence all power and energy calculations (W, VA, VAr, Wh) are inhibited.*

The following quantities will become invisible in the relevant measurement column:

- Peak and RMS quantities of phase to neutral voltages of all three phases
- V0
- Watts, VA, VAr and Wh

  As a result, all of the following protection functions which require measured quantities of phase to neutral and/or V_0 will become disabled or invisible:
- ‘Out of step’
- ‘Field failure’
- ‘Residual O/V’
- ‘Reverse power’
- ‘Loss of Load’
- ‘3 Phase Voltage Check’
- Directional elements of ‘Derived Earth Fault’ and ‘Sensitive Earth Fault’

1.3.1.1 2 VT + Vremanent is Connected:

During the **Anti-backs Delay** time the remanent phase-phase voltage must decrease below the **VRem Anti-backs** setting. As soon as this voltage is under the threshold, the DDB signal **Antibkspin Alarm: DDB 233** is reset (along with the time delay) and a new start is authorized. If the threshold is not reached and the time delay expires, the signal **Antibkspin Alarm** is reset and a new start is authorized (see the following *Anti-Backspin logic* diagram).

1.3.1.2 2 VT + Vremanent is Not Connected:

When the 2 VT + Vremanent VT is not used, anti-backspin protection function uses a time delay only **Anti-backs Delay**. While the timer is timing, a new start is not authorized. A new start is authorized only when the timer has timed out.

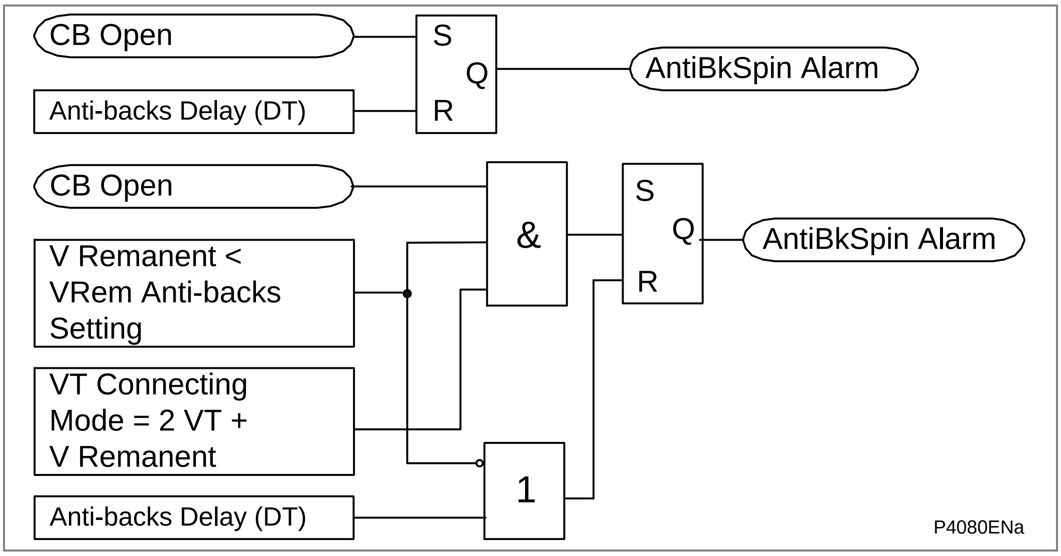


Figure 7 - Anti-Backspin logic

1.4 Thermal Overload (49)

In order for the Thermal overload protection function to operate correctly, it is essential that the circuit breaker to be closed and its associated closing signal, 52a, to be recognized by the relay.

1.4.1 Thermal Replica

Both the positive or RMS and negative sequence currents are analysed, to monitor the thermal state accounting for any phase unbalance present. This thermal model takes into account the overheating, which will be generated by the negative phase sequence current in the rotor.

The equivalent motor heating current is calculated by:

$$I_{eq} = \sqrt{(I_1^2 + K I_2^2)}$$

Note	*This equation is used in software version A4.x(09) and before.*

or

$$I_{eq} = \sqrt{(I_{rms}^2 + K I_2^2)}$$

Note	*This equation is used in software version B1.0(20) or later.*

Where:

I_1 = Positive sequence current
I_{rms} : root mean square current
I_2 : negative sequence current
K is a constant proportional to the thermal capacity of the motor
(**K Coefficient** default setting = 3)

The equivalent motor heating current is calculated every 20 ms. The maximum value recorded will then be utilized by the thermal algorithm.

1.4.2 Thermal Trip

A multiple time constant thermal replica is used, in order to take into account different operating conditions of the motor: overload, starting or cooling conditions.

The equation used to calculate the trip time at 100% of thermal state is:

$$t = \tau \ln ((k^2 - A^2) / (k^2 - 1))$$

Where the value of τ (thermal time constant) depends on the current value absorbed by the motor:

Over load time constant $\tau = T_1$ if $I_{th} < I_{eq} <= 2I_{th}$
Start-up time constant $\tau = T_2$ if $I_{eq} > 2I_{th}$
Cooling time constant $\tau = T_r$ if interrupting device opened
Measured thermal load (or thermal capacity) $k = I_{eq} / I_{th}$
Ith is thermal setting
A is initial state of the machine in percentage of the thermal state

The initial state of the machine is included in the time to trip calculation algorithm so that the operating time for a thermal trip will be decreased in case of a hot motor start.

During the starting of motors which have extreme starting conditions (for example, very long start time, very high start current value), an inhibition of the thermal curve during start-up is provided, in order to avoid false trips.

Note	*When the thermal state of the motor reaches 90%, this value is retained at 90% during the remaining period of the **Prol. Start Time** if an inhibition of the thermal overload protection is enabled.*

Comprehensive measurements and diagnostics can be accessed through the HMI : for example, the estimated time to the next thermal trip is calculated (see '**MEASUREMENTS 3**' menu).

1.4.2.1 Compensation for Ambient Temperature by RTD

To compensate for the ambient temperature variation, the thermal setting is corrected dependent upon the ambient temperature: the new value of the thermal capacity used becomes:

$K' = I_{eq} / (coef * I_{th})$

Where the correction coefficient is calculated depending upon the ambient temperature as shown below:

- Coef = 1 for T < 40° C
- Coef = 1.4 - (0.01T) for 40° C $\leq$ T $\leq$ 65° C
- Coef = 0.75 for T > 65° C

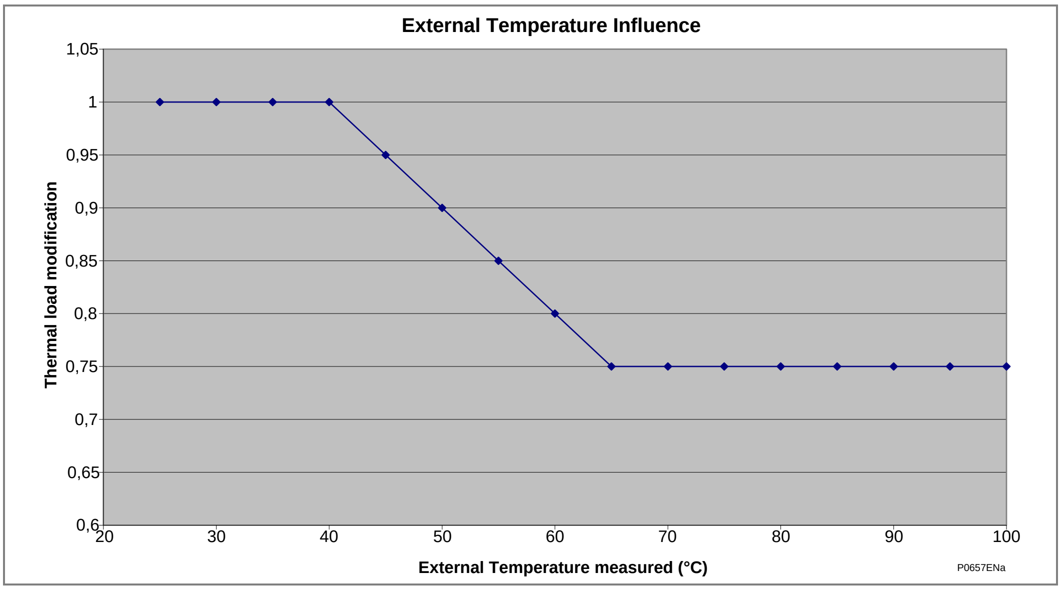


Figure 8 - Ambient temperature compensation

This compensation factor will be taken into account when any one of the ten possible RTDs are selected to measure the external/ambient temperature (see menu **RTD PROTECTION**).

The P24x relay can accommodate ten PT100, Ni100 or Ni120 RTDs. These RTDs are used to monitor the temperature of the stator windings, bearings and ambient temperature. Each RTD software element has two time delayed outputs; one for alarm and one for trip.

RTDs are fragile and susceptible to over voltage, therefore they are usually used in pairs; one main and one back-up. Open circuit and short circuit detection of the RTDs is also provided.

Only one external RTD will influence the thermal curve and second RTD is for the back-up.

1.4.2.2 Motor Thermal State

The thermal state is stored in non-volatile memory and updated every second. On resumption of the power supply, the value of the thermal state is restored if it is less than 90%. However, if it is greater than 90%, it is then reset to 90%, therefore allowing adequate protection and reducing the possibility of premature thermal overload tripping.

The thermal state of the motor is displayed in the measurements column **MEASUREMENTS 3** of the relay menu. This can be reset by an opto input (Reset Thermal: DDB109), using the user interface or through the remote communications. The latter two methods are password protected.

Note	*Resetting the thermal state, any associated inhibits will also reset (for example start inhibit threshold).*

A DDB signal **Thermal Trip** is available to indicate tripping of the element (DDB 236). A further DDB signal **Thermal Alarm** is generated from the thermal alarm stage (DDB 178). The state of the DDB signal can be programmed to be viewed in the **Monitor Bit** x cells of the **COMMISSION TESTS** column in the relay.

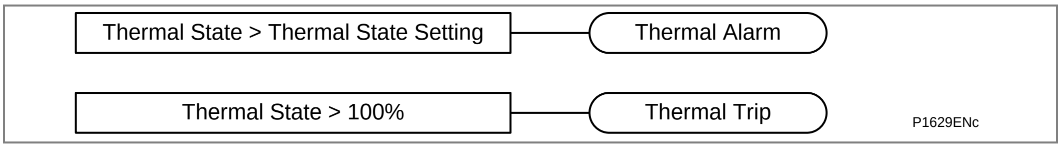


Figure 9 - Thermal overload protection logic diagram

1.4.2.3 Thermal Lockout

This function compares the thermal capacity available with the lockout setting immediately after a trip, for example when the interrupting device is open. If the thermal capacity available is insufficient to allow restart, an output contact programmed for the lockout function (Thermal Lockout: DDB 179) will be energized, which will inhibit a restart. When the motor has cooled down, this function resets the lockout output contact.

The thermal lockout will drop-off at 97% of the thermal lockout threshold.

The estimated time to next start (that is, to reach the thermal lockout threshold) is available in the **MEASUREMENTS 3** menu and is given by the following formula:

$$T = Tr * Ln (\theta 1/\theta 2)$$

Where:

T_r = cooling time constant
θ_1 = initial thermal state
θ_2 = final thermal state = 97% of thermal lockout threshold

1.4.2.4 Emergency Restart

Circumstances may dictate the necessity to restart a hot motor. An emergency restart can be enabled through an opto input (Emergency Rest: DDB108), via the user interface, or via the remote communications. This feature effectively removes all start inhibits (Thermal lockout, No of Hot starts, No of cold starts, and the Time between starts).

This feature will reset the thermal memory to 90% if it is greater than 90% or stays as it is if less than 90%.

When an emergency restart is required, the inhibition of thermal curve during start-up will be active, even if this function is not used during a start-up in normal operation.

1.4.2.5 User Programmable Curve for Thermal Over Load Protection

For information on how to program a customized thermal over load curve and send and extract curves to and from the relay, refer to these documents:

- User Programmable Curve Tool - Px4x/EN UPCT/A11
- Advanced User Programmable Curve Tool - Px4x/EN AUPCT/A11

Note 1	*If a user programmable curve is enabled in the Thermal Overload protection, the thermal state remains at 0% for as long as Ieq is less than Ith. As a consequence, the number of hot starts and cold starts should not be used.*

Note 2	*If Data Points rather than a Formula is used to configure a customized curve, data entered in the Time column can be in scientific format and the maximum time allowed by the tool is 1E+308.*

1.5 Motor Differential Protection (87)

Circulating current differential protection operates on the principle that current entering and leaving a zone of protection will be equal. Any difference between these currents is indicative of a fault being present in the zone. If CTs are connected as shown in the *Principle of circulating current differential protection* diagram, it can be seen that current flowing through the zone of protection will cause current to circulate around the secondary wiring. If the CTs are of the same ratio and have identical magnetizing characteristics they will produce identical secondary currents and hence zero current will flow through the relay.

If a fault exists within the zone of protection there will be a difference between the output from each CT; this difference flows through the relay causing it to operate.

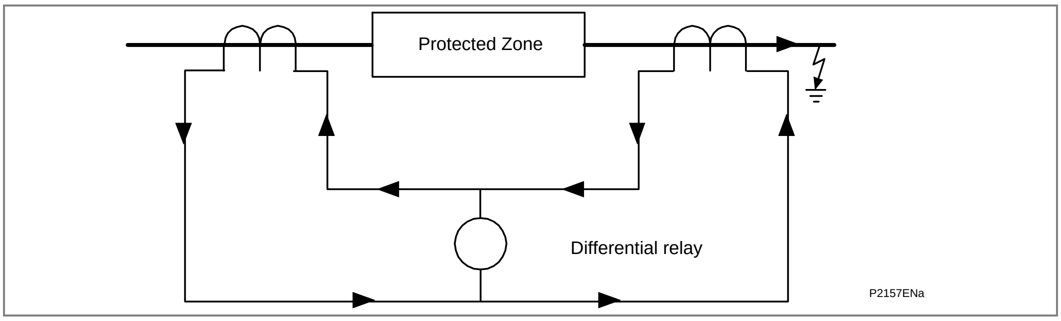


Figure 10 - Principle of circulating current differential protection

Heavy through current, arising from an external fault condition can cause one CT to saturate more than the other, resulting in a difference between the secondary current produced by each CT. It is essential to stabilize the protection for these conditions. Two methods are commonly used.

- A biasing technique, where the relay setting is raised as through current increases
- A high impedance technique, where the relay impedance is such that under maximum through fault conditions the current in the differential element is insufficient for the relay to operate.

The motor differential protection function available in the P243 relay can be used in either biased differential or high impedance differential mode. Both modes of operation are equally valid; users may have a preference for one over the other. The operating principle of each is described in the following sections.

A DDB (Digital Data Bus) signal is available to indicate the tripping of each phase of differential protection (Diff Trip A/B/C: DDB 315, DDB 316, DDB 317).

In addition a three phase trip DDB signal is provided (Trip Diff: DDB 318). These signals are used to operate the output relays and trigger the disturbance recorder as programmed into the programmable Scheme Logic (PSL). The state of the DDB signals can also be programmed to be viewed in the **Monitor Bit x** cells of the **COMMISSION TESTS** column in the relay.

The motor differential protection operation is in the *Motor differential logic* diagram.

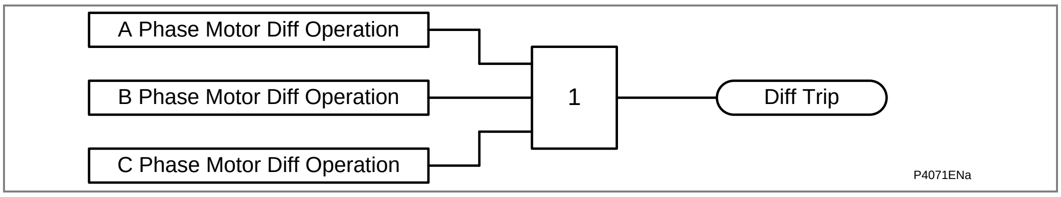


Figure 11 - Motor differential logic diagram

1.5.1 Biased Differential Protection

In a biased differential relay, the through current is used to increase the setting of the differential element. For heavy through faults, it is unlikely that the CT output at each zone end will be identical. This is due to the effects of CT saturation. In this case a differential current can be produced. However, the biasing will increase the relay setting, such that the differential spill current is insufficient to operate the relay.

A dual slope percentage bias characteristic is implemented in the relay. The lower slope provides sensitivity for internal faults, whereas the higher slope provides stability under through fault conditions, during which there may be transient differential currents due to saturation effect of the motor CTs.

The through current is calculated as the average of the scalar sum of the current entering and leaving the zone of protection. This calculated through current is then used to apply a percentage bias to increase the differential setting. The percentage bias can be varied to give the operating characteristic shown in the *Biased differential protection operating characteristic* diagram.

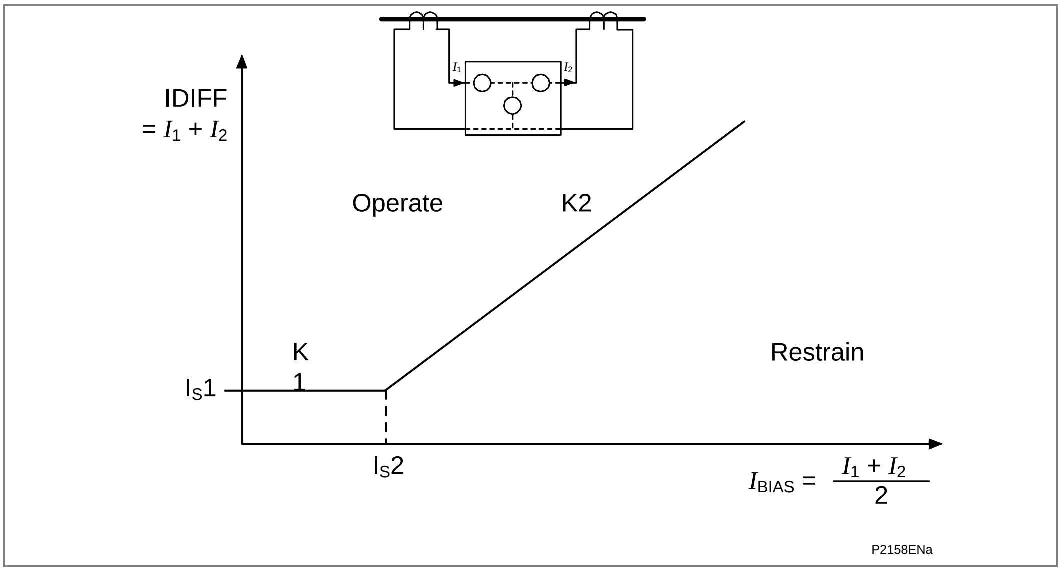


Figure 12 - Biased differential protection operating characteristic

Two bias settings are provided in the P243 relay. The initial bias slope, **Diff k1**, is applied for through currents up to **Diff Is2**. The second bias slope, **Diff k2**, is applied for through currents above the **Diff Is2** setting.

The Biased differential protection function uses the two sets of 3-phase current measurement inputs (IA, IB, IC, IA2, IB2, IC2), connected to measure the phase current at the neutral end and terminals of the machine, as shown in the *Biased differential protection operating characteristic* diagram. The bias and differential currents are calculated by the relay software, providing a phase segregated differential protection function, and may be viewed in the **MEASUREMENTS/MEAUREMENTS 1** column in the relay menu.

1.5.1.1 Differential and Bias Current Calculation

The calculation is performed on a per phase basis. The differential current is the vector sum of the phase currents measured at either end of the generator. The mean bias current (Ibias) is the scalar mean of the magnitude of these currents, that is:

$$I_{a\text{ - diff}} = \left| \overline{I_a - 1} + \overline{I_a - 2} \right|$$

$$I_{b\text{ - diff}} = \left| \overline{I_b - 1} + \overline{I_b - 2} \right|$$

$$I_{c\text{ - diff}} = \left| \overline{I_c - 1} + \overline{I_c - 2} \right|$$

$$I_{a}\text{ - }_{bias} = \frac{\left|\overline{I_{a}-1}\right| + \left|\overline{I_{a}-2}\right|}{2}$$

$$I_{b}\text{ - }_{bias} = \frac{\left|\overline{I_{b}-1}\right| + \left|\overline{I_{b}-2}\right|}{2}$$

$$I_{c}\text{ - }_{bias} = \frac{\left|\overline{I_{c}-1}\right| + \left|\overline{I_{c}-2}\right|}{2}$$

To provide further stability for external faults, a number of additional measures are taken on the bias calculations:

1.5.1.1.1 Delayed Bias

The bias quantity used is the maximum of the bias quantities calculated within the last cycle. This is to maintain the bias level, thus providing stability, during the time when an external fault is cleared. This feature is implemented on a per phase basis. The algorithm is expressed as follows; the function is executed 4 times per cycle:

Ia-bias(n) = Maximum [Ia-bias(n), Ia-bias(n-1), ..., Ia-bias(n - 3)]

Ib-bias(n) = Maximum [Ib-bias(n), Ib-bias(n-1),........., Ib-bias(n - 3)]

Ic-bias(n) = Maximum [Ic-bias(n), Ic-bias(n-1), ..., Ic-bias(n - 3)]

1.5.1.1.2 Transient Bias

An additional bias quantity is introduced into the bias calculation, on a per phase basis, if there is a sudden increase in the mean-bias measurement. This quantity decays exponentially afterwards. The transient bias is reset to zero once the relay has tripped or if the mean-bias quantity is below the Is1 setting. The transient bias is used to make the protection stable for external faults and allows for the time delay in CT saturation caused by small external fault currents and high X/R ratios. For single-end or double-end fed faults the differential current will be dominant and the transient bias will have no effect.

The transient bias is removed after the relay has tripped to avoid the possibility of chattering. It is also removed when Ibias is less than Is1 to avoid the possibility of residual values due to the numerical effects.

1.5.1.1.3 Maximum Bias

The bias quantity used per phase for the percentage bias characteristic is the maximum bias current calculated from all three phases, i.e.:

I-bias-max = Maximum [Ia-bias, Ib-bias, Ic-bias]

1.5.1.1.4 Tripping Criteria

The tripping criteria per phase are formulated as follows. The differential threshold changes according to the value of I-bias-max, as in the percentage bias characteristic.

Note	*The transient bias is on a per phase basis and is not be affected by the K1 or K2 setting.*

For I-bias-max <= Is2

Idiff > K1*I-bias-max + Transient_bias + Is1

For I-bias-max > Is2

Idiff > K2*I-bias-max + Transient Bias - Is2*(K2-K1) + Is1

A count strategy is used so that the protection will operate slower near the boundary of operation. This approach is used to stabilize the relay under some marginal transient conditions.

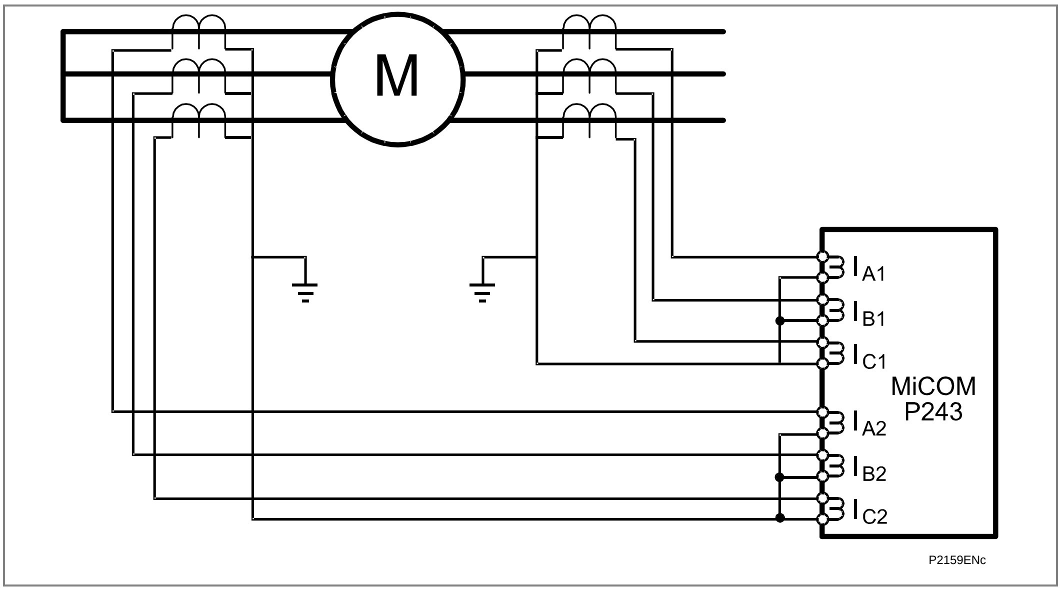
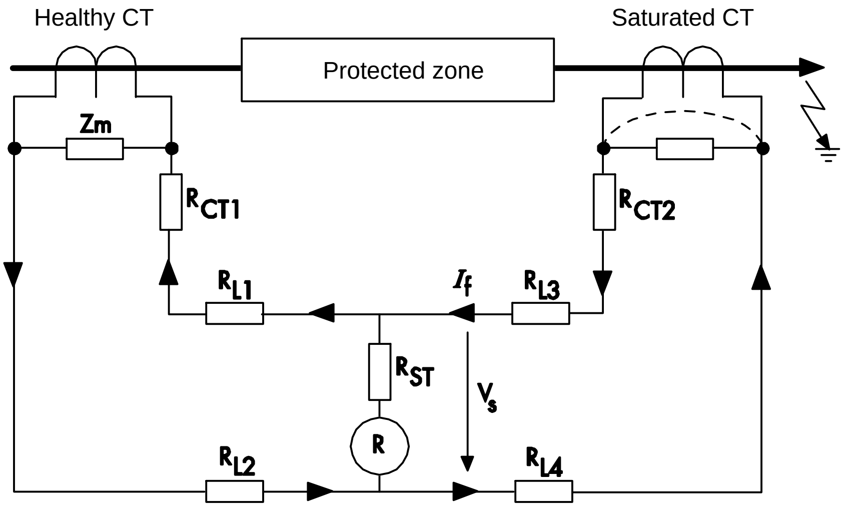


Figure 13 - Relay connections for biased differential protection

1.5.2 High Impedance Differential Protection

The high impedance principle is best explained by considering a differential scheme where one CT is saturated for an external fault, as shown in the *Principle of high impedance differential protectio*n diagram.



Voltage across relay circuit

$V_S = KI_F/(R_{CT} + 2R_L)$ – where K=1.5

Stabilising resistor, R_{ST}, limits spill current to I_S (relay setting)

$$R_{ST} = \frac{V_S}{I_S} - R_R$$

Where

I_F = Maximum secondary through fault current

R_R = Relay burden

R_{CT} = Current transformer secondary winding resistance

R_L = Resistance of a single lead from the relay to the current transformer

P0115ENd

Figure 14 - Principle of high impedance differential protection

If the relay circuit is considered to be very high impedance, the secondary current produced by the healthy CT will flow through the saturated CT. If the magnetizing impedance of the saturated CT is considered to be negligible, the maximum voltage across the relay circuit will be equal to the secondary fault current multiplied by the connected impedance, ($R_{L3} + R_{L4} + R_{CT2}$).

The relay can be made stable for this maximum applied voltage by increasing the overall impedance of the relay circuit, such that the resulting current through the relay is less than its current setting. As the impedance of the relay input alone is relatively low, a series connected external resistor is required. The value of this resistor, R_{ST}, is calculated by the formula shown above. An additional non-linear resistor, Metrosil, may be required to limit the peak secondary circuit voltage during internal fault conditions.

To ensure that the protection will operate quickly during an internal fault the CTs used to operate the protection must have a knee point voltage of at least 2 Vs.

The high impedance differential protection function uses the IA2, IB2, IC2 current inputs connected to measure the differential current in each phase, as shown in below.

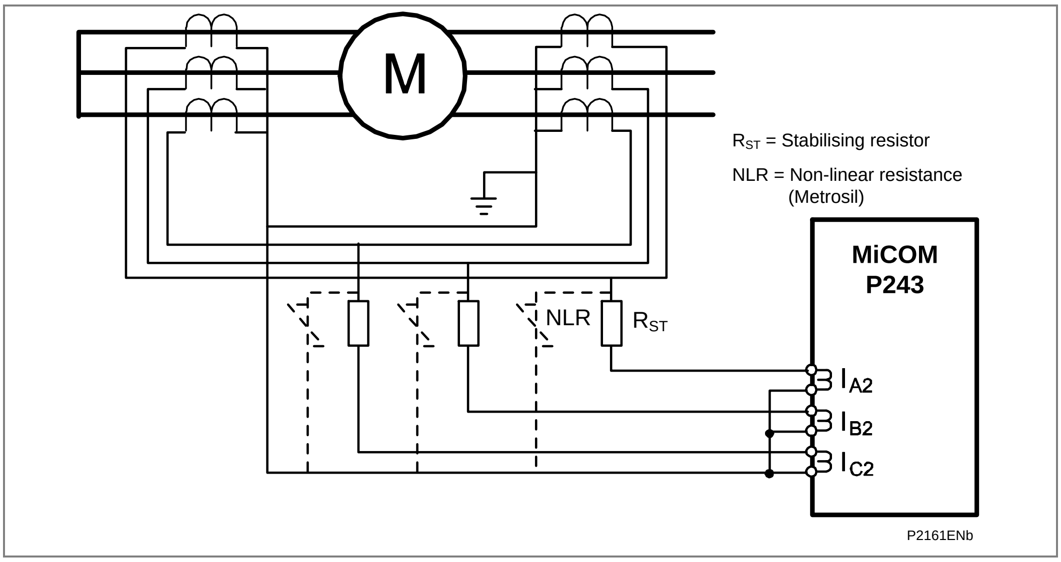


Figure 15 - Relay connections for high impedance differential protection

1.5.3 Self Balance Winding Differential

An alternative is to use self balance type differential protection arrangement, as shown in the *Self-balance winding differential protection* diagram, using the IA2, IB2, IC2 set of CTs

For this configuration, the relay must be set to **High Impedance** via the cell **Diff Function** in the **Differential** protection menu

If the conductors are placed reasonably concentric within the window of the core balance current transformers, spill current can be kept to a minimum. With this low spill current and a reasonably independence of CT ratio to full load a lower fault setting could be achieved than conventional high impedance circulating current differential schemes.

Disadvantages:

1. The necessity of passing both ends of each phase winding through the CT and hence the need for extra cabling on the neutral end.

2. To avoid long cabling, position of CTs are restricted to the proximity of the machine output terminals in which case the cable between the machine output terminals and controlling switchgear might not be included within the differential zone.

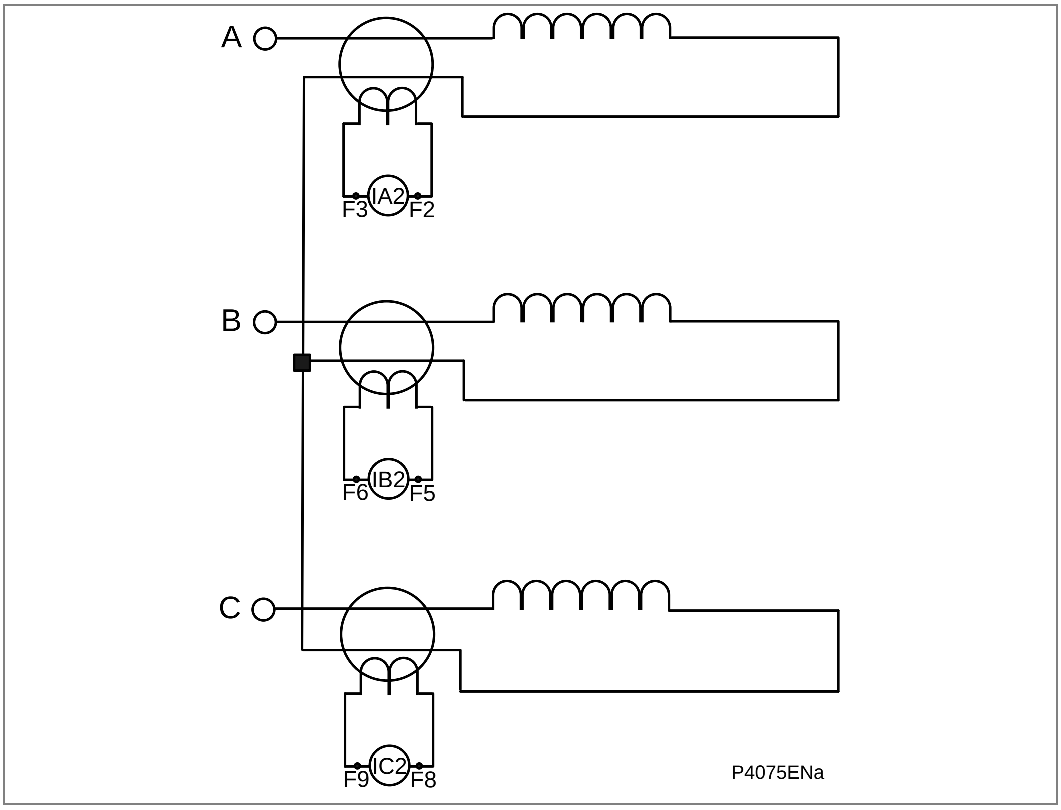


Figure 16 - Self-balance winding differential protection

1.6 Short Circuit Protection (50/51)

The overcurrent protection included in the relay provides four-stage non-directional three-phase overcurrent protection with independent time delay characteristics. All overcurrent settings apply to all three phases but are independent for each of the four stages.

The first two stages of overcurrent protection have time-delayed characteristics which are selectable between Inverse Definite Minimum Time (IDMT), or Definite Time (DT). The third and fourth stages have definite time characteristics only.

In order to avoid tripping during start-up as a result of asymmetric CT saturation, definite time element has a minimum operating time of 100 ms for currents in the range I> to 1.2I>.

The definite time characteristic is shown below in the *Definite time overcurrent element* diagram:

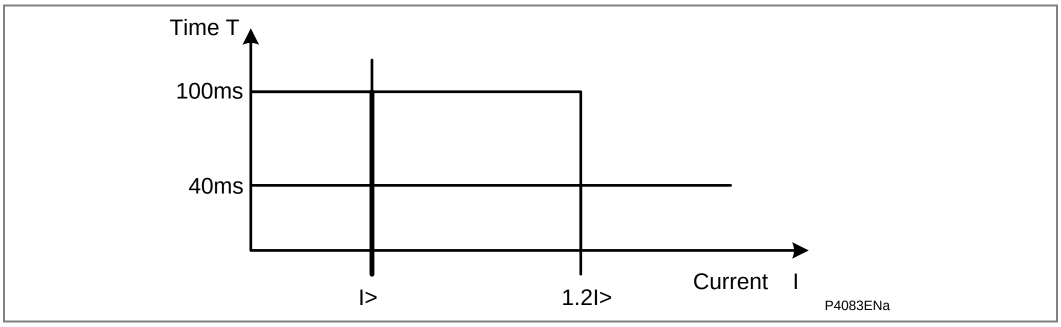


Figure 17 - Definite time overcurrent element

Various methods are available to achieve correct relay co-ordination on a system; by means of time alone, current alone or a combination of both time and current. Grading by means of current is only possible where there is an appreciable difference in fault level between the two relay locations. Grading by time is used by some utilities but can often lead to excessive fault clearance times at or near source substations where the fault level is highest. For these reasons the most commonly applied characteristic in coordinating overcurrent relays is the IDMT type.

The inverse time delayed characteristics indicated above, comply with the following formula:

IEC curves

$$t = Tx\left(\frac{\beta}{(M^{\alpha} - 1)} + L\right) + C$$

or

IEEE curves

$$t = TD/7x\left(\frac{\beta}{(M^{\alpha} - 1)} + L\right)$$

User Curves

$$t = (TD/7)\,xt_{ucrv}$$

Where:

t	=	Operation time
β	=	Constant
M	=	I/ Is
K	=	Constant
I	=	Measured current
Is	=	Current threshold setting
α	=	Constant
L	=	ANSI/IEEE constant (zero for IEC curves)
T	=	Time multiplier setting for IEC curves
TD	=	Time dial setting for IEEE and user programmable curves
t_{ucrv}	=	User curve operating time

IDMT Curve description	Standard	β constant	α constant	L constant
Standard Inverse	IEC	0.14	0.02	0
Very Inverse	IEC	13.5	1	0
Extremely Inverse	IEC	80	2	0
Long Time Inverse	UK	120	1	0
Rectifier	UK	45900	5.6	0
Moderately Inverse	IEEE	0.0515	0.02	0.114
Very Inverse	IEEE	19.61	2	0.491
Extremely Inverse	IEEE	28.2	2	0.1217
Inverse	US	5.95	2	0.18
Short Time Inverse	US	0.16758	0.02	0.11858

Table 1 - Standard IDMT curves and their corresponding coefficients

Note	*The IEEE, US curves and User Curves are set differently to the IEC/UK curves, with regard to the time setting. A time multiplier setting (TMS) is used to adjust the operating time of the IEC curves, whereas a time dial setting is employed for the IEEE/US/User curves. The menu is arranged such that if an IEC/UK curve is selected, the I> Time Dial cell is not visible and vice versa for the TMS setting.*

Note	*The IEC/UK inverse characteristics can be used with a definite time reset characteristic, however, the IEEE/US/User curves may have an inverse or definite time reset characteristic. The following equation can be used to calculate the inverse reset time for IEEE/US/User curves:*

$$tRESET = \frac{TD/7 \ x \ S}{\left(1 - M^{2}\right)} \text{ in seconds}$$

Where:

TD = Time dial setting for IEEE and user programmable curves
S = Constant
M = I/Is

Curve Description	Standard	S Constant
Moderately Inverse	IEEE	4.85
Very Inverse	IEEE	21.6
Extremely Inverse	IEEE	29.1
Inverse	US	5.95
Short Time Inverse	US	2.261

Table 2 - IEEE and US reset curve "S" coefficient values

And for User Programmable Curve:

$tRESET = t = TD \ x \ t_{ucrv}$

1.6.1 RI Curve

The RI curve (electromechanical) has been included in the first and second stage characteristic setting options for phase overcurrent and earth protections. The curve is represented by the following equation.

Where K is adjustable from 0.1 to 10 in steps of 0.05, and M = I / Is

$$t = K \ x \left(\frac{1}{0.339 - \left({}^{0.236}/_{M}\right)} \right) \text{ in seconds}$$

1.6.2 Timer Hold Facility

Important	***"Timer Hold Facility" is not available if the "DT" operation curve is selected.***

Note	*If an IEEE/US operate curve is selected, the reset characteristic may be set to either definite or inverse time in cell **I>1 Reset Char**.*

The first two stages of overcurrent protection in the relay are provided with a timer hold facility, which may either be set to zero or to a definite time value Setting of the timer to zero means that the overcurrent timer for that stage will reset instantaneously once the current falls below 95% of the current setting. Setting of the hold timer to a value other than zero, delays the resetting of the protection element timers for this period. This may be useful in certain applications, for example when grading with upstream electromechanical overcurrent relays which have inherent reset time delays.

Another situation where the timer hold facility may be used to reduce fault clearance times is where intermittent faults may be experienced. An example of this may occur in a plastic insulated cable. In this application it is possible that the fault energy melts and reseals the cable insulation, therefore extinguishing the fault. This process repeats to give a succession of fault current pulses, each of increasing duration with reducing intervals between the pulses, until the fault becomes permanent.

When the reset time of the overcurrent relay is instantaneous, the relay will be repeatedly reset and not be able to trip until the fault becomes permanent. By using the Timer Hold facility the relay will integrate the fault current pulses, thereby reducing fault clearance time.

The timer hold facility can be found for the first and second overcurrent stages as settings **I>1 tRESET** and **I>2 tRESET**, respectively.

Note	*This cell is not visible for the IEEE/US curves if an inverse time reset characteristic has been selected, as the reset time is then determined by the programmed time dial setting.*

The functional logic diagram for non-directional overcurrent is shown in the following *Non-directional overcurrent logic diagram*. The overcurrent block is a level detector that detects that the current magnitude is above the threshold. It provides a start and also initiates the IDMT/DT characteristic depending on the setting.

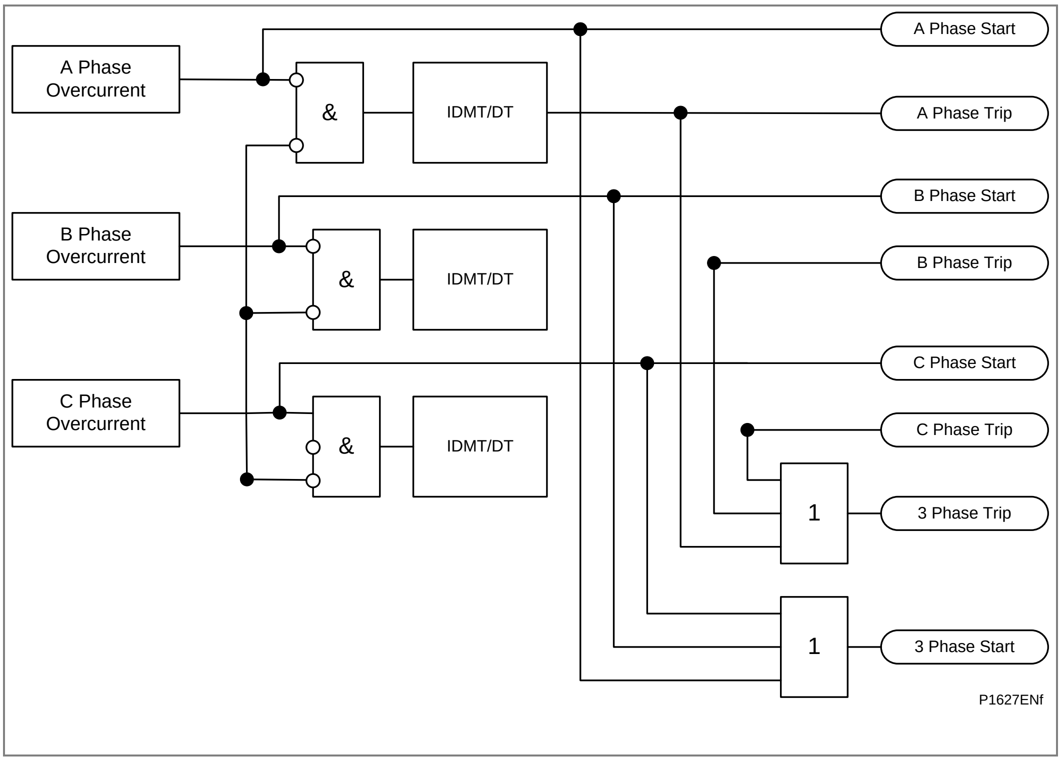


Figure 18 - Non-directional overcurrent logic diagram

A DDB (Digital Data Bus) signal is available to indicate the start and trip of each phase of the short circuit protection stages (Start I>1/2/3/4 A,B,C: DDB 242,243,244/DDB 253,254,255/DDB 343,344,345/DDB 354,355,356 Trip I>1/2/3/4 A,B,C: DDB 245,246,247/ DDB 256,257,258/DDB 346,347,348/DDB 357,358,359). In addition a three phase start and trip DDB signal is provided (Start I>1/2/3/4: DDB 241/252/342/353 Trip I>1/2/3/4: DDB237/ 248/338/349). These signals are used to operate the output relays and trigger the disturbance recorder as programmed into the programmable Scheme Logic (PSL). The state of the DDB signals can also be programmed to be viewed in the **Monitor Bit x** cells of the **COMMISSION TESTS** column in the relay.

1.6.3 User Programmable Overcurrent Protection

A user programmable overcurrent curve facility is available for the first and second stages of short circuit protection.

For information on how to program a customized thermal over load curve and send and extract curves to and from the relay, refer to these documents:

- User Programmable Curve Tool - Px4x/EN UPCT/A11
- Advanced User Programmable Curve Tool - Px4x/EN AUPCT/A11

1.7 Negative Phase Sequence (NPS) Overcurrent Protection (46)

The P24x relays provide two independent stages of negative phase sequence overcurrent protection. Stage 1 has a current pick up setting **I2>1 Current Set**, and is time delayed in operation by the adjustable timer **I2>1 Time Delay**. Stage 2 has a current pick up setting **I2>2 Current Set** and is time delayed in operation by a Time Multiplier Setting **I2>2 TMS**.

The second stage element monitors the negative phase sequence current and trip according to an inverse characteristic as follows:

$T = TMS \times (1.2/(I_2/I_n))$ for $0.2 \leq I_2/I_n \leq 2$

$T = TMS*0.6$ for $I_2/I_n > 2$

A DDB (Digital Data Bus) signal is available to indicate the trip of the negative phase sequence overcurrent protection stages (Trip I2>1/2: DDB274, 275). These signals are used to operate the output relays and trigger the disturbance recorder as programmed into the programmable Scheme Logic (PSL). The state of the DDB signals can also be programmed to be viewed in the **Monitor Bit x** cells of the **COMMISSION TESTS** column in the relay.

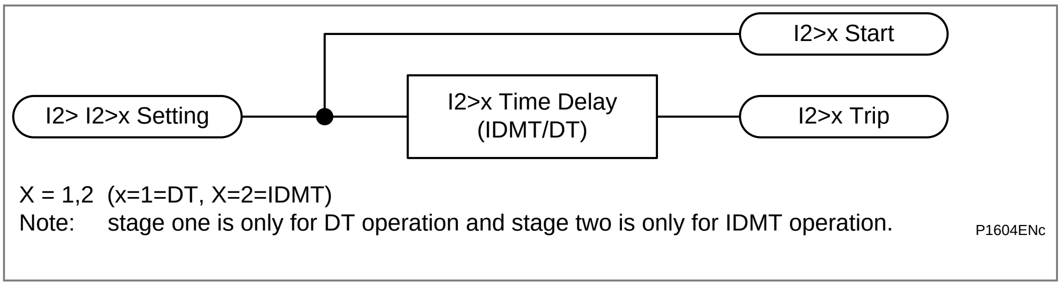


Figure 19 - Negative sequence overcurrent logic diagram

1.8 Voltage Elements (27/59/59N)

1.8.1 Undervoltage Protection (27)

Both the under and overvoltage protection functions can be found in the relay menu "**Volt Protection**". The undervoltage protection included in the relay consists of two independent stages. These are configurable as either phase to phase or phase to neutral measuring within the "**V<Measur't mode**" cell.

Stage 1 may be selected as IDMT, DT or Disabled, within the "**V<1 Function**" cell. Stage 2 is DT only and is enabled/disabled in the "**V<2 status**" cell.

The IDMT characteristic available on the first stage is defined by the following formula:

$t = K/(M - 1)$

Where:

K	=	Time multiplier setting (V<1 TMS)
t	=	Operating time in seconds
M	=	Measured voltage/relay setting voltage (V< Voltage Set)

Two stages are included to provide both alarm and trip stages, where required. Alternatively, different time settings may be required depending upon the severity of the voltage dip, i.e. motor loads will be able to withstand a small voltage depression for a longer time than if a major voltage excursion were to occur.

Note	*The Undervoltage protection will be blocked if the Circuit breaker is open. Therefore the 52a breaker status (CB Closed 3ph - DDB 105) must be mapped in the PSL for the Undervoltage protection to operate.*

The undervoltage fault protection starts are mapped internally to the ANY START DDB signal – DDB 369.

A DDB (Digital Data Bus) signal is available to indicate the start of each phase-phase of the undervoltage protection stages (Start V<1/2 AB/BC/CA: DDB 276-278, 284-286). In addition a three phase trip DDB signal is provided (Trip V<1/2: DDB 279, 287). These signals are used to operate the output relays and trigger the disturbance recorder as programmed into the programmable Scheme Logic (PSL). The state of the DDB signals can also be programmed to be viewed in the **Monitor Bit x** cells of the **COMMISSION TESTS** column in the relay.

The logic diagram of the undervoltage function is shown in the *Undervoltage - single and three phase tripping mode (single stage)* diagram below:

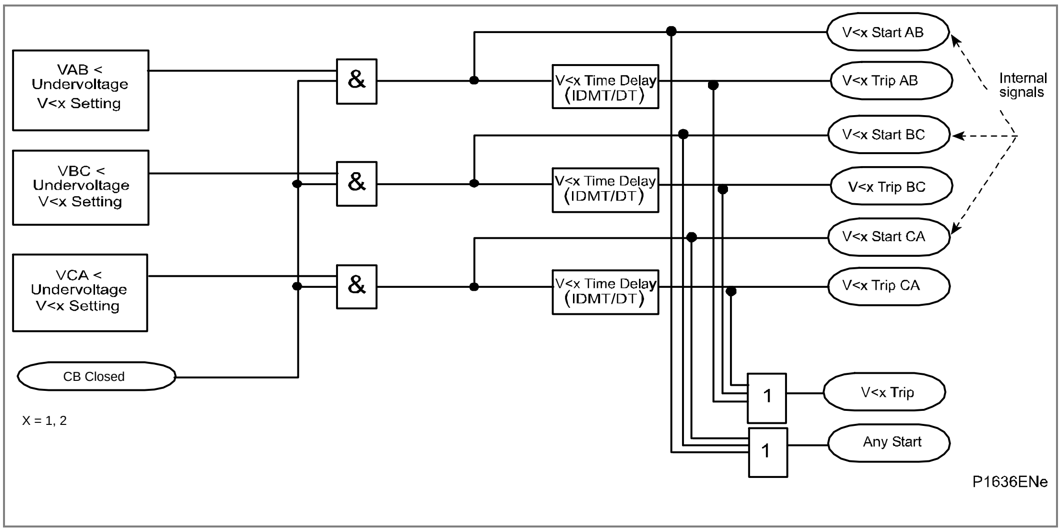


Figure 20 - Undervoltage - single and three phase tripping mode (single stage)

1.8.2 Overvoltage Protection (59)

The overvoltage protection included in the relay consists of two independent stages. Stage 1 and 2 may be selected as DT or Disabled, within the **V>1/2 Status** cell. These are configurable as either phase-to-phase or phase-to-neutral measuring within the "V>Measur't Mode" cell.

Note	*Phase overvoltage protection is phase segregated, but the operation of any phase is mapped to 3-phase tripping in the default PSL.*

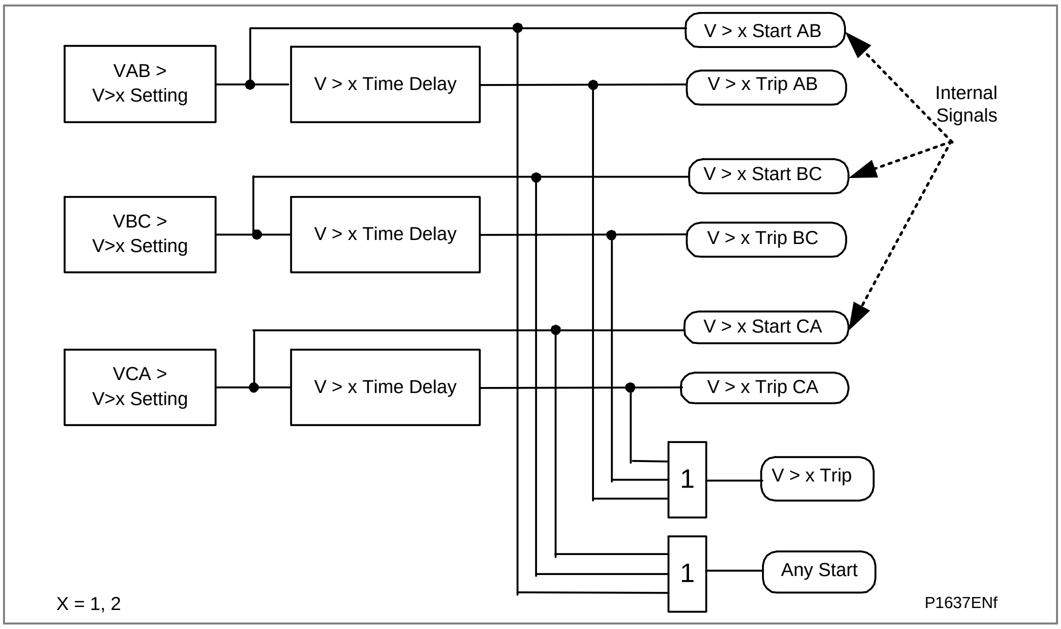


Figure 21 - Overvoltage - single and three phase tripping mode (single stage)

1.8.3 3-Phase Voltage Checking (47/27)

The input voltage rotation and magnitude are monitored to determine both correct phase rotation and sufficient supply voltage, prior to permitting motor starting.

For a good starting condition, the positive sequence voltage (V1) should be greater than the negative sequence voltage (V2), and according to V< measurement mode setting the corresponding voltages VA/VAB and VB/VBC and VC/VCA should be greater than the user settable threshold (V s).

The result of this function may be used into the programmable scheme logic in order to inhibit the start of the motor if the voltage is not sufficient (3Ph Volt Alarm: DDB177).

This feature requires a 52a circuit breaker auxiliary contact mapped to an opto input to get the information CB closed/CB open.

1.8.4 Residual Overvoltage / NVD Protection (59N)

The Neutral Voltage Displacement (NVD) protection function of the relays consist of two stages of measured (VN>1, VN>2) neutral overvoltage protection. Stage one can be set as Definite Time (DT) or Inverse Definite Minimum Time (IDMT).

The operation of this function depends on the parameter **VT connecting mode**: If this is set to **2 VT + Residual**, then the function uses the residual voltage measured from the connected residual voltage input.

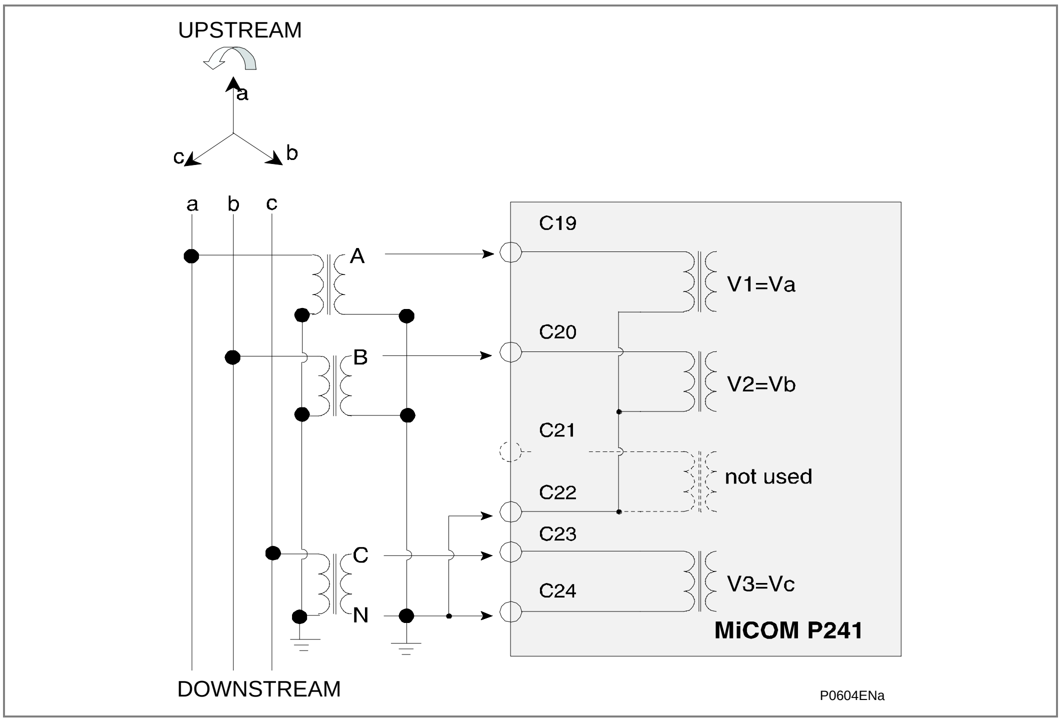


Figure 22 - Three VTS configuration

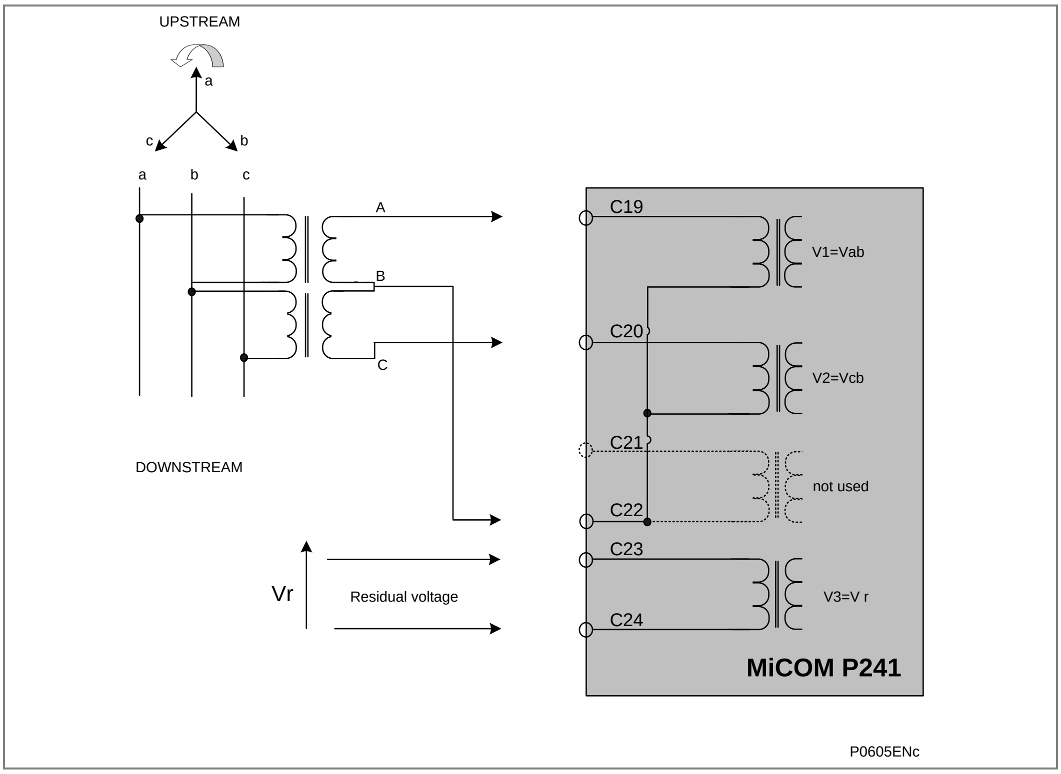


Figure 23 - Alternative relay connections for residual overvoltage/NVD protection

The functional block diagram of the first stage residual overvoltage is shown in the *Residual overvoltage logic (single stage)* diagram:

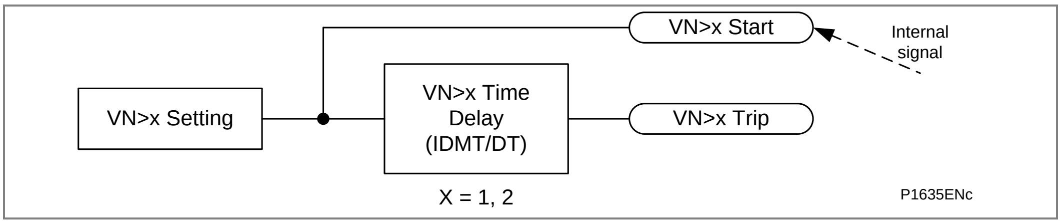


Figure 24 - Residual overvoltage logic (single stage)

The residual overvoltage fault protection starts are mapped internally to the ANY START DDB signal – DDB 369.

A DDB (Digital Data Bus) signal is available to indicate the trip of each of the neutral voltage protection stages (Trip NVD VN>1/2: DDB 292, 293). These signals are used to operate the output relays and trigger the disturbance recorder as programmed into the programmable Scheme Logic (PSL). The state of the DDB signals can also be programmed to be viewed in the **Monitor Bit x** cells of the **COMMISSION TESTS** column in the relay.

The IDMT characteristic available on the first stage is defined by the following formula:

$t = K/(M - 1)$

Where:

K = Time Multiplier Setting (**VN>1 TMS**)
t = Operating Time in Seconds
M = Measured Residual Voltage/Relay Setting Voltage (**VN>1 Voltage Set**)

1.9 Underfrequency Protection (81U)

The P24x relays include 2 stages of underfrequency. Stage 1 and 2 may be selected as DT or Disabled, within the **F<1/2 Status** cell.

The logic diagram for the underfrequency logic is as shown in the *Underfrequency logic* diagram. Only a single stage is shown. The other stage is identical in functionality.

If the frequency is below the setting and the breaker is closed (52A input high), the DT timer is started.

This feature is only enabled when the circuit breaker is closed, therefore it requires a 52a circuit breaker auxiliary contact mapped to an opto input to get the information CB closed / CB open.

If the frequency cannot be determined (Frequency Not Found), the function is also blocked. A Digital Data Bus (DDB) signal is available to indicate the trip of each of the underfrequency protection stages (Trip F<1/2: DDB 259, 260). These signals are used to operate the output relays and trigger the disturbance recorder as programmed into the Programmable Scheme Logic (PSL). The state of the DDB signals can also be programmed to be viewed in the **Monitor Bit x** cells of the **COMMISSION TESTS** column in the relay.

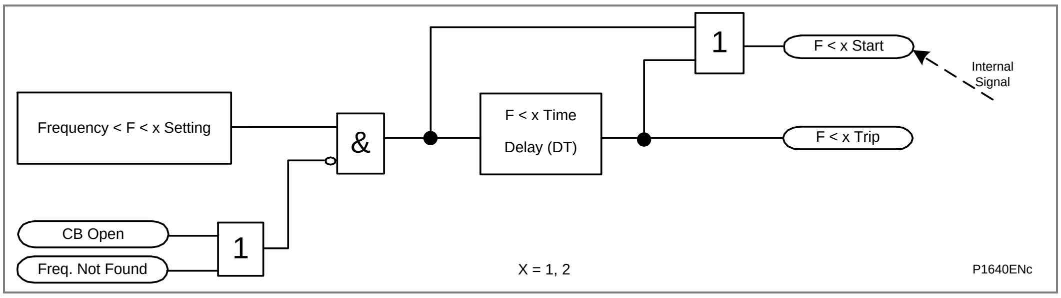


Figure 25 - Underfrequency logic

1.10 Field Failure Protection Function (40)

The field failure protection of the relay consists of two elements, an impedance element with two time delayed stages and a power factor alarm element, illustrated below in the *Field failure protection characteristics* diagram. The Field Failure protection impedance elements are also provided with an adjustable delay on reset (delayed drop off) timer. The elements operate from A phase current and A phase voltage signals measured by the Ia and Va inputs on the relay. The minimum phase current and voltage required for P241/P242/P243 field failure protection to work is 20 mA and 1 V (In = 1 A, Vn = 100/120 V) and 100 mA and 1V (In = 5 A, Vn = 100/120 V).

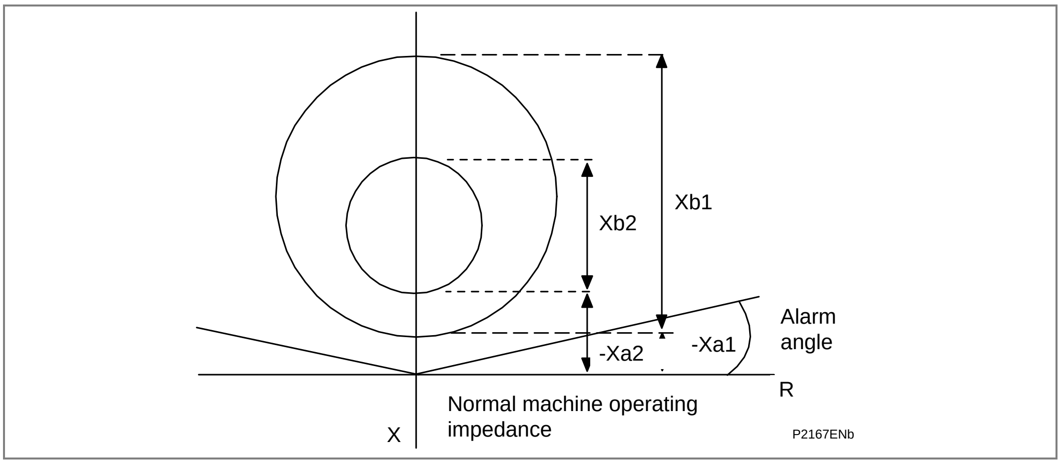


Figure 26 - Field failure protection characteristics

DDB signals are available to indicate the start and tripping of each stage (FFail Start 1/2: DDB 334, DDB 335, Field Fail1/2 Trip: DDB 336, DDB 337). A further DDB **Field Fail Alarm** signal is generated from the field failure alarm stage (DDB 234). The state of the DDB signals can be programmed to be viewed in the **Monitor Bit x** cells of the **COMMISSION TESTS** column in the relay.

The field failure protection starts are mapped internally to the ANY START DDB signal – DDB 369.

The field failure protection is provided with a FFail Block signal (DDB 117) which may be used in the Programmable Scheme Logic to block the Field Failure protection.

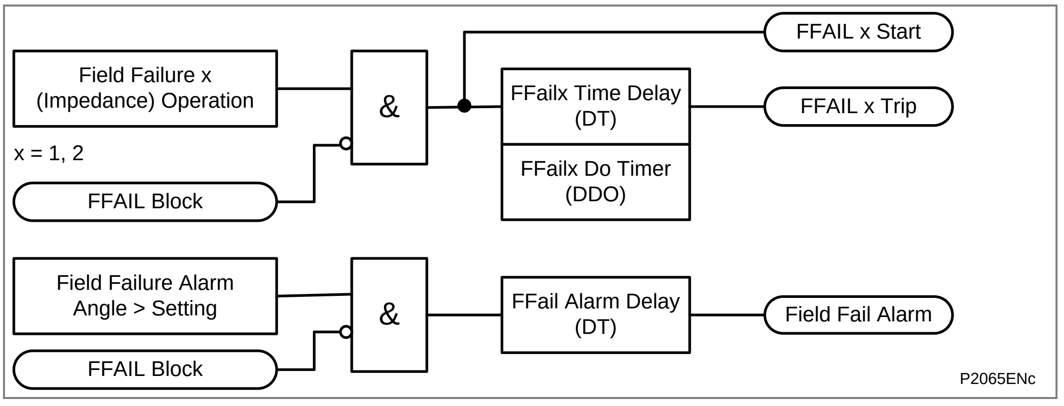


Figure 27 - Field failure logic diagram

1.11 Power Elements (32R/37/55)

The standard power protection elements of the relay calculate the three-phase active power based on the following formula, using the current measured at the Ia, Ib, Ic inputs of the relay.

$$P = Va\ Ia\ \cos\phi_a + Vb\ Ib\ \cos\phi_b + Vc\ Ic\ \cos\phi_c$$

1.11.1 Reverse Power (32R)

When a power supply failure occurs on the feeder, synchronous motors will become generators due to the inertia of their load and the induction motors will start to work as generators.

The aim of the reverse power protection is to detect the inverse flow of energy and to ensure that the motor does not feed the fault which has appeared on the network.

The Reverse Power protection in the relay has a single reverse power threshold **Rev P< Power Set**. If this setting is reached, the reverse power protection will trip in a time equal to the time delay setting **Rev P< Time Delay**.

A DDB (Digital Data Bus) signal is available to indicate the trip of the reverse power protection (Trip Rev Power: DDB 273). These signals are used to operate the output relays and trigger the disturbance recorder as programmed into the programmable Scheme Logic (PSL). The state of the DDB signals can also be programmed to be viewed in the **Monitor Bit x** cells of the **COMMISSION TESTS** column in the relay.

This feature is only enabled when the circuit breaker is closed, therefore it requires a 52a circuit breaker auxiliary contact mapped to an opto input to get the information CB closed / CB open.

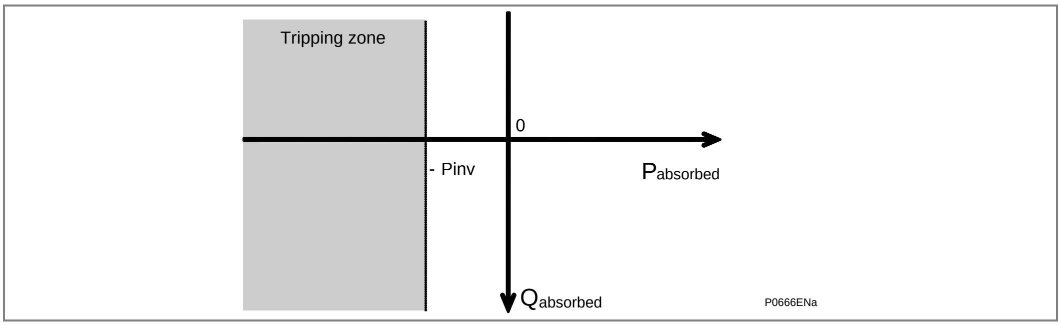


Figure 28 - Reverse power protection

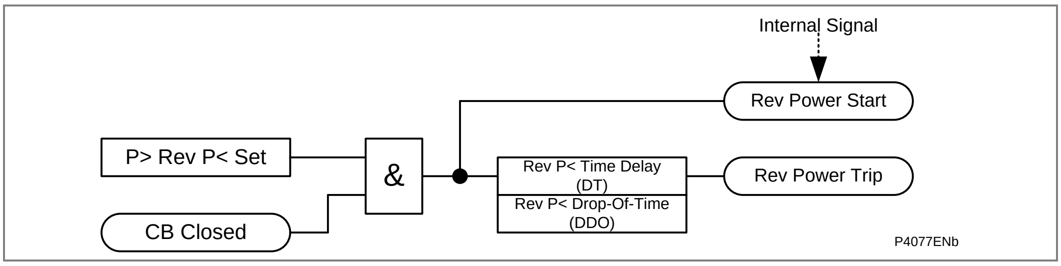


Figure 29 - Reverse power logic diagram

1.11.2 Out-of-Step Protection (Under Power Factor) (55)

Power factor protection is provided for out-of-step protection of synchronous machines. The 3ph power factor is taken into account: a drop-off time during the motor start time can be used, in order to avoid tripping during the motor start.

This feature is only enabled when the motor current is higher than 2%In and the voltage is higher than 1%Vn, where In is the CT secondary current rating and Vn is the PT secondary voltage rating.

This feature is only enabled when the circuit breaker is closed, therefore it requires a 52a circuit breaker auxiliary contact mapped to an opto input to get the information CB closed / CB open.

These protection features are not normally used simultaneously.

A DDB (Digital Data Bus) signal is available to indicate the trip of each of the out of step protection stages (Trip PF<Lead/Lag: DDB 271, 272). These signals are used to operate the output relays and trigger the disturbance recorder as programmed into the programmable Scheme Logic (PSL). The state of the DDB signals can also be programmed to be viewed in the **Monitor Bit x** cells of the **COMMISSION TESTS** column in the relay.

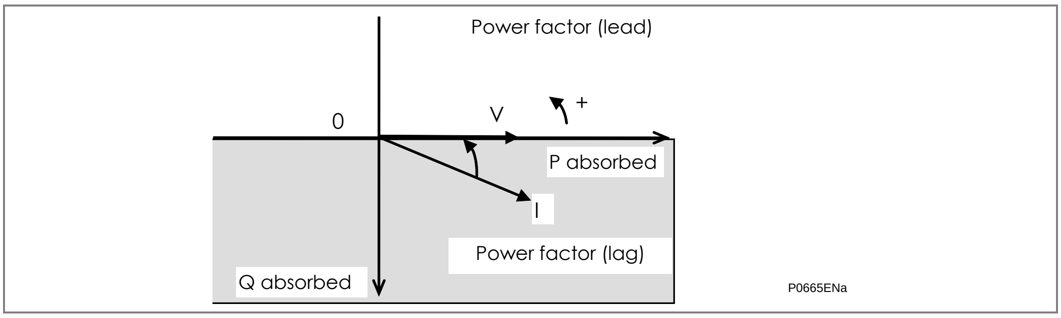


Figure 30 - Out-of-step protection

There are two stages of out of step protection, "Lead" stage and "Lag" stage. When the leading power factor is presented under the normal working condition of the synchronous motor, the "Lead" stage shall be selected. The "Lead" stage could be initiated when the power factor is in lag condition and the value is less than the setting, as shown in the *Out-of-step protection* diagram.

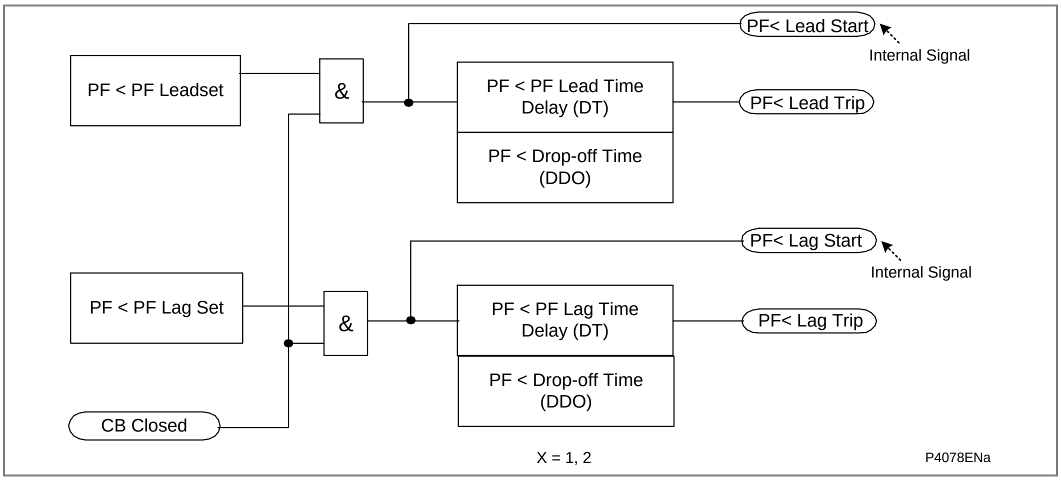


Figure 31 - Out of step logic diagram

In the MiCOM P24x, Field Failure Protection and Out-of-Step Protection are not normally used simultaneously. The out-of-step boundaries are usually outside the normal operating conditions.
In general, the protection range of "Out of Step" is wider and operation speed may be faster than "Field Failure". The application scenario must be considered to decide which one should be applied. Normally the automatic excitation system can detect the slip speed and pull the machine back to the synchronous speed after "Out-of-Step". This is automatic re-synchronization with load. For the application case where the automatic re-synchronization function is available (in other words, the excitation system provides the protection for "Out of Step"), it is better to apply the "Field Failure" element as the backup protection when the excitation system has failed. If the automatic re-synchronization function is not required, it is better to apply the "Out of Step" element which can quickly trip out both the excitation circuit and power supply.

1.11.3 Loss of Load (Under Power) (37)

The principle of this function is the following: if the minimum 3 phase active power is less than the programmed threshold for a settable time delay, a trip will be initiated.
Since rated power cannot be reached during starting, this feature can be disabled using a delay on drop off time during the motor start time.

A low forward power condition can only be established when the circuit breaker is closed and the active power calculated is above zero.

Note	*As the absolute power is used for this function, it can also be used to protect against "reverse power" of some synchronous motors.*

A DDB (Digital Data Bus) signal is available to indicate the trip of each of the underpower protection stages (Trip P<1/2: DDB 269, 270). These signals are used to operate the output relays and trigger the disturbance recorder as programmed into the programmable Scheme Logic (PSL). The state of the DDB signals can also be programmed to be viewed in the **Monitor Bit x** cells of the **COMMISSION TESTS** column in the relay.

This feature is only enabled when the circuit breaker is closed, therefore it requires a 52a circuit breaker auxiliary contact mapped to an opto input to get the information CB closed / CB open.

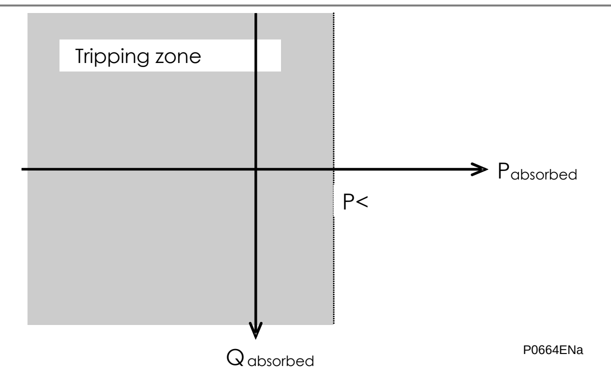


Figure 32 - Loss of load (underpower) protection

Tripping conditions:

- CB Closed
- Pactive < **P<1 Power Set' or 'P<2 Power Set**

Note	*If the active power is negative, this function may generate a trip.*

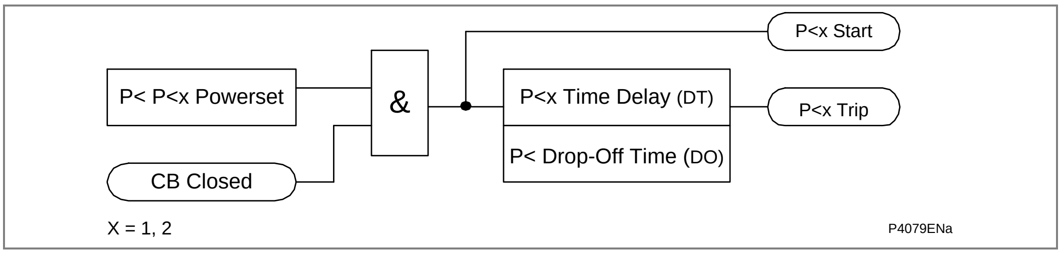


Figure 33 - Loss of load logic diagram

1.12 Sensitive Earth Fault Protection Function (50N/51N/67N/32N/64N)

Two stages of Sensitive Earth Fault (SEF) protection are provided in the relay. The first stage can be set as Inverse Definite Minimum Time (IDMT), and the second stage as Definite Time (DT) only. When Directional Earth Fault (DEF) protection is required the operating current should be derived from either a core balanced CT or the residual connection of three-phase CTs at the terminals of the machine. Direction of the earth fault current for this element is determined with reference to the polarizing signal, the residual voltage. The polarizing signal is taken from the residual overvoltage/NVD protection input.

A polarizing voltage threshold is also provided. The element cannot operate unless voltage exceeds this threshold. This helps to restrain the element during phase/phase faults when transient CT saturation produces spill current in the residual connection of the phase CTs. No residual voltage will be present during such non-earth fault conditions hence the DEF element cannot operate. The element will therefore be enabled only during genuine earth fault conditions when significant residual voltage will be present. As shown in the *Directional sensitive earth fault characteristic* diagram.

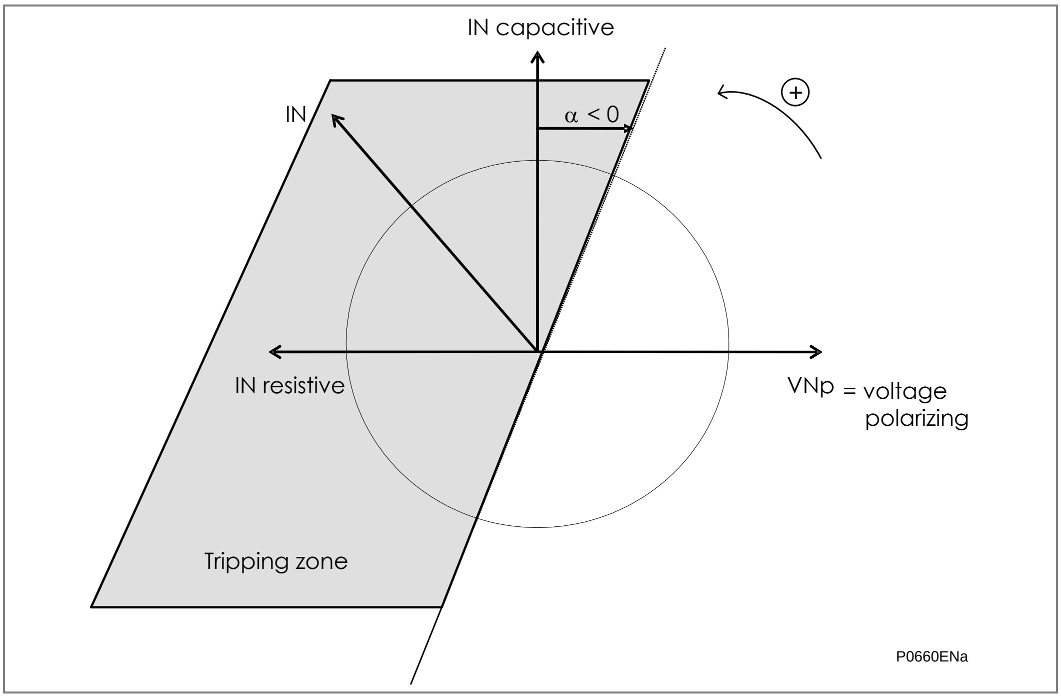


Figure 34 - Directional sensitive earth fault characteristic

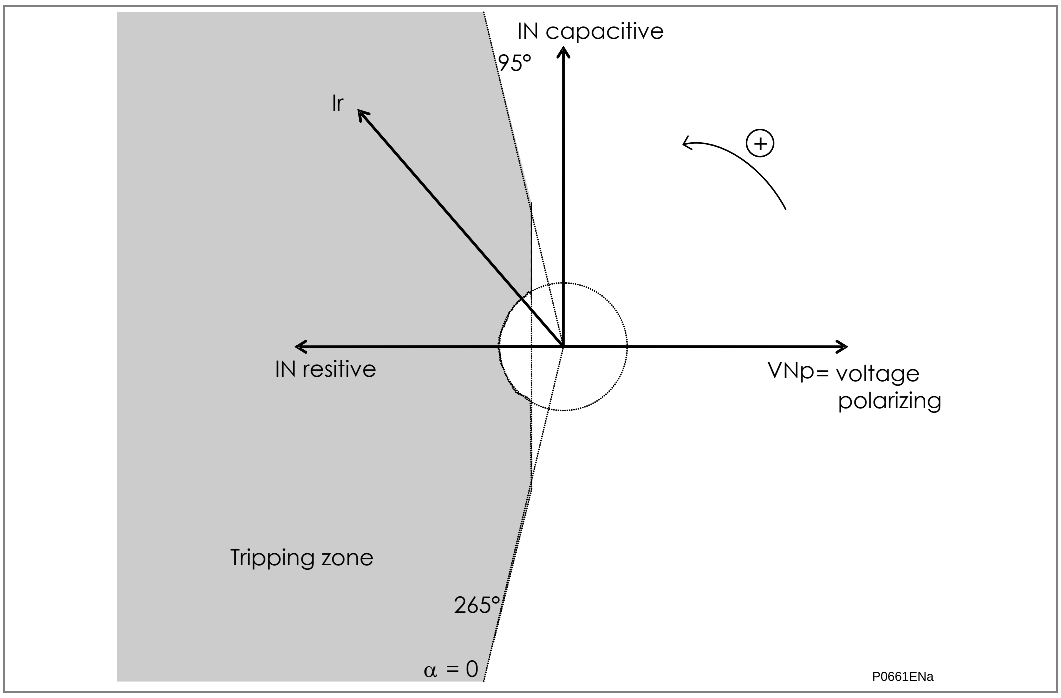


Figure 35 - Wattmetric directional characteristic

The Wattmetric active power is given by the following formula:

$$PO = \frac{1}{3} \; x \; V_n \; x \; I_n \; x \; Cos(\phi 0 - \alpha)$$

With: ϕ0 = phase shift between (In) and (-Vn)
α = Characteristic Angle

The tripping conditions are:

In = Residual current > **PO> Current Set**

Vn = residual voltage > **PO> Voltage Set**

ϕ0 = Angle(In) – Angle(-Vn) when ϕ0 > 275° + α and < 85° + α]
where α = **PO> Char Angle**

$$PO = \frac{1}{3} \; x \; V_n \; x \; I_n \; x \; Cos(\phi 0 - \alpha) \quad > K \; x \; (PO> Current Set) \; x \; (PO> Voltage Set)$$

A Digital Data Bus (DDB) signal is available to indicate the start and trip of each of the Sensitive Earth Fault (SEF) and wattmetric earth fault protection stages (Start ISEF>1/2: DDB 262, 264, Start PO>: DDB295, Trip ISEF>1/2: DDB261, 263, Trip PO>: DDB294). These signals are used to operate the output relays and trigger the disturbance recorder as programmed into the Programmable Scheme Logic (PSL). The state of the DDB signals can also be programmed to be viewed in the **Monitor Bit x** cells of the **COMMISSION TESTS** column in the relay.

The logic diagram for sensitive directional earth fault protection with neutral voltage polarization is shown in the *Directional SEF with VN polarization and wattmetric SEF* diagram.

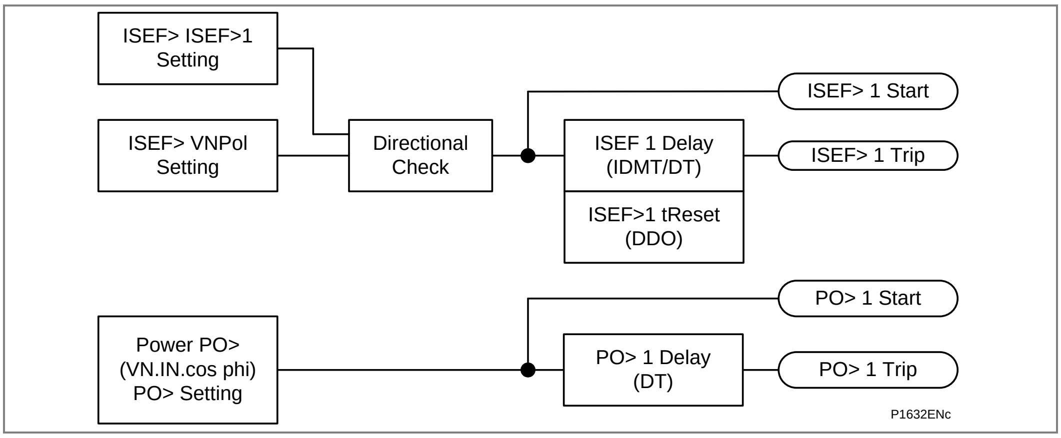


Figure 36 - Directional SEF with VN polarization and wattmetric SEF

The directional check criteria are given below for the standard directional sensitive earth fault element:

Directional forward:

$-90° < (angle(I_N) - angle(V_N + 180°) - RCA) < 90°$

1.12.1 User Programmable Sensitive Earth Fault Protection

A user programmable sensitive earth fault curve facility is available for the first stage of sensitive earth fault protection. For information on how to program a customized sensitive earth fault curve and send and extract curves to and from the relay, refer to the document *Px4x/EN UPCT/A11*.

1.13 Derived Earth Fault (DEF) Protection Function (50N/51N)

The Derived Earth Fault (DEF) protection can be either non-directional or directional. In order to cover all types of applications schemes, the criteria used for the directional boundary can be determined in two different ways:

- 3VTs connection scheme: same criteria as for the 'sensitive earth fault protection', i.e 'Zero-sequence voltage' polarization, with the same tripping conditions,
- 2VTs connection scheme: in this case, the criteria can be the angle between the negative phase sequence current and the negative phase sequence voltage.

The tripping conditions are indicated below:

I2 = negative phase sequence current > **IN> I2pol Set**

V2 = negative phase sequence voltage > **IN> V2pol Set**

$\phi 2$ = Angle(I2) – Angle(-V2) > 275+α and < 85 + α] where α = **IN> Char Angle**

A DDB (Digital Data Bus) signal is available to indicate the start and trip of each of the derived earth fault protection stages (Start IN>1/2: DDB 266, 268, Trip IN>1/2: DDB 265, 267). These signals are used to operate the output relays and trigger the disturbance recorder as programmed into the Programmable Scheme Logic (PSL). The state of the DDB signals can also be programmed to be viewed in the **Monitor Bit x** cells of the **COMMISSION TESTS** column in the relay.

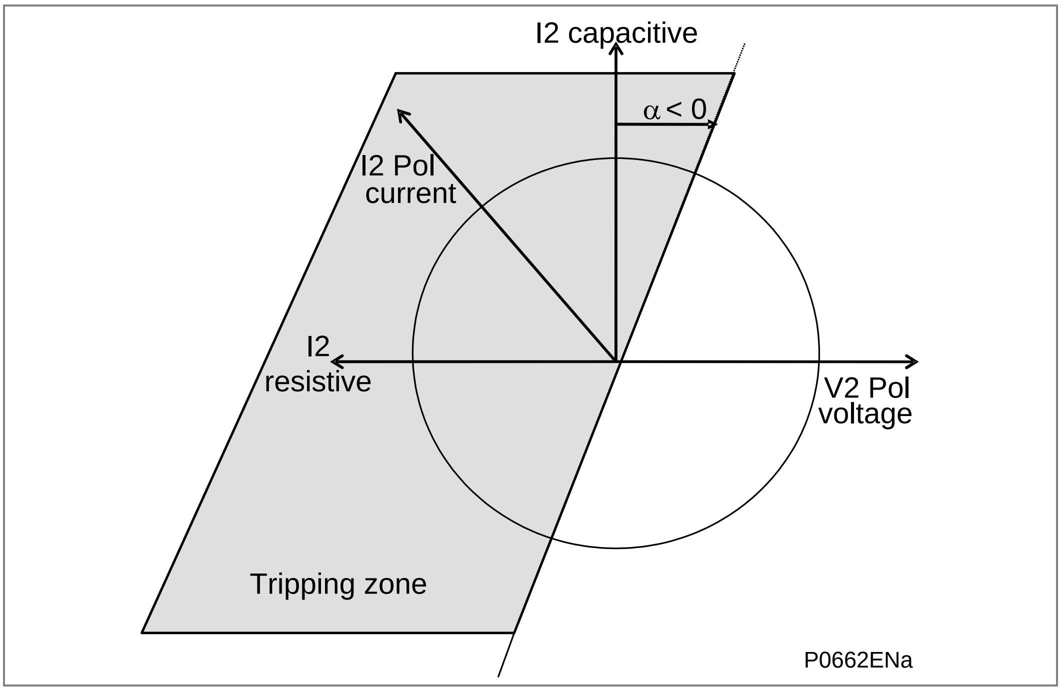


Figure 37 - Derived earth fault characteristic

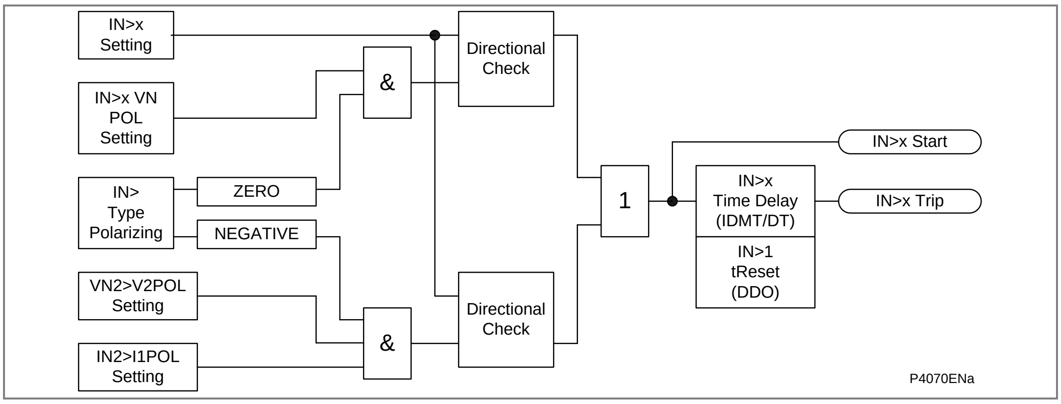


Figure 38 - Derived directional earth fault logic diagram

A Typical application of the derived earth fault protection is shown in the *Typical derived earth fault application* diagram:

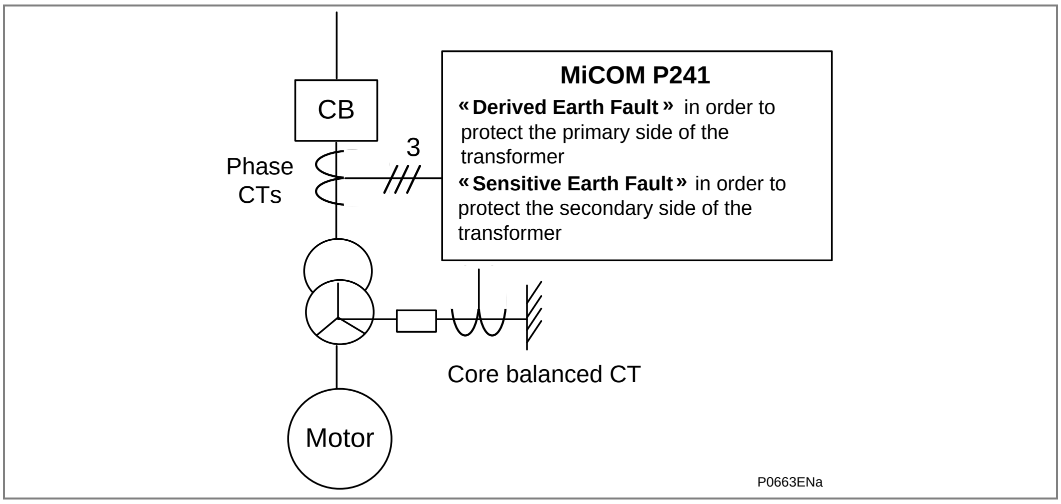


Figure 39 - Typical derived earth fault application

1.13.1 User Programmable Derived Earth Fault Protection

A user programmable derived earth fault curve facility is available for the first stage of derived earth fault protection. For information on how to program a customized derived earth fault curve and send and extract curves to and from the relay, refer to the document *Px4x/EN UPCT/A11*.

1.14 Resistive Temperature Device (RTD) Thermal Protection

To protect against any general or localized overheating, the P241/P242/P243 relay has the ability to accept inputs from up to 10 - 3-wire Type A PT100, Ni100 or Ni120 Resistive Temperature Sensing Devices (RTD). These are connected as shown in the *Connection for RTD thermal probes* diagram below.

Such probes can be strategically placed in areas of the machine that are susceptible to overheating or heat damage.

The probes can also be used to measure the external ambient temperature. The ambient temperature can be used to adapt the thermal overload protection operating time. A main and back-up RTD can be selected in the settings for the external ambient temperature.

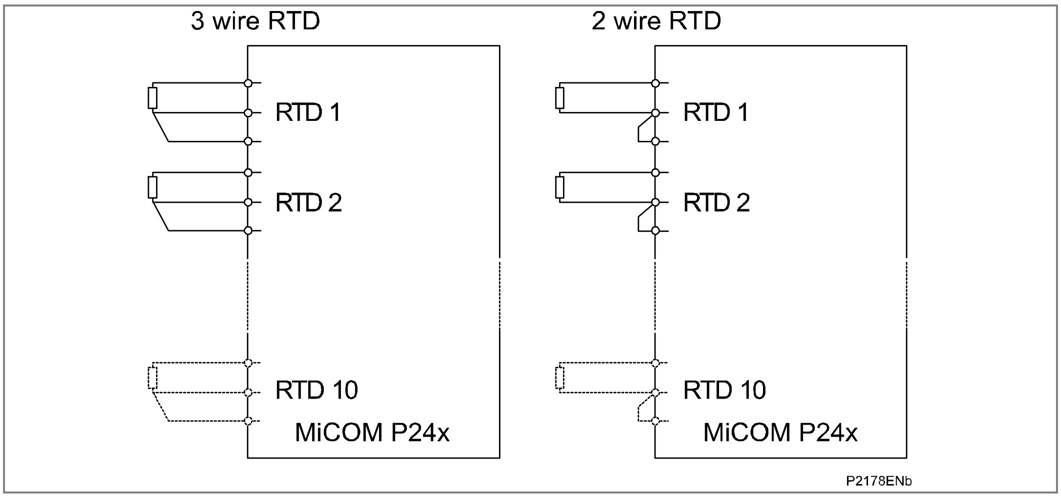


Figure 40 - Connection for RTD thermal probes

The units of temperature measurement Celsius or Fahrenheit can also be selected.

Typically a PT100/Ni100/Ni120 RTD probe can measure temperature within the range -0° to +400°C. The resistance of these devices changes with temperature, at 0°C a PT100 will have a resistance of 100Ω.

Should the measured resistance be outside of the permitted range, an RTD failure alarm will be raised, indicating an open or short circuit RTD input.

These conditions are signaled via DDB signals available within the PSL (RTD Short Cct, RTD Open Cct, RTD Data Error: DDB 201-203) and are also shown in the measurements 3 menu.

DDB signals are also available to indicate the alarm and trip of the each RTD, (RTD 1-10 Alarm: DDB 191-200, RTD 1-10 Trip: DDB 305-314). The state of the DDB signals can be programmed to be viewed in the **Monitor Bit x** cells of the **COMMISSION TESTS** column in the relay.

See the Connection Diagrams chapter, for recommendations on RTD connections and cables.

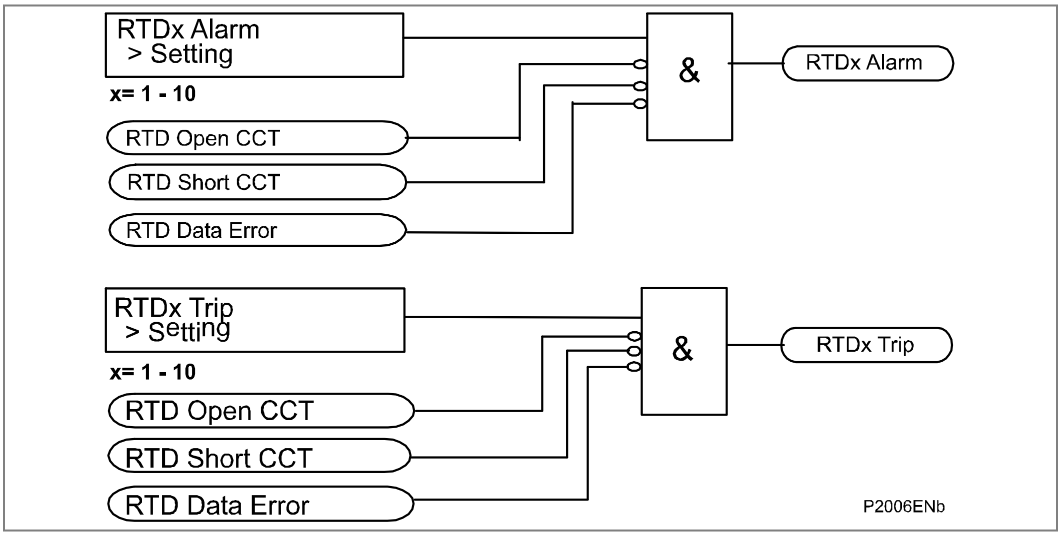


Figure 41 - RTD logic diagram

1.14.1 Principle of the RTD Connection

The aim of such a connection is to compensate the influence of the r1 and r2 resistors.

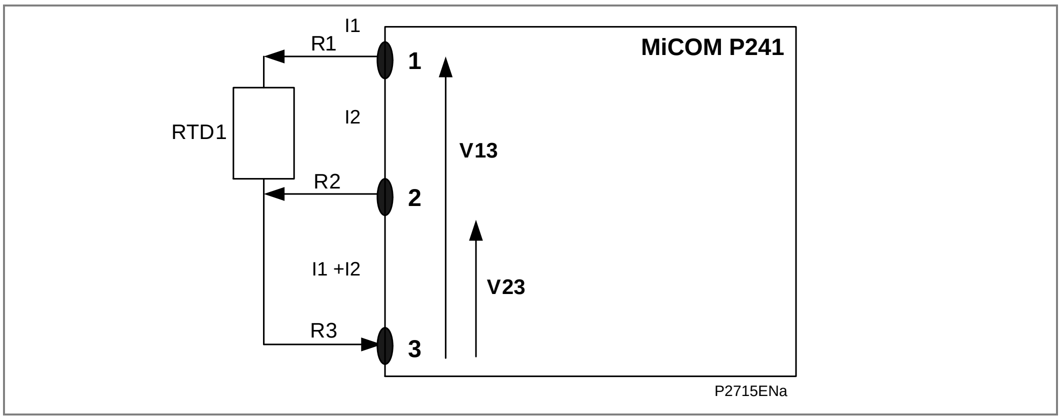


Figure 42 - RTD connection

A constant current is injected by the MICOM P241 relay from the connections 1 and 2:

$i1 = i2$
$V13 = r1 * I1 + R_{rtd} * I1 - r3 * (I1 + I2)$
$V23 = r2 * I2 - r3 * (I1 + I2)$
$V13 - U23 = r1 * I1 + R_{rtd} * I1 - r3 * (I1 + I2) - r2 * I2 + r3 * (I1 + I2)$

Assuming that the three cables have the same length and are the same material, hence the resistors r1, r2 and r3 are the same:

$V13 - V23 = R_{rtd} * I1$ = Voltage at the RTD terminals

1.15 Circuit Breaker Failure (50BF) Protection

The circuit breaker failure protection incorporates two timers, **CB Fail 1 Timer** and **CB Fail 2 Timer**, allowing configuration for these scenarios:

- Simple CBF, where only **CB Fail 1 Timer** is enabled. For any protection trip, the **CB Fail 1 Timer** is started, and normally reset when the circuit breaker opens to isolate the fault. If breaker opening is not detected, **CB Fail 1 Timer** times out and closes an output contact assigned to breaker fail (using the Programmable Scheme Logic (PSL)). This contact is used to backtrip upstream switchgear, generally tripping all infeeds connected to the same busbar section.
- A re-tripping scheme, plus delayed back-tripping. Here, **CB Fail 1 Timer** is used to route a trip to a second trip circuit of the same circuit breaker. This requires duplicated circuit breaker trip coils, and is known as re-tripping. Should re-tripping fail to open the circuit breaker, a back-trip may be issued following an additional time delay. The back-trip uses **CB Fail 2 Timer**, which is also started at the instant of the initial protection element trip.

CBF elements **CB Fail 1 Timer** and **CB Fail 2 Timer** can be configured to operate for trips triggered by protection elements within the relay or via an external protection trip. The latter is achieved by allocating one of the relay opto-isolated inputs to **External Trip** using the PSL.

In the case of the P24x, the opto-isolated inputs is allocated to DDB 115 External Trip.

Resetting of the CBF is possible from a breaker open indication (from the relay's pole dead logic) or from a protection reset. In these cases resetting is only allowed provided the undercurrent elements have also been reset. The resetting options are summarised in the following table.

Initiation (menu selectable)	CB fail timer reset mechanism
Current based protection (e.g. 50/51/46/67N/87..)	The resetting mechanism is fixed. [IA< operates] & [IB< operates] & [IC< operates] &
Non-current based protection (e.g. 27/59N/81U/32R..)	Three options are available. You can select from these options. [All I< elements operate] [Protection element reset] AND [All I< elements operate] CB open AND [All I< elements operate]
External protection	Three options are available. You can select from these options. [All I< elements operate] [Protection element reset] AND [All I< elements operate] CB open AND [All I< elements operate]

Table 3 - CBF resetting options

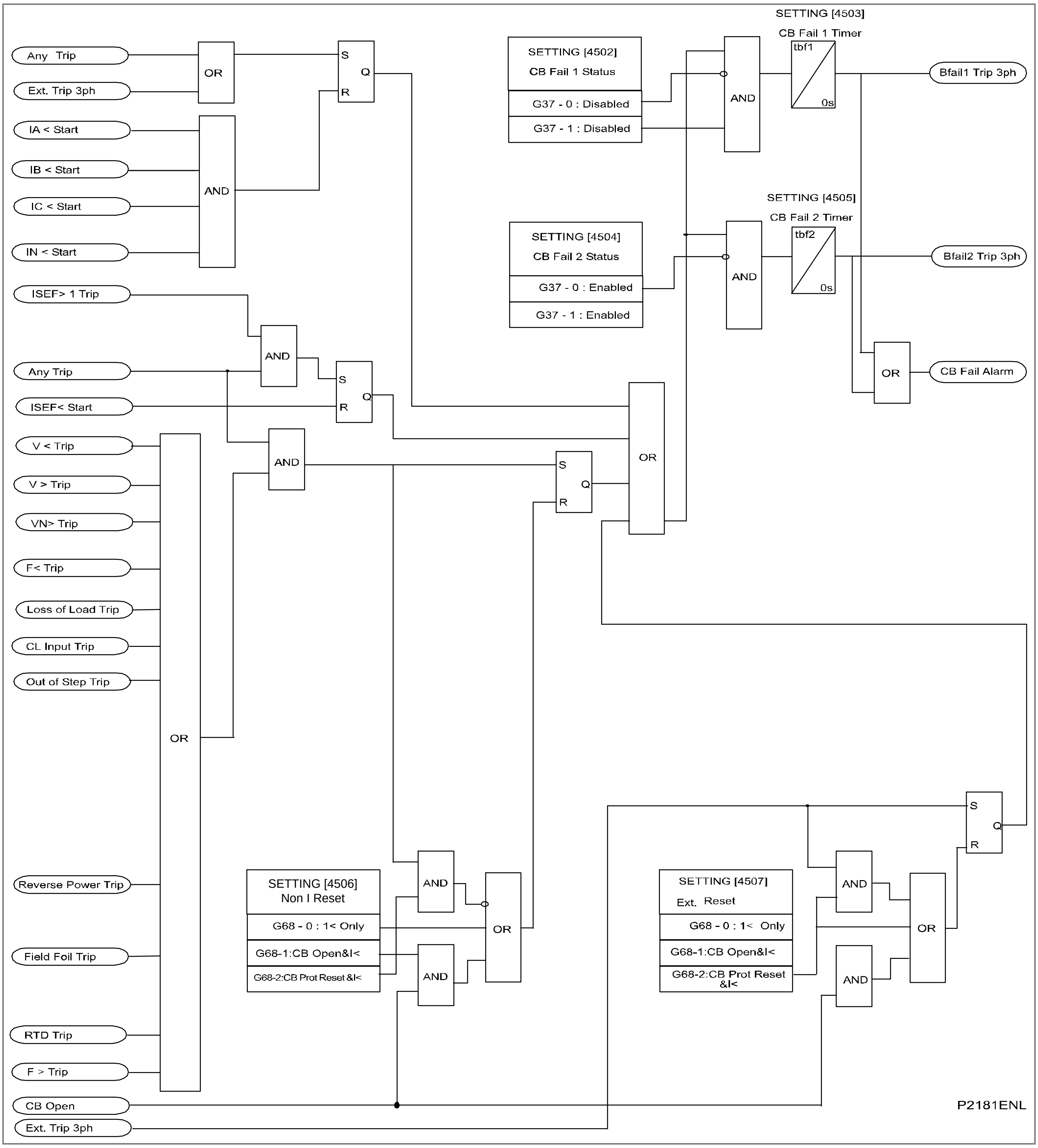


Figure 43 - CB fail logic

1.16 Current Loop Inputs and Outputs

1.16.1 Current Loop Inputs

Four analog (or current loop) inputs are provided for transducers with ranges of 0 - 1 mA, 0 - 10 mA, 0 - 20 mA or 4 - 20 mA. The analog inputs can be used for various transducers such as vibration monitors, tachometers and pressure transducers. Associated with each current loop input are units (A, V, Hz, W, Var, VA, °C, F, %, s) and there are two protection stages, one for alarm and one for trip. Each current loop input can be individually enabled or disabled and each input has a definite time delay alarm and trip stage. There is also a delay on drop off time which applies to all inputs.

The Alarm and Trip stages operate when the input current is above the input value. The sample interval is nominally 50 ms per input.

The relationship between the transducer measuring range and the current input range is linear. The maximum and minimum settings correspond to the limits of the current input range. This relationship is shown in the *Relationship between the transducer measuring quantity and the current input range* diagram.

This diagram also shows the relationship between the measured current and the analog to digital conversion (ADC) count. The hardware design allows for over-ranging, with the maximum ADC count (4095 for a 12-bit ADC) corresponding to 1.0836 mA for the 0 - 1 mA range, and 22.7556 mA for the 0 - 10 mA, 0 - 20 mA and 4 - 20 mA ranges. The relay will therefore continue to measure and display values beyond the Maximum setting, within its numbering capability.

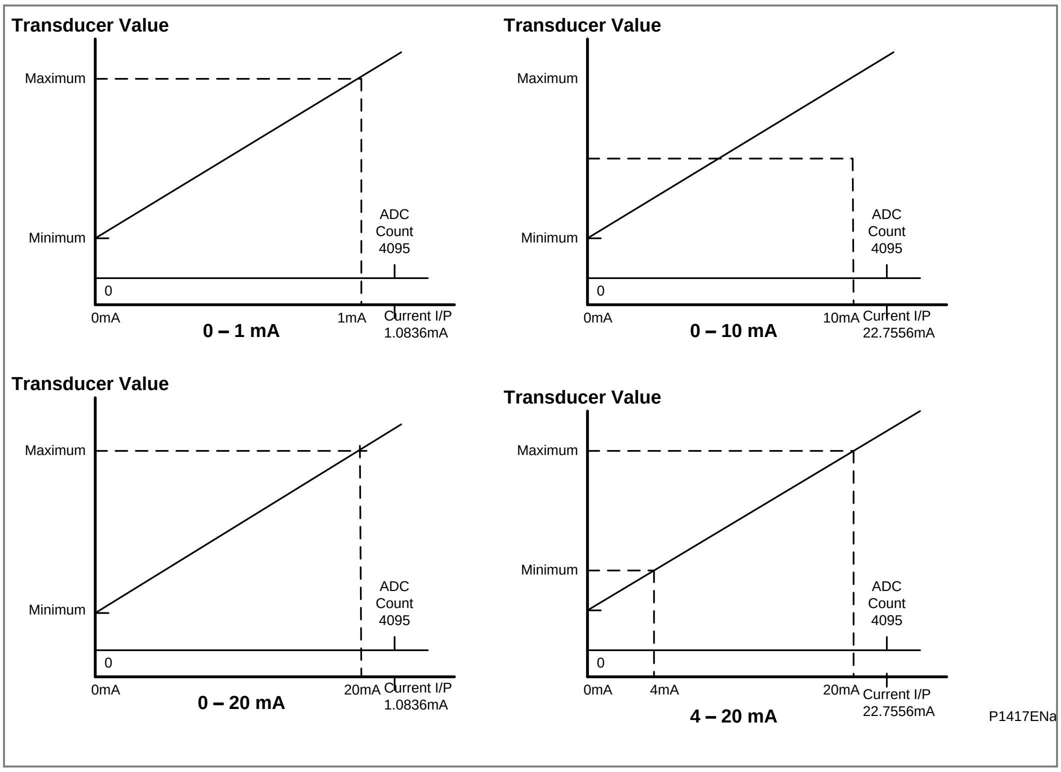


Figure 44 - Relationship between the transducer measuring quantity and the current input range

Note	*If the Maximum is set less than the Minimum, the slopes of the graphs will be negative. This is because the mathematical relationship remains the same irrespective of how Maximum and Minimum are set, e.g., for 0 - 1 mA range, Maximum always corresponds to 1 mA and Minimum to 0 mA.*

DDB signals are available to indicate operation of the alarm and trip stages of the each current loop inputs, (Analog Inp1/2/3/4 Alarm: DDB 211-214, Trip Analog Inp1/2/3/4: DDB 321-324. The state of the DDB signals can be programmed to be viewed in the **Monitor Bit x** cells of the **COMMISSION TESTS** column in the relay.

The current loop input starts are mapped internally to the Any Start DDB signal – DDB 369.

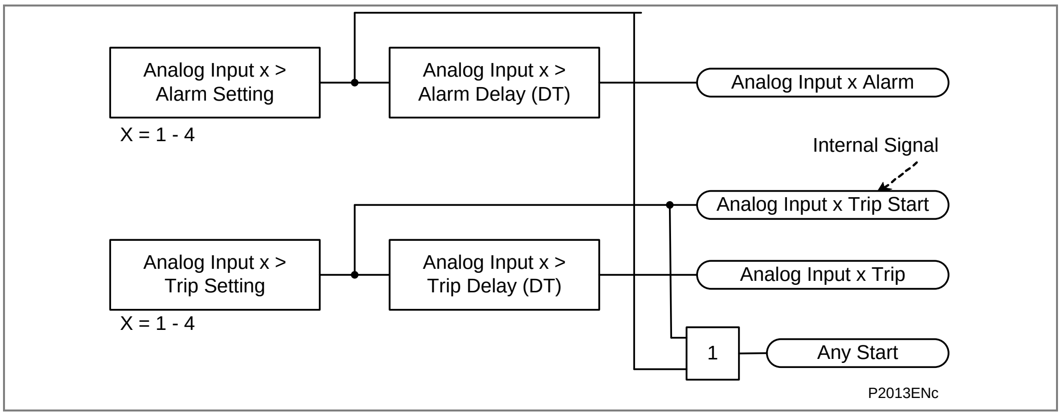


Figure 45 - Analog (current loop) input logic diagram

1.16.2 Current Loop Output

Four analog current outputs are provided with ranges of 0 to 1 mA, 0 to 10 mA, 0 to 20 mA or 4 to 20 mA, which can alleviate the need for separate transducers. These may be used to feed standard moving coil ammeters for analog indication of certain measured quantities or into a SCADA using an existing analog RTU.

The CLIO output conversion task runs every 50 ms and the refresh interval for the output measurements is nominally 200 ms.

The user can set the measuring range for each analog output. The range limits are defined by the Maximum and Minimum settings.

This allows the user to “zoom in” and monitor a restricted range of the measurements with the desired resolution. For voltage, current and power quantities, these settings are set in primary quantities.

The output current of each analog output is linearly scaled to its range limits, as defined by the Maximum and Minimum settings. The relationship is shown in the *Relationship between the current output and the relay measurement* diagram.

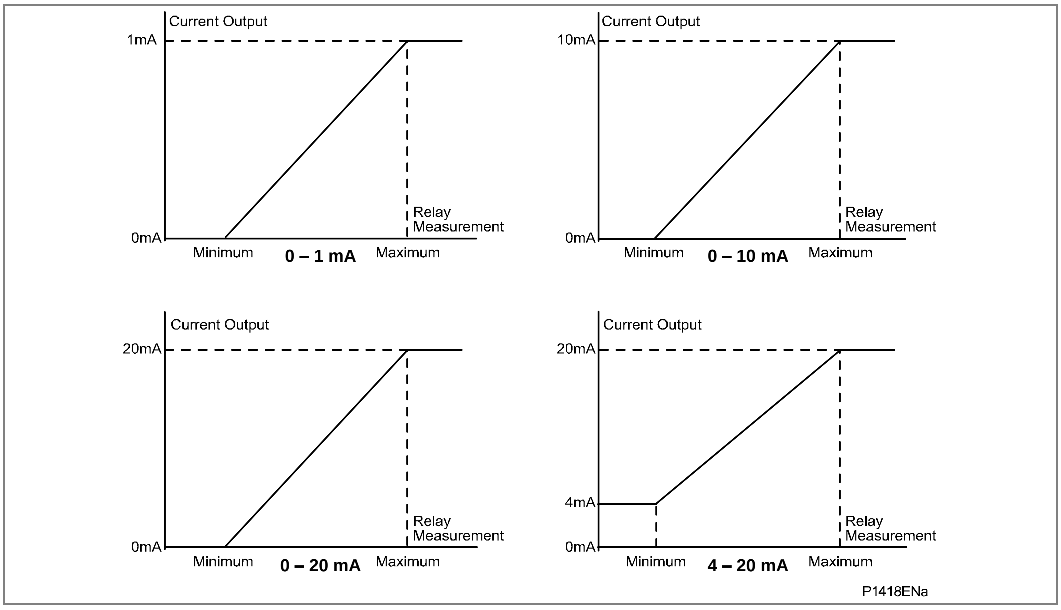


Figure 46 - Relationship between the current output and the relay measurement

Note	*If the Maximum is set less than the Minimum, the slopes of the graphs will be negative. This is because the mathematical relationship remains the same irrespective of how Maximum and Minimum are set, e.g., for 0 - 1 mA range, Maximum always corresponds to 1 mA and Minimum corresponds to 0 mA.*

The relay transducers are of the current output type. This means that the correct value of output will be maintained over the load range specified. The range of load resistance varies a great deal, depending on the design and the value of output current. Transducers with a full scale output of 10 mA will normally feed any load up to a value of 1000 Ω (compliance voltage of 10 V). This equates to a cable length of 15 km (approximately) for lightweight cable (1/0.6 mm cable). A screened cable earthed at one end only is recommended to reduce interference on the output current signal. The table below gives typical cable impedances/km for common cables. The compliance voltage dictates the maximum load that can be fed by a transducer output. Therefore, the 20 mA output will be restricted to a maximum load of 500 Ω approximately.

Cable	1/0.6 mm	1/0.85 mm	1/1.38 mm
CSA (mm2)	0.28	0.57	1.50
R (Ω/km)	65.52	32.65	12.38

Table 4 - Impedance per kilometre values of typical cables

The receiving equipment, whether it be a simple moving-coil (DC milliamp meter) instrument or a remote terminal unit forming part of a SCADA system, can be connected at any point in the output loop and additional equipment can be installed at a later date (provided the compliance voltage is not exceeded) without any need for adjustment of the transducer output.

Where the output current range is used for control purposes, it is sometimes worthwhile to fit appropriately rated diodes, or Zener diodes, across the terminals of each of the units in the series loop to guard against the possibility of their internal circuitry becoming open circuit. In this way, a faulty unit in the loop does not cause all the indications to disappear because the constant current nature of the transducer output simply raises the voltage and continues to force the correct output signal round the loop.

Current loop output parameter	Abbreviation	Units	Range	Step	Default min.	Defaultmax.
Current Magnitude	IA Magnitude IB Magnitude IC Magnitude IN Magnitude	A	0 to 100 k	1	0	100
RMS Phase Currents	IA RMS IB RMS IC RMS IN RMS	A	0 to 100 k	1	0	100
P-N voltage Magnitude	VAN Magnitude VBN Magnitude VCN Magnitude VN Magnitude	V	0 to 20 k	1	0	100
P-N voltage RMS	VAN RMS VBN RMS VCN RMS VN RMS	V	0 to 20 k	1	0	100
P-P voltage Magnitude	VAB Magnitude VBC Magnitude VCA Magnitude	V	0 to 20 k	1	0	100
RMS Phase-Phase Voltages	VAB RMS Magnitude VBC RMS Magnitude VCA RMS Magnitude	V	0 to 20 k	1	0	100
Frequency	Frequency	Hz	0 to 100	1	0	100
3 Ph Active Power	Three-Phase Watts	W	-10 M to 30 M	1	0	100
3 Ph Reactive Power	Three-Phase Vars	Var	-10 M to 30 M	1	0	100
3 Ph Apparent Power	Three-Phase VA	VA	-10 M to 30 M	1	0	100
3 Ph Power Factor	3Ph Power Factor		-1 to 1	0.01	0	1
RTD Temperatures	RTD 1 RTD 2 RTD 3 RTD 4 RTD 5 RTD 6 RTD 7 RTD 8 RTD 9 RTD 10	°C	-40 to 400	1	0	100.0
Number of hottest RTD	Nb Hottest RTD		1-10	1	0	10
Thermal State	Thermal State	%	0 to 150	0.1	0	100
Time to Thermal Trip	Time to Thermal Trip	Sec	0-300	0.1	0	100
Time to Next Start	Time to Next Start	Sec	0-300	0.1	0	100

Note 1	*The current loop (analog) outputs are refreshed every 200 ms.*
Note 2	*The polarity of Watts, Vars and power factor is affected by the Measurements Mode setting.*
Note 3	*These settings are for nominal 1 A and 100/120 V versions only.* *For other nominal versions they need to be multiplied accordingly.*
Note 4	*All current loop (analog) output measurements are in primary values.*

Table 5 - Current loop output parameters

2 OPERATION OF NON-PROTECTION FUNCTIONS

2.1 Voltage Transformer Supervision (VTS)

The Voltage Transformer Supervision (VTS) feature is used to detect failure of the ac voltage inputs to the relay. This may be caused by internal voltage transformer faults, overloading, or faults on the interconnecting wiring to relays. This usually results in one or more VT fuses blowing. Following a failure of the ac voltage input there would be a misrepresentation of the phase voltages on the power system, as measured by the relay, which may result in mal-operation.

The VTS logic in the relay is designed to detect the voltage failure, and automatically adjust the configuration of protection elements whose stability would otherwise be compromised. A time-delayed alarm output is also available.

There are three main aspects to consider regarding the failure of the VT supply. These are defined below:

- Loss of one or two-phase voltages
- Loss of all three-phase voltages under load conditions
- Absence of three-phase voltages upon line energization

The VTS feature within the relay operates on detection of Negative Phase Sequence (NPS) voltage without the presence of negative phase sequence current. This gives operation for the loss of one or two-phase voltages. Stability of the VTS function is assured during system fault conditions, by the presence of NPS current. The use of negative sequence quantities ensures correct operation even where three-limb or ‘V’ connected VT’s are used.

Negative sequence VTS element:

- The negative sequence thresholds used by the element are V2 = 10 V and I2 = 0.05 to 0.5 In settable (defaulted to 0.05 In).

2.1.1 Loss of all 3-Phase Voltages Under Load Conditions

Under the loss of all three phase voltages to the relay, there will be no zero phase sequence quantities present to operate the VTS function. However, under such circumstances, a collapse of the three phase voltages will occur. If this is detected without a corresponding change in any of the phase current signals (which would be indicative of a fault), then a VTS condition will be raised. In practice, the relay detects the presence of superimposed current signals (delta I), which are changes in the current applied to the relay. These signals are generated by comparison of the present value of the current with the value one cycle before. Under normal load conditions, the value of superimposed current should therefore be zero. Under a fault condition a superimposed current signal will be generated which will prevent operation of the VTS.

The phase voltage level detector is 10 V to 70 V settable (defaulted to 30 V) using the ‘Threshold 3P’ setting.

The sensitivity of the superimposed current elements is settable 0.1In to 5In (default 0.1In) using the ‘Delta I>’ setting.

2.1.2 Absence of 3-Phase Voltages Upon Line Energization

If a VT were inadvertently left isolated prior to line energization, incorrect operation of voltage dependent elements could result. The previous VTS element detected 3-phase VT failure by absence of all 3-phase voltages with no corresponding change in current. On line energization there will, however, be a change in current (as a result of load or line charging current for example). An alternative method of detecting 3-phase VT failure is therefore required on-line energization.

The absence of measured voltage on all three-phases on line energization can be as a result of two conditions.

- A three-phase VT failure
- A close up three-phase fault

The first condition would require blocking of the voltage dependent function and the second would require tripping.

To differentiate between these two conditions an overcurrent level detector (***VTS I> Inhibit***) is used which will prevent a VTS block from being issued if it operates. This element should be set in excess of any non-fault based currents on line energization (load, line charging current, transformer inrush current if applicable) but below the level of current produced by a close up three-phase fault. If the line is now closed where a three-phase VT failure is present the overcurrent detector will not operate and a VTS block will be applied. Closing onto a three-phase fault will result in operation of the overcurrent detector and prevent a VTS block being applied.

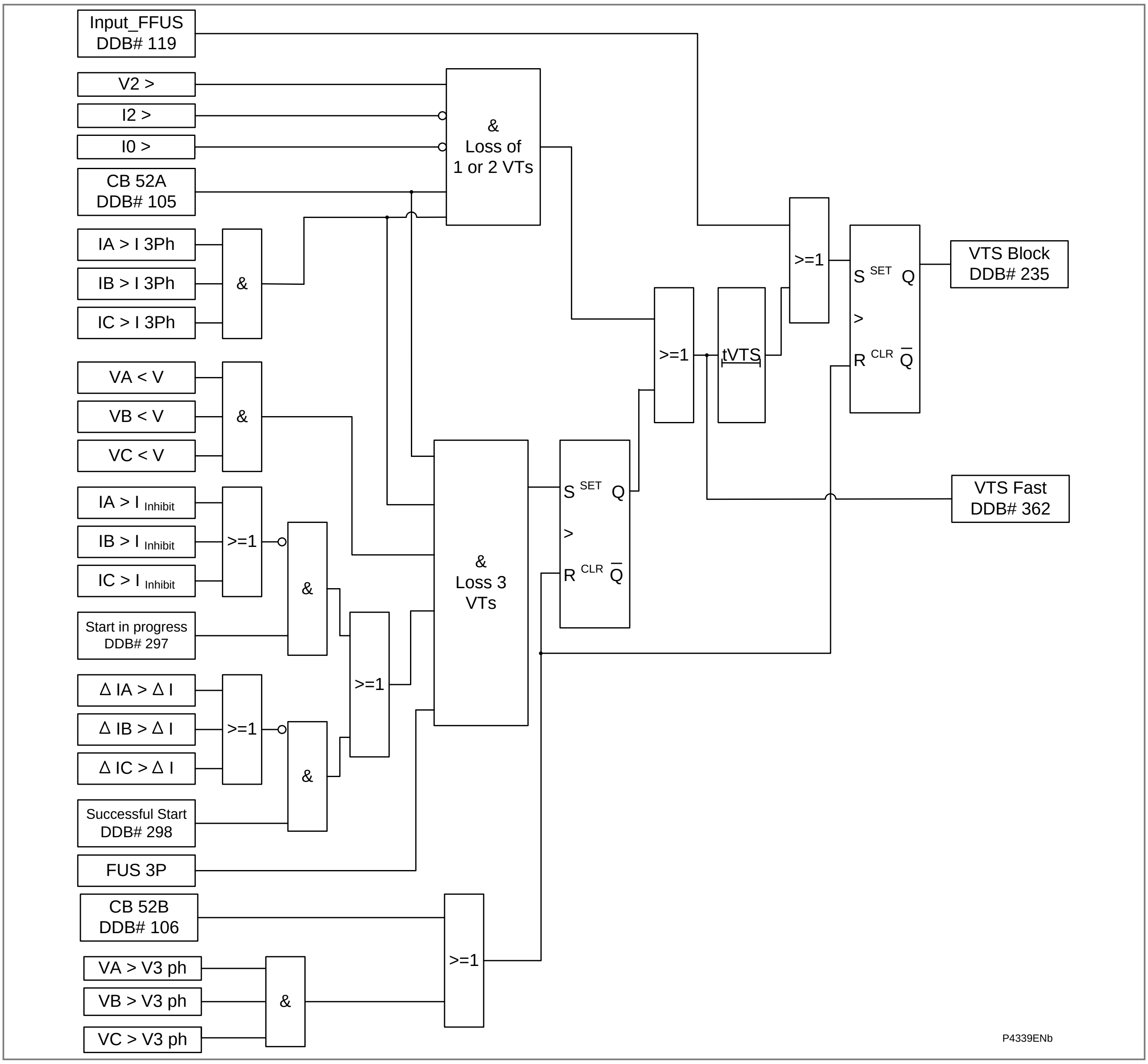


Figure 47 - VT supervision logic diagram

VTS Fast is given by the equation below:

(V2> And /I2> And /I0 And CB_Close And I3ph>) Or (FUS3P And V< And CB_Close And I3ph> And (/ΔI> Or /Iph>)

Required to drive the VTS logic are a number of dedicated level detectors as follows:

- I3Ph>, this level detector operates in less than 20 ms and this setting should be greater than load current. This setting is specified as the VTS current threshold. These level detectors pick-up at 100% of setting and drop-off at 95% of setting.
- I2>, this level detector operates on negative sequence current and has a user setting. This level detector picks-up at 100% of setting and drops-off at 95% of setting.
- Δ I>, this level detector operates on superimposed phase currents and has a settable setting.
- V3Ph>, this level detectors operates on phase voltages and has a settable setting.
- V2>, this level detector operates on negative sequence voltage, it has a fixed setting of 10 V with pick-up at 100% of setting and drop-off at 95% of setting.

2.1.2.1 Inputs

Signal name	Description
I3Ph>	Phase current levels (Fourier magnitudes)
I2>	I2 level (Fourier magnitude).
Δ I	Phase current samples (current and one cycle previous)
V3Ph>	Phase voltage signals (Fourier magnitudes)
V2>	Negative sequence voltage (Fourier magnitude)
Input FFUs	To remotely initiate the VTS blocking via an opto
FUS3P	Detect 3P setting which allows the fuse failure 3 poles detection

Table 6 - VTS inputs level detector settings outputs

Signal name	Description
VTS Fast	Internal fuse failure
VTS Block	Alarm indication, internal fuse failure confirmed at the end of VTS timer

Table 7 - VTS outputs

2.1.3 Operation

The relay may respond as follows to an operation of any VTS element:

- Forced blocking of voltage dependent protection elements (DDB 364 VT Supervision, Fast Block and DDB 363 VT, confirmed block)
- VTS provides alarm indication (DDB 363 VT, confirmed block)

The confirmed fuse failure VTS_Block blocks these protection functions:

- Undervoltage
- Positive sequence undervoltage
- Loss of load
- Reverse power
- Residual Overvoltage
- Wattmetric SEF
- Reacceleration (if enabled)
- Overcurrent DEF (if directional is used)
- Overcurrent SEF (if directional is used)

Functions which use the directional element will be blocked if set as directional:

- "IN> VTS Blocking" = xx for each stage. When the relevant bit is set to 1, operation of VTS will block the stage if directionnalized, when set to 0 the function will be set to Non-directional.
- "ISEF> VTS Blocking" = xx for each stage. Meaning and behavior is the same.

The internal fuse failure VTS_Fast blocks the same functions, but if a fault is detected before the confirmation timer is issued, the functions will be unblocked. The fault can be detected by the criteria Iph>, I2>, I0> and ΔI>.

The VTS I> Inhibit element is used to override a VTS block in event of a fault occurring on the system which could trigger the VTS logic. Once the VTS block has been established, however, then it would be undesirable for subsequent system faults to override the block. The VTS block will therefore be latched after a user settable time delay VTS Time Delay. Once the signal has latched then resetting method is automatic by CB Open or the restoration of the three-phase voltages above the phase level detector settings mentioned previously.

A VTS indication will be given after the VTS Time Delay has expired.

Where a Miniature Circuit Breaker (MCB) is used to protect the voltage transformer ac output circuits, it is common to use MCB auxiliary contacts to indicate a three-phase output disconnection. As previously described, it is possible for the VTS logic to operate correctly without this input. However, this facility has been provided for compatibility with various utilities current practices. Energizing an opto-isolated input assigned to DDB 362 "MCB/VTS on the relay will therefore provide the necessary block.

The blocking of the VTS logic for a number of different fault conditions is considered below.

Phase-phase fault

- The I2> element should detect phase-phase faults when the CB is closed and block the VTS logic.

Three phase faults

- The delta current level detectors should detect the change in current for a close up 3 phase fault when the CB is closed and block the VTS.

The IPh> level detector should detect a 3 phase fault when closing the CB onto a fault and block the VTS logic.

2.2 CT Supervision

The CT supervision feature operates on detection of derived residual current, in the absence of corresponding derived or measured residual voltage that would normally accompany it.

The CT supervision can be set to operate from the residual voltage measured at the $V_{NEUTRAL}$ input (VN1 input for P241/P242/P243) or the residual voltage derived from the three-phase-neutral voltage inputs as selected by the **CTS Vn Input** setting.

The voltage transformer connection used must be able to refer residual voltages from the primary to the secondary side. Therefore, this element should only be enabled where the three-phase VT is of five limb construction, or comprises three single-phase units, and has the primary star point earthed. A derived residual voltage or a measured residual voltage is available.

There are two stages of CT supervision CTS-1 and CTS-2. The derived neutral current is calculated vectorially from IA, IB, IC for CTS-1 and IA-2, IB-2, IC-2 for CTS-2. The neutral voltage is either measured or derived, settable by the user.

CTS-1 supervises the CT inputs to IA, IB, IC which are used by the biased differential protection and all the power, impedance and overcurrent based protection functions. CTS-2 supervises the CT inputs to IA-2, IB-2, IC-2 which are used by the biased differential protection in the P243. The CTS-2 independent enabled/disabled setting is to prevent CTS-2 from giving unnecessary alarms when the Motor Differential is disabled.

Operation of the element will produce a time-delayed alarm visible on the LCD and event record (plus DDB 229: CT-1 Fail Alarm, DDB 230: CT-2 Fail Alarm), with an instantaneous block (DDB 360: CTS-1 Block, DDB 361 CTS-2 Block) for inhibition of protection elements. Protection elements operating from derived quantities, (Negative Phase Sequence (NPS) Overcurrent, NPS Thermal, Thermal Overload protection) are always blocked on operation of the CTS-1 supervision element; other protections can be selectively blocked by customizing the PSL, integrating DDB 360: CTS-1 Block and DDB 361: CTS-2 Block with the protection function logic.

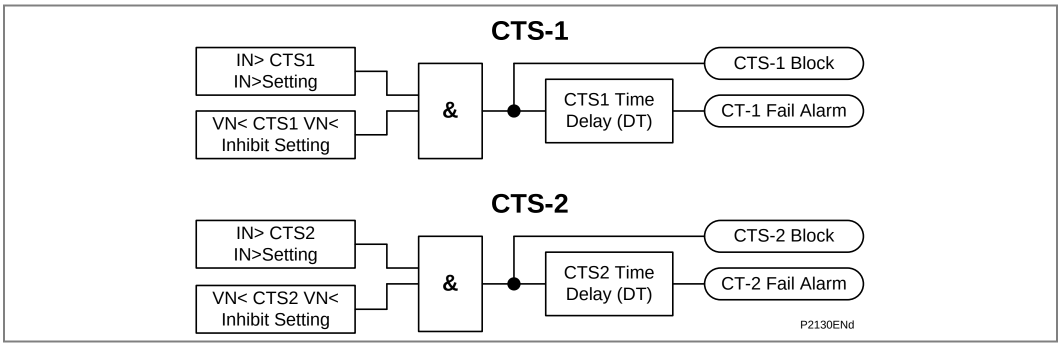


Figure 48 - CT supervision diagram

2.3 Circuit Breaker State Monitoring

MiCOM relays can be set to monitor Normally Open (52a) and Normally Closed (52b) auxiliary contacts of the circuit breaker. Under healthy conditions, these contacts will be in opposite states. Should both sets of contacts be open, this would indicate one of the following conditions:

- Auxiliary contacts / wiring defective
- Circuit Breaker (CB) is defective
- CB is in isolated position

Should both sets of contacts be closed, only one of these two conditions would apply:

- Auxiliary contacts / wiring defective
- Circuit Breaker (CB) is defective

If any of the above conditions exist, an alarm will be issued after a 5s time delay. A normally open / normally closed output contact can be assigned to this function via the Programmable Scheme Logic (PSL). The time delay is set to avoid unwanted operation during normal switching duties.

Where only 52A is used on its own then the relay will assume a 52B signal from the absence of the 52A signal. Circuit breaker status information will be available in this case but no discrepancy alarm will be available. The above is also true where only a 52B is used. If both 52A and 52B are used then status information will be available and in addition a discrepancy alarm will be possible (CB Status Alarm: DDB 185), according to the following table. 52A and 52B inputs are assigned to relay opto-isolated inputs via the PSL (CB Aux 3ph 52A: DDB 105, CB Aux 3ph 52A: DDB 106). The CB State Monitoring logic is shown in the *CB state monitoring* diagram.

Auxiliary Contact Position		CB State Detected	Action
52a	52b		
Open	Closed	Breaker Open	Circuit breaker healthy
Closed	Open	Breaker Closed	Circuit breaker healthy
Closed	Closed	CB Failure	Alarm raised if the condition persists for greater than 5s
Open	Open	State Unknown	Alarm raised if the condition persists for greater than 5s

Table 8 - CB auxiliary contacts and CTS element actions

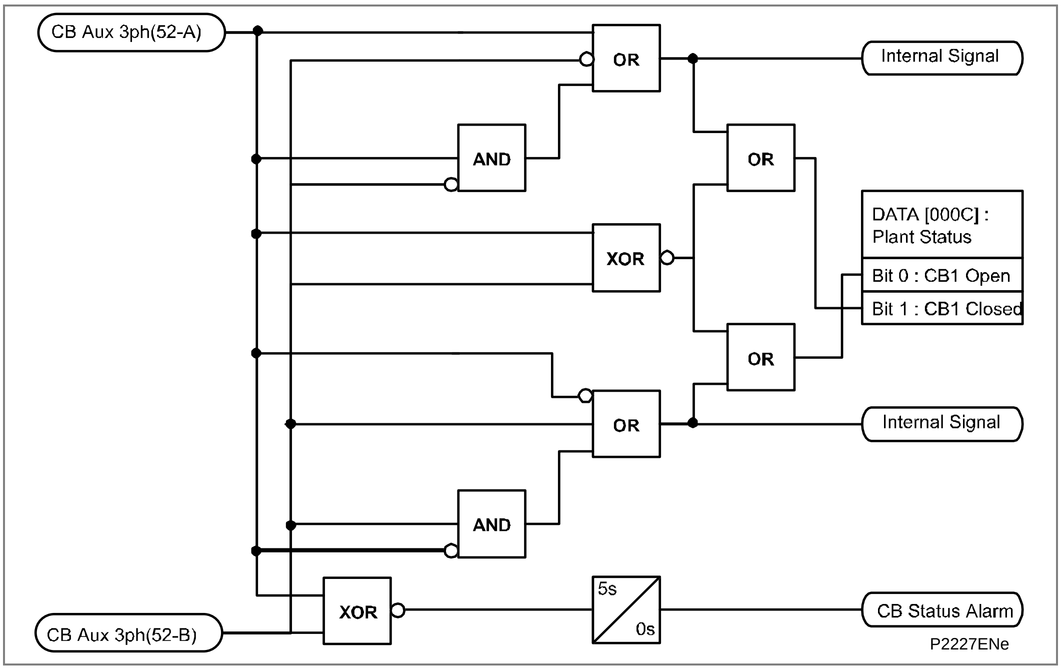


Figure 49 - CB state monitoring

2.4 Circuit Breaker Condition Monitoring

The relay records various statistics related to each circuit breaker trip operation, allowing a more accurate assessment of the circuit breaker condition to be determined. These monitoring features are discussed in the following section.

2.4.1 Circuit Breaker Condition Monitoring Features

For each circuit breaker trip operation the relay records statistics as shown in the following table taken from the relay menu. The menu cells shown are counter values only. The Min./Max. values in this case show the range of the counter values. These cells can not be set:

Menu text	Default setting	Setting range		Step size
		Min.	Max.	
CB Operations	0	0	10000	1
Displays the total number of trips issued by the relay.				
Total IA Broken	0	0	25000 In^	1
Displays the total accumulated fault current interrupted by the relay for the A phase.				
Total IB Broken	0	0	25000 In^	1
Displays the total accumulated fault current interrupted by the relay for the A phase.				
Total IC Broken	0	0	25000 In^	1 In^
Displays the total accumulated fault current interrupted by the relay for the A phase.				
CB Operate Time	0	0	0.5 s	0.001
Displays the calculated CB operating time. CB operating time = time from protection trip to undercurrent elements indicating the CB is open.				
Reset All Values	No		Yes, No	
Reset CB Data command. Resets CB Operations and Total IA/IB/IC broken current counters to 0.				

Table 9 - Circuit breaker condition monitoring features

The above counters may be reset to zero, for example, following a maintenance inspection and overhaul.

The circuit breaker condition monitoring counters will be updated every time the relay issues a trip command. In cases where the breaker is tripped by an external protection device it is also possible to update the CB condition monitoring. This is achieved by allocating one of the relays opto-isolated inputs (using the programmable scheme logic) to accept a trigger from an external device. The signal that is mapped to the opto is called **External Trip**, DDB 115.

Note	*When in **Commissioning Test Mode** the CB condition monitoring counters will not be updated.*

The motor accumulated run time displayed in the menu cell “Motor Run Time” of the “Measurement 3” menu is initiated each time the switching device is closed and remains closed.

2.5 Circuit Breaker Control

The relay includes the following options for control of a single circuit breaker:

- Local tripping and closing, via the relay menu
- Local tripping and closing, via relay opto-isolated inputs
- Remote tripping and closing, using the relay communications

It is recommended that separate relay output contacts are allocated for remote circuit breaker control and protection tripping. This enables the control outputs to be selected via a local/remote selector switch. Where this feature is not required the same output contact(s) can be used for both protection and remote tripping.

For the P24x, in the case of the local tripping and closing, via relay opto-isolated inputs, the relevant DDB Numbers are DDD111: Close and DDB112: Trip.

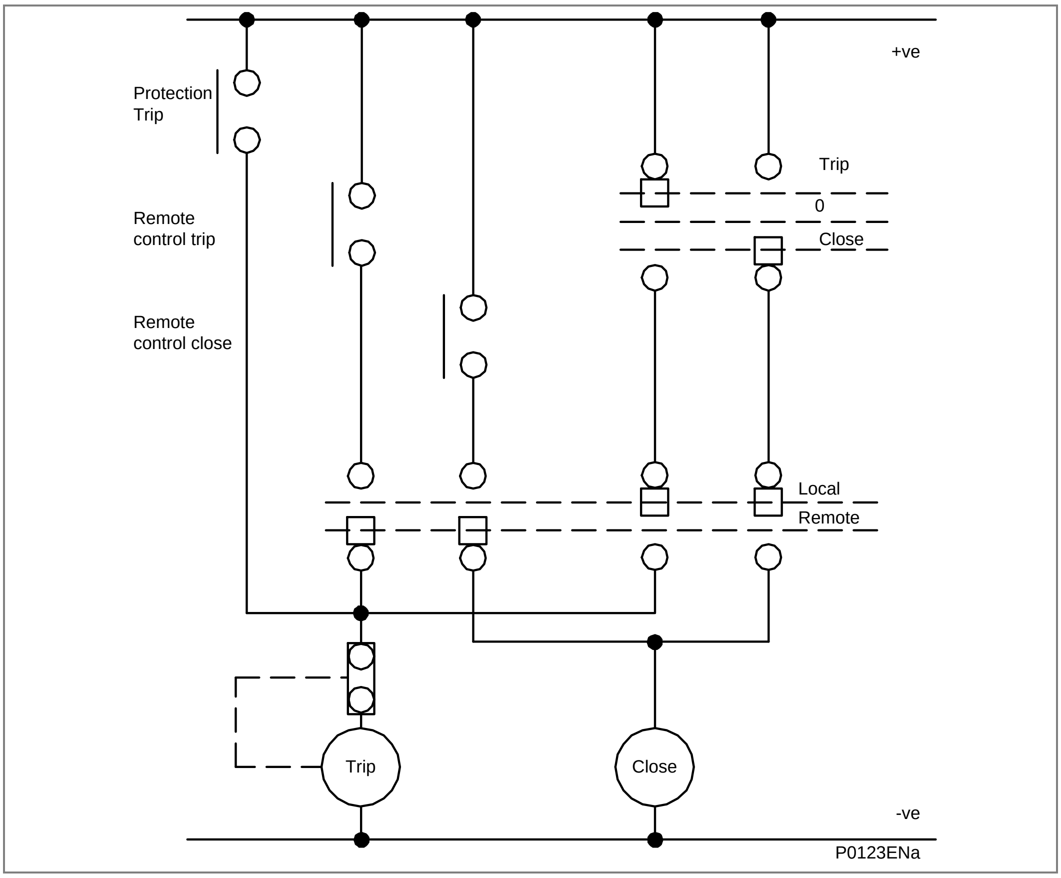


Figure 50 - Remote control of circuit breaker

A manual trip will be possible if the circuit breaker is closed. Likewise, a close command can only be issued if the CB is initially open.

Therefore, it will be necessary to use the breaker positions 52a and/or 52b contacts via PSL. If no CB auxiliary contacts are available, no CB control (manual or auto) will be possible (see the different solutions proposed in the *CBAux logic* section).

Once a CB Close command is initiated the output contact can be set to operate following a user defined time delay **(Man Close Delay**). This would give personnel time to move away from the circuit breaker following the close command. This time delay will apply to all manual CB Close commands.

The length of the trip or close control pulse can be set via the **Trip Pulse Time** and **Close Pulse Time** settings respectively. These should be set long enough to ensure the breaker has completed its open or close cycle before the pulse has elapsed.

Note	*CB close command is in the **System Data** column (**CB Trip/Close** cell).*

If an attempt to close the breaker is being made, and a protection trip signal is generated, the protection trip command overrides the close command.

If the CB fails to respond to the control command (indicated by no change in the state of CB Status inputs) a **CB Failed to Trip** or **CB Failed to Close** alarm will be generated after the relevant trip or close pulses have expired. These alarms can be viewed on the relay LCD display, remotely via the relay communications, or can be assigned to operate output contacts for annunciation using the relays Programmable Scheme Logic (PSL).

2.6 Changing Setting Groups

The setting groups can be changed either via a DDB signal or via a menu selection or via the hotkey menu. In the Configuration column if **Setting Group - select via optos** is selected then the Setting Group DDB (107) which is dedicated for setting group selection, can be used to select the setting group. This DDB signal can be connected to an opto input for local selection or a control input for remote selection of the setting groups. If an opto is used to change the setting group, Setting Group 1 is selected when the Setting Group DDB (107) is de-energized and Setting Group 2 is selected when the Setting Group DDB (107) is energized. If **Setting Group - select via menu** is selected then in the Configuration column the **Active Settings - Group1/2** can be used to select the setting group. The setting group can be changed via the hotkey menu providing **Setting Group select via menu** is chosen.

Note	*Setting groups comprise both Settings and Programmable Scheme Logic (PSL). Each is independent per group - not shared as common. The settings are generated in the Settings and Records application within S1 Studio, or can be applied directly from the relay front panel menu. The PSL can only be set using the PSL Editor application within S1 Studio, generating files with extension ".psl".*

It is essential that where the installation needs application-specific PSL that the appropriate .psl file is downloaded (sent) to the relay, for each and every setting group that will be used. If the user fails to download the required .psl file to any setting group that may be brought into service, then factory default PSL will still be resident. This may have severe operational and safety consequences.

2.7 Control Inputs

The control inputs function as software switches that can be set or reset either locally or remotely. These inputs can be used to trigger any function that they are connected to as part of the PSL. There are three setting columns associated with the control inputs that are: “CONTROL INPUTS”, “CTRL. I/P CONFIG.” and “CTRL. I/P LABELS”. The function of these columns is described below:

Menu Text	Default Setting	Setting Range	Step Size
CONTROL INPUTS			
Ctrl I/P Status	00000000000000000000000000000000		
Control Input 1	No Operation	No Operation, Set, Reset	
Control Input 2 to 32	No Operation	No Operation, Set, Reset	

Table 10 - Control inputs setting columns and their descriptions

The Control Input commands can be found in the **Control Input** menu. In the **Ctrl I/P status** menu cell there is a 32 bit word which represent the 32 control input commands. The status of the 32 control inputs can be read from this 32 bit word. The 32 control inputs can also be set and reset from this cell by setting a 1 to set or 0 to reset a particular control input. Alternatively, each of the 32 Control Inputs can be set and reset using the individual menu setting cells **Control Input 1, 2, 3** etc. The Control Inputs are available through the relay menu as described above and also via the rear communications.

In the Programmable Scheme Logic (PSL) editor 32 Control Input signals, DDB 608-639, which can be set to a logic 1 or On state, as described above, are available to perform control functions defined by the user.

The status of the Control Inputs are held in non-volatile memory (battery backed RAM) such that when the relay is power-cycled, the states are restored upon power-up.

Menu Text	Default Setting	Setting Range	Step Size
CTRL. I/P CONFIG.			
Hotkey Enabled	11111111111111111111111111111111		
Control Input 1	Latched	Latched, Pulsed	
Ctrl Command 1	SET/RESET	SET/RESET, IN/OUT, ENABLED/DISABLED, ON/OFF	
Control Input 2 to 32	Latched	Latched, Pulsed	
Ctrl Command 2 to 32	SET/RESET	SET/RESET, IN/OUT, ENABLED/DISABLED, ON/OFF	
Menu Text	Default Setting	Setting Range	Step Size
CTRL. I/P LABELS			
Control Input 1	Control Input 1	16 character text	
Control Input 2 to 32	Control Input 2 to 32	16 character text	

Table 11 - Control inputs commands and labels

The **CTRL. I/P CONFIG.** column has several functions one of which allows the user to configure the control inputs as either **latched** or **pulsed**. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10ms after the set command is given and will then reset automatically (i.e. no reset command required).

In addition to the latched/pulsed option this column also allows the control inputs to be individually assigned to the **Hotkey** menu by setting **1** in the appropriate bit in the **Hotkey Enabled** cell. The hotkey menu allows the control inputs to be set, reset or pulsed without the need to enter the **CONTROL INPUTS** column. The **Ctrl. Command** cell also allows the SET/RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as **ON/OFF**, **IN/OUT** etc.

The **CTRL. I/P LABELS** column makes it possible to change the text associated with each individual control input. This text will be displayed when a control input is accessed by the hotkey menu, or it can be displayed in the PSL.

Note	*With the exception of pulsed operation, the status of the control inputs is stored in battery backed memory. In the event that the auxiliary supply is interrupted the status of all the inputs will be recorded. Following the restoration of the auxiliary supply the status of the control inputs, prior to supply failure, will be reinstated. If the battery is missing or flat the control inputs will set to logic 0 once the auxiliary supply is restored.*

2.8 Enhanced Opto-Input Time Stamping

Each opto-input sample is time stamped within a tolerance of ±1 ms with respect to the relay's Real Time Clock. These time stamps are used for the opto event logs and for the disturbance recording. The relay needs to be synchronized accurately to an external clock source such as the GPS clock and the synchronization consists of IRIG-B and SNTP through Ethernet communication. The P24x time synchronization accuracy is 1 ms through IRIG-B (both modulated and un-modulated) and SNTP. The total time stamping accuracy, with reference to an external clock source, also takes the time synchronization accuracy into consideration.

For both the filtered and unfiltered opto inputs, the time stamp of an opto change event is the sampling time at which the opto change of state has occurred. If a mixture of filtered and unfiltered opto inputs change state at the same sampling interval, then two events are logged in the event file, the first event corresponds to the unfiltered opto input and the second event corresponds to the filtered opto input. The enhanced opto event time stamping is consistent across all the implemented protocols. The GOOSE messages are published in a timely manner and are not delayed by any event filtering mechanism that is used to align the event time stamps.

2.9 PSL Data Column

The relay contains a PSL DATA column that can be used to track PSL modifications. A total of 12 cells are contained in the PSL DATA column, 3 for each setting group. The function for each cell is shown below:

Grp PSL Ref	When downloading a PSL to the relay, the user will be prompted to enter which groups the PSL is for and a reference ID. The first 32 characters of the reference ID will be displayed in this cell. The ⇦ and ⇨ keys can be used to scroll through 32 characters as only 16 can be displayed at any one time.
18 Nov 2002 08:59:32.047	This cell displays the date and time when the PSL was down loaded to the relay.
Grp 1 PSL ID - 2062813232	This is a unique number for the PSL that has been entered. Any change in the PSL will result in a different number being displayed.

Note The above cells are repeated for each setting group.

2.10 Reset of Programmable LEDs and Output Contacts

The programmable LEDs and output contacts can be set to be latched in the Programmable Scheme Logic. If there is a fault record then clearing the fault record by pressing the Ⓒ key once the fault record has been read will clear any latched LEDs and output contacts. If there is no fault record, then as long as the initiating signal to the LED or output contact is reset the LEDs and contacts can be reset by one of these methods.

- Via the **View Records - Reset Indications** menu command cell
- Via DDB 113 **Reset Latches** which can be mapped to an Opto Input or a Control Input for example

2.11 Real Time Clock Synchronization via Opto-Inputs

In modern protective schemes it is often desirable to synchronize the relays real time clock so that events from different relays can be placed in chronological order. This can be done using the IRIG-B input, if fitted, or via the communication interface connected to the substation control system. In addition to these methods, the relay offers the facility to synchronize via an opto-input by routing it in PSL to DDB xxx (Time Sync.) (xxx=116 for P24x or xxx=400 for P445/P44y/P54x/P841). Pulsing this input will result in the real time clock snapping to the nearest minute if the pulse input is ± 3 s of the relay clock time. If the real time clock is within 3 s of the pulse the relay clock will crawl (the clock will slow down or get faster over a short period) to the correct time. The recommended pulse duration is 20 ms to be repeated no more than once per minute. An example of the time sync function is shown below:

Time of "Sync. Pulse"	Corrected time	
19:47:00 to 19:47:29	19:47:00	This assumes a time format of hh:mm:ss
19:47:30 to 19:47:59	19:48:00	

Table 12 - Example of time sync by using opto-inputs

Note The above assumes a time format of hh:mm:ss

To avoid the event buffer from being filled with unnecessary time sync. events, it is possible to ignore any event that generated by the time sync. opto input. This can be done by applying the following settings:

Menu text	Value
RECORD CONTROL	
Opto Input Event	Enabled
Protection Event	Enabled
DDB 064 - 079 (Opto Inputs)	Set "Time Sync." associated opto to 0

Table 13 - Setting example to avoid event buffer overflow

To improve the recognition time of the time sync. opto input by approximately 10 ms, the opto input filtering could be disabled. This is achieved by setting the appropriate bit to 0 in the **Opto Filter Cntl** cell in the **OPTO CONFIG** column.

Disabling the filtering may make the opto input more susceptible to induced noise. Fortunately the effects of induced noise can be minimized by using the methods described in the *Product Design* chapter.

2.12 Read Only Mode

With IEC 61850 and Ethernet / Internet communication capabilities, security has become a pressing issue. The Px40 relay provides a facility to allow the user to enable or disable the change in configuration remotely. This feature is available only in relays with Courier, Courier with IEC 60870-5-103, Courier with IEC 61850 and Courier with IEC 60870-5-103 and IEC 61850 protocol options. It has to be noted that in IEC 60870-5-103 protocol, Read Only Mode function is different from the existing Command block feature.

2.12.1 Protocol / Port Implementation:

2.12.1.1 IEC 60870-5-103 Protocol on Rear Port 1:

The protocol does not support settings but the indications, measurands and disturbance records commands are available at the interface.

Blocked:

Write parameter (=change setting) (private ASDUs)
General Commands (ASDU20), namely:

- INF16 auto-recloser on/off
- INF19 LED reset
- Private INFs (e.g CB open/close, Control Inputs)

Allowed:

Poll Class 1 (read spontaneous events)
Poll Class 2 (read measurands)
GI sequence (ASDU7 'Start GI', Poll Class 1)
Transmission of Disturbance Records sequence (ASDU24, ASDU25, Poll Class 1)
Time Synchronization (ASDU6)
General Commands (ASDU20), namely:

- INF23 activate characteristic 1
- INF24 activate characteristic 2
- INF25 activate characteristic 3
- INF26 activate characteristic 4

2.12.1.2 Courier Protocol on Rear Port 1/2 and Ethernet

Blocked:

Write settings
All controls, including:

- Reset Indication (Trip LED)
- Operate Control Inputs
- CB operations
- Auto-reclose operations
- Reset demands
- Clear event / fault / maintenance / disturbance records
- Test LEDs & contacts

Allowed:

- Read settings, statuses, measurands
- Read records (event, fault, disturbance)
- Time Synchronization command
- Change active setting group command

2.12.1.3 **IEC 61850**

Blocked:

All controls, including:

Enable / Disable protection
Operate Control Inputs
CB operations (Close / Trip, Lock)
Reset LEDs

Allowed:

Read statuses, measurands
Generate Reports
Extract Disturbance Records
Time Synchronization
Change active setting group

2.12.1.4 **Courier Database Support**

Three new settings, one for each remote communications port at the back of the relay are created to support the enabling and disabling of the read only mode at each port.

The **NIC Read Only** setting will apply to all the communications protocols (including the Tunnelled Courier) that are transmitted via the Ethernet Port. Their default values are 'Disabled'.

Depending on the product options, the Modbus and DNP3 communications interfaces that do not support the feature will ignore these settings.

2.12.2 New DDB Signals

The remote read only mode is also available in the PSL via three dedicated DDB signals:

- RP1 Read Only
- RP2 Read Only
- NIC Read Only

Through careful scheme logic design, the activations of these read only signals can be facilitated via Opto Inputs, Control Inputs and Function Keys.

These DDBs are available in every build, however they are effective only in Courier, IEC 60870-5-103 build and in latest IEC 61850 (firmware version 42/57 onwards). Depending on the product options, the setting cells may not be available in Modbus and DNP3.0.

2.13 Any Trip

The **Any Trip** DDB (DDB 371) is a combination of all the individual trip signals. This DDB has been made independent from relay 3 in the version C2.0 software and later. In the previous versions of software the **Any Trip** signal was the operation of Relay 3. In the version C2.0 software and later DDB371 is the **Any Trip** signal and any output contact used for tripping can be connected to the **Any Trip** DDB leaving Relay 3 to be freely assigned for any function. The **Any Trip** signal affects the following functions:

- Operates the Trip LED
- Triggers CB condition maintenance counters
- Used to measure the CB operating time
- Triggers the circuit breaker failure logic
- Used in the Fault recorder logic

In the default PSL, Relay 3 is still mapped to the **Any Trip** DDB and **Trip LED** DDB as well as the **Fault REC TRIG** DDB signals as shown in the PSL diagram below.

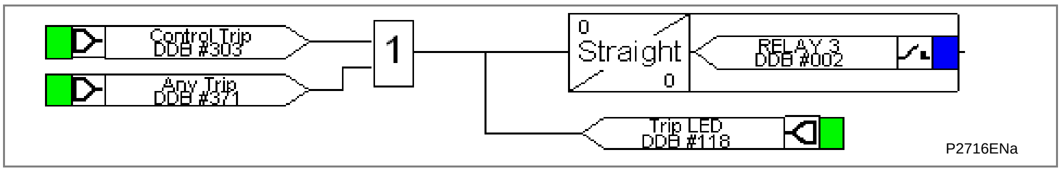


Figure 51 - Default PSL showing Any Trip mapping

The new **Trip LED** DDB (DDB118) allows (in PSL) switching on Trip LED for a particular trip signal concerned. An example is shown below.

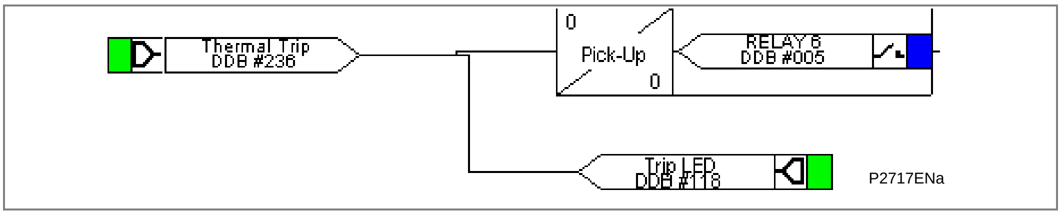


Figure 52 - Example of using Trip LED

In the scheme shown above the trip relay is relay 6 and only the thermal trip will provoke a Trip, and the Trip LED will be switched on only with the thermal Trip.

2.14 Function Keys (P242/P243)

Important	**Only the P242/P243 relay offers users 10 function keys.**

The relay offers users 10 function keys for programming any operator control functionality via PSL. Each function key has an associated programmable tri-colour LED that can be programmed to give the desired indication on function key activation.

These function keys can be used to trigger any function that they are connected to as part of the PSL. The function key commands can be found in the ‘Function Keys’ menu (see the Settings chapter). In the ‘Fn. Key Status’ menu cell there is a 10-bit word which represent the 10 function key commands and their status can be read from this 10-bit word.

In the programmable scheme logic editor 10 function key signals, which can be set to a logic 1 or On state, as described above, are available to perform control functions defined by the user.

Note	*The 10 function key signals use DDB 676-685.*

The “Function Keys” column has ‘Fn. Key n Mode’ cell which allows the user to configure the function key as either ‘Toggled’ or ‘Normal’. In the ‘Toggle’ mode the function key DDB signal output will remain in the set state until a reset command is given, by activating the function key on the next key press. In the ‘Normal’ mode, the function key DDB signal will remain energized for as long as the function key is pressed and will then reset automatically.

A minimum pulse duration can be programmed for a function key by adding a minimum pulse timer to the function key DDB output signal.

The “Fn. Key n Status” cell is used to enable/unlock or disable the function key signals in PSL. The ‘Lock’ setting has been specifically provided to allow the locking of a function key thus preventing further activation of the key on consequent key presses. This allows function keys that are set to ‘Toggled’ mode and their DDB signal active ‘high’, to be locked in their active state thus preventing any further key presses from deactivating the associated function. Locking a function key that is set to the “Normal” mode causes the associated DDB signals to be permanently off. This safety feature prevents any inadvertent function key presses from activating or deactivating critical relay functions.

The “Fn. Key Labels” cell makes it possible to change the text associated with each individual function key. This text will be displayed when a function key is accessed in the function key menu, or it can be displayed in the PSL.

The status of the function keys is stored in battery backed memory. In the event that the auxiliary supply is interrupted the status of all the function keys will be recorded. Following the restoration of the auxiliary supply the status of the function keys, prior to supply failure, will be reinstated. If the battery is missing or flat the function key DDB signals will set to logic 0 once the auxiliary supply is restored.

Note	*The relay will only recognize a single function key press at a time and that a minimum key press duration of approximately 200msec. is required before the key press is recognized in PSL. This deglitching feature avoids accidental double presses.*

2.15 Phase Rotation

2.15.1 Description

A facility is provided in the P241/P242/P243 to maintain correct operation of all the protection functions even when the motor is running in a reverse phase sequence. This is achieved through user configurable settings available for the two setting groups.

The default phase sequence for P24x is the clockwise rotation ABC. However, some applications may require an intermediate anti-clockwise phase rotation of ACB.

In process industry there is often a common practice to reverse two phases to facilitate the process, using phase reversal switches. The following sections describe some common scenarios and their effects.

2.15.2 Phase Reversal Switches affecting all CTs and VTs

The phase reversal affects all the voltage and current measurements in the same way, irrespective of which two phases are being swapped. This is also equivalent to a power system that is permanently reverse phase reversed.

All the protection functions that use the positive and negative sequence component of voltage and current will be affected (Thermal Overload, 3 Ph Volt Check, Negative Sequence O/C, VT Supervision). The motor differential protection is not affected, since the phase reversal applies to CT1 and CT2 in the same way.

The relationship between voltages and currents from CT for the standard phase rotation and reverse phase rotation are shown in the *Standard and reverse phase rotation* diagram.

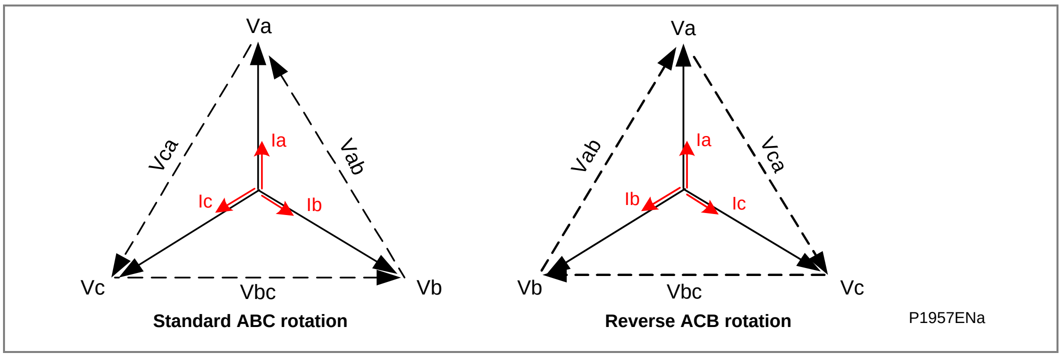


Figure 53 - Standard and reverse phase rotation

2.15.2.1 System Config Settings

The following settings are available in the **SYSTEM CONFIG** menu as follows. These new settings are available for each of the two protection setting groups.

Menu text	Default setting	Setting range		Step size
		Min.	Max.	
System Config				
Phase Sequence	Standard ABC	Standard ABC, Reverse ACB		N/A

Table 14 - Phase rotation setting in SYSTEM CONFIG

The Phase Sequence setting applies to a power system that has a permanent phase sequence of either ABC or ACB. It is also applicable for temporary phase reversal which affects all the VTs and CTs. As distinct from the other phase reversal settings, this setting does not perform any internal phase swapping of the analogue channels.

The Phase Sequence setting affects the sequence component calculations as follows:

Standard ABC

The calculations of positive (I1, V1) and negative (I2, V2) phase sequence voltage and current remain unchanged as follows:

$$\overline{X_1} = \frac{1}{3}\left(\overline{X_a} + \alpha\overline{X_b} + \alpha^2\overline{X_c}\right)$$

$$\overline{X_2} = \frac{1}{3}\left(\overline{X_a} + \alpha^2\overline{X_b} + \alpha\overline{X_c}\right)$$

Reverse ACB

The calculations of positive (I1, V1) and negative (I2, V2) phase sequence voltage and current are given by the equations:

$$\overline{X_1} = \frac{1}{3}\left(\overline{X_a} + \alpha^2\overline{X_b} + \alpha\overline{X_c}\right)$$

$$\overline{X_2} = \frac{1}{3}\left(\overline{X_a} + \alpha\overline{X_b} + \alpha^2\overline{X_c}\right)$$

Where $\alpha = 1\angle 120°$

APPLICATION NOTES

CHAPTER 6

Date:	05/2017
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.
Hardware suffix:	L (P241) & M (P242 & P243)
Software version:	D1
Connection diagrams:	10P241xx (xx = 01 to 02) 10P242xx (xx = 01) 10P243xx (xx = 01)

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FIGURES

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1 INTRODUCTION

1.1 Protection of Asynchronous and Synchronous Motors

Both asynchronous (induction) and synchronous motors perform a vital role in many industrial processes throughout the world, a vast majority of which would be unable to function without such a device. Clearly, loss of a motor through damage incurs much more than a possible electrical rewind but also a stop in an electrical process, resulting in expensive plant down time. This problem may be exacerbated by the damaged machine being positioned in an inaccessible position, such as an awkward corner of a factory or by a spare not being readily available. Therefore prior warning of a problem is vitally important to reduce the impact on a process resulting from a faulted motor.

Comprehensive protection relays, such as the P24x, can be used to protect a motor from catastrophic failure, or possibly give the operator prior warning of a problem, which may in turn reduce plant down time. Any protective device, though reliable in operation under abnormal conditions, must not affect the continuous operation of the motor under normal operating conditions.

Unfortunately, motor characteristics vary greatly depending upon their precise application. Each application therefore requires careful consideration regarding the specification and setting of the motor protection. For example, starting and stalling currents and times must be known when applying overload protection, and furthermore the thermal withstand of the machine under balanced and unbalanced loading must be defined.

The conditions which motor protection may be required to detect can be divided into two broad categories; imposed external conditions and internal faults. The former category includes unbalanced supply voltages, undervoltages, single phasing and reverse phase sequence starting, and in the case of synchronous machines only, loss of synchronism. The latter category includes bearing failures, internal shunt faults (which are commonly earth faults), and overloads.

1.2 Introduction to the P24x Relay

The MiCOM Px40 relay range uses the latest numerical technology and includes devices designed for the protection of a wide range of power system plant such as motors, generators, feeders, overhead lines and cables.

These relays are designed around a common hardware and software platform in order to achieve a high degree of commonality between products. One such product in the range is the Motor Protection Relay. This relay has been designed to cater for the protection of both asynchronous and synchronous motors, which may require extensive protection.

The relay also includes a comprehensive range of non-protection features to aid with power system diagnosis and fault analysis. All these features can be accessed remotely from one of the relays remote, serial communications options.

2 APPLICATION OF INDIVIDUAL PROTECTION FUNCTIONS

The following sections detail the individual protection functions in addition to where and how they may be applied. Worked examples are provided, to show how the settings are applied to the IED.

2.1 Motor Differential Protection (P243 only) (87)

Failure of stator windings, or connection insulation, can result in severe damage to the windings and the stator core. The extent of the damage will depend upon the fault current level and the duration of the fault. Protection should be applied to limit the degree of damage in order to limit repair costs.

The P243 relay provides motor differential protection. This form of unit protection allows discriminative detection of winding faults, with no intentional time delay, where a significant fault current arises. The zone of protection, defined by the location of the CTs, should be arranged to overlap protection for other items of plant, such as a busbar or transformer.

Heavy through current, arising from an external fault condition, can cause one CT to saturate more than the other, resulting in a difference between the secondary current produced by each CT. It is essential to stabilize the protection for these conditions. Three methods are commonly used:

- A biasing technique, where the relay setting is raised as through-current increases.
- A high impedance technique, where the relay impedance is such that under maximum through-fault conditions, the current in the differential element is insufficient for the relay to operate.
- A self balance type differential protection arrangement.

Note	*If the conductors are placed reasonably concentric within the window of the core balance current transformers, spill current can be kept to a minimum. With this low spill current and a reasonably independence of CT ratio to full load a lower fault setting could be achieved than conventional high impedance circulating current differential schemes.*

The motor differential protection function available in the P24x relay can be used in either biased differential or high impedance differential mode.

Note	*The high impedance mode can be used to achieve a self balance scheme. Both modes of operation are equally valid; users may have a preference for one over the other. The operating principle of each is described in the Operation chapter, P24x/EN OP.*

2.1.1 Setting Guidelines for Biased Differential Protection

To select biased differential protection the **Diff Function** cell should be set to **Percentage Bias**.

The differential current setting, **Diff Is1**, should be set to a low setting to protect as much of the machine winding as possible. A setting of 5% of rated current of the machine is generally considered to be adequate. **Diff Is2**, the threshold above which the second bias setting is applied, should be set to 120% of the machine rated current.

The initial bias slope setting, **Diff k1**, should be set to 0% to provide optimum sensitivity for internal faults. The second bias slope, **Diff k2** may typically be set to 150% to provide adequate stability for external faults.

These settings may be increased where low accuracy class CTs are used to supply the protection.

2.1.2 Setting Guidelines for High Impedance Differential Protection

To select high impedance differential protection the **Diff Function** cell should be set to **High Impedance**.

The differential current setting, **Diff Is1**, should be set to a low setting to protect as much of the machine winding as possible. A setting of 5% of rated current of the machine is generally considered to be adequate. This setting may need to be increased where low accuracy class CTs are used to supply the protection. A check should be made to ensure that the primary operating current of the element is less than the minimum fault current for which the protection should operate.

The primary operating current (Iop) will be a function of the current transformer ratio, the relay operating current (**Diff Is1**), the number of current transformers in parallel with a relay element (n) and the magnetizing current of each current transformer (Ie) at the stability voltage (Vs). This relationship can be expressed in three ways:

To determine the maximum current transformer magnetizing current to achieve a specific primary operating current with a particular relay operating current.

$$I_e < \frac{1}{n} \text{ x} \left(\frac{I_{op}}{\text{CT ratio}} \text{ - Mot.Diff.REF > } I_s1 \right)$$

To determine the maximum relay current setting to achieve a specific primary operating current with a given current transformer magnetizing current.

$$\text{Mot.Diff.}I_s1 < \left(\frac{I_{op}}{\text{CT.Ratio}} - nI_e \right)$$

To express the protection primary operating current for a particular relay operating current and with a particular level of magnetizing current.

$$I_{OP} = (\text{CT.Ratio}) \text{ x } (\text{Mot.Diff.Is1} + nI_e)$$

To achieve the required primary operating current with the current transformers that are used, a current setting (Diff Is1) must be selected for the high impedance element, as detailed in expression (ii) above. The setting of the stabilizing resistor (RST) must be calculated in the following manner, where the setting is a function of the required stability voltage setting (Vs) and the relay current setting (Diff Is1).

$$R_{st} = \frac{V_s}{\text{Mot.Diff.}I_s1} = \frac{1.5 \text{ x } I_F \text{ x } (R_{CT} + 2RL)}{\text{Mot.Diff.}I_s1}$$

Note	*The above formula assumes negligible relay burden.*

USE OF “METROSIL” NON-LINEAR RESISTORS

Metrosils are used to limit the peak voltage developed by the current transformers under internal fault conditions, to a value below the insulation level of the current transformers, relay and interconnecting leads, which are normally able to withstand 3000 V peak.

The following formulae should be used to estimate the peak transient voltage that can be produced for an internal fault. The peak voltage produced during an internal fault will be a function of the current transformer kneepoint voltage and the prospective voltage that would be produced for an internal fault if current transformer saturation did not occur.

This prospective voltage will be a function of maximum internal fault secondary current, the current transformer ratio, the current transformer secondary winding resistance, the current transformer lead resistance to the common point, the relay lead resistance and the stabilizing resistor value.

$$Vp = 2\sqrt{2V_k (V_f - V_k)}$$

V_f = $I'f (R_{ct} + 2R_L + R_{ST})$

Where:

V_p = Peak voltage developed by the CT under internal fault conditions
V_k = Current transformer kneepoint voltage
V_f = Maximum voltage that would be produced if CT saturation did not occur
I'_f = Maximum internal secondary fault current
R_{ct} = Current transformer secondary winding resistance
R_L = Maximum lead burden from current transformer to relay
R_{ST} = Relay stabilizing resistor

When the value given by the formulae is greater than 3000 V peak, metrosils should be applied. They are connected across the relay circuit and serve the purpose of shunting the secondary current output of the current transformer from the relay in order to prevent very high secondary voltages.

Metrosils are externally mounted and take the form of annular discs. Their operating characteristics follow the expression:

V = $CI^{0.25}$

Where:

V = Instantaneous voltage applied to the non-linear resistor (metrosil)
C = Constant of the non-linear resistor (metrosil)
I = Instantaneous current through the non-linear resistor (metrosil)

With a sinusoidal voltage applied across the metrosil, the RMS current would be approximately 0.52 x the peak current. This current value can be calculated as follows:

$$I(rms) = 0.52\left(\frac{Vs\ (rms) \times \sqrt{2}}{C}\right)^4$$

Where:

Vs(rms) = rms value of the sinusoidal voltage applied across the metrosil.

This is due to the fact that the current waveform through the metrosil is not sinusoidal but appreciably distorted.

For satisfactory application of a non-linear resistor (metrosil), it's characteristic should be such that it complies with these requirements:

- At the relay voltage setting, the non-linear resistor (metrosil) current should be as low as possible, but no greater than approximately 30 mA rms for 1 A current transformers and approximately 100 mA rms for 5 A current transformers.
- At the maximum secondary current, the non-linear resistor (metrosil) should limit the voltage to 1500 V rms or 2120 V peak for 0.25 second. At higher relay voltage settings, it is not always possible to limit the fault voltage to 1500V rms, so higher fault voltages may have to be tolerated.

The following tables show the typical Metrosil types that will be required, depending on relay current rating, REF voltage setting etc.

Metrosil Units for Relays with a 1 Amp CT

The Metrosil units with 1 Amp CTs have been designed to comply with the following restrictions:

1. At the relay voltage setting, the Metrosil current should be less than 30 mA rms.
2. At the maximum secondary internal fault current the Metrosil unit should limit the voltage to 1500 V rms if possible.

The Metrosil units normally recommended for use with 1Amp CT's are as shown below:

Relay voltage setting	Nominal characteristic		Recommended Metrosil type	
	C	β	Single pole relay	Triple pole relay
Up to 125 V rms 125 to 300 V rms	450 900	0.25 0.25	600 A/S1/S256 600 A/S1/S1088	600 A/S3/1/S802 600 A/S3/1/S1195

Note *Single pole Metrosil units are normally supplied without mounting brackets unless otherwise specified by the customer.*

Table 1 - Metrosil characteristics and types for 1 Amp CTs

Metrosil units for relays with a 5 amp CT

These Metrosil units have been designed to comply with these requirements:

- At the relay voltage setting, the Metrosil current should be less than 100 mA rms (the actual maximum currents passed by the units shown below their type description.
- At the maximum secondary internal fault current the Metrosil unit should limit the voltage to 1500 V rms for 0.25 secs. At the higher relay settings, it is not possible to limit the fault voltage to 1500 V rms hence higher fault voltages have to be tolerated (indicated by *, **, ***).

The Metrosil units normally recommended for use with 5 Amp CTs and single pole relays are as shown in the following table:

Secondary internal fault current	Recommended Metrosil type			
	Relay voltage setting			
Amps rms	Up to 200 V rms	250 V rms	275 V rms	300 V rms
50 A	600 A/S1/S1213 C = 540/640 35 mA rms	600 A/S1/S1214 C = 670/800 40 mA rms	600 A/S1/S1214 C =670/800 50 mA rms	600 A/S1/S1223 C = 740/870* 50 mA rms
100 A	600 A/S2/P/S1217 C = 470/540 70 mA rms	600 A/S2/P/S1215 C = 570/670 75 mA rms	600 A/S2/P/S1215 C =570/670 100 mA rms	600 A/S2/P/S1196 C =620/740* 100 mA rms
150 A	600 A/S3/P/S1219 C = 430/500 100 mA rms	600 A/S3/P/S1220 C = 520/620 100 mA rms	600 A/S3/P/S1221 C = 570/670** 100 mA rms	600 A/S3/P/S1222 C =620/740*** 100 mA rms
Note:			**2200 V peak	*2400 V peak ***2600 V peak

Table 2 - Metrosil characteristics and types for 5 Amp CTs

In some situations single disc assemblies may be acceptable, contact Schneider Electric for detailed applications.

1. The Metrosil units recommended for use with 5 Amp CTs can also be applied for usewith triple pole relays and consist of three single pole units mounted on the same central stud but electrically insulated from each other. To order these units please specify **Triple pole Metrosil type**, followed by the single pole type reference.
2. Metrosil units for higher relay voltage settings and fault currents can be supplied if required.
3. To express the protection primary operating current for a particular relay operating current and with a particular level of magnetizing current.

For further advice and guidance on selecting Metrosils please contact the Applications department at Schneider Electric.

2.1.3 Setting Guidelines for the Self Balance Winding Differential

For this configuration, the relay must be set to **High Impedance** via the cell **Diff Function** in the **Differential** protection menu.

The differential current setting, **Diff Is1**, should be set to a low setting to protect as much of the machine winding as possible. A setting of 5% of rated current of the machine is generally considered to be adequate.

If the conductors are placed reasonably concentric within the window of the core balance current transformers, spill current can be kept to a minimum. With this low spill current and a reasonably independence of CT ratio to full load a lower fault setting could be achieved than conventional high impedance circulating current differential schemes.

Disadvantages:

1. The necessity of passing both ends of each phase winding through the CT and hence the need for extra cabling on the neutral end.
2. To avoid long cabling, position of CTs are restricted to the proximity of the machine output terminals in which case the cable between the machine output terminals and controlling switchgear might not be included within the differential zone.

2.2 Thermal Overload Protection (49)

Thermal overload protection can be used to prevent electrical plant from operating at temperatures in excess of the designed maximum withstand. Prolonged overloading causes excessive heating, which may result in premature ageing of the insulation, or in extreme cases, insulation failure.

In order for the Thermal overload protection function to operate correctly, it is essential that the circuit breaker to be closed and its associated closing signal, 52a, to be recognized by the relay.

2.2.1 Introduction

Overloads can result in stator temperature rises which exceed the thermal limit of the winding insulation. Empirical results suggest that the life of insulation is approximately halved for each 10°C rise in temperature above the rated value. The life of insulation is not wholly dependent upon the rise in temperature but on the time the insulation is maintained at this elevated temperature. Due to the relatively large heat storage capacity of an induction motor, infrequent overloads of short duration may not damage the machine. However, sustained overloads of a few per cent may result in premature ageing and failure of insulation.

The physical and electrical complexity of motor construction, their diverse applications, variety of possible abnormal operating conditions and the different modes of failure that may occur, result in a complex thermal relationship. It is not therefore possible to create an accurate mathematical model of the true thermal characteristics of the machine.

However, if a motor is considered to be a homogeneous body, developing heat internally at a constant rate and dissipating heat at a rate directly proportional to its temperature rise, it can be shown that the temperature at any instant is given by:

$$T = T_{max} (1 - e^{-t/\tau})$$

Where:
T_{max} = Final steady state temperature
τ = Heating time constant

This assumes a thermal equilibrium in the form :

Heat developed = Heat stored + Heat dissipated

Temperature rise is proportional to the current squared:

$$T = KI_R^2 (1 - e^{-t/\tau})$$

Where:
I_R = That current, which when left to flow continuously, would produce a temperature T_{max}, in the motor.

For an overload current 'I', the temperature is given by:

$$T = KI^2 (1 - e^{-t/\tau})$$

For a motor not to exceed the rated temperature, then the time 't' for which the motor can withstand the current 'I' can be shown to be given by:

$$t = \tau \; Ln \left[\frac{1}{\{1-(I_R/I)^2\}} \right]$$

An overload protection element should therefore satisfy the above relationship. The value of I_R may be the full load motor current or a percentage of it, depending on the motor design.

As previously stated, it is an oversimplification to regard a motor as a homogeneous body. The temperature rise of different parts, or even of various points in the same part, may be very uneven. However, it is reasonable to consider that the current-time relationship follows an inverse fashion. A more accurate representation of the thermal state of the motor can be obtained through the use of temperature monitoring devices (RTDs) which target these specific areas.

2.2.2 Thermal Replica

The P24x relay models the time-current thermal characteristic of a motor by internally generating a thermal replica of the machine. The thermal overload protection can be selectively enabled or disabled. The positive or rms and negative sequence components of the load current are measured independently and are combined together to form an equivalent current, I_{eq}, which is supplied to this replica circuit. The heating effect in the thermal replica is produced by I_{eq}^2 and therefore takes into account the heating effect due to both positive or rms and negative sequence components of current.

The equivalent current for operation of the overload protection is in accordance with the following expressions:

$$\mathbf{I_{eq} = \sqrt{(I_1^2 + K\,I_2^2)}}$$

Note	This equation is used in software version A4.x (09) and before.

$$I_{eq}=\sqrt{(I_{rms}^2 + K\,I_2^2)}$$

Note	This equation is used in software version B1.0 (20) and later.

Where:
I_{RMS} = Root Mean Square current
I_1 = Positive sequence current
I_2 = Negative sequence current
K = A user settable constant proportional to the thermal capacity of the motor

As previously described, the temperature of a motor will rise exponentially with increasing current. Similarly, when current decreases, the temperature also decreases in a similar manner. Therefore, in order to achieve close sustained overload protection, the P24x relay incorporates a wide range of thermal time constants. These allow the relay replica to closely match the protected motor during heating and cooling.

Furthermore, the thermal withstand capability of the motor is affected by heating in the winding prior to the fault. The thermal replica is designed to take into account the extremes of zero pre-fault current, known as the 'cold' condition, and full rated pre-fault current, known as the 'hot' condition. With no pre-fault current, the relay will be operating on the 'cold curve'. When a motor is, or has been, running at full load prior to a fault, the windings will already be dissipating heat and the 'hot curve' is applicable. Therefore, during normal operation, the relay will be operating within these two limits, unless programmed to do otherwise.

To protect the motor during all operating conditions, three independently adjustable time constants are employed in the overload curve:

T1 = Overload time constant applied when the current is between I_{th} & $2I_{th}$.
T2 = Overload time constant applied for currents above 2Ith.
Tr = Cooling time constant applied when the motor is stopped.

The following equation is used to calculate the trip time for a given current.

Note	*The relay will trip at a value corresponding to 100% of its thermal state. The percentage of thermal capacity follows the relationship* $\%\theta = (I_{eq}/I_{th})^2 \times 100$.

$$t = \tau \ln \left((k^2 - A^2) / (k^2 - 1) \right)$$

And the following equation is used to calculate the time it takes for the thermal alarm to be set.

$$t_{alarm} = \tau \ \ln \left[\frac{(k^2 - A^2)}{(k^2 - (\text{Thermal Alarm}/100))} \right]$$

Where:
T = T1 if $I_{th} < I_{eq} <= 2I_{th}$
T = T2 if $I_{eq} > 2I_{th}$
T = Tr if $I_{eq} = 0$ (CB open)
k = I_{eq}/I_{th}
A = initial thermal state of the machine
I_{th} = Thermal current setting
Thermal Alarm = Thermal alarm setting (20%-100%)

The time to trip varies depending on the load current carried before application of the overload, i.e. whether the overload was applied from “hot” or “cold”.

2.2.3 Setting Guidelines for Thermal Overload

2.2.3.1 Thermal Setting I_{th}

The **I_{th} Current Set** setting chosen will depend on the type of motor being protected. Most machines are termed Continuous Maximum Rating (CMR) motors. These motors are designed to carry the nameplate value or full load current continuously. A CMR motor may be run at some value less than its CMR and set to trip at its CMR.

Alternatively, if the machine is not a CMR motor, then the I_{th} setting will need to take into account the amount of overload, which can be tolerated, without resulting in thermal damage. A typical allowable overload may be in the region of 10% of rated temperature. It is important to realize that the temperature build up within the machine is approximately equal to the current squared, therefore a 10% temperature overload is equivalent to a 5% current overload.

Setting Example:

These motor parameters are used to show how to determine the P24x settings:

Voltage	11 kV
Full load current	293 A
Starting current	470 %
Starting time	10 s
Heating time constant	20 min
Cooling time constant	100 min
Hot locked rotor withstand time	20 s
Cold locked rotor withstand time	30 s
CT Ratio	300 / 1
VT Ratio	11.5 kV / 110 V
Starting	D.O.L

Table 3 - Specific motor parameters showing how to determine P24x settings

For this application we have assumed that the machine is a CMR motor and therefore the I^{th} setting is calculated as follows:

$I_{th} = I_{CMR}$ x (1/CT Ratio)

Where :

I_{CMR} = Continuous Motor Rating

Therefore:

$$I_{th} = \frac{293}{300} \times In = 0.976\ In$$

Therefore set:

$I_{th} = 0.98$ In

2.2.3.2 K Coefficient

The constant **K Coefficient** is used to increase the influence of negative sequence current on the thermal replica. This factor should be set equal to the ratio of negative phase sequence, rotor resistance to positive sequence resistance at rated speed. When an exact setting cannot be calculated, a default setting of 3 should be used. This is a typical setting and will suffice for the majority of applications.

Therefore set : **K Coefficient = 3**

2.2.3.3 Thermal Time Constants

The relay heating and cooling time constants are set in accordance with the stator thermal heating and cooling time constants. The relay heating time constant (**Thermal Const T1**) should be set equal to, or as close as possible to, the stator heating thermal time constant, which is obtainable from the motor manufacturer. It is good practice to set T1 slightly less than the stator heating thermal time constant to allow for relay tolerances. However, this is not always necessary, since the stator thermal time constants provided by the motor manufacturer are usually conservative.

Thermal Const T2 is automatically applied above 2 I_{th} and is used to modify the relay thermal curve during starting for certain applications, for example, where star/delta starters are being utilized. During normal running, with the motor connected in delta, the current in the motor winding is only 57% of that monitored by the relay. However, during starting, with the motor connected in star, the current monitored by the relay is equal to the current in the motor winding. For this reason, T2 can be used to reduce the operating time of the relay during starting. For applications where direct on line (DOL) starting is utilized, T2 should be set equal to T1, resulting in one continuous thermal curve.

It is important to plot the chosen thermal characteristics on a time-current graph to ensure that the cold curve does not intersect the starting characteristic.

In certain applications, the thermal time constants may not be available. However, a graphical representation of these values may be given. In such applications, a stator heating time constant must be chosen, such that when plotted on a time-current graph, it closely matches the cold withstand curve of the motor.

Cooling Const Tr is the cooling time constant. This setting is important for cyclic operation of the motor, since precise information of the thermal state of the motor is required during heating and cooling. It is set as a multiple of T1 and should be set to the nearest value above the motor cooling time constant.

Setting Example:

For this particular application the stator thermal time constants of the motor are known, therefore the required time constant settings are as follows:

Therefore set : **T1 = 20 minutes**
T2 = T1 since machine is DOL starting
Tr to 5 x T1 = 100 mins.

These settings are shown in this diagram.

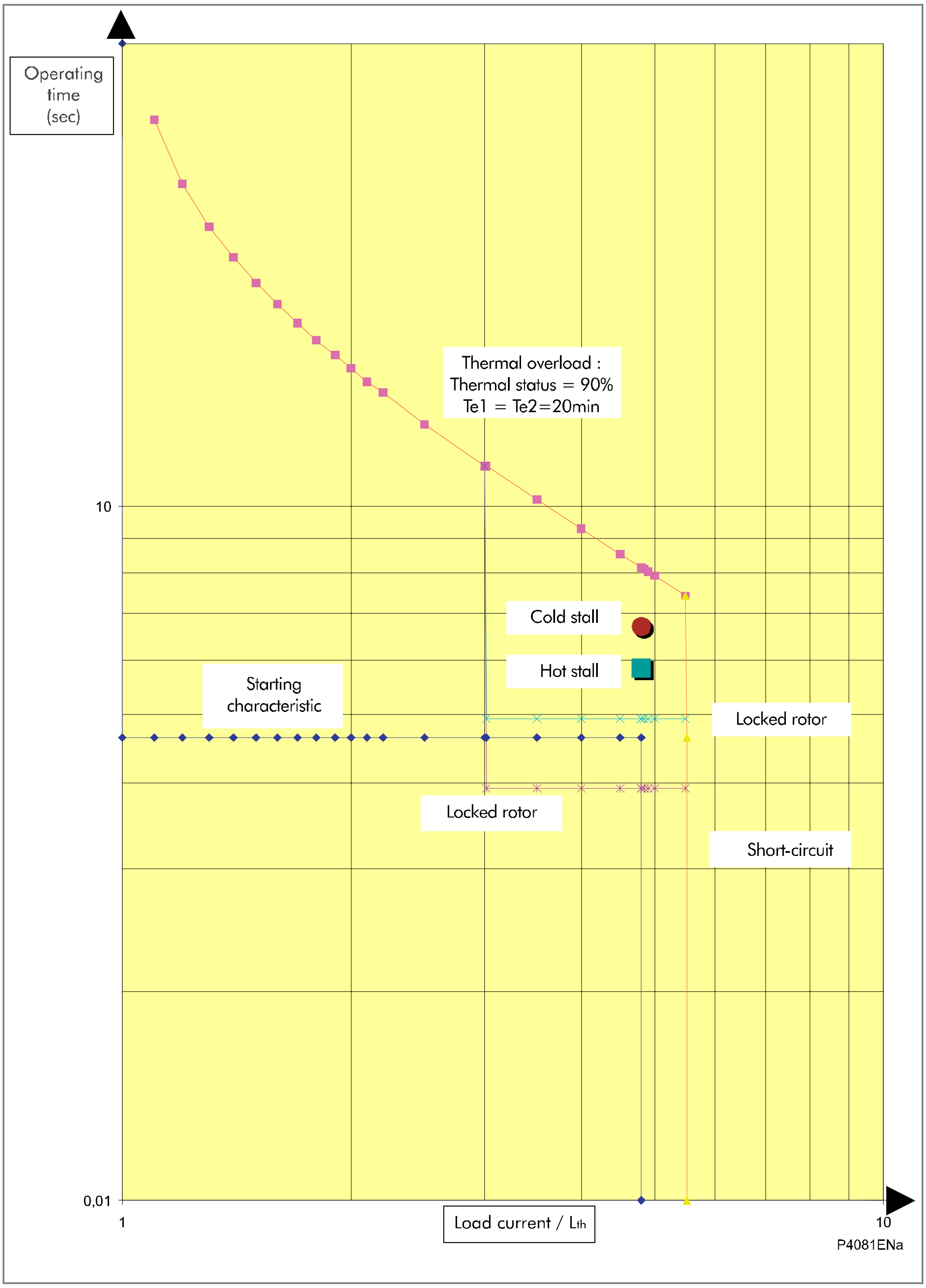


Figure 1 - Example of settings

2.2.4 Thermal State Modification

If a CMR induction motor is fully loaded, this is equivalent to a temperature of 100%, as far as the thermal replica is concerned. The motor protection relay will therefore normally be set to trip when the temperature reaches 100%. However, a stator temperature of 100% does not necessarily correspond to a rotor temperature of 100%; the rotor temperature could be as low as 50% of the permitted level. The main reason for this is that the rotor winding is able to dissipate the heat more efficiently than the stator winding, particularly with fan-driven, air-flow machines.

During starting, the slip will be low and both the stator and rotor currents will be high, thereby creating heat in both windings. However, a motor will usually be designed to allow one start when it has previously been run at a stator temperature not exceeding its rating.

From cold, the motor thermal replica characteristic will be on its 'cold' curve, with the highest tripping times. As the machine is run over a period of time, the projected thermal trip times will reduce, eventually reaching their minimum when operating on the 'hot' curve. Unfortunately, any rapid increase in current, for example a starting condition, may result in an unnecessary trip. This is shown in the following *Thermal curve modification* diagram.

In the past, motor manufacturers and end users have been aware of the limitation of the stator thermal model and the possible solution has been to oversize the machine. Clearly this is expensive.

The P24x relay incorporates a feature whereby the thermal curve may be modified to overcome this problem. Previously, it has been seen that the relay has a dual time constant (T1 and T2) characteristic for applications such as star/delta starting. In this example T2 was set to a lower value than T1. To enable a hot re-start, for a DOL machine, it may be necessary to set T2 to a higher value than T1 in order to avoid the starting characteristic. This is shown in the following *Thermal curve modification* diagram.

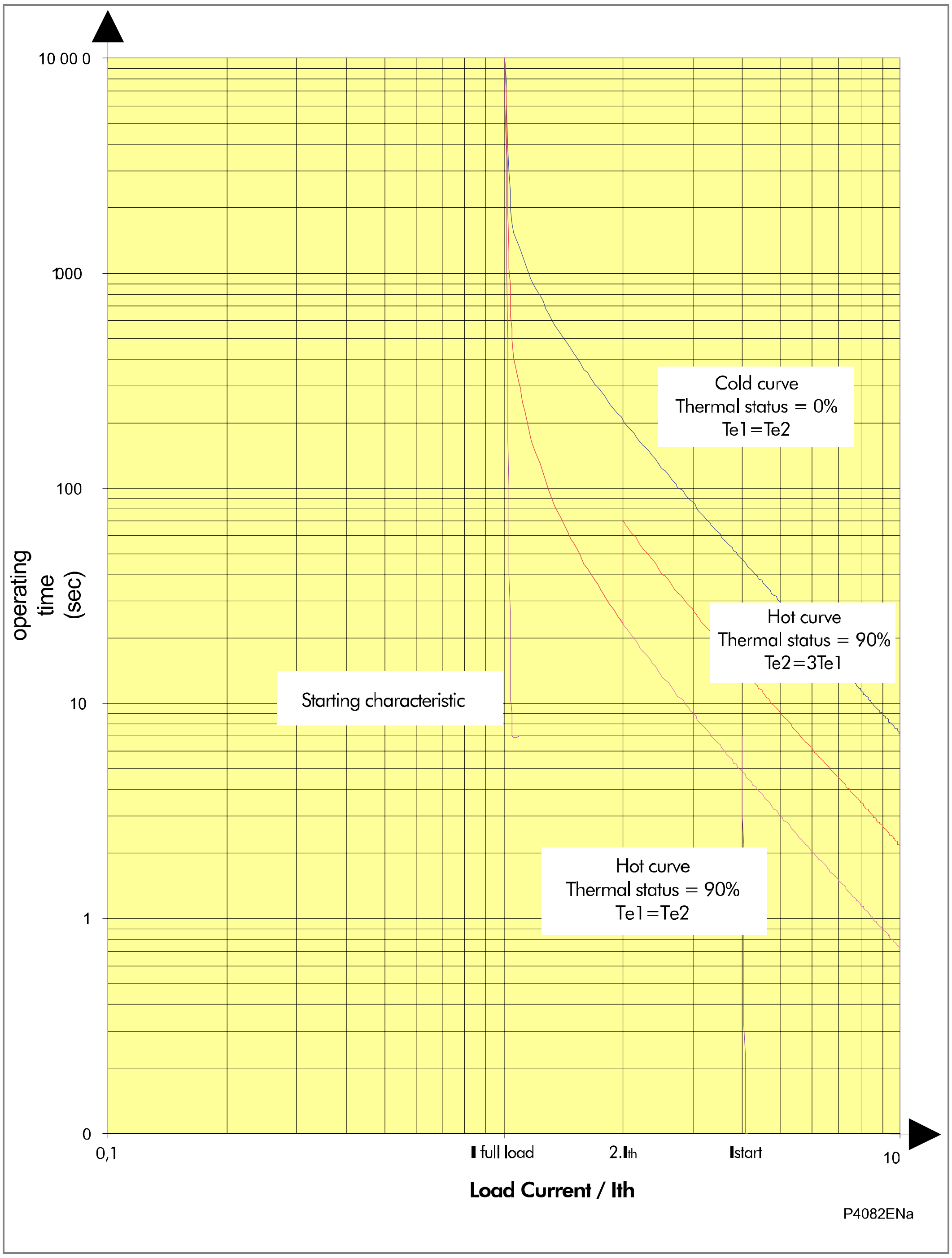


Figure 2 - Thermal curve modification

2.2.5 Thermal Probe Influence

Motors are designed to operate within a specific ambient temperature. If the machine is operated in a higher ambient temperature than specified, the windings may overheat resulting in insulation deterioration, even if it is operating within rated load. Therefore, if the machine is operated in an environment where the ambient temperature may fluctuate, it is important to compensate the thermal overload curve in order to maintain close thermal overload protection. Strategically placed temperature sensors can be used to provide information on ambient conditions, which in turn can then be used to influence the thermal replica. Motors which are particularly at risk are those operated in direct sunlight, boiler houses, tropical environments and motors which are reliant upon forced cooling.

The power delivered by a motor varies with the ambient temperature, the following table shows variations in power delivered as the temperature changes for a typical motor.

Ambient Temperature °C	40	45	50	55	60
Power delivered as a % of nominal power	100	95	90	85	80

Table 4 - Reduction of per unit power delivered by motors relative to the ambient temperature

As the nominal power varies linearly with nominal current, with a constant voltage, the above table is applicable to nominal current.

The thermal setting is also directly proportional to nominal current. So to compensate for the ambient temperature variation, the thermal setting is corrected dependent upon the ambient temperature for the following conditions :

- During the calculation of thermal state
- During the detection of thermal alarm
- During the detection of thermal overload
- During the detection of thermal lockout

A correction coefficient is calculated depending upon the temperature as shown in the table below and is multiplied to the thermal thresholds:

Ambient Temperature °C	40	45	50	55	60	65
Multiplication Coefficient	1	0.95	0.90	0.85	0.80	0.75

Table 5 - Correction coefficients used by the relay to offset the thermal replica at different ambient temperatures

The P24x accepts inputs from up to 10 RTDs (Resistance Temperature Detectors). Two of these RTDs (one main and one back-up), can be used to measure the external/ambient temperature and influences the thermal curve.

2.2.6 Specific Applications

2.2.6.1 Inhibition of the Thermal Trip during Starting

It may be necessary to disable the thermal overload curve when starting motors which have extreme starting conditions, such as very long start times or very high start current values. With this feature enabled, if the calculated thermal state reaches 90% before the end of the starting period, this value is retained at 90% for the remaining starting period. At the end of the starting period the inhibit is removed.

Note	*This function does not affect the operation of the Thermal Alarm feature.*

2.2.6.2 Emergency Restart

Where a motor forms part of an essential process, it is sometimes desirable for it to continue operation, even under severe overload conditions. This usually means the motor being subjected to temperatures in excess of its design limits. Even though this may decrease the life of the motor, or even under extreme circumstances, burn the motor out, this may be justified for the application.

2.2.6.3 Thermal Alarm

The **Thermal Alarm** threshold is expressed as a percentage of the thermal state of the machine and is used to give an alarm when the thermal state reaches a predetermined value. There is no definitive setting for the thermal alarm threshold since it is application dependent. A typical setting would be 90%.

2.2.6.4 Lockout Threshold

This facility can be used to inhibit a hot restart until the motor has cooled to the **Lockout Thresh**. This setting is expressed as a percentage of the thermal state of the motor.
A contact is designed to open when the thermal state of the machine reaches this setting and close again when the thermal state drops below this setting. This contact would therefore be wired into the starting circuitry in order to provide the inhibit.

There is no definitive setting for the lockout threshold since it is based on the motors capability to withstand a hot restart. It is typically set to the minimum value of 20%Ith.

2.3 Resistive Temperature Detectors (RTDs)

Prolonged overloading of motors or generators may cause their windings to overheat, resulting in premature ageing of the insulation, or in extreme cases, insulation failure. Worn or unlubricated bearings can also generate localized heating within the bearing housing. To protect against any general or localized overheating, the P24x relays have the ability to accept inputs from Resistive Temperature sensing Devices (RTDs). Such probes are strategically placed in areas of the machine which are susceptible to overheating, or heat damage.

2.3.1 RTD Thermal Protection Features

Typically an RTD probe can measure temperature within the range -40 to +400°C. The temperature at each probe location can be determined by the relay, and is available for:

- Temperature monitoring, displayed locally, or remotely via the relay communications
- Alarming, should a temperature threshold be exceeded for longer than a set time delay
- Tripping, should a temperature threshold be exceeded for longer than a set time delay

If the measured resistance is outside the permitted range, an RTD failure alarm will be raised, indicating an open or short circuit RTD input.

> *Note* *Direct temperature measurement can provide more reliable thermal protection than devices that use a thermal replica energized from phase current. The latter is susceptible to inaccuracies in time constants used by the replica model, and also inaccuracies due to the variation in ambient temperature.*

See the *Installation* chapter for recommendations on RTD connections and cables.

2.3.2 RTD Thermal Protection Settings

Each RTD can be enabled by setting the relevant bit in **Select RTD**. For example if Select RTD is set to 0000000111, then RTD1, RTD2 and RTD3 would be enabled and the associated settings would be visible in the menu.

The temperature setting for the alarm stage for each RTD can be set in the **RTD x Alarm Set** cells and the alarm time delay in the **RTD x Alarm Dly** cell.

The temperature setting for the trip stage for each RTD can be set in the **RTD x Trip Set** cells and the trip stage time delay in the **RTD x Trip Dly** cell.

Typical operating temperatures for protected plant are given in the table below. These are provided as a guide, actual figures MUST be obtained from the equipment manufacturers:

Parameter	Typical service temperature	Short term overloading at full load
Bearing temperature generators	60 - 80°C, depending on the type of bearing.	60 - 80°C+
Top oil temperature of transformers	80°C (50 - 60°C above ambient).	A temperature gradient from winding temperature is usually assumed, so that top oil RTDs can provide winding protection
Winding hot spot temperature	98°C for normal ageing of insulation.	140°C+ during emergencies

Table 6 - Typical operating temperatures of a healthy plan

The P24x relay has an alarm threshold setting, with a time delay for each RTD input. Each input also has a trip element, with a temperature threshold and a time delay. The time delays may be set to 0 s if instantaneous protection is required.

Temperature settings may be set, in degrees Celsius/Fahrenheit, within the range 0-400°C.

2.4 Short Circuit Protection (50/51)

Faults between phases seldom occur because of the relatively large amount of insulation between phase windings. As the stator windings are completely enclosed in earthed metal, most faults will involve earth, which would then operate the earth fault protection. However, a fast operating overcurrent element is often employed to protect against phase faults occurring at the motor terminals; such as terminal flashovers.

The short circuit protection included within the relays consists of a four-stage non-directional overcurrent element. Each stage can be selectively enabled or disabled.

This element uses the Ia, Ib, and Ic relay inputs and can be fed from CTs at the terminal of the motor.

The first two stages of overcurrent protection have time-delayed characteristics which are selectable between Inverse Definite Minimum Time (IDMT), or Definite Time (DT). The third and fourth stages have definite time characteristics only.

To avoid tripping during start-up as a result of asymmetric CT saturation, definite time element has a minimum operating time of 100 ms for currents in the range I> to 1.2I>.

The definite time characteristic is shown in the *Definite time overcurrent element* diagram:

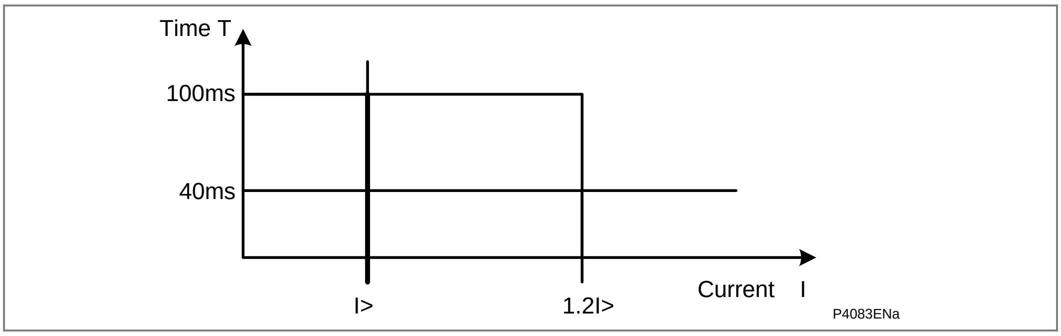


Figure 3 - Definite time overcurrent element

2.4.1 Setting Guidelines

To prevent operation during starting, the instantaneous element is usually set to 1.25 times the maximum starting current.

The timer setting is very much system dependent, but may typically be set to a value in the region of 100 ms.

Note	*If the motor is controlled by a fused contactor, it will need to be coordinated with the fuse. This is to prevent the contactor attempting to interrupt current in excess of its breaking capacity.*

2.4.2 Setting Example

Utilizing the previously specified motor parameters, set:

I>Current Set = (1.25 x 4.7 x 293)/300 = 5.7 In
I> Time Delay = 100 ms

These settings are shown in the *Definite time overcurrent element* diagram.

2.5 Earth Fault Protection (50N/51N/67N/32N/64N)

One of the most common faults to occur on a motor is a stator winding fault. This is usually the result of prolonged or cyclic overheating, which causes the insulation to deteriorate. Since the windings are surrounded by an earthed metal case, stator faults usually manifest themselves as earth faults. The type of earth fault protection and CT arrangement adopted will depend on the amount of earth fault current available during a fault. The magnitude of current is dependent upon the system earthing arrangements.

The P24x earth fault element is equipped with two independent stages, which are selectable as either forward, reverse or non-directional. The first stage may be selected as either IDMT or DT and the second stage is DT only.

The inverse time-delay characteristics listed above comply with this formula:

$$t = T \times \left[\frac{K}{(I / Is)^{\alpha} - 1} + L\right]$$

Where:

t	=	operation time
K	=	constant
I	=	measured current
Is	=	current threshold setting
α	=	constant
L	=	ANSI/IEEE constant (zero for IEC curves)
T	=	Time multiplier Setting

IDMT Curve description	Standard	K constant	α constant	L constant
Standard Inverse	IEC	0.14	0.02	0
Very Inverse	IEC	13.5	1	0
Extremely Inverse	IEC	80	2	0
Long Time Inverse	UK	120	1	0
Moderately Inverse	IEEE	0.0515	0.02	0.0114
Very Inverse	IEEE	19.61	2	0.491
Extremely Inverse	IEEE	28.2	2	0.1217
Inverse	US	5.95	2	0.18
Short Time Inverse	US	0.02394	0.02	0.1694

Note that the IEEE and US curves are set differently to the IEC/UK curves, with regard to the time setting. A time multiplier setting (TMS) is used to adjust the operating time of the IEC curves, whereas a time dial setting is employed for the IEEE/US curves. Both the TMS and Time Dial settings act as multipliers on the basic characteristics but the scaling of the time dial is 10 times that of the TMS, as shown in the previous menu. The menu is arranged such that if an IEC/UK curve is selected, the **I> Time Dial** cell is not visible and vice versa for the **TMS** setting.

Table 7 - Standard IDMT curve constant values

Note	*All the curves are shown in the Technical Data chapter.*

The element operates from residual current obtained from either the residual connection of the three phase CTs, or from an independent core balance CT. The core-balance CT is normally of the ring type, through the centre of which is passed the three phase cable to the motor. The advantage in using this CT arrangement lies in the fact that only one CT core is used, in place of the conventional three phase CTs whose three secondary windings are residually connected. In this way the CT magnetizing current at relay operation is reduced by approximately three-to-one; an important consideration in the detection of low level earth faults, where low effective settings are required. Furthermore, the primary current rating does not need to be related to motor full load current as no secondary current flows under normal balanced conditions. This allows the CT ratio to be chosen such as to optimize the effective primary pick-up current.

Core-balance transformers are normally mounted over a cable at a point close to the cable gland. Physically split cores, that is 'slip-over' types, are normally available for applications in which the cable is already in position, as on existing installations. The *Core balanced CT with cable* diagram shows the correct method of earthing the cable sheath when using a core balance CT.

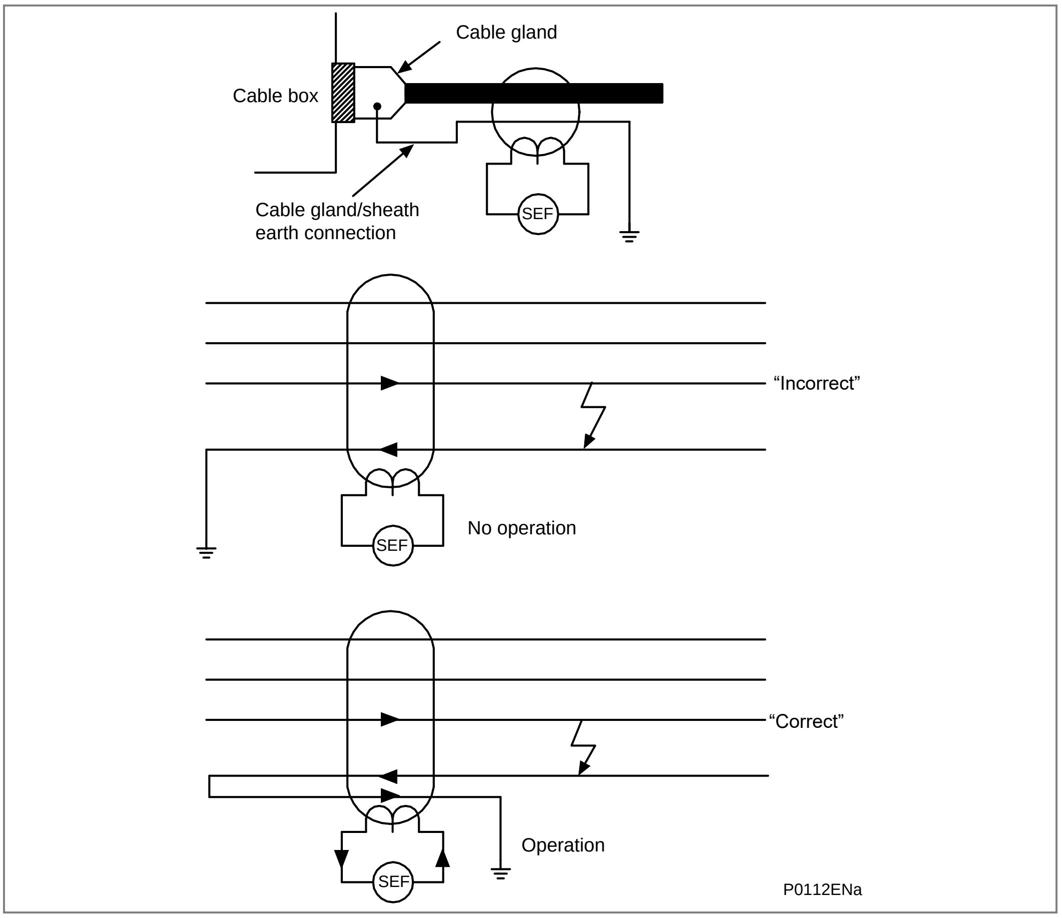


Figure 4 - Core balanced CT with cable

Where directional earth fault protection is required, the element should be polarized from residual voltage (-3Vo). This is derived from either the three phase VT inputs to the relay or the residual voltage input. The **VT Connect Mode**, **3VT, 2VT+VResidual, 2VT+Vremanent** can be selected in the **CT and VT Ratios** menu.

Different VT ratio settings for the three modes of connection are available.

2.5.1 Solidly Earthed System

2.5.1.1 Principle

On solidly earthed systems, for earth fault settings >20% of the motor continuous rated current, it is acceptable to use the conventional residual CT connection for the detection of earth faults. Below this value the use of a core balance CT may be more applicable.

Care must be taken to ensure that the relay does not operate from the spill current resulting from asymmetric CT saturation during starting. To achieve stability under these conditions, it is usual to insert a stabilizing resistor in series with the relay or use a time delay. The required value of resistor is calculated as follows:

$R_{stab} = (I_{st}/I_0) * (R_{ct} + N*R_1)$

Where:

I_o = earth fault setting in amps

I_{st} = motor starting current referred to CT secondary

R_{ct} = d.c. resistance of CT secondary

N = 1 for 4 wire CT connection (star point at CT side)

2 for 6 wire CT connection (both star points formed at relay panel).

R_1 = resistance of single lead from relay to CT

R_r = Relay resistance in ohms

2.5.1.2 Typical Settings

Typically, the earth fault element should be set non-directional with a setting of approximately 30% of the motor continuous rated current.

Where a stabilizing resistor is used, the earth fault element should be set instantaneous. If one is not used, stability during asymmetric CT saturation can be achieved by time delaying the earth fault element. The actual timer setting is very much system dependent.

If the motor is supplied by a fused contactor, it is important to grade the earth fault protection to ensure that the contactor does not attempt to interrupt fault current in excess of its breaking capacity. The following diagram gives an example:

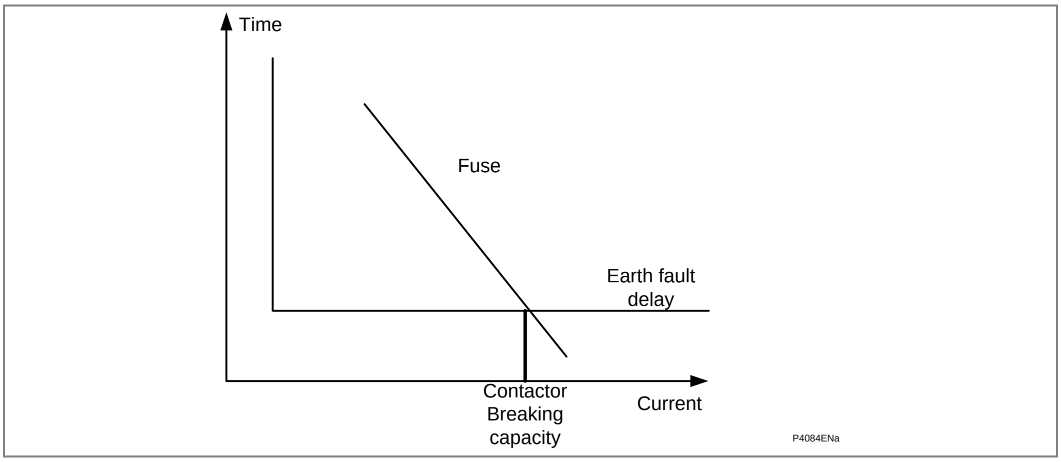


Figure 5 - Fuse characteristic

2.5.2 Insulated System

2.5.2.1 Principle

The advantage gained by running a power system which is insulated from earth, is the fact that during a single phase to earth fault condition, no earth fault current is allowed to flow. Consequently, it is possible to maintain power flow on the system, even when an earth fault condition is present. This advantage is offset by the fact that the resultant steady state and transient overvoltages on the sound phases can be very high.

Clearly, operational advantages may be gained by the use of insulated systems. However, it is still vital that detection of the fault is achieved. This is obviously not possible by means of standard current operated earth fault protection. One possibility for fault detection is by means of a residual overvoltage device. This functionality is included within the P24x relay and is detailed in the *Residual Overvoltage (Neutral Displacement) Protection (59N)* section. However, fully discriminative earth fault protection on this type of system may be achieved by the application of a sensitive earth fault element. This type of relay is set to detect the resultant imbalance in the system charging currents that occurs under earth fault conditions. It is therefore essential that a core balance CT is used for this application.

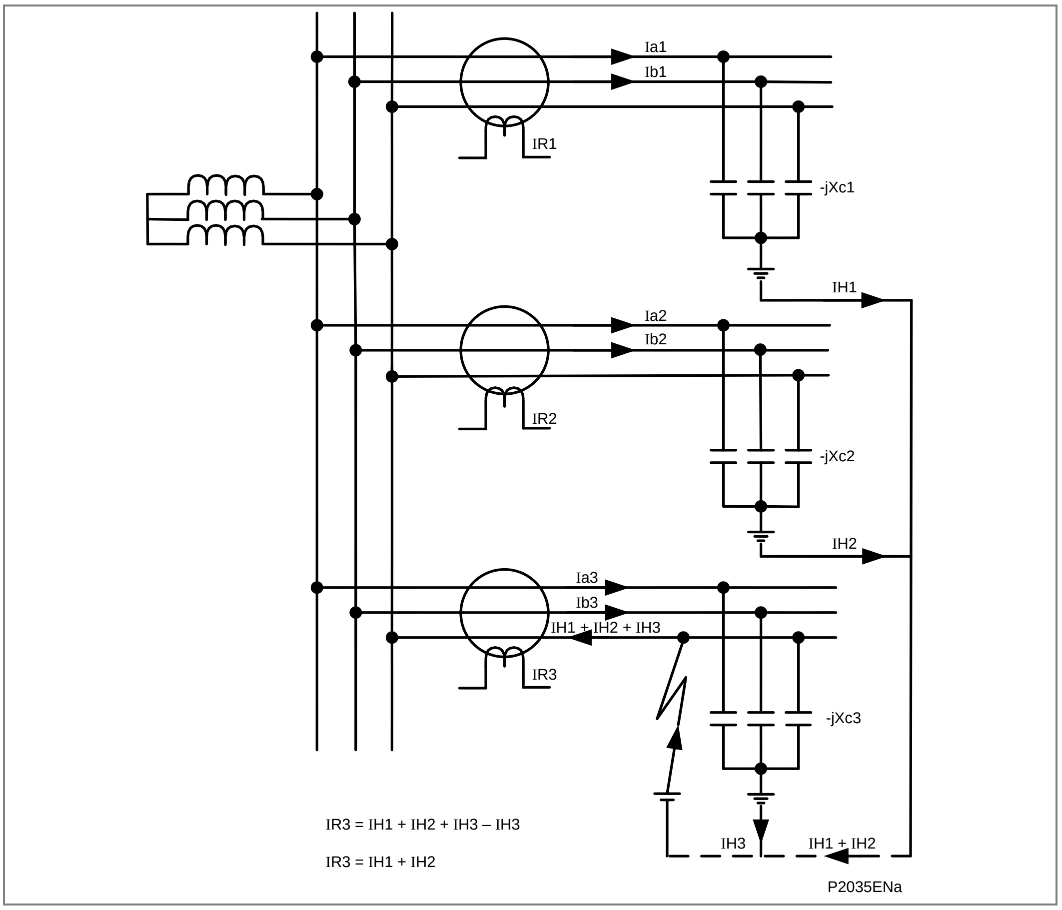


Figure 6 - Current distribution in an insulated system with C phase fault

The above diagram shows that the relays on the healthy motor feeders see the unbalance in the charging currents for their own feeder.

The relay on the faulted feeder, however, sees the charging current from the rest of the system (IH1 and IH2 in this case), with its own feeders charging current (IH3) becoming cancelled out. This is further illustrated by the phasor diagrams below.

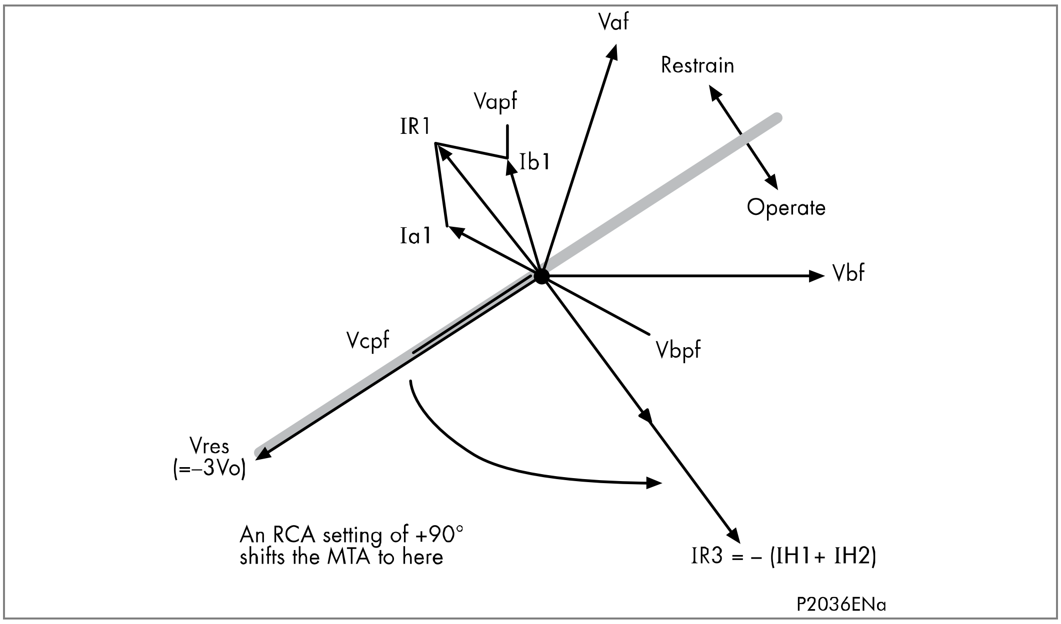


Figure 7 - Phasor diagrams for insulated system with C phase fault

Referring to the phasor diagram, it can be seen that the C phase to earth fault causes the voltages on the healthy phases to rise by a factor of √3. The A phase charging currents (Ia1), is then shown to be leading the resultant A phase voltage by 90°. Likewise, the B phase charging current leads the resultant Vb by 90°.

The unbalance current detected by a core balance current transformer on the healthy motor feeders can be seen to be a simple vector addition of Ia1 and Ib1, giving a residual current which lies at exactly 90° lagging the residual voltage (-3Vo). As the healthy phase voltages have risen by a factor of √3, the charging currents on these phases will also be √3 times larger than their steady state values. Therefore, the magnitude of residual current, IR1, is equal to 3 x the steady state per phase charging current.

The phasor diagrams indicate that the residual currents on the healthy and faulted motor feeders, IR1 and IR3 respectively, are in antiphase. A directional element could therefore be used to provide discriminative earth fault protection.

If the polarizing voltage of this element, Vres (equal to -3Vo), is shifted through +90°, the residual current seen by the relay on the faulted feeder will lie within the operate region of the directional characteristic and the current on the healthy feeders will fall within the restrain region.

Note	*The actual residual voltage used as a reference signal for the directional earth fault protection in the P24x relay is internally phase shifted by 180° and is therefore shown as -3Vo in the vector diagrams.*

As previously stated, the required characteristic angle setting for the sensitive earth fault element when applied to insulated systems is +90°.

Note	*The recommended setting corresponds to the relay being connected such that it's direction of current flow for operation is from the motor feeder into the busbar. The correct relay connections to give a defined direction for operation are shown in the relay connection diagrams in the Connection Diagrams chapter.*

The P24x relay internally derives the residual polarizing voltage for the directional earth fault element. Consequently, either a 5-limb or three single phase VT's should be applied to drive the relay, not a VT of the three-limb design. The former types allow the passage of residual flux through the VT and consequently permit the relay to derive the required residual voltage. A three limb VT provides no path for the flow of residual flux and is therefore unsuitable. Alternatively, the relay can be driven by a phase to phase connected VT with a broken delta winding connected to the residual voltage input.

Note	Discrimination can be provided without the need for directional control. This can only be achieved if it is possible to set the relay in excess of the charging current of the protected feeder and below the charging current for the rest of the system.

2.5.2.2 Setting Guidelines

As shown previously, the residual current detected by the relay on the faulted feeder is equal to the sum of the charging currents flowing from the rest of the system. Further, as stated earlier, the addition of the two healthy phase charging currents on each feeder gives a total charging current which has a magnitude of three times the per phase value. Therefore, the total unbalance current detected by the relay is equal to three times the per phase charging current of the rest of the system. A typical relay setting may therefore be in the order of 30% of this value, that is. equal to the per phase charging current of the remaining system. Practically though, the required setting may well be determined on site, where system faults can be applied and suitable settings can be adopted based upon practically obtained results. The use of the P24x relays comprehensive measurement and fault recording facilities may prove very useful in this respect.

The timer setting of this element is not critical, since for the first fault only capacitive current exists on the system. However, for subsequent faults, fast tripping will be required. If the motor is operated using a fused contactor it is important to delay the protection sufficiently in order to ensure that the contactor does not attempt to interrupt fault current in excess of its breaking capacity.

2.5.3 Resistance Earthed Systems

Earthing the system by means of a resistor reduces both the fault current and transient overvoltages. In addition to this, resistance earthing can sometimes be advantageous in hazardous environments such as mines etc. since the earthing resistance effectively reduces touch and step potentials during earth faults.

2.5.3.1 Setting Guidelines

On a resistance earthed system, it is common practice to limit the fault current to approximately full load current.

For such an application, the relay may be set non-directional with a current sensitivity of less than 30% of the minimum earth fault level but greater than three times the steady state charging current of the motor feeder. (It is apparent from the *Current distribution in an insulated system with C phase fault* diagram that the healthy feeder, regardless of the method of earthing, will see this value of charging current).

Similar guidelines to those given for solidly earthed systems (as described in the *Solidly Earthed System* section) are applicable with regard to the required time delay setting.

Note	If the above setting guidelines for applying a non-directional relay cannot be achieved due to the current magnitudes, then a sensitive directional earth fault element will be required. This eliminates the need to set the relay in excess of the charging current for the protected feeder.

2.5.3.2 High Resistance Earthing

For certain applications, the fault current may be severely limited by the use of very high resistance earthing. It is usual in this case to choose a value of resistor which will limit the resistive fault current to a similar magnitude as the system charging current. Therefore, charging current will have a marked influence on the angle of the fault current with respect to the polarizing voltage (-3Vo).

In this application sensitive directional earth fault protection, operated from a core balance CT, will be required. The relay characteristic angle setting should therefore be set to +45° (refer to the *Phasor diagrams for insulated system with C phase fault* diagram).

Note	*This recommended setting corresponds to the relay being connected so its direction of current flow for operation is from the motor feeder into the busbar.*

The current sensitivity of the relay should be approximately 30% of √2 times the charging current for the rest of the system (3 x steady state value). The correct relay connections to give a defined direction for operation are shown on the relay connection diagram in the *Connection Diagrams* chapter.

The timer setting of this element is not critical, since for the first fault minimal damage will result. However, for subsequent faults, fast tripping will be required.

Note	*Similar comments apply with respect to those given in the Insulated System section regarding the VT requirements for the P24x relay when directionalizing earth fault elements (RCA = relay characteristic angle).*

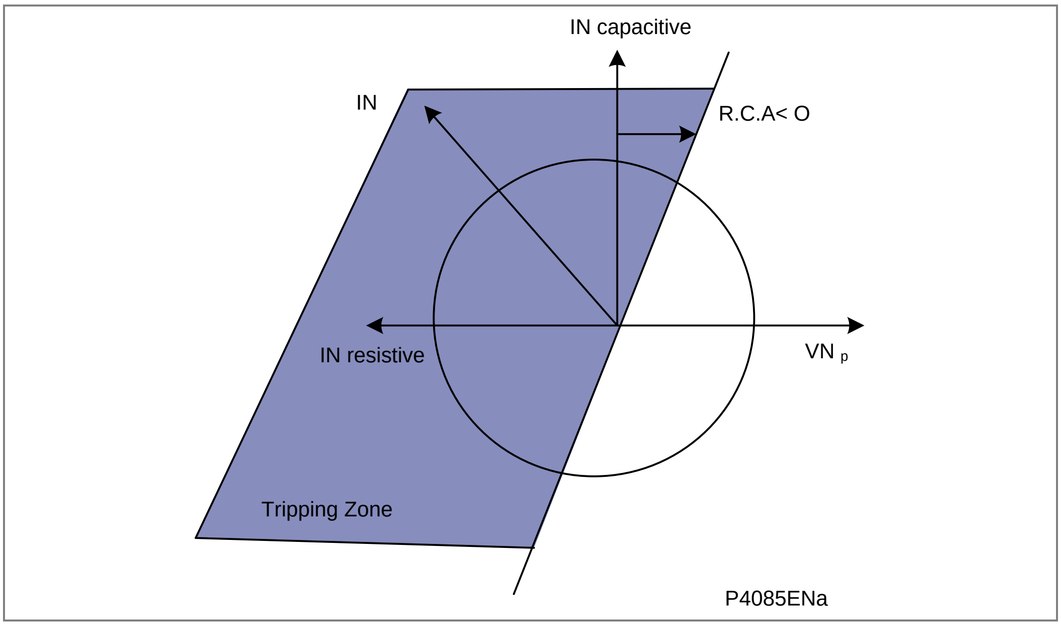


Figure 8 - Directional tripping characteristic

2.5.4 Petersen Coil Earthed Systems

2.5.4.1 Principle

Power systems are usually earthed to limit transient overvoltages during arcing faults and also to assist with detection and clearance of earth faults. Impedance earthing has the advantage of limiting damage incurred by plant during earth fault conditions and also limits the risk of explosive failure of switchgear, which is a danger to personnel. In addition, it limits touch and step potentials at a substation or in the vicinity of an earth fault.

If a high impedance device is used for earthing the system, or the system is unearthed, the earth fault current will be reduced but the steady state and transient overvoltages on the sound phases can be very high. Consequently, it is generally the case that high impedance earthing will only be used in low/medium voltage networks in which it does not prove too costly to provide the necessary insulation against such overvoltages. Higher system voltages would normally be solidly earthed or earthed via a low impedance.

A special case of high impedance earthing via a reactor occurs when the inductive earthing reactance is made equal to the total system capacitive reactance to earth at system frequency. This practice is widely referred to as Petersen (or resonant) Coil Earthing. With a correctly tuned system, the steady state earth fault current will be zero, so that earth faults become self-extinguishing. Such a system can, if designed to do so, be run with one phase earthed for a long period until the cause of the fault is identified and rectified. With the effectiveness of this method being dependent upon the correct tuning of the coil reactance to the system capacitive reactance, an expansion of the system at any time would clearly necessitate an adjustment of the coil reactance.

Petersen coil earthed systems are commonly found in areas where the power system consists mainly of rural overhead lines and can be particularly beneficial in locations which are subject to a high incidence of transient faults. The Petersen coil, for example, can extinguish transient earth faults caused by lightning strikes without the need for outages.

The *Current distribution in Petersen coil earthed system* diagram shows a source of generation earthed through a Petersen Coil, with an earth fault applied on the A Phase. Under this situation, it can be seen that the A phase shunt capacitance becomes short circuited by the fault. Consequently, the calculations show that if the reactance of the earthing coil is set correctly, the resulting earth fault current will be zero.

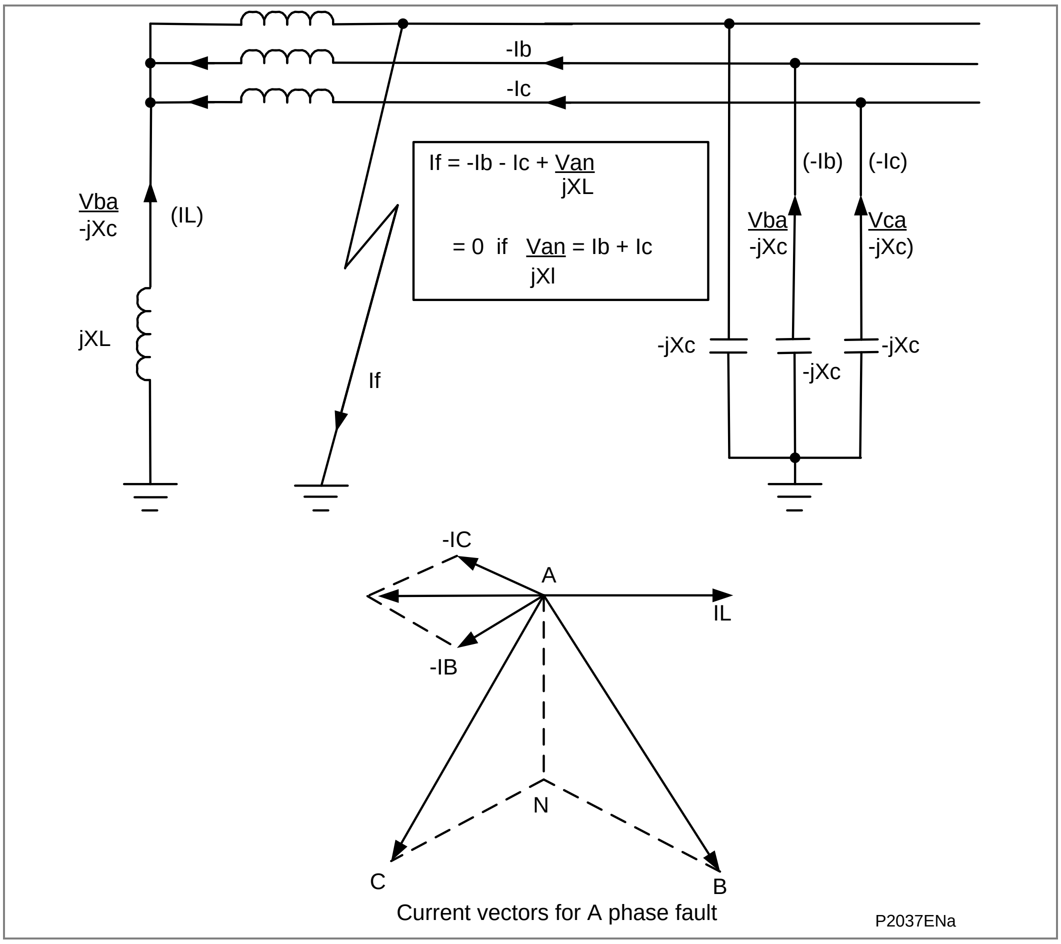


Figure 9 - Current distribution in Petersen coil earthed system

Prior to actually applying protective relays to provide earth fault protection on systems which are earthed using a Petersen Coil, it is imperative to gain an understanding of the current distributions that occur under fault conditions on such systems. With this knowledge, it is then possible to decide on the type of relay that may be applied, ensuring that it is both set and connected correctly.

The *Distribution of currents during a C phase to earth fault* diagram shows a radial distribution system having a source which is earthed using a Petersen Coil. Three outgoing feeders are present, the lower of which has a phase to earth fault applied on the C phase.

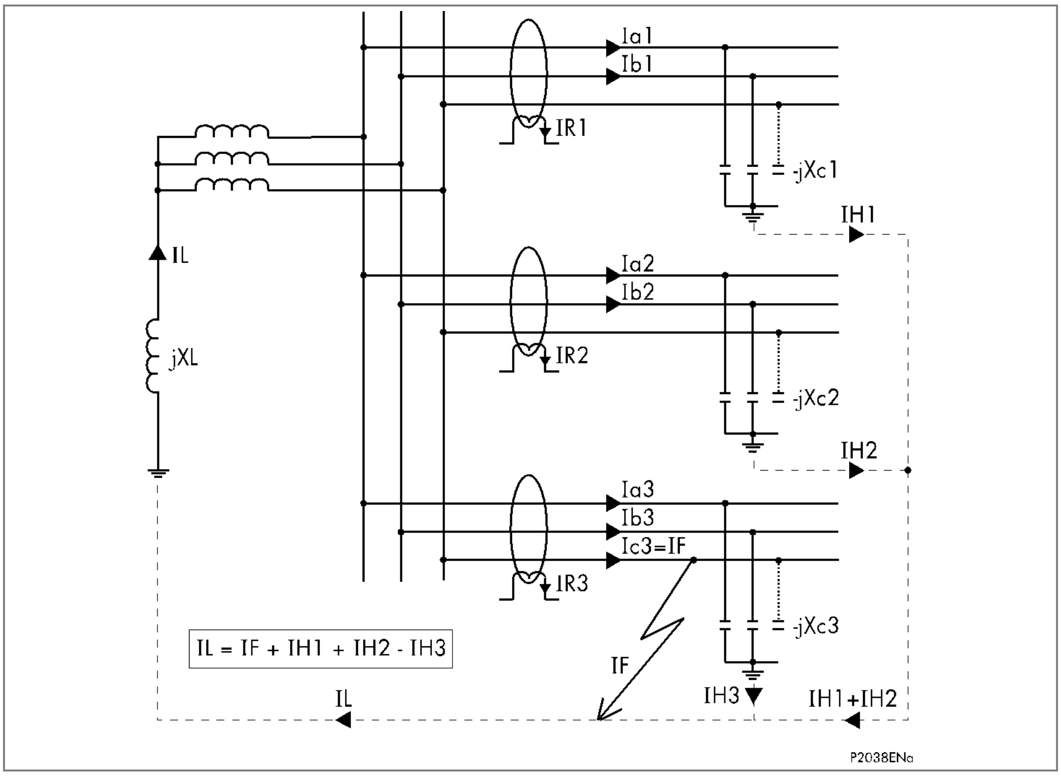


Figure 10 - Distribution of currents during a C phase to earth fault

The *Theoretical case - no resistance present in XL or XC* diagram (parts a, b and c) shows vector diagrams for the previous system, assuming that it is fully compensated (i.e. coil reactance fully tuned to system capacitance), in addition to assuming a theoretical situation where no resistance is present either in the earthing coil or in the feeder cables.

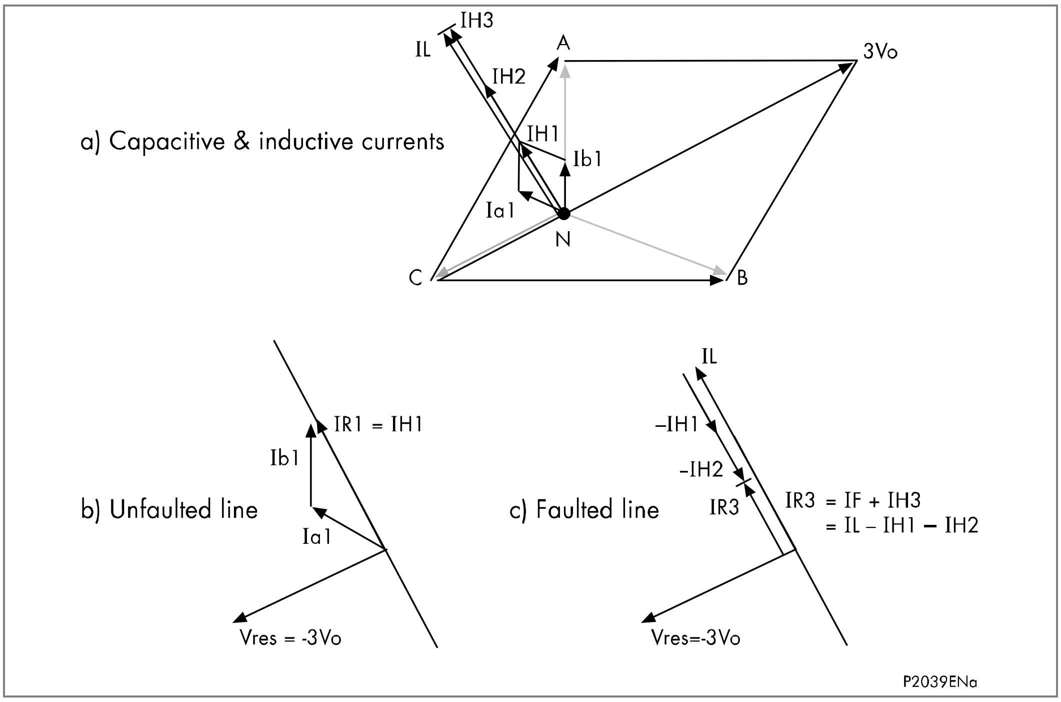


Figure 11 - Theoretical case - no resistance present in XL or XC

Referring to the vector diagram illustrated in part a of the *Theoretical case - no resistance present in XL or XC* diagram, it can be seen that the C phase to earth fault causes the voltages on the healthy phases to rise by a factor of √3. The A phase charging currents (Ia1, Ia2 and Ia3), are then shown to be leading the resultant A phase voltage by 90° and likewise for the B phase charging currents with respect to the resultant Vb.

The unbalance current detected by a core balance current transformer on the healthy feeders can be seen to be a simple vector addition of Ia1 and Ib1, giving a residual current which lies at exactly 90° lagging the residual voltage (part b of the *Theoretical case - no resistance present in XL or XC* diagram). Clearly, as the healthy phase voltages have risen by a factor of √3, the charging currents on these phases will also be √3 times larger than their steady state values. Therefore, the magnitude of residual current, IR1, is equal to 3 x the steady state per phase charging current.

Note	*The actual residual voltage used as a reference signal for directional earth fault relays is phase shifted by 180° and is therefore shown as -3Vo in the vector diagrams. This phase shift is automatically introduced within the 24x relays.*

Note	*On the faulted feeder, the residual current is the addition of the charging current on the healthy phases (Ih3) plus the fault current (If). The net unbalance is therefore equal to Il-Ih1-Ih2, as shown in part c of the* Theoretical case - no resistance present in XL or XC *diagram.* *This situation may be more readily observed by considering the zero sequence network for this fault condition. This is depicted in the Theoretical case - no resistance present in XL or XC diagram shown below;*

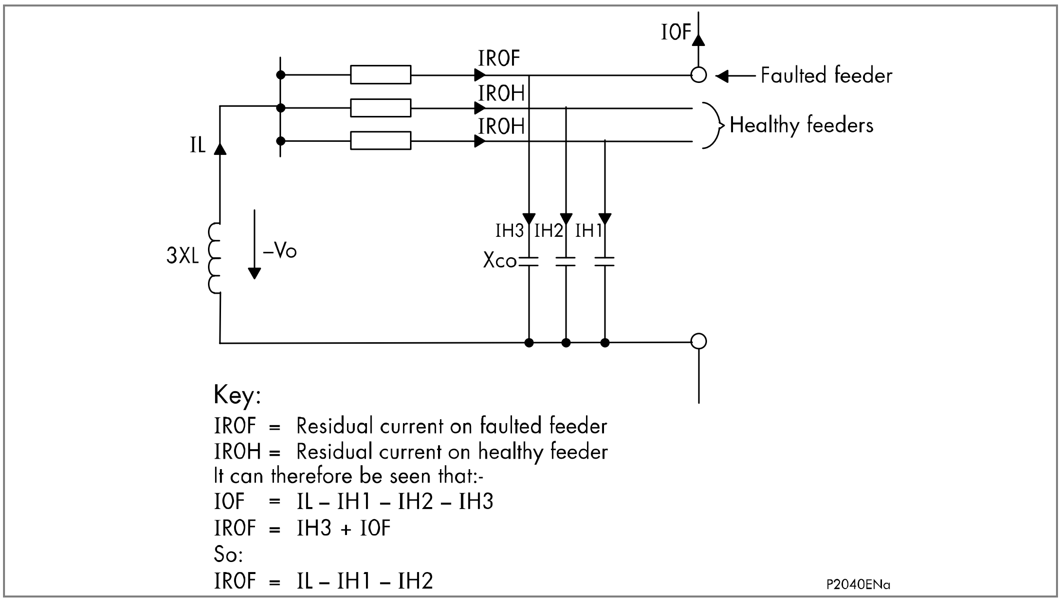


Figure 12 - Theoretical case - no resistance present in XL or XC

2.5.5 Zero Sequence Network Showing Residual Currents

In comparing the residual currents occurring on the healthy and on the faulted feeders (as shown in parts b & c of the *Theoretical case - no resistance present in XL or XC* diagram), it can be seen that the currents would be similar in both magnitude and phase; so it would not be possible to apply a relay which could provide discrimination.

However, as previously stated, the scenario of no resistance being present in the coil or feeder cables is purely theoretical. Further consideration therefore needs to be given to a practical application in which the resistive component is no longer ignored as shown in the following diagram.

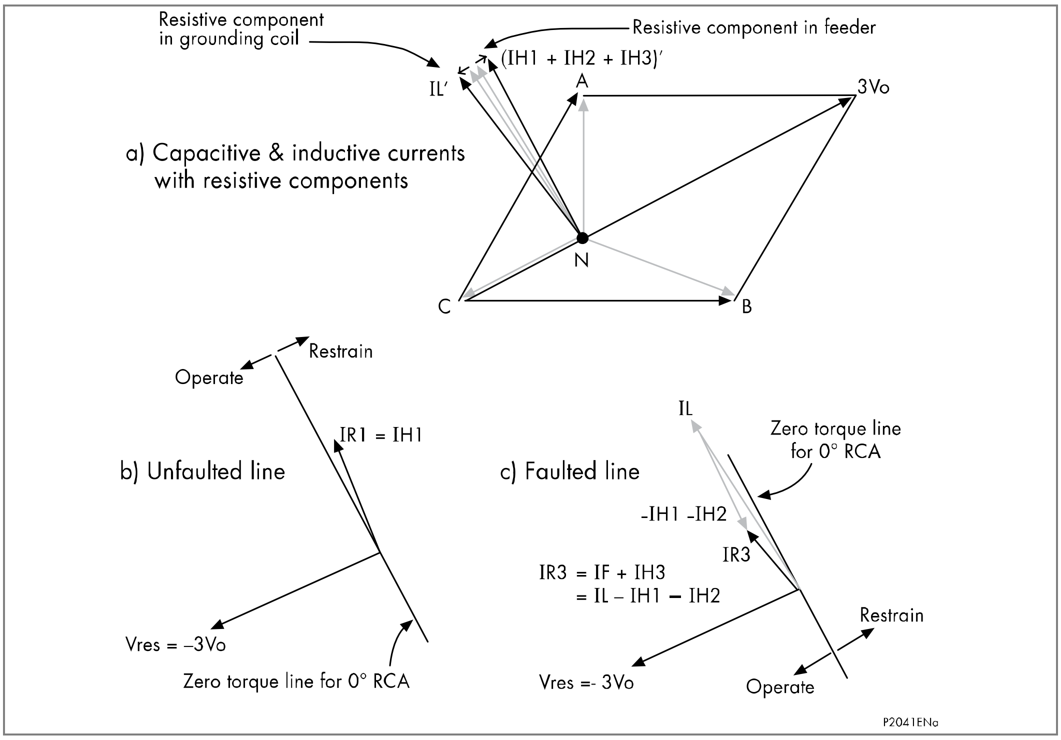


Figure 13 - Practical case:- resistance present in XL and Xc

Part a of the above diagram again shows the relationship between the capacitive currents, coil current and residual voltage. It can now be seen that due to the presence of resistance in the feeders, the healthy phase charging currents are now leading their respective phase voltages by less than 90°. In a similar manner, the resistance present in the earthing coil has the effect of shifting the current, IL, to an angle less than 90° lagging. The result of these slight shifts in angles can be seen in figures 13b and 13c.

The residual current now appears at an angle in excess of 90° from the polarizing voltage for the unfaulted feeder and less than 90° on the faulted feeder. Hence, a directional relay having a characteristic angle setting of 0° (with respect to the polarizing signal of -3Vo) could be applied to provide discrimination. i.e. the healthy feeder residual current would appear within the restrain section of the characteristic but the residual current on the faulted feeder would lie within the operate region.

In practical systems, it may be found that a value of resistance is purposely inserted in parallel with the earthing coil. This serves two purposes; one is to actually increase the level of earth fault current to a more practically detectable level and the second is to increase the angular difference between the residual signals; again to aid in the application of discriminating protection.

2.5.5.1 Operation of Sensitive Earth Fault Element

It has been shown that the angular difference between the residual currents on the healthy and faulted feeders allows the application of a directional relay whose zero torque line passes between the two currents. Two possibilities exist for the type of protection element that may consequently be applied for earth fault detection.

- A suitably sensitive directional earth fault relay having a relay characteristic angle setting (RCA) of zero degrees, with the possibility of fine adjustment about this threshold.
- A sensitive directional zero sequence wattmetric relay having similar requirements to the above with respect to the required RCA settings.

Both stages 1 and 2 of the sensitive earth fault element of the P24x relay are settable down to 0.2% of rated current and would therefore fulfill the requirements of the first method listed above and could therefore be applied successfully. However, many utilities (particularly in central Europe) have standardized on the wattmetric method of earth fault detection, which is described in the following section.

Zero sequence power measurement, as a derivative of Vo and Io, offers improved relay security against false operation with any spurious core balance CT output for non earth fault conditions. This is also the case for a sensitive directional earth fault relay having an adjustable Vo polarizing threshold.

2.5.6 Wattmetric Characteristic

2.5.6.1 Principle

The previous analysis has shown that a small angular difference exists between the spill current on the healthy and faulted feeders. It can be seen that this angular difference gives rise to active components of current which are in antiphase to one another. This is shown in the *Resistive components of spill current* diagram below:

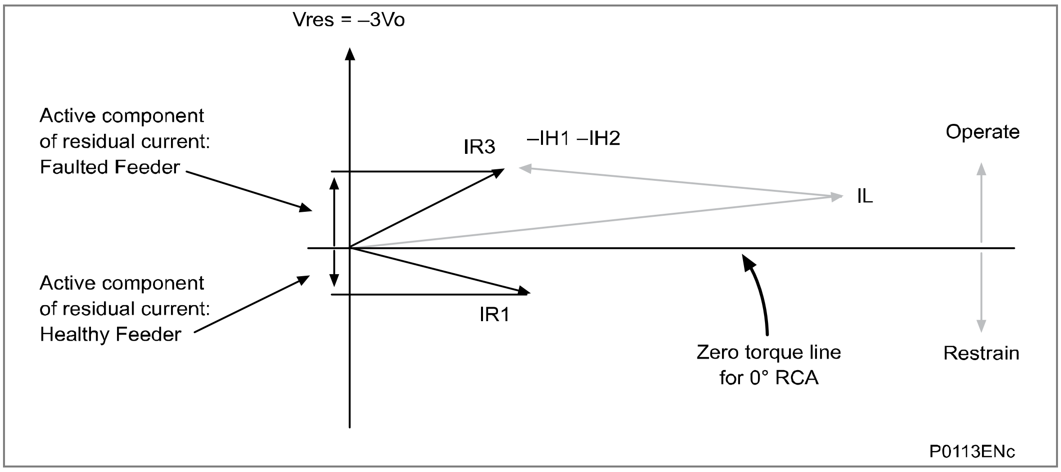


Figure 14 - Resistive components of spill current

Consequently, the active components of zero sequence power will also lie in similar planes and so a relay capable of detecting active power would be able to make a discriminatory decision. That is, if the wattmetric component of zero sequence power was detected in the forward direction, then this would be indicative of a fault on that feeder; if power was detected in the reverse direction, then the fault must be present on an adjacent feeder or at the source.

For operation of the directional earth fault element within the P24x relays, all three of the settable thresholds on the relay must be exceeded ; namely the current (**P0>Current Set**), the voltage (**P0>Voltage Set**) and the power (**P0>Coef. K Set**). It should be noted though, that the directional decision within the relays is based purely on current rather than power. The 'Coef. K' threshold is simply present as an additional level that must be exceeded before a trip is initiated.

As can be seen from the following formula, the wattmetric power is calculated using residual rather than zero sequence quantities. Residual quantities are three times their respective zero sequence values and so the complete formula for operation is as shown below:

The wattmetric element setting corresponds to:

$$Vres \times Ires \times Cos(\Phi - \Phi c) = 9 \times Vo \times Io \times Cos(\Phi - \Phi c)$$

Where:
Φ = Angle between the Polarizing Voltage (-Vres) and the Residual Current
Φc = Relay Characteristic Angle (RCA) Setting (ISEF> Char Angle)
Vres = Residual Voltage
Ires = Residual Current
Vo = Zero Sequence Voltage
Io = Zero Sequence Current

2.5.6.2 Application Considerations

Required Relay Current and Voltage Connections:

Referring to the relevant application diagram for the P24x relay, it should be applied such that its direction for forward operation is looking down into the protected feeder (away from the busbar), with a 0° RCA setting.

As illustrated in the relay application diagram, it is usual for the earth fault element to be driven from a Core Balance Current Transformer (CBCT). This eliminates the possibility of spill current that may arise from slight mismatches between residually connected line CTs. It also enables a much lower CT ratio to be applied, thereby allowing the required protection sensitivity to be more easily achieved.

Calculation of Required Relay Settings:

As has been previously shown, for a fully compensated system, the residual current detected by the relay on the faulted feeder is equal to the coil current minus the sum of the charging currents flowing from the rest of the system. Further, as stated in the previous section, the addition of the two healthy phase charging currents on each feeder gives a total charging current which has a magnitude of three times the steady state per phase value. Therefore, for a fully compensated system, the total unbalance current detected by the relay is equal to three times the per phase charging current of the faulted circuit. A typical relay setting may therefore be in the order of 30% of this value, i.e. equal to the per phase charging current of the faulted circuit. Practically though, the required setting may well be determined on site, where system faults can be applied and suitable settings can be adopted based upon practically obtained results.

Also, in most situations, the system will not be fully compensated and consequently a small level of steady state fault current will be allowed to flow. The residual current seen by the relay on the faulted feeder may thus be a larger value, which further emphasizes the fact that relay settings should be based upon practical current levels, wherever possible.

The above also holds true regarding the required Relay Characteristic Angle (RCA) setting. As has been shown earlier, a nominal RCA setting of 0º is required. However, fine tuning of this setting will require to be carried out on site in order to obtain the optimum setting in accordance with the levels of coil and feeder resistances present. The loading and performance of the CT will also have an effect in this regard. The effect of CT magnetizing current will be to create phase lead of current. Whilst this would assist with operation of faulted feeder relays it would reduce the stability margin of healthy feeder relays. A compromise can therefore be reached through fine adjustment of the RCA. This is adjustable in 1° steps on the P24x relays.

2.6 Residual Overvoltage (Neutral Displacement) Protection (59N)

On a healthy three-phase power system, the addition of each of the three-phase to earth voltages is nominally zero, as it is the vector addition of three balanced vectors at 120° to one another. However, when an earth fault occurs on the primary system this balance is upset and a '**residual**' voltage is produced. This could be measured, for example, at the secondary terminals of a voltage transformer having a "**broken delta**" secondary connection. Hence, a residual voltage-measuring relay can be used to offer earth fault protection on such a system.

Note	*This condition causes a rise in the neutral voltage with respect to earth that is commonly referred to as "**neutral voltage displacement**" or NVD.*

The detection of a residual overvoltage condition is an alternative means of earth fault detection, which does not require any measurement of current. This may be particularly advantageous in high impedance earthed or insulated systems, where the provision of core balance CT's on each feeder may be either impractical, or uneconomic.

Note	*Where residual overvoltage protection is applied, such a voltage will be generated for a fault occurring anywhere on that section of the system and hence the applied protection must be discriminative. The NVD element within the P24x relay is of two stage design, each stage having separate voltage and time delay settings. Stage 1 may be set to operate on either an IDMT or DT characteristic, whilst stage 2 may be set to DT only.*

The IDMT characteristic available on the first stage is defined by the following formula:

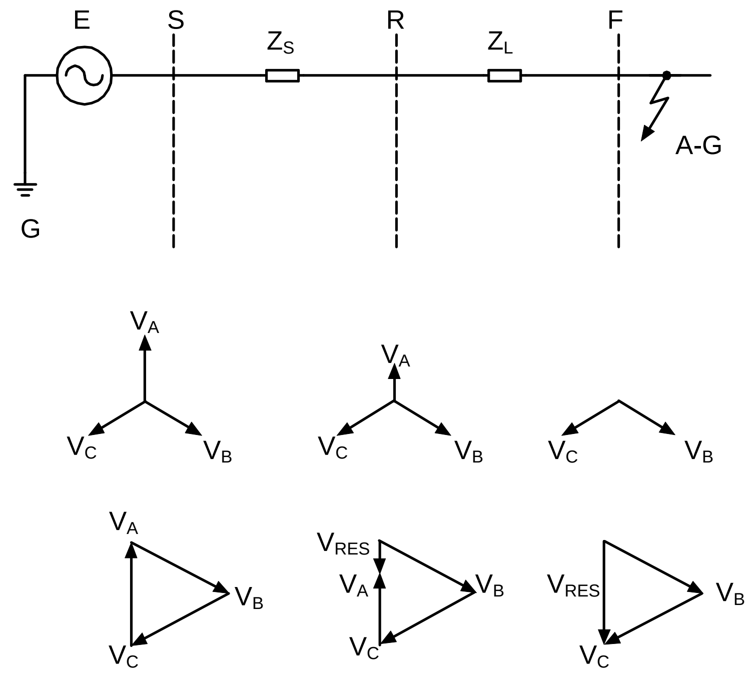
$$t = TMS/(1 - M)$$

Where:
TMS = Time Multiplier Setting
t = Operating Time in Seconds
M = Derived Residual Voltage / Relay Setting Voltage

Two stages are included for this NVD protection to account for applications which require both alarm and trip stages. In such applications, an alarm is usually required to be generated soon after the condition is detected which simply serves to indicate the presence of an earth fault on the system. It is common for the system to have been designed to withstand the associated healthy phase overvoltages for a number of hours following fault inception. This therefore gives time for system operators to locate and hopefully remove the fault condition.

This element should be driven from residual voltage (-3Vo). This can be derived from either the three phase VT inputs to the relay or the residual voltage input. The **VT Connect Mode, 3VT, 2VT+VResidual, 2VT+Vremanent** can be selected in the **CT and VT Ratios** menu.

Different VT ratio settings for the three modes of connection are available.

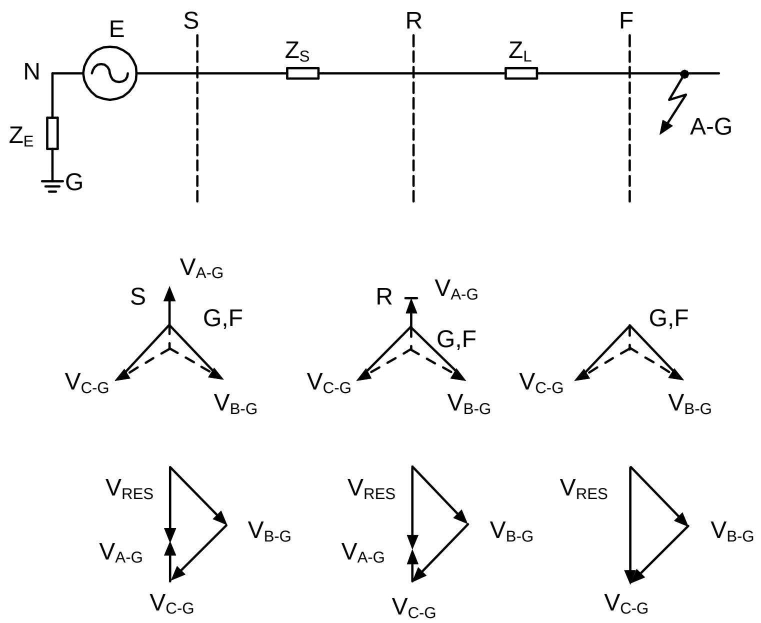


Residual voltage at R (relay point) is dependant upon Z_S/Z_L ratio.

$$V_{RES} = \frac{Z_{S0}}{2Z_{S1} + Z_{S0} + 2Z_{L1} + Z_{L0}} \times 3E$$

P0117ENa

Figure 15 - Residual voltage



$$V_{RES} = \frac{Z_{S0} + 3Z_E}{2Z_{S1} + Z_{S0} + 2Z_{L1} + Z_{L0} + 3Z_E} \times 3E$$

P0118ENa

Figure 16 - Residual voltage

2.6.1 Setting Guidelines

The voltage setting applied to the elements depends on the magnitude of residual voltage that is expected to occur during the earth fault condition. This in turn is dependent on the method of system earthing employed and may be calculated by using the formulae previously given in the previous diagrams. It must also be ensured that the relay is set above any standing level of residual voltage that is present on the system.

Note	*IDMT characteristics are selectable on the first stage of NVD so that elements located at various points on the system may be time graded with one another.*

2.7 Negative Phase Sequence Protection (46)

Negative phase sequence current is generated from an unbalanced current condition, such as unbalanced loading, loss of one phase or single phase faults.

Consider the equivalent circuits for positive and negative phase sequence currents shown in the following *Equivalent circuits* diagram, the magnetizing impedance being neglected.

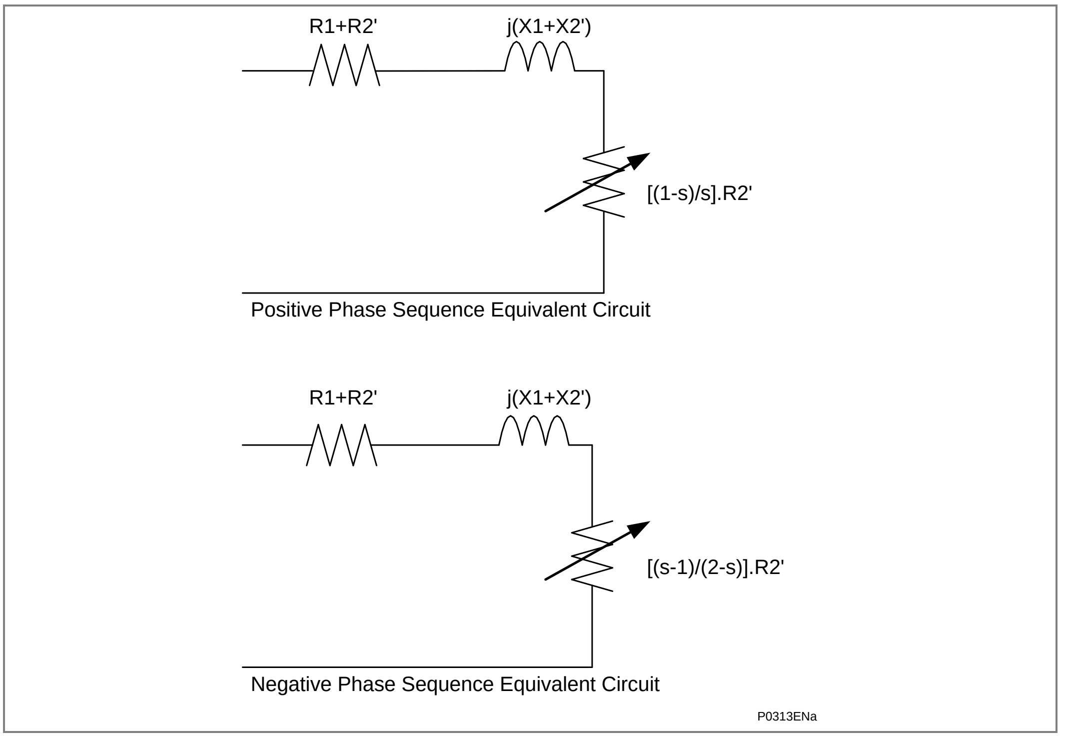


Figure 17 - Equivalent circuits

With positive phase sequence voltages applied to the motor, a rotating field is set up between the stator and rotor. The resulting effect is that the direction of rotation of the rotor is equal to that of the applied field. With negative phase sequence voltages, the field will rotate in the opposite direction, cutting a rotating rotor conductor at almost twice the system frequency. The actual frequency of negative phase sequence voltage and current in the rotor circuit is equal to (2-s)f.

From the equivalent circuits:

Motor positive sequence impedance at a given slip s by the formula:

$$[(R_1 + R'_2/2\text{-}s)^2 + (X_1 + X'_2)^2]^{0.5}$$

That means : $[(R_1 + R'_2)^2 + (X_1 + X'_2)^2]^{0.5}$ when s = 1 at standstill.

Motor negative sequence impedance at a given slip s by the formula:

$$[(R_1 + R'_2/s)^2 + (X_1 + X'_2)^2]^{0.5}$$

That means : $[(R_1 + R'_2/_2)^2 + (X_1 + X'_2)^2]^{0.5}$ when s << 1 at normal running speed.

Where:
PPS = positive phase sequence
NPS = negative phase sequence
R_1 = PPS Stator Resistance
R'_1 = PPS Rotor Resistance Referred to Stator
X_1 = PPS Rotor Reactance
X'_1 = PPS Rotor Reactance Referred to Stator
R_2 = NPS Stator Resistance
R'_2 = NPS Rotor Resistance Referred to Stator
X_2 = NPS Rotor Reactance
X'_2 = NPS Rotor Reactance Referred to Stator
s = Slip

The value of resistance is generally much less than the leakage reactance. Therefore, neglecting the resistance term, the motor negative phase sequence impedance at normal running speed can be approximated to the positive phase sequence impedance at standstill.

At normal running speed:

$$\frac{\text{positive sequence impedance}}{\text{negative sequence impedance}} \cong \frac{\text{starting current}}{\text{normal load current}}$$

For example, if a motor has a starting current of six times the full load value, the negative sequence impedance would be about 1/6 the positive sequence impedance.

Consequently, the presence of 5% negative sequence voltage in the supply would result in approximately 30% of negative sequence current.

The a.c. resistance of the rotor conductor to the induced negative sequence current is greater due to the higher frequency [(2-s)f], causing skin effect. The heating effect of negative sequence current is therefore greater and increases the motor losses.

It is therefore essential to detect any negative sequence current present on the system and act accordingly before dangerous temperatures occur in the motor.

The P24x relay includes a number of methods for the detection of negative phase sequence currents, depending upon the cause of the unbalance. These methods are addressed in detail below.

2.7.1 Loss of one Phase while Starting and Running

2.7.1.1 Principle

If a motor is started with one phase open, it will remain stationary and it can be shown to draw a current equal to 0.866 times the normal starting current. Under these circumstances, the negative phase sequence component present in the current is equal to half the normal starting current value. This is an extreme condition, as this amount of negative phase sequence current will rapidly overheat the motor, and unless corrective action is taken, the motor will be seriously damaged.

Loss of one phase of the supply to a motor during normal running conditions, results in the following conditions:

Heating increases considerably due to high rotor losses caused by the -ve sequence current now present.

Output of the motor is reduced and, depending on the load, an induction motor may stall or a synchronous motor may pull out of synchronism, the motor current will increase.

One common factor in the aforementioned conditions is the presence of negative phase sequence current. The P24x relay therefore incorporates a negative phase sequence current element to detect such extreme operating conditions. This negative phase sequence current element operating time characteristic is of an inverse time nature and is governed by the following formula:

t = TMS * (1.2/I2/In) for $0.2 \leq I2/In \leq 2$

t = TMS * 0.6 for I2/In >2

The element may be selectively enabled or disabled.
In addition to this, an independent, definite time alarm stage is provided.

2.7.1.2 Setting Guidelines

This element should be set in excess of the anticipated negative phase sequence current resulting from asymmetric CT saturation during starting, but less than the negative phase sequence current resulting from loss of one phase during starting.

A typical setting for the negative sequence overcurrent element is 30% of the anticipated negative sequence current resulting from loss of one phase during starting. For a motor with a starting current to load current ratio of 6 to 1.

Therefore set:

I2>2 Current Set = 1/6 normal starting current or full load current

The setting for the alarm time delay is application dependent.

2.7.2 Three-Phase Voltage Check (Reverse Phase Detection) (47/27)

2.7.2.1 Principle

Incorrect phase rotation of the incoming supply to the motor will result in the motor rotating in the opposite direction. For certain directionally sensitive applications, such as lifts and conveyor belts, this is a potentially dangerous condition and must be detected rapidly.

Although the above condition does not result in the flow of negative phase sequence current in the motor, 100% negative phase sequence current will be presented to the measuring circuitry of the relay.

If the machine is allowed to rotate in the opposite direction, the thermal protection and negative phase sequence overcurrent element will detect the condition and trip the circuit breaker in their respective time delays. However, as stated above, it is sometimes undesirable to allow the motor to rotate at all.

For such applications, the P24x relay includes a 3-phase voltage check detector. This element monitors the input voltage rotation and magnitude. The positive sequence voltage should be greater than the negative sequence voltage, and accroding to V< measurement mode setting the corresponding voltages VA/VAB and VB/VBC and VC/VCA should be greater than the user settable threshold.

This feature requires a 52a circuit breaker auxiliary contact mapped to an opto input to get the information CB closed/CB open.

2.7.2.2 Setting Guidelines

The undervoltage interlock (**Start Low V Set**) is provided to prevent the motor attempting to start on reduced voltage. The setting is system dependent but may typically be set to 80% - 90% of Vn.

2.8 Start / Stall Protection (48/51LR/50S/14)

When a motor is started, it will draw a value of current in excess of full load rating for a set period of time, namely the starting time. It is normal practice to assume a constant starting current for the whole of the starting time.

The starting current will vary depending upon the type and method of starting utilized. If the motor is started Direct-On-Line (DOL), the current could easily reach 6 times full load current. However, when star/delta starting is utilized, the starting current will be $\sqrt{3}$ less than when DOL starting.

Should a motor stall whilst running, or be unable to start due to excessive loading, it will draw a current equivalent to the locked rotor current. Due to the fact that the level of starting current will be equal to the level of locked rotor current, it is clearly not possible to distinguish between 3 phase stalling and healthy starting, by monitoring current alone.

In the majority of cases the starting time of a normal induction motor is less than the maximum stall withstand time. Under this condition it is possible to discriminate on a time basis between the two conditions and thus provide protection against stalling.

However, where motors are used to drive high inertia loads, the stall withstand time may be less than the starting time. In such cases, it is not possible to discriminate between start and stall conditions by time alone.

The P24x relay provides extensive start and stall protection, in order that all of the aforementioned conditions may be accounted for. The methods used to achieve this are discussed in more detail below.

2.8.1 Excessive Start Time/Locked Rotor Protection - Stall Time > Start Time (51LR)

A motor may fail to accelerate for a number of reasons. For example, loss of one supply phase, mechanical failure, insufficient supply voltage, etc. As stated previously, failure of a machine to accelerate will result in excessive current being drawn by the motor. This current will generate extremely high temperatures within the machine. Coupled with the fact that the motor is without the added cooling normally provided by rotation, irreparable damage will result very quickly.

Where the stall withstand time is less than the starting time, it is possible to utilize a contact from a speed sensing device wired into a specified opto input (Speed Input: DDB 104) in conjunction with measurement of the phase current to detect a safe start.

Three methods are available for detecting a start and they are menu selectable. See the Operation chapter, *P24x/EN OP*, for detailed information.

2.8.1.1 Setting Guidelines

The starting current threshold should be set greater than full load current, but less than motor starting current. Where the stall withstand time is greater than the starting time, timer **– Prol Start Time** - should be set 1 or 2 seconds above the motor starting time and less than the cold stall withstand time. The **Prolonged Start** needs to be set to **Enabled** for this function to operate.

Setting example:

Utilizing the previously specified motor parameters:

Starting current	= 3 x Ith = 882A
Prolonged start time	= 12 seconds.

These settings are illustrated graphically in the *Example of settings* diagram.

2.8.2 Stall Protection (50S)

2.8.2.1 Principle

An induction motor may stall for a number of reasons, such as overloading, undervoltage etc. When a machine stalls it will run down whilst drawing a current equal to the locked rotor current.

Where the stall withstand time is greater than the starting time, a stall condition during running is simply detected by the line current exceeding the programmed threshold. If the current fails to fall back below this threshold before the programmed time delay has elapsed, a trip can be initiated.

Note	*This function is disabled when the relay detects a start condition.*

2.8.2.2 Setting Guidelines

The stall current threshold (**Stall Setting**) should be set greater than full load current, but less than motor stall current (which is usually equal to starting current). Its corresponding timer (**Stall Time**) should be set less than the motor hot stall withstand time. The **Stall Detection** needs to be set to **Enabled** for this function to operate.

Setting example:

Utilizing the previously specified motor parameters:

Stall Setting = 3 x I_{th} = 882 A

Stall Time = 6 seconds

These settings are illustrated graphically in the *Example of settings* diagram.

2.8.3 Excessive Start Time/Locked Rotor Protection - Stall Time < Start Time (14)

As the rotor resistance of an induction motor is proportional to slip, it will decrease during acceleration. When the motor is stationary, the rotating field in the air gap, set up by currents flowing in the stator winding will cut the rotor. This field will be traveling at synchronous speed relative to the rotor and will induce a voltage at system frequency, thus generating circulating currents in the rotor bars. At this frequency, the reactance of the rotor will cause the current to flow in the outer section of the rotor conductors; commonly known as the 'skin effect'. Since the current is occupying a smaller section of the rotor, the apparent impedance presented to it is increased, therefore the I^2R heating is greatly increased. As the motor accelerates during starting the slip begins to decrease and the current is able to occupy more of the rotor conductor. The apparent impedance therefore reduces along with the heating effect. The motor is therefore able to tolerate starting current for the starting time, but not locked rotor current.

The above description explains why, for certain applications, such as motors driving high inertia loads, the stall withstand time may be safely exceeded during starting, without resulting in an overtemperature condition within the motor. Consequently, since the stall withstand time is less than the start time, it is not possible to use time alone to distinguish between a start and a stall condition.

Where the stall withstand time is less than the starting time, it is possible to utilize a contact from a speed sensing device wired into a specified opto input (Speed Input: DDB 104) in conjunction with measurement of the phase current to detect a safe start.

2.8.3.1 Setting Guidelines

The Starting current threshold (**Starting current**) should be set greater than full load current, but less than motor locked rotor current (usually equal to starting current). Its corresponding timer (**Stall Time**) should be set less than the motor cold stall withstand time. The **Stall Rotor-str** needs to be set to **Enabled** for this function to operate.

2.8.4 Number of Starts Limitation (66)

Repeated starting, or intermittent operation of a motor, may generate dangerously high temperatures within the motor, unless sufficient time is allowed for cooling between starts.

The P24x relay incorporates a number of starts limitation facilities. This limitation is fully programmable and is applicable to both hot and cold start conditions. A hot start is defined by a thermal state greater than 50% and a cold start is defined as a thermal state lower than 50%.

Restarting the motor from a hot thermal state:

For certain applications, it is not desirable to allow the motor time to cool down to a specified thermal state before a re-start is permitted. The P24x relay incorporates a number of features which allow a subsequent start from a hot thermal state, these are discussed in the *Thermal Overload Protection* section.

The motor accumulated run time displayed in the menu cell “Motor Run Time” of the “Measurement 3” menu is initiated each time the switching device is closed and remains closed.

2.8.5 Anti-Backspin Protection (ABS) (27)

A motor may be driving a very high inertia load. Once the CB/Contactor supplying power to the motor is switched off, the rotor may continue to turn for a considerable length of time as it decelerates. The motor has now become a generator and applying supply voltage out of phase may result in catastrophic failure. In some other applications for example when a motor is on a down-hole pump, after the motor stops, the liquid may fall back down the pipe and spin the rotor backwards. It would be very undesirable to start the motor at this time. In these circumstances the anti-backspin function is used to detect when the rotor has completely stopped, in order to allow re-starting of the motor.

The operation of this function depends on the parameter **VT connecting mode**: If this is set to **2 VT + Vremanent**, then the function uses an undervoltage with the connected Phase-Phase remanent voltage. If not, the function uses only a time delay.

2.8.5.1 Setting Guidelines for ABS Protection

The voltage threshold setting for the anti-backspin protection **VRem Antibacks** should be set at some low value to indicate that the motor is stopped. The default setting of 10 V secondary is adequate for most applications.

If the **VT connecting mode** is set to **2 VT + Vremanent** the time delay **Antibacks Delay** must be set to an adequate time for the motor to stop after and the remanent voltage has dropped below the **VRem Antibacks** setting following a trip.

If **the VT connecting mode is not set to 2 VT + Vremanent** then the time delay **Antibacks Delay** must be set to an adequate time for the motor to stop after the trip. The default setting of 3000 s is adequate for the majority of applications.

2.8.6 Low Voltage Protection (Re-Acceleration)

Following a transient dip in the supply voltage, a motor will attempt to re-accelerate. Under these circumstances it will draw a level of current exceeding the relay stall protection threshold, (**Stall Setting**). Consequently, for successful re-acceleration the P24x relay can be configured to temporarily inhibit the stall protection.

If a low voltage condition exists on the system for a time in excess of 100 ms, upon recovery of the voltage the relay will inhibit stall protection. Re-acceleration will be recognized if current above the set threshold is detected within 5 seconds of the voltage recovery. During this period the excessive start protection is enabled. This will provide protection in the event of unsuccessful re-acceleration. For example, a dip in the busbar voltage supplying several motors would result in each of them attempting re-acceleration. Subsequently, a large current will be drawn from the supply, thus further reducing the supply voltage, resulting in potential stalling of all machines. This would not occur during normal starting as a staggered approach is normally adopted.

This function is disabled during the starting period, and requires a 52a circuit breaker auxiliary contact mapped to an opto input to get the information CBclosed/CB open.

Setting Guidelines:

The low voltage threshold (**Reac Low V Set**) is very much system dependent, however a typical setting may be 0.8-0.9 Vn.

2.9 Undervoltage Protection Function (27)

2.9.1 Principle

Undervoltage conditions may occur on a power system as a result of increased loading, fault conditions or incorrect regulation. Transient voltage dips may allow successful motor re-acceleration. However, sustained undervoltage conditions will result in motor stalling. Time delayed undervoltage protection is therefore commonly applied.

The undervoltage protection included within the P24x relays consists of two independent stages. This can be either ph-ph or ph-n measurement depending on the "V<Measur't Mode" setting.

Two stages are included to provide both alarm and trip stages, where required. Alternatively, different time settings may be required depending upon the severity of the voltage dip. i.e. motor loads will be able to withstand a small voltage depression for a longer time than if a major voltage excursion were to occur. Consequently, two stages could be used; one with a higher setting and a longer time delay and vice versa for the second stage.

The inverse characteristic is given by the following formula:

$$t = TMS/(1 - M)$$

Where:
TMS = Time Multiplier Setting
t = operating time in seconds
M = Applied input voltage/Relay setting voltage

2.9.2 Setting Guidelines for Undervoltage Protection

The voltage threshold setting for the undervoltage protection should be set at some value below the voltage excursions which may be expected under normal system operating conditions. Clearly, this threshold is dependent upon the system in question but typical healthy system voltage excursions may be in the order of -10% of nominal value.

Similar comments apply with regard to a time setting for this element, i.e. the required time delay is dependent upon the time for which the motor is able to withstand depressed voltage. A typical time setting may be in the order of 0.5 seconds.

The setting **Inhibit During St** must be set to **Enabled** to allow the voltage decrease during motor starting.

This feature must be interlocked with the motor control gear in order to ensure that it is disabled when the motor is stopped. The interlock is made by the CB Close signal.

2.10 Loss-of-Load Protection (37)

2.10.1 Principle

To detect loss of motor load the P24x relay includes a low forward power element. It can be used, for example, to protect electric pumps against becoming unprimed or to stop a motor in the event of a failure in the mechanical transmission.

Note	*A low forward power condition can only be established when the circuit breaker is closed and the active power calculated is above zero.*

Where rated power cannot be reached during starting (for example where the motor is started with no connected load) it will be necessary to inhibit this function for a set time.

This feature requires a 52a circuit breaker auxiliary contact mapped to an opto input to get the information CB closed/CB open.

2.10.2 Setting Guidelines

The setting of this element is very much system dependent. However, it will typically be set to 10-20% below minimum load.

Referring to the previous example details, the motor rated power will be:

$$P = \sqrt{3} \times 293 \times 11000 = 5.6 \text{ MVA}$$

Assuming that minimum loading may be 70%, the minimum power threshold may be set to 80% of this value i.e. 300 kW.

P< Power Set = 300 kW

The time delay, **P<Drop-off time**, should be set in excess of the time between motor starting and the load being established.

The time delay on pickup, **P<Time Delay**, is application dependent.

2.11 Synchronous Motor Protection

In the majority of applications, a synchronous motor would be started as an induction motor. If this is the case the aforementioned protection elements apply equally to both induction and synchronous motors. However, for the complete protection of synchronous motors, additional protective features will be required. These features are discussed in the following sections.

2.11.1 Out-of-Step Protection (Under Power Factor) (55)

A synchronous motor may decelerate and fall out of step when it is subjected to a mechanical overload exceeding its maximum available output. It may also lose synchronism from a fall in the field current or supply voltage. An out-of-step condition will subject the motor to undesirable overcurrent and pulsating torque, leading to eventual stalling.

When loss of synchronism is detected the motor must be disconnected from the supply.

Upon loss of synchronism a heavy current at a very low power factor is drawn from the supply. The P24x is able to monitor this change in power factor when the motor pole slips, thus allowing appropriate action to be taken. If the power factor passes under a defined threshold for a defined time, a trip is generated.

This feature is only enabled when the motor current is higher than 2%In and the voltage is higher than 1%Vn.

Setting Guidelines:

The ability of a motor to run at a low power factor will be design dependent.

For a unity power factor machine, the following settings will be typical:

Power factor = 0.9
Time delay = 50 ms
Drop-off time delay = 1 or 2 seconds above the start time of the machine

However, some machines are designed to operate at power factors as low as 0.7, in this case the setting will have to be adjusted accordingly.

2.11.2 Reverse Power (Loss-of-Supply) (32R)

On loss of supply, a synchronous motor should be disconnected if the supply could be restored automatically or without the machine operator's knowledge. This is to avoid the possibility of the supply being restored out of phase with the motor generated emf.

Starts are detected using 52A or motor current criteria.

2.11.3 Under-Frequency (81U)

If the motor is loaded, it will decelerate fairly quickly on loss of supply and the frequency of the terminal voltage will fall. The P24x relay is able to detect the fall in frequency and take appropriate action. This underfrequency element is a two stage device, which can be used for both alarm and trip purposes.

Starts are detected using 52A or motor current criteria.

Setting Guidelines:

This setting is very much system dependent, since it may be possible for the frequency of the supply to deviate during normal conditions.

Small source frequency changes may arise following power transmission disturbances or immediately following a sudden increase in system loading. Significant frequency variations are relatively rare for large interconnected power systems. In some regions of the world, significant drops in system frequency have been experienced due to unavoidable deficit of generation during peak load periods.

So as not to trip the motor unnecessarily, it is therefore important to determine the minimum system frequency and set the underfrequency element below this value.

2.11.4 Overvoltage (59)

If the supply busbars have no other load connected and the motor is not loaded, upon loss-of-supply the motor terminal voltage could rise instantaneously to 20-30% due to the open circuit regulation of the machine.

The P24x relay has an overvoltage feature which can be used to detect this condition. It consists of two independent definite time measuring elements which measure phase-phase voltage or phase-to-neutral voltage.

Setting Guidelines:

The setting is very much system dependent. However, it would typically be set to 15% above rated voltage. Therefore for a 110 V VT, the relay setting would be 1.15 x 110 = 126.5 V. The timer would be motor design and application dependent.

2.12 Field Failure Protection Function (40)

Complete loss of excitation may arise as a result of accidental tripping of the excitation system, an open circuit or short circuit occurring in the excitation DC circuit, flashover of any slip rings or failure of the excitation power source. The field failure protection of the P24x consists of two elements, an impedance element with two time delayed stages and a power factor alarm element.

When the excitation of a synchronous motor fails not enough synchronizing torque is provided to keep the rotor locked in step with the stator rotating magnetic field. The machine would then be excited from the power system and hence be operating as an induction motor. This results in an increasing level of reactive power being drawn from the power system at a highly lagging power factor. If the field excitation is too low to meet the load requirements the synchronous motor can pole slip. An out-of-step (pole slip) condition will subject the motor to undesirable overcurrent and pulsating torque, leading to eventual stalling.

Operation as an induction motor under field failure conditions relies upon the ability of the rest of the system being able to supply the required reactive power to the machine. If the system cannot supply enough reactive power the system voltage will drop and the system may become unstable. This could occur if a large motor running at high power suffers a loss of field when connected to a relatively weak system. To ensure fast tripping under this condition one of the impedance elements can be used with a short time delay. This can trip the machine quickly to preserve system stability. This element should have a small diameter to prevent tripping under power swinging conditions. The second impedance element, set with a larger diameter, can provide detection of field failure under lightly loaded conditions. This second element should be time delayed to prevent operation during power swing conditions.

The P24x offers a power factor alarm element in the field failure protection which can operate when the motor is running at a lagging power factor caused by a loss of excitation. There is also a dedicated out of step protection function based on power factor measurement, see the *Out-Of-Step Protection (Under Power Factor) (55)* section.

For large motors impedance based loss of excitation is recommended which provides improved protection for partial loss of field in addition to complete loss.

The field failure protection impedance elements are also provided with an adjustable delay on reset (delayed drop off) timer. This time delay can be set to avoid delayed tripping that may arise as a result of cyclic operation of the impedance measuring element, during the period of pole slipping following loss of excitation.

Some care would need to be exercised in setting this timer, since it could make the field failure protection function more likely to give an unwanted trip in the case of stable power swinging. The impedance element trip time delay should therefore be increased when setting the reset time delay.

2.12.1 Setting Guidelines for Field Failure Protection

Each stage of field failure protection may be selected as **Enabled** or **Disabled**, within the **FFail1 Status, FFail2 Status** cells. The power factor alarm element may be selected as Enabled or Disabled within the **FFail Alm** Status cell.

2.12.1.1 Impedance Element 1

To quickly detect a loss-of field condition, the diameter of the field failure impedance characteristic (**FFail1 Xb1**) should be set as large as possible, without conflicting with the impedance that might be seen under normal stable conditions or during stable power swing conditions.

Where a motor is operated with a rotor angle of less than 90° and never at a lagging power factor, it is recommended that the diameter of the impedance characteristic, **FFail1 Xb1**, is set equal to the machine direct-axis synchronous reactance. The characteristic offset, **FFail1 -Xa1** should be set equal to half the direct-axis transient reactance (0.5Xd’) in secondary ohms.

FFail1 Xb1 = Xd

FFail1 -Xa1 = 0.5 Xd’

Where:
Xd = machine direct-axis synchronous reactance in ohms
Xd’ = machine direct-axis transient reactance in ohms

Where high-speed voltage regulation equipment is used it may be possible to operate motors at rotor angles up to 120°. In this case, the impedance characteristic diameter, **FFail1 Xb1**, should be set to 50% of the direct-axis synchronous reactance (0.5Xd) and the offset, F**Fail1 -Xa1**, should be set to 75% of the direct axis transient reactance (0.75Xd’).

FFail1 Xb1 = 0.5 Xd

FFail1 -Xa1 = 0.75 Xd’

The field failure protection time delay, **FFail1 Time Delay**, should be set to minimize the risk of operation of the protection function during stable power swings following system disturbances. However, it should be ensured that the time delay is not so long that stator winding or rotor thermal damage will occur. A typical stator winding should be able to withstand a current of 2.0 p.u. for the order of 15 s. It may also take some time for the impedance seen at the motor terminals to enter the characteristic of the protection. A time delay less than 10 s would typically be applied. The minimum permissible delay, to avoid problems of false tripping due to stable power swings with the above impedance settings, would be of the order of 0.5 s.

The protection reset (delayed drop off) timer, **FFail1 DO Timer**, would typically be set to 0 s to give instantaneous reset of the stage. A setting other than 0 s can be used to provide an integrating function for instances when the impedance may cyclically enter and exit the characteristic. This can allow detection of pole slipping conditions. When settings other than 0 s are used the protection pick-up time delay, **FFail1 Time Delay**, should be increased to prevent mal-operation during stable power swing conditions.

It is desirable not to trip on the impedance field failure element until the field has been applied. Therefore, this feature can be selectively blocked in the PSL (FFail Block: DDB 117) until the motor comes up to speed and the field is applied.

2.12.1.2 Impedance Element 2

The second impedance element can be set to give fast operation when the field fails under high load conditions. The diameter of the characteristic, **FFail2 Xb**, should be set to 1 p.u. The characteristic offset, **FFail2 -Xa2**, should be set equal to half the direct-axis transient reactance (0.5Xd’).

$$\text{FFail2 Xb2} = \frac{\text{kV}^2}{\text{MVA}}$$

FFail2 -Xa2 = 0.5 Xd’

This setting will detect a field failure condition from full load to about 30% load.

The time delay, **FFail2 Time Delay**, can be set to instantaneous, i.e. 0 s.

The protection reset (delayed drop off) timer, F**Fail2 DO Timer**, would typically be set to 0 s to give instantaneous reset of the stage. A setting other than 0 s can be used to provide an integrating function for instances when the impedance may cyclically enter and exit the characteristic. This can allow detection of pole slipping conditions. When settings other than 0 s are used the protection pick-up time delay, **FFail2 Time Delay**, should be increased to prevent mal-operation during stable power swing conditions.

It is desirable not to trip on the impedance field failure element until the field has been applied. Therefore, this feature can be selectively blocked in the PSL (FFail Block: DDB 117) until the motor comes up to speed and the field is applied.

2.12.1.3 Power Factor Element

The power factor alarm can be used to signal to the operator that excitation has failed.

The angle setting, **FFail Alm Angle**, should be set to greater than any angle that the machine could be operated at in normal running. A typical setting would be 25°, equivalent to a power factor of 0.9 lagging. The power factor element time delay, **FFail Alm. Delay**, should be set longer than the (**FFail1 Time Delay**). This is to prevent operation of the alarm element under transient conditions such as power swinging and to provide discrimination with the conventional field failure impedance elements.

2.13 Circuit Breaker Failure (CBF) Protection (50BF)

Following inception of a fault one or more main protection devices will operate and issue a trip output to the circuit breaker(s) associated with the faulted circuit. Operation of the circuit breaker is essential to isolate the fault, and prevent damage / further damage to the power system. For transmission/sub-transmission systems, slow fault clearance can also threaten system stability. It is therefore common practice to install Circuit Breaker Failure (CBF) protection, which monitors that the circuit breaker has opened within a reasonable time. If the fault current has not been interrupted following a set time delay from circuit breaker trip initiation, CBF protection will operate.

CBF operation can be used to backtrip upstream circuit breakers to ensure that the fault is isolated correctly. CBF operation can also reset all start output contacts, ensuring that any blocks asserted on upstream protection are removed.

2.13.1 Breaker Failure Protection Configurations

The circuit breaker failure protection incorporates two time-delays, '**CB Fail 1 Timer**' and '**CB Fail 2 Timer**', allowing configuration for the following scenarios:

- Simple CBF, where only **CB Fail 1 Timer** is enabled. For any protection trip, the **CB Fail 1 Timer** is started, and normally reset when the circuit breaker opens to isolate the fault. If breaker opening is not detected, **CB Fail 1 Timer** times out and closes an output contact assigned to breaker fail (using the Programmable Scheme Logic (PSL)). This contact is used to backtrip upstream switchgear, generally tripping all infeeds connected to the same busbar section.
- A re-tripping scheme, plus delayed back-tripping. Here, **CB Fail 1 Timer** is used to route a trip to a second trip circuit of the same circuit breaker. This requires duplicated circuit breaker trip coils, and is known as re-tripping. Should re-tripping fail to open the circuit breaker, a back-trip may be issued following an additional time delay. The back-trip uses **CB Fail 2 Timer**, which is also started at the instant of the initial protection element trip.

CBF elements **CB Fail 1 Timer** and **CB Fail 2 Timer** can be configured to operate for trips triggered by protection elements within the relay or via an external protection trip. The latter is achieved by allocating one of the relay opto-isolated inputs to **External Trip** using the PSL.

2.13.2 Reset Mechanisms for Breaker Fail Timers

It is common practice to use low set undercurrent elements in protection relays to indicate that Circuit Breaker (CB) poles have interrupted the fault or load current, as required. This covers the following situations:

- Where CB auxiliary contacts are defective, or cannot be relied on to definitely indicate that the CB has tripped.
- Where a CB has started to open but has become jammed. This may result in continued arcing at the primary contacts, with an additional arcing resistance in the fault current path. Should this resistance severely limit fault current, the initiating protection element may reset. Therefore reset of the element may not give a reliable indication that the CB has opened fully.

For any protection function requiring current to operate, the relay uses operation of undercurrent elements (I<) to detect that the necessary circuit breaker poles have tripped and reset the CB fail timers. However, the undercurrent elements may not be reliable methods of resetting circuit breaker fail in all applications. For example:

- Where non-current operated protection, such as under/overvoltage or under/overfrequency, derives measurements from a line connected voltage transformer. Here, I< only gives a reliable reset method if the protected circuit would always have load current flowing. Detecting drop-off of the initiating protection element might be a more reliable method.
- Where non-current operated protection, such as under/overvoltage or under/overfrequency, derives measurements from a busbar connected voltage transformer. Again using I< would rely on the feeder normally being loaded. Also, tripping the circuit breaker may not remove the initiating condition from the busbar, so drop-off of the protection element may not occur. In such cases, the position of the circuit breaker auxiliary contacts may give the best reset method.

Resetting of the CBF is possible from a breaker open indication (from the relay's pole dead logic) or from a protection reset. In these cases resetting is only allowed provided the undercurrent elements have also been reset. The resetting options are summarised in the following table.

Initiation (menu selectable)	CB fail timer reset mechanism
Current based protection	The resetting mechanism is fixed (e.g. 50/51/46/87..) [IA< operates] & [IB< operates] & [IC< operates] & [IN< operates]
Sensitive earth fault element	The resetting mechanism is fixed. [ISEF< operates]
Non-current based protection (e.g. 27/59/81/32R..)	Three options are available. The user can select from the following options. [All I< and IN< elements operate] [Protection element reset] AND [All I< and IN< elements operate] CB open (all 3 poles) AND [All I< and IN< elements operate]
External protection	Three options are available. The user can select any or all of the options. [All I< and IN< elements operate] [External trip reset] AND [All I< and IN< elements operate] CB open (all 3 poles) AND [All I< and IN< elements operate]

Table 8 - CBF resetting options

2.13.3 Typical Breaker Fail Timer Settings

Typical timer settings to use are as follows:

CB fail reset mechanism	tBF time delay	Typical delay for 2½ cycle circuit breaker
Initiating element reset	CB interrupting time + element reset time (max.) + error in tBF timer + safety margin	50 + 50 + 10 + 50 = 160 ms
CB open	CB auxiliary contacts opening/closing time (max.) + error + safety margin	50 + 10 + 50 = 110 ms in tBF timer
Undercurrent elements	CB interrupting time + undercurrent element (max.) + operating time	50 + 12 + 50 = 112 ms safety margin

Table 9 - Typical CBF timer settings

Note that all CB Fail resetting involves the operation of the undercurrent elements. Where element reset or CB open resetting is used the undercurrent time setting should still be used if this proves to be the worst case.

The examples above consider direct tripping of a 2½ cycle circuit breaker. Note that where auxiliary tripping relays are used, an additional 10-15ms must be added to allow for trip relay operation.

2.14 Current Loop Inputs and Outputs

2.14.1 Current Loop Inputs

Four analog (or current loop) inputs are provided for transducers with ranges of 0 - 1 mA, 0 - 10 mA, 0 - 20 mA or 4 - 20 mA. The analog inputs can be used for various transducers such as vibration monitors, tachometers and pressure transducers. Associated with each input there are two protection stages, one for alarm and one for trip. Each stage can be individually enabled or disabled and each stage has a definite time delay setting. The Alarm and Trip stages can be set for operation when the input current is above the Alarm/Trip threshold. Associated with each current loop input are units (None, A, V, Hz, W, Var, VA, °C, F, %, s).

2.14.2 Setting Guidelines for Current Loop Inputs

For each analog input, the user can define the following:

- The current input range: 0 - 1 mA, 0 - 10 mA, 0 - 20 mA, 4 - 20 mA
- The analog input unit (A, V, Hz, W, Var, VA, °C, F, %, s, none)
- Analog input minimum value (setting range A: 0 to 100 K, V: 0 to 20 k, Hz: 0 to 100, W/VAr: +/- 1.41 G, VA: 0 to 1.41 G, °C: -40 to 400, F: -40 to 752, %: 0 to 150, s: 0 to 300, none -32.5 k to 50 k)
- Analog input maximum value (setting range as above)
- Alarm threshold, range within the maximum and minimum set values
- Alarm delay
- Trip threshold, range within maximum and minimum set values
- Trip delay

Each current loop input can be selected as Enabled or Disabled. The Alarm and Trip stages operate when the input current is above the input value. One of four types of analog inputs can be selected for transducers with ranges of 0 - 1 mA, 0 - 10 mA, 0 - 20 mA or 4 - 20 mA.

The Maximum and Minimum settings allow the user to enter the range of physical or electrical quantities measured by the transducer.

The user can select the unit of the measurement - None, A, V, Hz, W, Var, VA, °C, F, %, s. For example, if the analog input is used to monitor a power measuring transducer, the appropriate unit would be W.

The alarm and trip threshold settings should be set within the range of physical or electrical quantities defined by the user. The relay will convert the current input value into its corresponding transducer measuring value for the protection calculation.

For example if the Minimum is –1000 and the Maximum is 1000 for a 0 - 10 mA input, an input current of 10 mA is equivalent to a measurement value of 1000, 5 mA is 0 and 1mA is –800. If the Minimum is 1000 and the Maximum is -1000 for a 0 - 10 mA input, an input current of 10 mA is equivalent to a measurement value of –1000, 5 mA is 0 and 1 mA is 800. These values are available for display in the **Analog Input 1/2/3/4** cells in the **MEASUREMENTS 3** menu.

2.14.3 Current Loop Outputs

Four analog current outputs are provided with ranges of 0 to 1 mA, 0 to 10 mA, 0 to 20 mA or 4 to 20 mA, which can alleviate the need for separate transducers. These may be used to feed standard moving coil ammeters for analog indication of certain measured quantities or into a SCADA using an existing analog RTU.

The outputs can be assigned to any of the following relay measurements:

- Magnitudes of IA, IB, IC, IN
- IA RMS, IB RMS, IC RMS
- Magnitudes of VAB, VBC, VCA, VAN, VBN, VCN, VN
- VAN RMS, VBN RMS, VCN RMS
- Frequency
- Three-phase active, reactive and apparent power, Three-phase power factor
- RTD temperatures
- Number of Hot Starts Allowed, Thermal State, Time to Thermal Trip, Time to Next Start

The user can set the measuring range for each analog output. The range limits are defined by the Maximum and Minimum settings. This allows the user to “zoom in” and monitor a restricted range of the measurements with the desired resolution. The voltage, current and power quantities are in primary quantities.

2.14.4 Setting Guidelines for Current Loop Outputs

Each current loop output can be selected as Enabled or Disabled.
One of four types of analog output can be selected for transducers with ranges of 0-1 mA, 0-10 mA, 0-20 mA or 4-20 mA. The 4-20 mA range is often used so that an output current is still present when the measured value falls to zero. This is to give a fail safe indication and may be used to distinguish between the analog transducer output becoming faulty and the measurement falling to zero.

The Maximum and Minimum settings allow the user to enter the measuring range for each analog output. The range, step size and unit corresponding to the selected parameter is shown in the table in the Operations chapter. This allows the user to “zoom in” and monitor a restricted range of the measurements with the desired resolution.

The voltage, current and power quantities are in primary quantities. The relationship of the output current to the value of the measurand is of vital importance and needs careful consideration. Any receiving equipment must, of course, be used within its rating but, if possible, some kind of standard should be established.

One of the objectives must be to have the capability to monitor the voltage over a range of values, so an upper limit must be selected, typically 120%. However, this may lead to difficulties in scaling an instrument.

The same considerations apply to current transducers outputs and with added complexity to watt transducers outputs, where both the voltage and current transformer ratios must be taken into account.

Some of these difficulties do not need to be considered if the transducer is only feeding, for example, a SCADA outstation. Any equipment which can be programmed to apply a scaling factor to each input individually can accommodate most signals. The main consideration will be to ensure that the transducer is capable of providing a signal right up to the full-scale value of the input, that is, it does not saturate at the highest expected value of the measurand.

2.15 Phase Rotation

A facility is provided in the P241/P242/P243 to maintain correct operation of all the protection functions even when the motor is running in a reverse phase sequence. This is achieved through user configurable settings available for the two setting groups.

The default phase sequence for P24x is the clockwise rotation ABC. However, some applications may require an intermediate anti-clockwise phase rotation of ACB.

In process industry there is often a common practice to reverse two phases to facilitate the process, using phase reversal switches. The following sections describe some common scenarios and their effects.

For such applications the correct phase rotation settings can be applied for a specific operating mode and phase configuration in different setting groups. The phase configuration can then be set by selecting the appropriate setting group. This method of selecting the phase configuration removes the need for external switching of CT circuits or the duplication of relays with connections to different CT phases. The phase rotation settings should only be changed when the motor is off-line so that transient differences in the phase rotation between the relay and power system due to the switching of phases don’t cause operation of any of the protection functions. To ensure that setting groups are only changed when the machine is off-line the changing of the setting groups could be interlocked with the IA/IB/IC undercurrent start signals and an undervoltage start signal in the PSL.

All the protection functions that use the positive and negative sequence component of voltage and current will be affected (Thermal Overload, 3 Ph Volt Check, Negative Sequence O/C, VT Supervision). The motor differential protection is not affected, since the phase reversal applies to CT1 and CT2 in the same way.

3 APPLICATION OF NON-PROTECTION FUNCTIONS

3.1 Voltage Transformer Supervision (VTS)

The Voltage Transformer Supervision (VTS) feature is used to detect failure of the ac voltage inputs to the relay. This may be caused by internal voltage transformer faults, overloading, or faults on the interconnecting wiring to relays. This usually results in one or more VT fuses blowing. Following a failure of the ac voltage input there would be a misrepresentation of the phase voltages on the power system, as measured by the relay, which may result in mal-operation.

The VTS logic in the relay is designed to detect the voltage failure, and automatically adjust the configuration of protection elements whose stability would otherwise be compromised. A time-delayed alarm output is also available.

3.1.1 Setting the VT Supervision Element

If the VT supervision is enabled, these operations will occur upon detection of VTS.

- VTS provides alarm indication.
- Blocking of voltage dependent protection elements.
- The VTS block will be latched after a user settable time delay 'VTS Time Delay'. Once the signal has latched then resetting is available, provided the VTS condition has been removed and the 3 phase voltages have been restored above the phase level detector settings or CB has been opened.

The **VTS I> Inhibit** overcurrent setting is used to inhibit the voltage transformer supervision in the event of a loss of all three phase voltages caused by a close up 3-phase fault occurring on the system following closure of the CB to energize the line. This element should be set in excess of any non-fault based currents on line energization (load, line charging current, transformer inrush current if applicable) but below the level of current produced by a close up 3-phase fault.

This **VTS I2> Inhibit** NPS overcurrent setting is used to inhibit the voltage transformer supervision in the event of a fault occurring on the system with negative sequence current above this setting. The NPS current pick-up threshold must be set higher than the negative phase sequence current due to the maximum normal load unbalance on the system. This can be set practically at the commissioning stage, making use of the relay measurement function to display the standing negative phase sequence current, and setting at least 20% above this figure.

The delta (superimposed) phase current setting is used to distinguish between a close up 3 phase fault and a 3 phase VT failure condition under load conditions. For a close up 3 phase fault there will be a loss of 3 phase voltage but there will be a delta change in the measured current. For a 3 phase VT failure where there will a loss of 3 phase voltage but no delta change in the measured current.

The **Delta I>** superimposed current setting is used to detect the change in current for a close up 3 phase fault when the CB is closed and block the VTS. This element should be set less than the superimposed current due to a 3 phase fault. The default setting of 0.1In is adequate for the majority of applications.

The **Threshold 3P** undervoltage setting is used to indicate a loss of 3 phase voltage that could be caused by a 3 phase VT fail condition or a close up 3 phase fault. The default setting of 30 V is adequate for the majority of applications.

3.2 Current Transformer Supervision (CTS)

The Current Transformer Supervision (CTS) feature is used to detect failure of one or more of the ac phase current inputs to the relay. Failure of a phase CT or an open circuit of the interconnecting wiring can result in incorrect operation of any current operated element. Additionally, interruption in the ac current circuits risks dangerous CT secondary voltages being generated.

3.2.1 Setting the CT Supervision Element

The residual voltage setting, **CTS VN< Inhibit** and the residual current setting, **CTS IN> set**, should be set to avoid unwanted operation during healthy system conditions. For example **CTS VN< Inhibit** should be set to 120% of the maximum steady state residual voltage. The **CTS IN> set** will typically be set below minimum load current. The time-delayed alarm, **CTS Time delay**, is generally set to 5 seconds.

Where the magnitude of residual voltage during an earth fault is unpredictable, the element must be disabled to prevent a protection elements being blocked during fault conditions.

The DDB: '**CT Fail Alarm**' output is associated to CTS in the PSL (see the *Programmable Logic* chapter).

3.3 Trip Circuit Supervision (TCS)

The trip circuit, in most protective schemes, extends beyond the IED enclosure and passes through components such as fuses, links, relay contacts, auxiliary switches and other terminal boards. This complex arrangement, coupled with the importance of the trip circuit, has led to dedicated schemes for its supervision.
Several Trip Circuit Supervision (TCS) scheme variants are offered. Although there are no dedicated settings for TCS, in the MiCOM P24x / P34x / P443 / P445 / P446 / P54x / P547 / P64x / P746 / P841 the following schemes can be produced using the Programmable Scheme Logic (PSL). A user alarm is used in the PSL to issue an alarm message on the relay front display. If necessary, the user alarm can be re-named using the menu text editor to indicate that there is a fault with the trip circuit.

3.3.1 TCS Scheme 1

3.3.1.1 Scheme Description

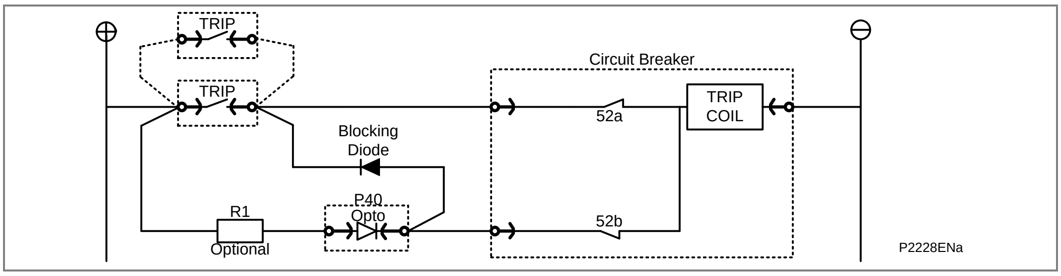


Figure 18 - TCS scheme 1

This scheme provides supervision of the trip coil with the breaker open or closed, however, pre-closing supervision is not provided. This scheme is also incompatible with latched trip contacts, as a latched contact will short out the opto for greater than the recommended DDO timer setting of 400ms. If breaker status monitoring is required a further 1 or 2 opto inputs must be used.

Note	*A 52a CB auxiliary contact follows the CB position and a 52b contact is the opposite.*

When the breaker is closed, supervision current passes through the opto input, blocking diode and trip coil. When the breaker is open current still flows through the opto input and into the trip coil via the 52b auxiliary contact. Hence, no supervision of the trip path is provided whilst the breaker is open. Any fault in the trip path will only be detected on CB closing, after a 400ms delay.
Resistor R1 is an optional resistor that can be fitted to prevent maloperation of the circuit breaker if the opto input is inadvertently shorted, by limiting the current to <60mA. The resistor should not be fitted for auxiliary voltage ranges of 30/34 volts or less, as satisfactory operation can no longer be guaranteed. The table below shows the appropriate resistor value and voltage setting (**Opto Config.** menu) for this scheme.
This TCS scheme will function correctly even without resistor R1, since the opto input automatically limits the supervision current to less that 10mA. However, if the opto is accidentally shorted the circuit breaker may trip.

Auxiliary Voltage (Vx)	Resistor R1 (ohms)	Opto Voltage Setting with R1 Fitted
24/27	-	-
30/34	-	-
48/54	1.2k	24/27
110/250	2.5k	48/54
220/250	5.0k	110/125

Note	*When R1 is not fitted the opto voltage setting must be set equal to supply voltage of the supervision circuit.*

3.3.2 Scheme 1 PSL

The next figure shows the scheme logic diagram for the TCS scheme 1. Any of the available opto inputs can be used to show whether or not the trip circuit is healthy. The delay on drop off timer operates as soon as the opto is energized, but will take 400ms to drop off/reset in the event of a trip circuit failure. The 400ms delay prevents a false alarm due to voltage dips caused by faults in other circuits or during normal tripping operation when the opto input is shorted by a self-reset trip contact. When the timer is operated the NC (normally closed) output relay opens and the LED and user alarms are reset.

The 50ms delay on pick-up timer prevents false LED and user alarm indications during the relay power up time, following an auxiliary supply interruption.

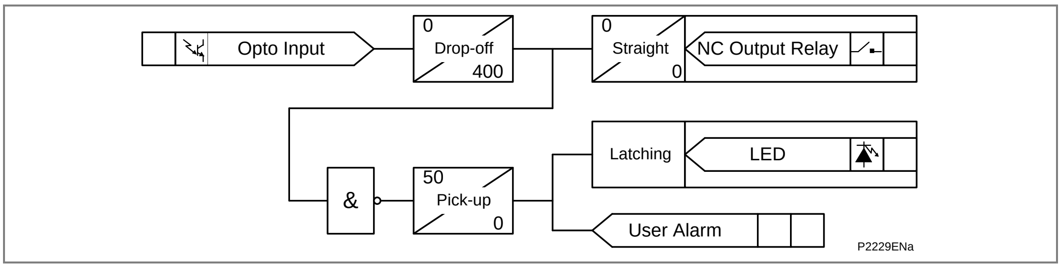


Figure 19 - PSL for TCS schemes 1 and 3

3.3.3 TCS Scheme 2

3.3.3.1 Scheme Description

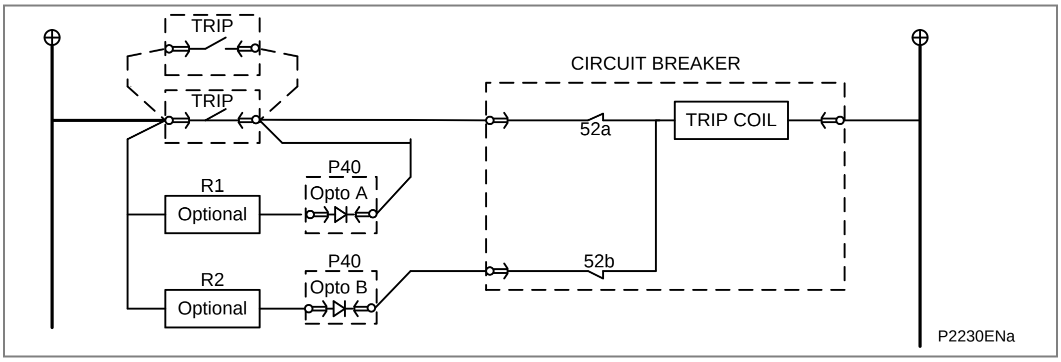


Figure 20 - TCS scheme 2

Much like scheme 1, this scheme provides supervision of the trip coil with the breaker open or closed and also does not provide pre-closing supervision. However, using two opto inputs allows the relay to correctly monitor the circuit breaker status since they are connected in series with the CB auxiliary contacts. This is achieved by assigning Opto A to the 52a contact and Opto B to the 52b contact. Provided the **Circuit Breaker Status** is set to **52a and 52b** (CB CONTROL column) the relay will correctly monitor the status of the breaker. This scheme is also fully compatible with latched contacts as the supervision current will be maintained through the 52b contact when the trip contact is closed.

When the breaker is closed, supervision current passes through opto input A and the trip coil. When the breaker is open current flows through opto input B and the trip coil. As with scheme 1, no supervision of the trip path is provided whilst the breaker is open. Any fault in the trip path will only be detected on CB closing, after a 400 ms delay.

As with scheme 1, optional resistors R1 and R2 can be added to prevent tripping of the CB if either opto is shorted. The resistor values of R1 and R2 are equal and can be set the same as R1 in scheme 1.

3.3.4 Scheme 2 PSL

The PSL for this scheme is practically the same as that of scheme 1. The main difference being that both opto inputs must be off before a trip circuit fail alarm is given.

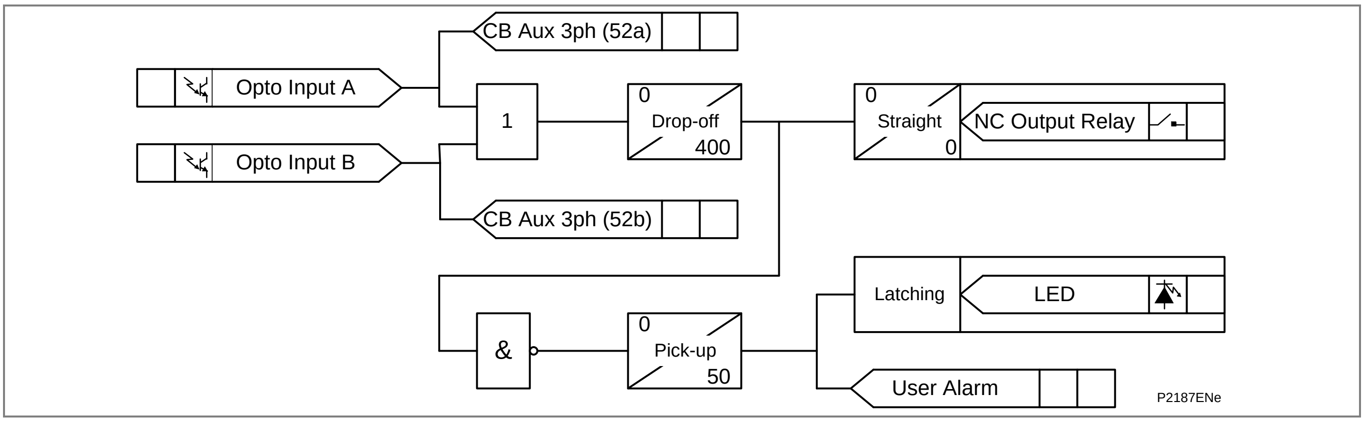


Figure 21 – PSL for TCS scheme 2

3.3.5 TCS Scheme 3

3.3.5.1 Scheme Description

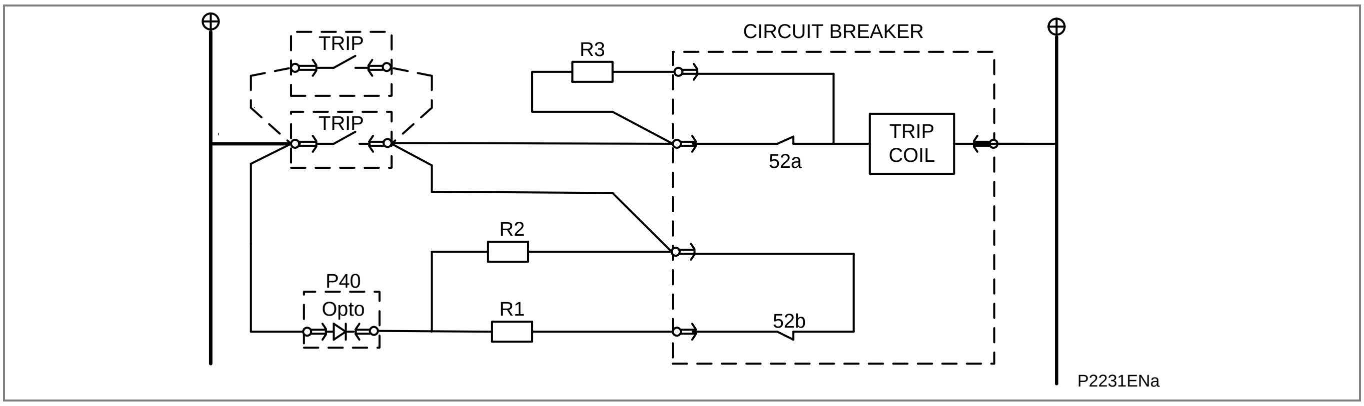


Figure 22 – TCS scheme 3

Scheme 3 is designed to provide supervision of the trip coil with the breaker open or closed, but unlike schemes 1 and 2, it also provides pre-closing supervision. Since only one opto input is used, this scheme is not compatible with latched trip contacts. If circuit breaker status monitoring is required a further 1 or 2 opto inputs must be used.

When the breaker is closed, supervision current passes through the opto input, resistor R2 and the trip coil. When the breaker is open current flows through the opto input, resistors R1 and R2 (in parallel), resistor R3 and the trip coil. Unlike schemes 1 and 2, supervision current is maintained through the trip path with the breaker in either state, thus giving pre-closing supervision.

As with schemes 1 and 2, resistors R1 and R2 are used to prevent false tripping, if the opto-input is accidentally shorted. However, unlike the other two schemes, this scheme is dependent upon the position and value of these resistors. Removing them would result in incomplete trip circuit monitoring. The table below shows the resistor values and voltage settings required for satisfactory operation.

Auxiliary Voltage (Vx)	Resistor R1 & R2 (ohms)	Resistor R3 (ohms)	Opto Voltage Setting
24/27	-	-	-
30/34	-	-	-
48/54	1.2k	0.6k	24/27
110/250	2.5k	1.2k	48/54
220/250	5.0k	2.5k	110/125

Note *Scheme 3 is not compatible with auxiliary supply voltages of 30/34 volts and below.*

3.3.6 Scheme 3 PSL

The PSL for scheme 3 is identical to that of scheme 1.

4 CURRENT TRANSFORMER REQUIREMENTS

The current transformer requirements for each current input will depend on the protection function with which they are related and whether the line current transformers are being shared with other current inputs. Where current transformers are being shared by multiple current inputs, the kneepoint voltage requirements should be calculated for each input and the highest calculated value used.

The CT requirements for the P24x protection functions except the current differential are as shown below. The P243 is the only model which includes differential protection and for this relay the highest calculated value from the general protection and differential protection CT requirements should be used. The Differential CT requirements are shown in section 0.

The general Current Transformer (CT) requirements are based on a maximum prospective fault current of 50 times the relay rated current (In) and the relay having an instantaneous setting of 25 times rated current (In). The CT requirements are designed to provide operation of all protection elements except the differential protection.

Where the criteria for a specific application are in excess of those detailed above, or the actual lead resistance exceeds the limiting value quoted, the CT requirements may need to be increased according to the formulae in these sections:

- Non-Directional Definite Time/IDMT Short Circuit and Definite Time/IDMT Derived Earth Fault Protection
- Non-Directional Instantaneous Short Circuit and Derived Earth Fault Protection
- Directional Definite Time/IDMT Derived Earth Fault Protection

Nominal rating	Nominal output	Accuracy class	Accuracy limited factor	Limiting lead resistance
1 A	2.5 VA	10P	20	1.3 ohms
5 A	7.5 VA	10P	20	0.11 ohms

Table 10 - CT requirements for P24x protection functions excluding differential protection

4.1 Motor Differential Function (P243)

4.1.1 Biased Differential Protection

The kneepoint voltage requirements for the current transformers used for the current inputs of the motor differential function based on settings of Is1 = 0.05 In, k1 = 0%, Is2 = 1.2 In, k2 = 150%, and with a boundary condition of starting current less than or equal to 10In, are:

Where the motor is not earthed or resistance earthed at the motor neutral point then the CT knee point voltage requirements are:

$$V_k \geq 30I_n (R_{ct} + R_L + R_r) \text{ with a minimum of } \frac{60}{In}$$

Where the motor is solidly earthed at the motor neutral point then the CT knee point voltage requirements are:

$$V_k \geq 40I_n (R_{ct} + 2R_L + R_r) \text{ with a minimum of } \frac{60}{In}$$

Where:

V_k = Minimum current transformer kneepoint voltage for through fault stability.
I_n = Relay rated current.
R_{ct} = Resistance of current transformer secondary winding (Ω).
R_L = Resistance of a single lead from relay to current transformer (Ω).
R_r = Resistance of any other protective relays sharing the current transformer (Ω).

For Class-X current transformers, the excitation current at the calculated kneepoint voltage requirement should be less than 2.5In (<5% of the maximum perspective fault current 50 In, on which these CT requirements are based). For IEC standard protection class current transformers, it should be ensured that class 5P are used.

4.1.2 High Impedance Differential Protection

If the motor differential protection function is to be used to implement high impedance differential protection, then the current transformer requirements will be as follows:

$R_s = [1.5 \times (If) * (R_{CT} + 2R_L)] / I_{S1}$

$V_K \geq 2 \times I_{S1} * R_s$

Where:

Rs	=	Value of stabilizing resistor (ohms)
If	=	Maximum starting current (amps)
V_K	=	CT knee point voltage (volts)
I_{S1}	=	Current setting of differential element (amps)
R_{CT}	=	Resistance of current transformer secondary winding (ohms)
R_L	=	Resistance of a single lead from relay to current transformer (ohms)

4.2 Non-Directional Definite Time/IDMT Short Circuit and Definite Time/IDMT Derived Earth Fault Protection

4.2.1 Definite Time/IDMT Delayed Short Circuit Elements

$V_K \geq I_{cp}/2 \times (R_{CT} + R_L + R_{rp})$

4.2.2 Definite Time Delayed/IDMT Derived Earth Fault Elements

$V_K \geq I_{cn}/2 \times (R_{CT} + 2_{RL} + R_{rp} + R_{rn})$

4.3 Non-Directional Instantaneous Short Circuit and Derived Earth Fault Protection

4.3.1 Instantaneous Short Circuit Elements

$V_K \geq I_{sp} \times (R_{CT} + R_L + R_{rp})$

4.3.2 Instantaneous Derived Earth Fault Elements

$V_K \geq I_{sn} \times (R_{CT} + 2R_L + R_{rp} + R_{rn})$

4.4 Directional Definite Time/IDMT Derived Earth Fault Protection

4.4.1 Directional Time Delayed Derived Earth Fault Protection

$V_K \geq Icn/2 \times (R_{CT} + 2_{RL} + R_{rp} + R_{rn})$

4.4.2 Directional Instantaneous Derived Earth Fault Protection

$V_K \geq Ifn/2 \times (R_{CT} + 2R_L + R_{rp} + R_{rn})$

4.5 Non-Directional/Directional Definite Time/IDMT Sensitive Earth Fault (SEF) Protection

4.5.1 Non-Directional Time Delayed SEF Protection (Residually Connected)

$V_K \geq I_{cn}/2 \times (R_{CT} + 2R_L + R_{rp} + R_{rn})$

4.5.2 Non-Directional Instantaneous SEF Protection (Residually Connected)

$V_K \geq I_{sn}/2 \times (R_{CT} + 2R_L + R_{rp} + R_{rn})$

4.5.3 Directional Time Delayed SEF Protection (Residually Connected)

$V_K \geq I_{cn}/2 \times (R_{CT} + 2R_L + R_{rp} + R_{rn})$

4.5.4 Directional Instantaneous SEF Protection (Residually Connected)

$V_K \geq I_{fn}/2 \times (R_{CT} + 2R_L + R_{rp} + R_{rn})$

4.5.5 SEF Protection - as fed from a Core-Balance CT

Core balance current transformers of metering class accuracy are required and should have a limiting secondary voltage satisfying the formulae given below:

Directional non-directional time delayed element:

$V_K \geq I_{cn}/2 \times (R_{CT} + 2R_L + R_{rn})$

Directional instantaneous element:

$V_K \geq I_{fn}/2 \times (R_{CT} + 2R_L + R_{rn})$

Non-directional instantaneous element:

$V_K \geq I_{sn}/2 \times (R_{CT} + 2R_L + R_{rn})$

Note	*In addition, it should be ensured that the phase error of the applied core balance current transformer is less than 90 minutes at 10% of rated current and less than 150 minutes at 1% of rated current.*

Abbreviations used in the previous formulae are explained below:

Where:

V_K	=	Required CT knee-point voltage (volts)
I_{fn}	=	Maximum prospective secondary earth fault current (amps)
I_{fp}	=	Maximum prospective secondary phase fault current (amps)
I_{cn}	=	Maximum prospective secondary earth fault current or 31 times I> setting (whichever is lower) (amps)
I_{cp}	=	Maximum prospective secondary phase fault current or 31 times I> setting (whichever is lower) (amps)
I_{sn}	=	Stage 2 Earth Fault setting (amps)
I_{sp}	=	Stage 2 setting (amps)
R_{CT}	=	Resistance of current transformer secondary winding (ohms)
R_L	=	Resistance of a single lead from relay to current transformer (ohms)
R_{rp}	=	Impedance of relay phase current input at 30In (ohms)
R_{rn}	=	Impedance of the relay neutral current input at 30In (ohms)

4.6 Converting an IEC185 Current Transformer Standard Protection Classification to a Kneepoint Voltage

The suitability of an IEC standard protection class current transformer can be checked against the kneepoint voltage requirements specified previously.

If, for example, the available current transformers have a 15 VA 5P 10 designation, then an estimated kneepoint voltage can be obtained as follows:

$$V_k = \frac{VA \times ALF}{In} + A_{LF} \times I_n \times R_{ct}$$

Where:

V_k	=	Required kneepoint voltage
VA	=	Current transformer rated burden (VA)
ALF	=	Accuracy limit factor
I_n	=	Current transformer secondary rated current (A)
R_{ct}	=	Resistance of current transformer secondary winding (Ω)

If Rct is not available, then the second term in the above equation can be ignored.
Example: 400/5A, 15VA 5P 10, Rct = 0.2Ω

$$V_k = \frac{15 \times 10}{5} + 10 \times 5 + 0.2$$

$$V_k = 40\ V$$

4.7 Converting IEC185 Current Transformer Standard Protection Classification to an ANSI/IEEE Standard Voltage Rating

MiCOM Px40 series protection is compatible with ANSI/IEEE current transformers as specified in the IEEE C57.13 standard. The applicable class for protection is class "C", which specifies a non air-gapped core. The CT design is identical to IEC class P, or British Standard class X, but the rating is specified differently.

The ANSI/IEEE "C" Class standard voltage rating required will be lower than an IEC knee point voltage. This is because the ANSI/IEEE voltage rating is defined in terms of useful output voltage at the terminals of the CT, whereas the IEC knee point voltage includes the voltage drop across the internal resistance of the CT secondary winding added to the useful output. The IEC/BS knee point is also typically 5% higher than the ANSI/IEEE knee point.

Therefore:

$$V_c = [V_k - \text{Internal voltage drop}] / 1.05$$
$$= [V_k - (In\ .\ RCT\ .\ ALF)] / 1.05$$

Where:

Vc	=	"C" Class standard voltage rating
Vk	=	IEC Knee point voltage required
In	=	CT rated current = 5 A in USA
RCT	=	CT secondary winding resistance (for 5 A CTs, the typical resistance is 0.002 ohms/secondary turn)
ALF	=	The CT accuracy limit factor, the rated dynamic current output of a "C" class CT (Kssc) is always 20 x In

The IEC accuracy limit factor is identical to the 20 times secondary current ANSI/IEEE rating.
Therefore:

$$V_c = [\ V_k - (100\ .\ R_{CT}\ )\ ] / 1.05$$

5 READ ONLY MODE

With IEC 61850 and Ethernet/Internet communication capabilities, security has become a pressing issue. The Px40 IED provides a facility to allow the user to enable or disable the change in configuration remotely.

Read Only mode can be enabled/disabled for the following rear ports:

- Rear Port 1 - IEC 60870-5-103 and Courier protocols
- Rear Port 2 (if fitted) - Courier protocol
- Ethernet Port (if fitted) - Courier protocol (**tunnelled**)

6 AUXILIARY SUPPLY FUSE RATING

In the Safety Information part of this manual, the maximum allowable fuse rating of 16A is quoted. To allow time grading with fuses upstream, a lower fuselink current rating is often preferable. Use of standard ratings of between 6A and 16A is recommended. Low voltage fuselinks, rated at 250V minimum and compliant with IEC60269-2 general application type gG are acceptable, with high rupturing capacity. This gives equivalent characteristics to HRC "red spot" fuses type NIT/TIA often specified historically.

The table below recommends advisory limits on relays connected per fused spur. This applies to MiCOM Px40 series devices with hardware suffix C and higher, as these have inrush current limitation on switch-on, to conserve the fuse-link.

Maximum Number of MiCOM Px40 Relays Recommended Per Fuse				
Battery Nominal Voltage	**6A**	**10A Fuse**	**15 or 16A Fuse**	**Fuse Rating > 16A**
24 to 54V	2	4	6	Not permitted
60 to 125V	4	8	12	Not permitted
138 to 250V	6	10	16	Not permitted
Alternatively, Miniature Circuit Breakers (MCBs) may be used to protect the auxiliary supply circuits.				

Table 11 - Maximum number of Px40 relays recommended per fuse

USING THE PSL EDITOR

CHAPTER 7

Date:	05/2017	
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.	
Hardware Suffix:	All MiCOM Px4x products	
Software Version:	All MiCOM Px4x products	
Connection Diagrams:	P14x (P141, P142, P143 & P145): 10P141xx (xx = 01 to 02) 10P142xx (xx = 01 to 05) 10P143xx (xx = 01 to 11) 10P145xx (xx = 01 to 11) P24x (P241, P242 & P243): 10P241xx (xx = 01 to 02) 10P242xx (xx = 01) 10P243xx (xx = 01) P34x (P342, P343, P344, P345 & P391): 10P342xx (xx = 01 to 17) 10P343xx (xx = 01 to 19) 10P344xx (xx = 01 to 12) 10P345xx (xx = 01 to 07) 10P391xx (xx = 01 to 02) P445: 10P445xx (xx = 01 to 04) P44x: 10P44101 (SH 1 & 2) 10P44201 (SH 1 & 2) 10P44202 (SH 1) 10P44203 (SH 1 & 2) 10P44401 (SH 1) 10P44402 (SH 1) 10P44403 (SH 1 & 2) 10P44404 (SH 1) 10P44405 (SH 1) 10P44407 (SH 1 & 2) P44y (P443 & P446): 10P44303 (SH 01 and 03) 10P44304 (SH 01 and 03) 10P44305 (SH 01 and 03) 10P44306 (SH 01 and 03) 10P44600 10P44601 (SH 1 to 2) 10P44602 (SH 1 to 2) 10P44603 (SH 1 to 2)	P54x (P543, P544, P545 & P546): 10P54302 (SH 1 to 2) 10P54303 (SH 1 to 2) 10P54400 10P54404 (SH 1 to 2) 10P54405 (SH 1 to 2) 10P54502 (SH 1 to 2) 10P54503 (SH 1 to 2) 10P54600 10P54604 (SH 1 to 2) 10P54605 (SH 1 to 2) 10P54606 (SH 1 to 2) P547: 10P54702xx (xx = 01 to 02) 10P54703xx (xx = 01 to 02) 10P54704xx (xx = 01 to 02) 10P54705xx (xx = 01 to 02) P64x (P642, P643 & P645): 10P642xx (xx = 1 to 10) 10P643xx (xx = 1 to 6) 10P645xx (xx = 1 to 9) P74x: 10P740xx (xx = 01 to 07) P746: 10P746xx (xx = 00 to 21) P841: 10P84100 10P84101 (SH 1 to 2) 10P84102 (SH 1 to 2) 10P84103 (SH 1 to 2) 10P84104 (SH 1 to 2) 10P84105 (SH 1 to 2) P849: 10P849xx (xx = 01 to 06)

CONTENTS

FIGURES

TABLES

Notes:

1 OVERVIEW

The purpose of the Programmable Scheme Logic (PSL) is to allow the relay user to configure an individual protection scheme to suit their own particular application. This is achieved through the use of programmable logic gates and delay timers.

The input to the PSL is any combination of the status of opto inputs. It is also used to assign the mapping of functions to the opto inputs and output contacts, the outputs of the protection elements, e.g. protection starts and trips, and the outputs of the fixed protection scheme logic. The fixed scheme logic provides the relay's standard protection schemes.

The PSL itself consists of software logic gates and timers. The logic gates can be programmed to perform a range of different logic functions and can accept any number of inputs. The timers are used either to create a programmable delay, and/or to condition the logic outputs, e.g. to create a pulse of fixed duration on the output regardless of the length of the pulse on the input. The outputs of the PSL are the LEDs on the front panel of the relay and the output contacts at the rear.

The execution of the PSL logic is event driven; the logic is processed whenever any of its inputs change, for example as a result of a change in one of the digital input signals or a trip output from a protection element. Also, only the part of the PSL logic that is affected by the particular input change that has occurred is processed. This reduces the amount of processing time that is used by the PSL; even with large, complex PSL schemes the relay trip time will not lengthen.

This system provides flexibility for the user to create their own scheme logic design. However, it also means that the PSL can be configured into a very complex system; hence setting of the PSL is implemented through the PC support package MiCOM S1 Studio.

Note	*MiCOM S1 Studio has been renamed as Easergy Studio.*

2 EASERGY STUDIO (MICOM S1 STUDIO) PSL EDITOR

Note	MiCOM S1 Studio has been renamed as Easergy Studio.

The PSL Editor can be used inside Easergy Studio (MiCOM S1 Studio) or directly.
This chapter assumes that you are using the PSL Editor from within Easergy Studio (MiCOM S1 Studio).
If you use it from Easergy Studio (MiCOM S1 Studio), the Studio software will be locked whilst you are using the PSL editor software. The Studio software will be unlocked when you close the PSL Editor software.
The Easergy Studio (MiCOM S1 Studio) product is updated periodically. These updates provide support for new features (such as allowing you to manage new MiCOM products, as well as using new software releases and hardware suffixes). The updates may also include fixes. **Accordingly, we strongly advise customers to use the latest Schneider Electric version of Easergy Studio (MiCOM S1 Studio).**

2.1 How to Obtain Easergy Studio (MiCOM S1 Studio) Software

Easergy Studio (MiCOM S1 Studio) is available from the Schneider Electric website:

- www.schneider-electric.com

2.2 To Start Easergy Studio (MiCOM S1 Studio)

To Start the Easergy Studio (MiCOM S1 Studio) software, click the **Start** > **Programs** > **Schneider Electric** > **MiCOM S1 Studio** > **MiCOM S1 Studio** menu option.

2.3 To Open a Pre-Existing System

Within Easergy Studio (MiCOM S1 Studio), click the **File** + **Open System** menu option. Navigate to where the scheme is stored, then double-click to open the scheme.

2.4 To Start the PSL Editor

The PSL editor lets you connect to any MiCOM device front port, retrieve and edit its PSL files and send the modified file back to a suitable MiCOM device.
Px30 and Px40 products are edited different versions of the PSL Editor. There is one link to the Px30 editor and one link to the Px40 editor.
To start the PSL editor for Px40 products:

Highlight the PSL file you wish to edit, and then either:

Double-click the highlighted PSL file,

Click the open icon or

In the MiCOM S1 Studio main menu, select Tools > PSL PSL editor (Px40) menu.

The PSL Editor will then start, and show you the relevant PSL Diagram(s) for the file you have opened. An example of such a PSL diagram is shown in the *Example of a PSL editor module* diagram.

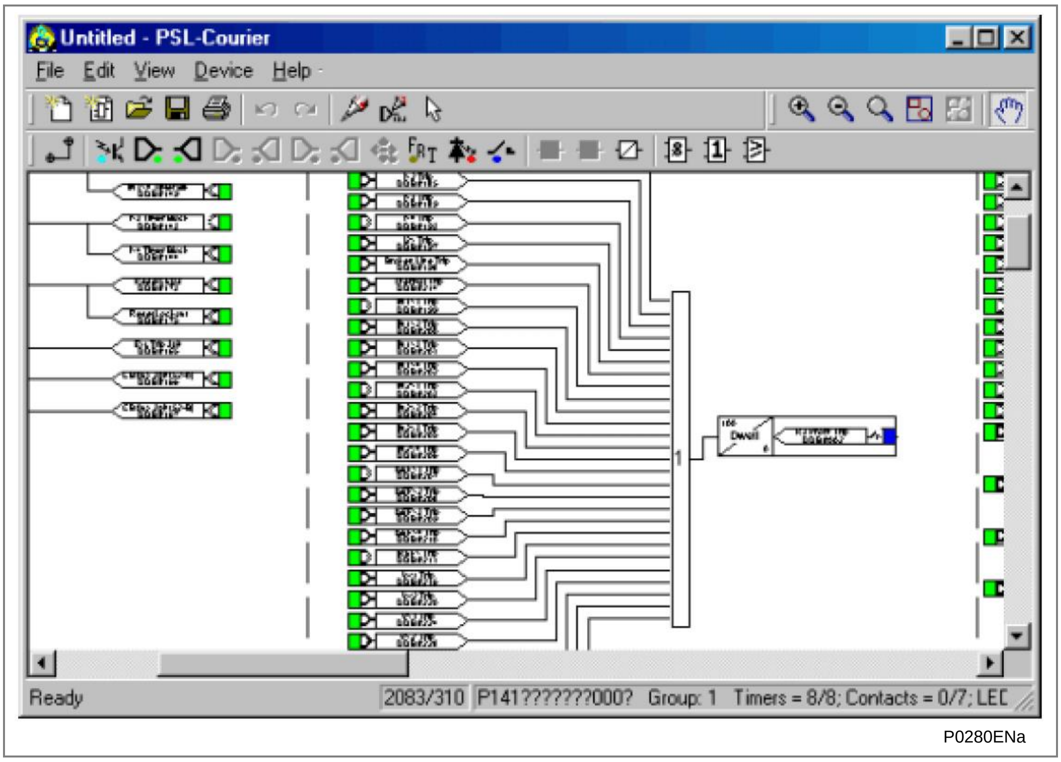


Figure 1 - Example of a PSL editor module

2.5 How to use MiCOM PSL Editor

The MiCOM PSL editor lets you:

- Start a new PSL diagram
- Extract a PSL file from a MiCOM Px40 IED
- Open a diagram from a PSL file
- Add logic components to a PSL file
- Move components in a PSL file
- Edit link of a PSL file
- Add link to a PSL file
- Highlight path in a PSL file
- Use a conditioner output to control logic
- Download PSL file to a MiCOM Px40 IED
- Print PSL files

For a detailed discussion on how to use these functions, please refer to the Easergy Studio (MiCOM S1 Studio) User Manual.

2.6 Warnings

Before the scheme is sent to the relay checks are done. Various warning messages may be displayed as a result of these checks.

The Editor first reads in the model number of the connected relay, then compares it with the stored model number. A "wildcard" comparison is used. If a model mismatch occurs, a warning is generated before sending starts. Both the stored model number and the number read from the relay are displayed with the warning. However, the user must decide if the settings to be sent are compatible with the relay that is connected. Ignoring the warning could lead to undesired behavior of the relay.

If there are any potential problems of an obvious nature then a list will be generated. The types of potential problems that the program attempts to detect are:

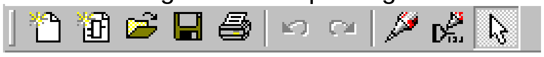
- One or more gates, LED signals, contact signals, and/or timers have their outputs linked directly back to their inputs. An erroneous link of this sort could lock up the relay, or cause other more subtle problems to arise.
- Inputs to Trigger (ITT) exceeds the number of inputs. If a programmable gate has its ITT value set to greater than the number of actual inputs; the gate can never activate. There is no lower ITT value check. A 0-value does not generate a warning.
- Too many gates. There is a theoretical upper limit of 256 gates in a scheme, but the practical limit is determined by the complexity of the logic. In practice the scheme would have to be very complex, and this error is unlikely to occur.
- Too many links. There is no fixed upper limit to the number of links in a scheme. However, as with the maximum number of gates, the practical limit is determined by the complexity of the logic. In practice the scheme would have to be very complex, and this error is unlikely to occur.

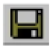
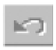
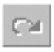
3 TOOLBAR AND COMMANDS

There are a number of toolbars available for easy navigation and editing of PSL.

3.1 Standard Tools

For file management and printing.

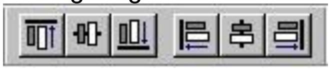


	Blank Scheme	Create a blank scheme based on a relay model.
	Default Configuration	Create a default scheme based on a relay model.
	Open	Open an existing diagram.
	Save	Save the active diagram.
	Print	Display the Windows Print dialog, enabling you to print the current diagram.
	Undo	Undo the last action.
	Redo	Redo the previously undone action.
	Redraw	Redraw the diagram.
	No of DDBs	Display the DDB numbers of the links.
	Calculate CRC	Calculate unique number based on both the function and layout of the logic.
	Compare Files	Compare current file with another stored on disk.
	Select	Enable the select function. While this button is active, the mouse pointer is displayed as an arrow. This is the default mouse pointer. It is sometimes referred to as the selection pointer.

Point to a component and click the left mouse button to select it. Several components may be selected by clicking the left mouse button on the diagram and dragging the pointer to create a rectangular selection area.

3.2 Alignment Tools

To align logic elements horizontally or vertically into groups.



Align Top	Align all selected components so the top of each is level with the others.
Align Middle	Align all selected components so the middle of each is level with the others.
Align Bottom	Align all selected components so the bottom of each is level with the others.
Align Left	Align all selected components so the leftmost point of each is level with the others.
Align Centre	Align all selected components so the centre of each is level with the others.
Align Right	Align all selected components so the rightmost point of each is level with the others.

3.3 Drawing Tools

To add text comments and other annotations, for easier reading of PSL schemes.

Rectangle When selected, move the mouse pointer to where you want one of the corners to be hold down the left mouse button and move it to where you want the diagonally opposite corner to be. Release the button. To draw a square hold down the SHIFT key to ensure height and width remain the same.

Ellipse When selected, move the mouse pointer to where you want one of the corners to be hold down the left mouse button and move until the ellipse is the size you want it to be. Release the button. To draw a circle hold down the SHIFT key to ensure height and width remain the same.

Line When selected, move the mouse pointer to where you want the line to start, hold down left mouse, move to the position of the end of the line and release button. To draw horizontal or vertical lines only hold down the SHIFT key.

Polyline When selected, move the mouse pointer to where you want the polyline to start and click the left mouse button. Now move to the next point on the line and click the left button. Double click to indicate the final point in the polyline.

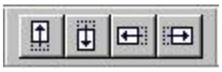
Curve When selected, move the mouse pointer to where you want the polycurve to start and click the left mouse button. Each time you click the button after this a line will be drawn, each line bisects its associated curve. Double click to end. The straight lines will disappear leaving the polycurve.
Note: whilst drawing the lines associated with the polycurve, a curve will not be displayed until either three lines in succession have been drawn or the polycurve line is complete.

Text When selected, move the mouse pointer to where you want the text to begin and click the left mouse button. To change the font, size or colour, or text attributes select Properties from the right mouse button menu.

Image When selected, the Open dialog is displayed, enabling you to select a bitmap or icon file. Click Open, position the mouse pointer where you want the image to be and click the left mouse button.

3.4 Nudge Tools

To move logic elements.

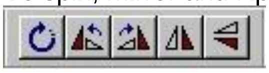


The nudge tool buttons enable you to shift a selected component a single unit in the selected direction, or five pixels if the SHIFT key is held down.
As well as using the tool buttons, single unit nudge actions on the selected components can be achieved using the arrow keys on the keyboard.

	Nudge Up	Shift the selected component(s) upwards by one unit. Holding down the SHIFT key while clicking on this button will shift the component five units upwards.
	Nudge Down	Shift the selected component(s) downwards by one unit. Holding down the SHIFT key while clicking on this button will shift the component five units downwards.
	Nudge Left	Shift the selected component(s) to the left by one unit. Holding down the SHIFT key while clicking on this button will shift the component five units to the left.
	Nudge Right	Shift the selected component(s) to the right by one unit. Holding down the SHIFT key while clicking on this button will shift the component five units to the right.

3.5 Rotation Tools

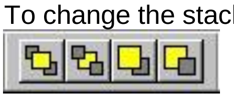
To spin, mirror and flip.

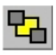


	Free Rotate	Enable the rotation function. While rotation is active components may be rotated as required. Press the ESC key or click on the diagram to disable the function.
	Rotate Left	Rotate the selected component 90 degrees to the left.
	Rotate Right	Rotate the selected component 90 degrees to the right.
	Flip Horizontal	Flip the component horizontally.
	Flip Vertical	Flip the component vertically.

3.6 Structure Tools

To change the stacking order of logic components.



	Bring to Front	Bring the selected components in front of all other components.
	Send to Back	Bring the selected components behind all other components.
	Bring Forward	Bring the selected component forward one layer.
	Send Backward	Send the selected component backwards one layer.

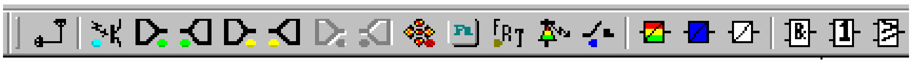
3.7 Zoom and Pan Tools

For scaling the displayed screen size, viewing the entire PSL, or zooming to a selection.

Zoom In	Increases the Zoom magnification by 25%.
Zoom Out	Decreases the Zoom magnification by 25%.
Zoom	Enable the zoom function. While this button is active, the mouse pointer is displayed as a magnifying glass. Right-clicking will zoom out and left-clicking will zoom in. Press the ESC key to return to the selection pointer. Click and drag to zoom in to an area.
Zoom to Fit	Display at the highest magnification that will show all the diagram's components.
Zoom to Selection	Display at the highest magnification that will show the selected component(s).
Pan	Enable the pan function. While this button is active, the mouse pointer is displayed as a hand. Hold down the left mouse button and drag the pointer across the diagram to pan. Press the ESC key to return to the selection pointer.

3.8 Logic Symbols

This toolbar provides icons to place each type of logic element into the scheme diagram. Not all elements are available in all devices. Icons will only be displayed for those elements available in the selected device. Depending on the device, the toolbar may not include Function key or coloured LED conditioner/signal or Contact conditioner or SR Gate icons.



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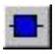
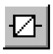
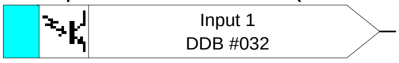
Link Create a link between two logic symbols.	
Opto Signal Create an opto signal.	
Input Signal Create an input signal.	
Output Signal Create an output signal.	
GOOSE In Create an input signal to logic to receive a UCA2.0 or IEC 61850 GOOSE message transmitted from another IED.	
GOOSE Out Create an output signal from logic to transmit a UCA2.0 or IEC 61850 GOOSE message to another IED.	
Control In Create an input signal to logic that can be operated from an external command.	
Integral Intertripping In/InterMiCOM In Create an input signal to logic to receive a MiCOM command transmitted from another IED. InterMiCOM is not available for all products.	
Integral Intertripping Out/InterMiCOM OutCreate an output signal from logic to transmit a MiCOM command to another IED. InterMiCOM is not available for all products.	

Function Key Create a function key input signal.	
Trigger Signal Create a fault record trigger.	
LED Signal Create an LED input signal that repeats the status of the LED. The icon colour shows whether the product uses mono-colour or tri-color LEDs.	
Contact Signal Create a contact signal.	
LED Conditioner Create a LED conditioner. The icon colour shows whether the product uses mono-colour or tri-color LEDs.	
Contact Conditioner Create a contact conditioner. Contact conditioning is not available for all products.	
Timer Create a timer.	
AND Gate Create an AND Gate.	
OR Gate Create an OR Gate.	
Programmable Gate Create a programmable gate.	
SR gate Create an SR gate.	

4 PSL LOGIC SIGNALS PROPERTIES

The logic signal toolbar is used for the selection of logic signals.
This allows you to link signals together to program the PSL. A number of different properties are associated with each signal. In the following sections, these are characterized by the use of an icon from the toolbar; together with a signal name and a DDB number. The name and DDB number are shown in a pointed rectangular block, which includes a colour code, the icon, the name, DDB No and a directional pointer. One example of such a block (for P54x for Opto Signal 1 DDB No #032) is shown below:



More examples of these are shown in the following properties sections.

Important	**The DDB Numbers vary according to the particular product and the particular name, so that Opto Signal 1 may not be DDB No #032 for all products. The various names and DDB numbers illustrated below are provided as an example.** **You need to look up the DDB numbers for the signal and the specific MiCOM product you are working on in the relevant DDB table for your chosen product.** **Available functions will depend on model/firmware version.**

4.1 Signal Properties Menu

The logic signal toolbar is used for the selection of logic signals. To use this:

- Use the logic toolbar to select logic signals.
  This is enabled by default but to hide or show it, select **View** > **Logic Toolbar**.
- Zoom in or out of a logic diagram using the toolbar icon or select **View** > **Zoom Percent**.
- Right-click any logic signal and a context-sensitive menu appears.
- Certain logic elements show the **Properties…** option. Select this and a **Component Properties** window appears. The Component Properties window and the signals listed vary depending on the logic symbol selected.

The following subsections describe each of the available logic symbols.

4.2 Link Properties

Links form the logical link between the output of a signal, gate or condition and the input to any element.
Any link that is connected to the input of a gate can be inverted. Right-click the input and select **Properties…**. The **Link Properties** window appears.

Figure 2 - Link properties

4.2.1 Rules for Linking Symbols

An inverted link is shown with a small circle on the input to a gate. A link must be connected to the input of a gate to be inverted.
Links can only be started from the output of a signal, gate, or conditioner, and can only be ended at an input to any element.

Signals can only be an input or an output. To follow the convention for gates and conditioners, input signals are connected from the left and output signals to the right. The Editor automatically enforces this convention.

A link is refused for the following reasons:

- An attempt to connect to a signal that is already driven. The reason for the refusal may not be obvious because the signal symbol may appear elsewhere in the diagram.

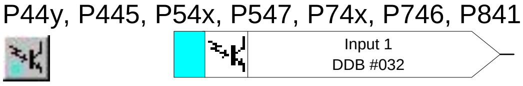
  Right-click the link and select Highlight to find the other signal. Click anywhere on the diagram to disable the highlight.

- An attempt is made to repeat a link between two symbols. The reason for the refusal may not be obvious because the existing link may be represented elsewhere in the diagram.

4.3 Opto Signal Properties

Each opto input can be selected and used for programming in PSL. Activation of the opto input drives an associated DDB signal.

For example, activating opto Input L1 asserts DDB 032 in the PSL for the P14x, P34x, P44y, P445, P54x, P547, P74x, P746, P841, P849 products.

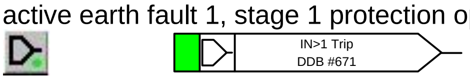


DDB Nos	*“Input 1 DDB #064” applies to: P24x, P64x.* *“Opto Label DDB #064” applies to: P44x.*

4.4 Input Signal Properties

Relay logic functions provide logic output signals that can be used for programming in PSL. Depending on the relay functionality, operation of an active relay function drives an associated DDB signal in PSL.

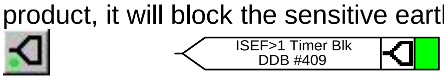
For example, DDB 671 is asserted in the PSL for the P44y, P547 & P841 product if the active earth fault 1, stage 1 protection operate/trip.



4.5 Output Signal Properties

Relay logic functions provide logic input signals that can be used for programming in PSL. Depending on the relay functionality, activation of the output signal will drive an associated DDB signal in PSL and cause an associated response to the relay function.

For example, if DDB 409 is asserted in the PSL for the P44y, P54x, P547 and P841 product, it will block the sensitive earth function stage 1 timer.

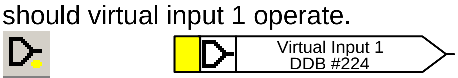


4.6 GOOSE Input Signal Properties

The PSL interfaces with the GOOSE Scheme Logic using virtual inputs. The Virtual Inputs can be used in much the same way as the Opto Input signals.

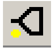
The logic that drives each of the Virtual Inputs is contained within the relay’s GOOSE Scheme Logic file. It is possible to map any number of bit-pairs, from any enrolled device, using logic gates onto a Virtual Input (see Easergy Studio (MiCOM S1 Studio) User Manual for more details). The number of available GOOSE virtual inputs is shown in the *Programmable Logic* chapter.

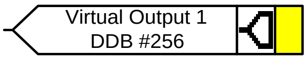
For example DDB 224 will be asserted in PSL for the P44y, P54x, P547 & P841 product should virtual input 1 operate.



4.7 GOOSE Output Signal Properties

The PSL interfaces with the GOOSE Scheme Logic using 32 virtual outputs. Virtual outputs can be mapped to bit-pairs for transmitting to any enrolled devices.
For example if DDB 256 is asserted in PSL for the P44y, P54x, P547 and P841 product, Virtual Output 32 and its associated mappings will operate.



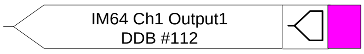


4.8 Control In Signal Properties

There are 32 control inputs which can be activated via the relay menu, ‘hotkeys’ or via rear communications. Depending on the programmed setting i.e. latched or pulsed, an associated DDB signal will be activated in PSL when a control input is operated
For example, when operated control input 1 will assert DDB 192 in the PSL for the P44y, P54x, P547 and P841 products.

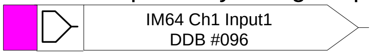
4.9 InterMiCOM Output Commands Properties

There are 16 InterMiCOM outputs that could be selected and use for teleprotection, remote commands, etc. “InterMiCOM Out” is a send command to a remote end that could be mapped to any logic output or opto input. This will be transmitted to the remote end as corresponding “InterMiCOM In” command for the P14x, P44y, P445 & P54x products.



4.10 InterMiCOM Input Commands Properties

There are 16 InterMiCOM inputs that could be selected and use for teleprotection, remote commands, etc. "InterMiCOM In" is a received signal from remote end that could be mapped to a selected output relay or logic input.



Example:

Relay End A — At end A, InterMiCOM Output 1 is mapped to the command indication "Clear Statistics" (issued at end A).

Relay End B — At end B, InterMiCOM Input 1 is mapped to the command "Clear Statistics".

Upon receive of IM64 1 from relay at end A, the relay at end B will reset its statistics.

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4.11 Function Key Properties

Each function key can be selected and used for programming in PSL. Activation of the function key will drive an associated DDB signal and the DDB signal will remain active depending on the programmed setting i.e. toggled or normal. Toggled mode means the DDB signal will remain latched or unlatched on key press and normal means the DDB will only be active for the duration of the key press.

For example, operate function key 1 to assert DDB 1096 in the PSL for the P44y, P54x, P547 or P841 products.

4.12 Fault Recorder Trigger Properties

The fault recording facility can be activated by driving the fault recorder trigger DDB signal.

For example assert DDB 702 to activate the fault recording in the PSL for the P44y, P54x, P547 or P841 product.

4.13 LED Signal Properties

All programmable LEDs will drive associated DDB signal when the LED is activated. For example DDB 1036 will be asserted when LED 7 is activated for the P44y, P54x, P547 or P841 product.

4.14 Contact Signal Properties

All relay output contacts will drive associated DDB signal when the output contact is activated.
For example, DDB 009 will be asserted when output R10 is activated for all products.

4.15 LED Conditioner Properties

1. Select the **LED name** from the list (only shown when inserting a new symbol).
2. Configure the LED output to be Red, Yellow or Green.

   Configure a Green LED by driving the Green DDB input.
   Configure a RED LED by driving the RED DDB input.
   Configure a Yellow LED by driving the RED and GREEN DDB inputs simultaneously.

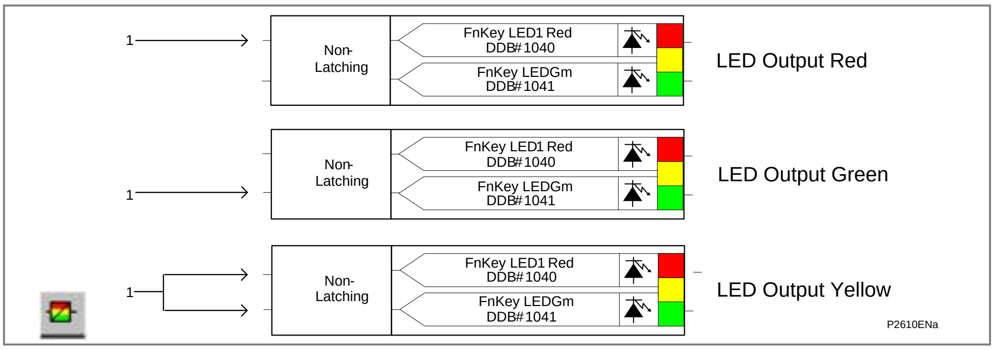


Figure 3 - Red, green and yellow LED outputs

3. Configure the LED output to be latching or non-latching.

DDB #642 and DDB #643 applies to these products: P14x, P44x, P74x, P746 and P849. DDB #1040 and DDB #1041 applies to these products: P24x, P34x, P44y, P54x, P547, P64x and P841.

4.16 Contact Conditioner Properties

Each contact can be conditioned with an associated timer that can be selected for pick up, drop off, dwell, pulse, pick-up/drop-off, straight-through, or latching operation. **Straight-through** means it is not conditioned in any way whereas **Latching** is used to create a sealed-in or lockout type function.

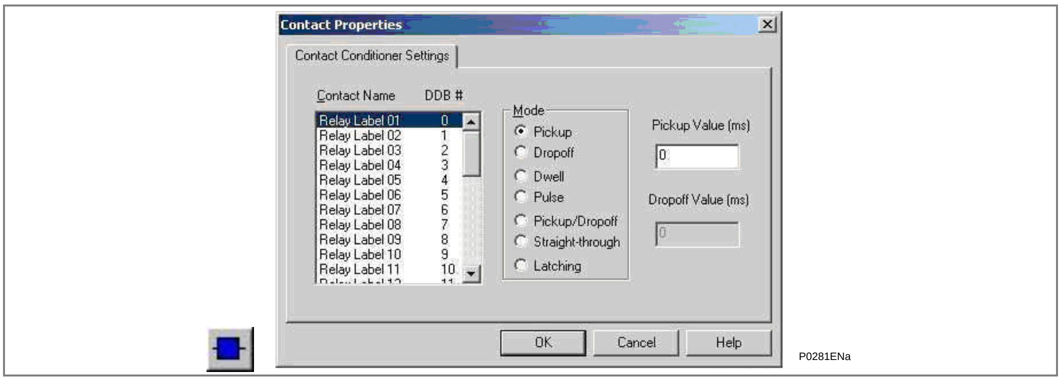


Figure 4 - Contact conditioner settings

1. Select the contact **name** from the **Contact Name** list (only shown when inserting a new symbol).
2. Choose the conditioner type required in the **Mode** tick list.
3. Set the **Pick-up** Time (in milliseconds), if required.
4. Set the **Drop-off** Time (in milliseconds), if required.

4.17 Timer Properties

Each timer can be selected for pick up, drop off, dwell, pulse or pick-up/drop-off operation.

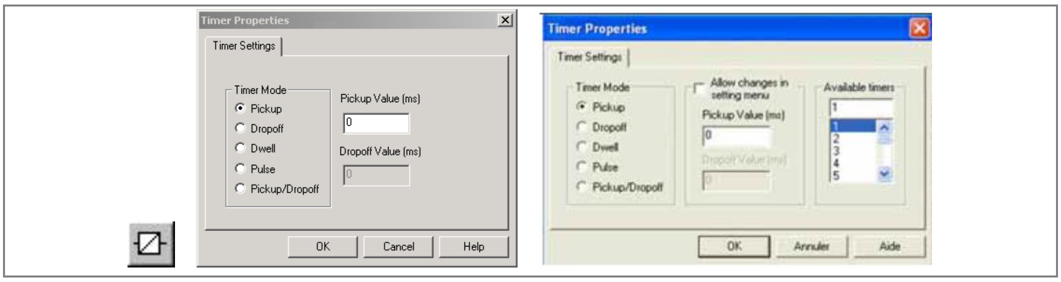
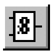
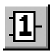
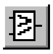


Figure 5 - Timer settings

1. Choose the operation mode from the **Timer Mode** tick list.
2. Set the Pick-up Time (in milliseconds), if required.
3. Set the Drop-off Time (in milliseconds), if required.

4.18 Gate Properties

A Gate may be an AND, OR, or programmable gate.

	An **AND** gate requires that all inputs are TRUE for the output to be TRUE.
	An **OR** gate requires that one or more input is TRUE for the output to be TRUE.
	A **Programmable** gate requires that the number of inputs that are TRUE is equal to or greater than its ‘Inputs to Trigger’ setting for the output to be TRUE.

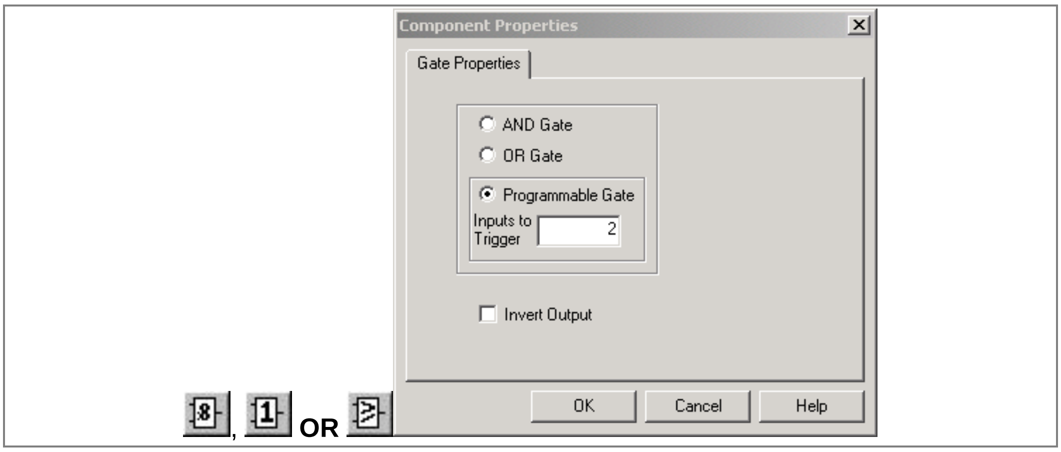


Figure 6 - Gate properties

1. Select the Gate type AND, OR, or Programmable.
2. Set the number of inputs to trigger when Programmable is selected.
3. Select if the output of the gate should be inverted using the Invert Output check box. An inverted output is indicated with a "bubble" on the gate output.

4.19 SR Programmable Gate Properties

For many products a number of programmable SR Latches are added. They are configured by an appropriate version of PSL Editor (S1v2.14 version 5.0.0 or greater) where an SRQ icon features on the toolbar.

Each SR latch has a Q output. The Q output may be inverted in the PSL Editor under the SR Latch component properties window. The SR Latches may be configured as Standard (no input dominant), Set Dominant or Reset Dominant in the PSL Editor under the SR Latch component properties window. The truth table for the SR Latches is given below.

A **Programmable** SR gate can be selected to operate with these latch properties:

S input	R input	O - Standard	O – Set input dominant	O – Reset input dominant
0	0	0	0	0
0	1	0	0	0
1	0	1	1	1
1	1	0	1	0

Table 1 - SR programmable gate properties

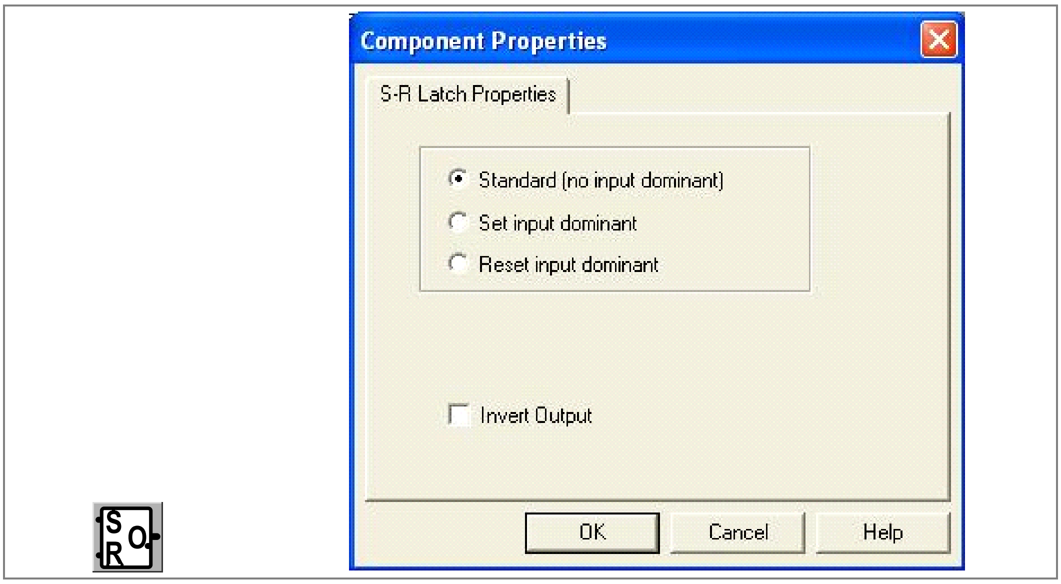


Figure 7 - SR latch component properties

Select if the output of the gate should be inverted using the Invert Output check box. An inverted output is indicated with a "bubble" on the gate output.

4.20 PSL Signal Grouping Modes

PSL Signal Grouping Nodes

For Software Version D1a and later, these DDB “Group” Nodes can be mapped to individual or multiple DDBs in the PSL:

PSL Group Sig 1
PSL Group Sig 2
PSL Group Sig 3
PSL Group Sig 4

There are now four additional ***DDB Group Sig x*** Nodes that can be mapped to individual or multiple DDBs in the PSL. These can then be set to trigger the DR via the DISTURBANCE RECORD menu.

These "Nodes" are general and can also be used to group signals together in the PSL for any other reason. These four nodes are available in each of the four PSL setting groups.

Number	PSL Group Sig
992	PSL Group Sig 1
993	PSL Group Sig 2
994	PSL Group Sig 3
995	PSL Group Sig 4

1. For a control input, the DR can be triggered directly by triggering directly from the Individual Control Input (e.g. Low to High (L to H) change)
2. For an input that cannot be triggered directly, or where any one of a number of DDBs are required to trigger a DR, map the DDBs to the new PSL Group sig n and then trigger the DR on this.

e.g. in the PSL:

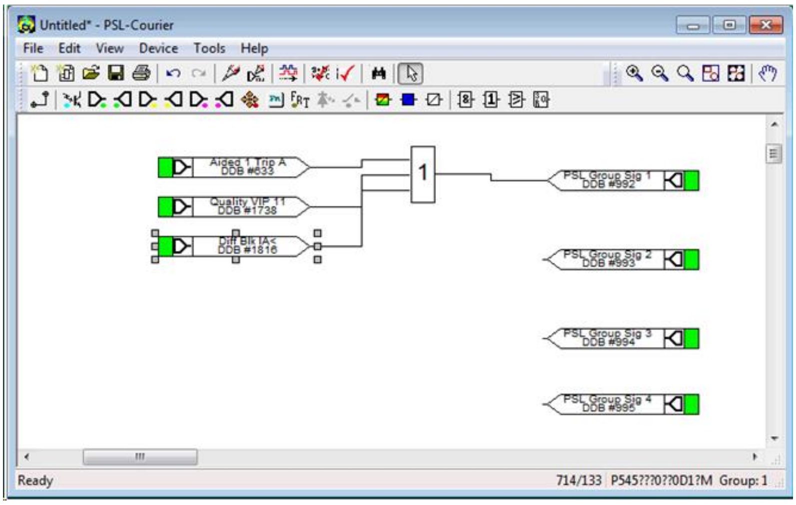


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Figure 8 - PSL diagram

In the DR Settings:

- Digital Input 1 is triggered by the PSL Group Sig 1 (L to H)
- Digital Input 2 is triggered by Control Input 1 (L to H)

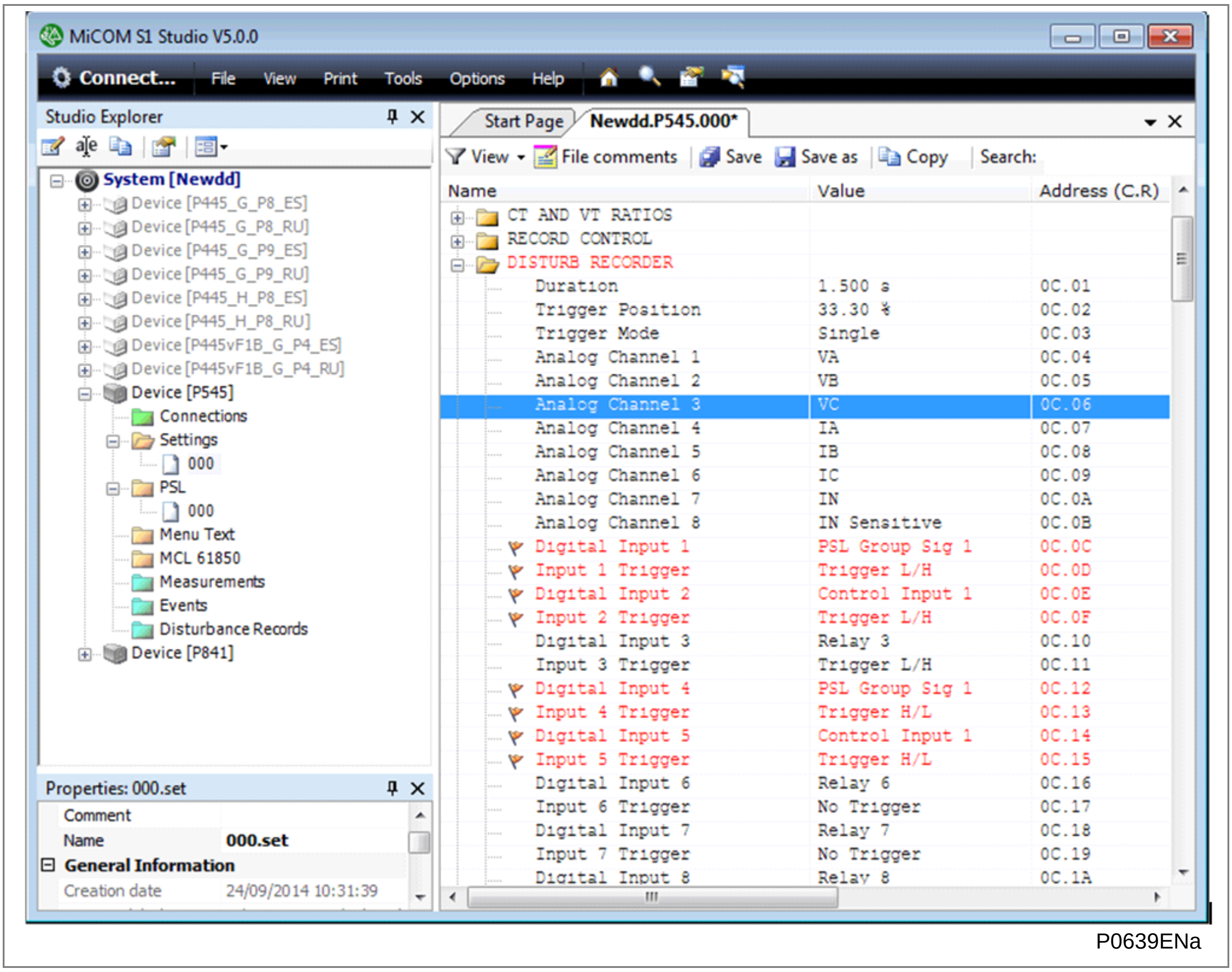


Figure 9 – Easergy Studio (MiCOM S1 Studio) Disturb Recorder table diagram

If triggering on both edges is required map another DR channel to the H/L as well

Digital Input 4 is triggered by the PSL Group Sig 1 (H to L)

Digital Input 5 is triggered by Control Input 1 (H to L)

5 SPECIFIC TASKS

Note	*MiCOM S1 Studio has been renamed as Easergy Studio.*

5.1 Digital Input Label Operation (not included in P24x/P44x)

The digital input labels can be modified via the MiCOM Px40 user interface or Easergy Studio (MiCOM S1 Studio). The following example is using S1 Studio Version 5.0.0.
The digital input labels are available in the “DR CHAN LABELS” folder in the settings file as shown below:

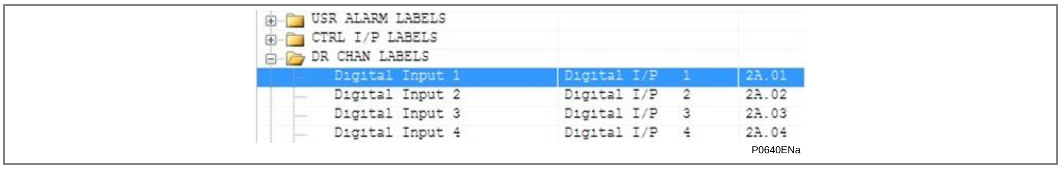


Figure 10 - DR Chan Labels tree

Easergy Studio (MiCOM S1 Studio) removes leading spaces from the value field so making the ‘D’ look as if it’s the 1st character in the label. The default values above in fact have a leading space which is used to switch off the use of the label as show below in the change settings view.

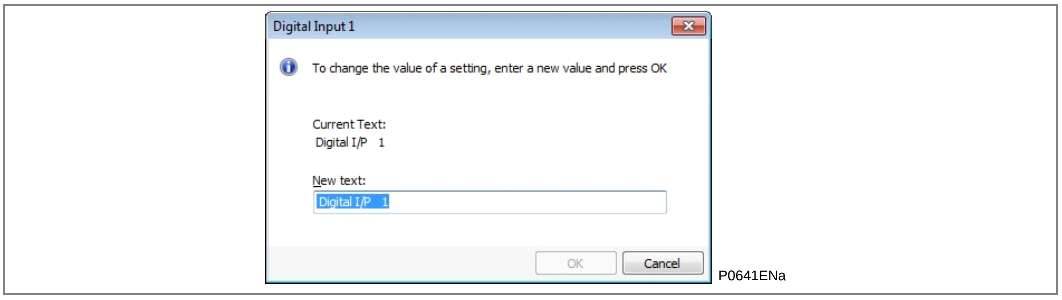


Figure 11 - Digital Input 1 dialog box

Pressing OK will save the setting and return to the settings page as follows:

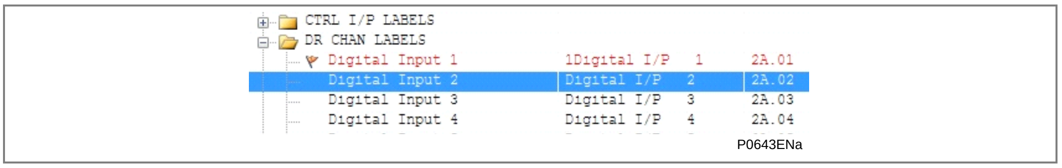


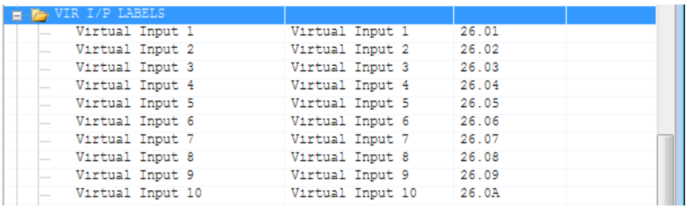
Figure 12 - DR Chan Labels tree

Digital Input 1 label will now be used in the Disturbance Record when the settings file is downloaded to the relay.

5.2 Virtual Input Label Operation

The Virtual Input labels can be modified via the MiCOM Px40 user interface or Easergy Studio (MiCOM S1 Studio). The following example is using S1 Studio Version 5.0.0.

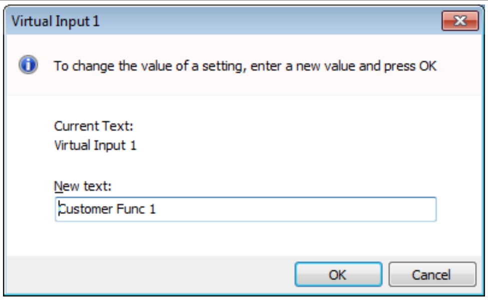
The default labels are available in the “VIR I/P LABELS” (or “VIRT I/P LABELS”) folder in the settings file as shown below:



P0649ENa

Figure 13 - MiCOM S1 Studio VIR I/P Labels Tree

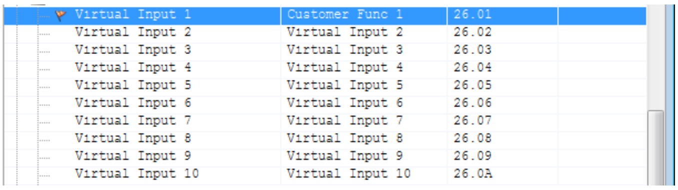
The default “Virtual Input” labels can be changed to suit the customer requirements. For example, to change default text from “Virtual Input 1” to “Customer Func 1” open the ***Virtual Input 1*** dialog box, and change “Virtual Input 1” in the ***New Text:*** text box to be “Customer Func 1”, as follows:



P0651ENa

Figure 14 - Virtual Input 1 dialog box

Pressing OK will save the setting and return to the settings page as follows:



P0668ENa

Figure 15 - Easergy Studio (MiCOM S1 Studio) VIR I/P Labels Tree

The above “Customer Func 1” label text will now be used in place of “Virtual Input 1” in the Disturbance / Event Records after the settings file is downloaded to the relay.

5.3 Virtual Output Label Operation

The Virtual Output labels can be modified via the MiCOM Px40 user interface or Easergy Studio (MiCOM S1 Studio). The following example is using S1 Studio Version 5.0.0.

The virtual Output labels are available in the “VIR O/P LABELS” ” (or “VIRT O/P LABELS”) folder in the settings file as shown below:

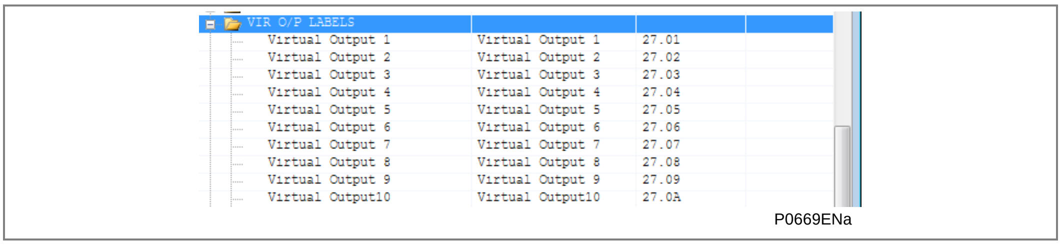


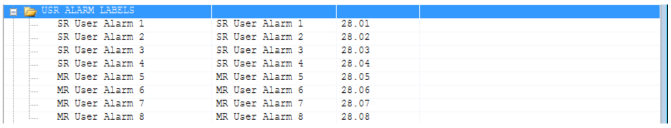
Figure 16 - Easergy Studio (MiCOM S1 Studio) VIR O/P Labels Tree

The default “Virtual Output Labels” can be changed to suit the customer requirements. The process is identical to the previously described procedure for the Virtual Input Labels.

5.4 SR/MR User Alarm Label Operation

The SR/MR User Alarm input labels can be modified via the MiCOM Px40 user interface or Easergy Studio (MiCOM S1 Studio). This example is using S1 Studio Version 5.0.0.

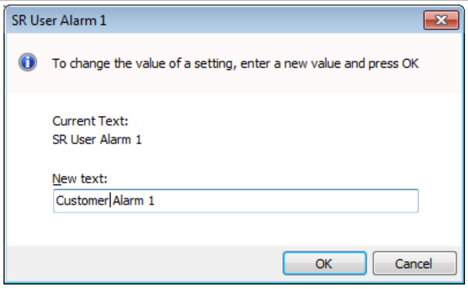
The default labels are available in the “USR ALARM LABELS” folder in the settings file as shown below:



P0670ENa

Figure 17 - Easergy Studio (MiCOM S1 Studio) USR Labels Tree

The default “SR User Alarm” and “MR User Alarm” labels can be changed to suit the customer requirements. For example, to change default text from “SR User Alarm 1” to “Customer Alarm 1” open the ***SR User Alarm 1*** dialog box and change “SR User Alarm 1” in the ***New Text:*** Text box to be “Customer Alarm 1”.



P0672ENa

Figure 18 - Virtual Input 1 dialog box

Pressing OK will save the setting and return to the settings page as follows:

Error! Not a valid link.

Figure 19 - Virtual Input 1 settings

The above “Customer Alarm 1” label text will now be used in place of “SR User Alarm 1” in the Disturbance / Event Records after the settings file is downloaded to the relay.

5.5 Settable Control Input Operation (not included in P24x/P44x)

The settings should be applied to all relays in the current differential protection scheme. As from Software Versions C1/D1/F1/G4/H4/J4, there are now 32 Standard Control Inputs and 16 additional Settable Control Inputs available. These are settable via the "CONTROL INPUTS" folder and are located after the standard "Control Input" labels in the relevant settings file.

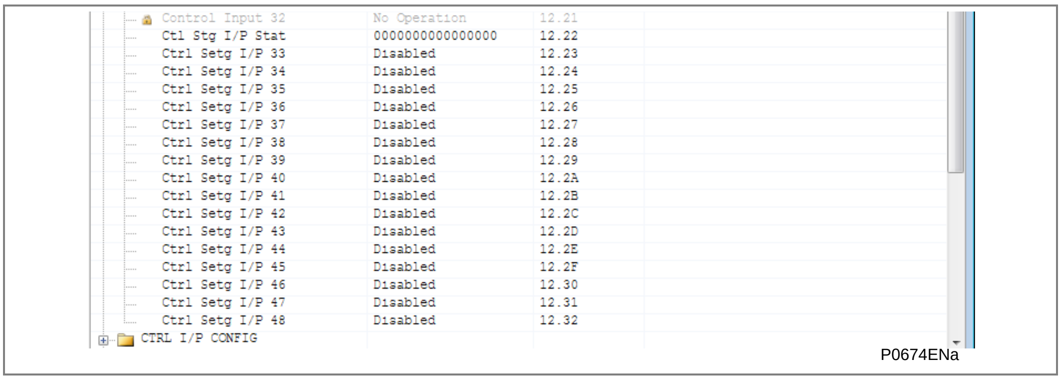


Figure 20 - Easergy Studio (MiCOM S1 Studio) Control Inputs tree

Each Settable control Input "Ctrl Setg I/P xx" can be controlled using Enable / Disable settings. To change from (the default) Disabled to Enabled, open the ***Ctrl Setg I/P xx*** dialog box, then change Disabled to Enabled in the ***New Setting*** drop-down list box:

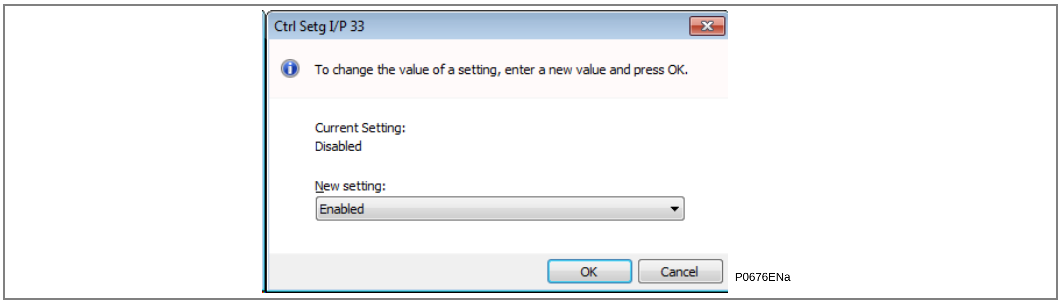


Figure 21 – Ctrl Setg I/P 33 dialog box

Pressing OK will save the setting and return to the settings page as follows:

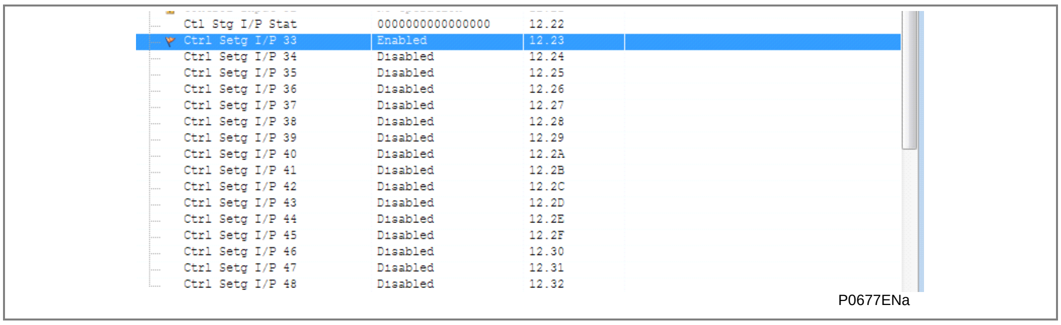


Figure 22 - Easergy Studio (MiCOM S1 Studio) Control Inputs (Ctl Setg I/P 33) tree

The setting "Ctl Stg I/P Stat" can be used to control multiple "Ctrl Setg I/P" at the same time, e.g. clear Ctrl Setg I/P 33 and set Ctrl Setg I/P 34 to 38, but please note that the status will not be reflected in the individual inputs settings or vice versa.

This cell may be hidden in the Easergy Studio (MiCOM S1 Studio) files.

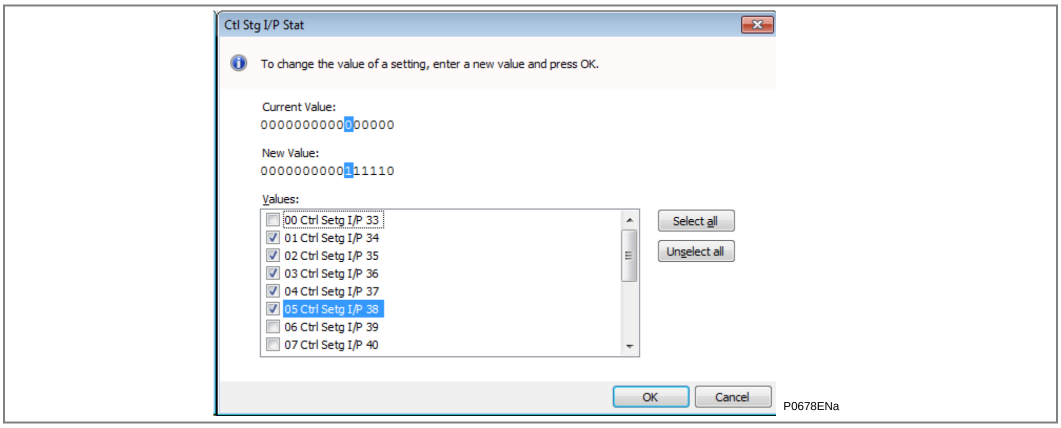


Figure 23 – Ctrl Stg I/P Stat dialog box

5.6 Settable Control Setg I/P Label Operation (P14x, P44y, P54x, P445 & P841 only) (not included in P24x/P44x)

The default labels are available in the "CTRL I/P LABELS" folder and are located after the standard "Control Input" labels in the settings file as shown below:

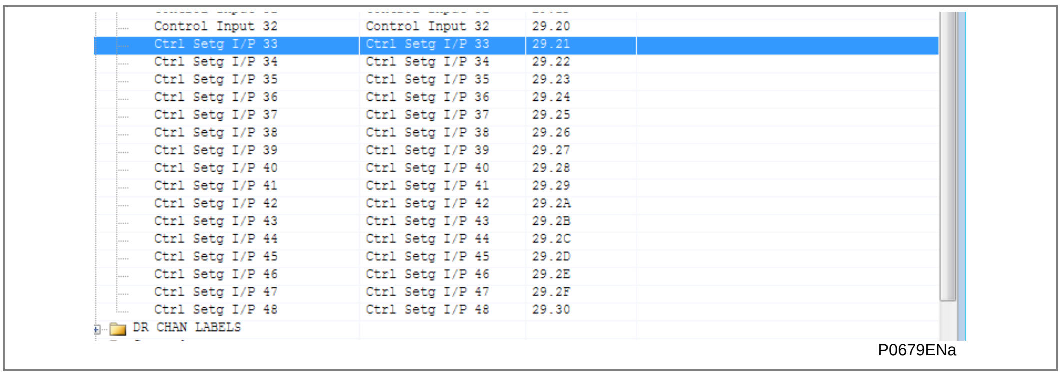


Figure 24 - Easergy Studio (MiCOM S1 Studio) Control I/P Labels (Ctl Setg I/P 33) tree

The default "Ctrl Setg I/P" labels can be changed to suit the customer requirements using the same procedure as for the standard "Control Inputs". For example to change the default text from "Ctrl Setg I/P 33" to "Custom Ctrl Sg 1" open the ***Ctrl Setg I/P 33*** dialog box, then change "Ctrl Setg I/P 33" in the ***New Text:*** box to be "Custom Ctrl Sg 1".

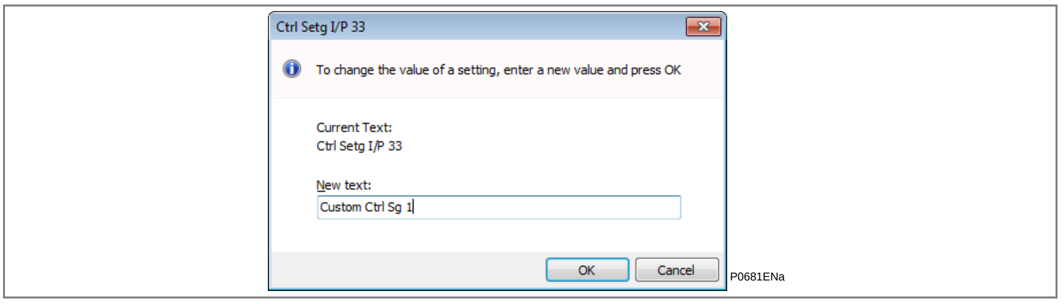


Figure 25 – Ctrl Setg I/P 33 dialog box

Pressing OK will save the setting and return to the settings page as follows:

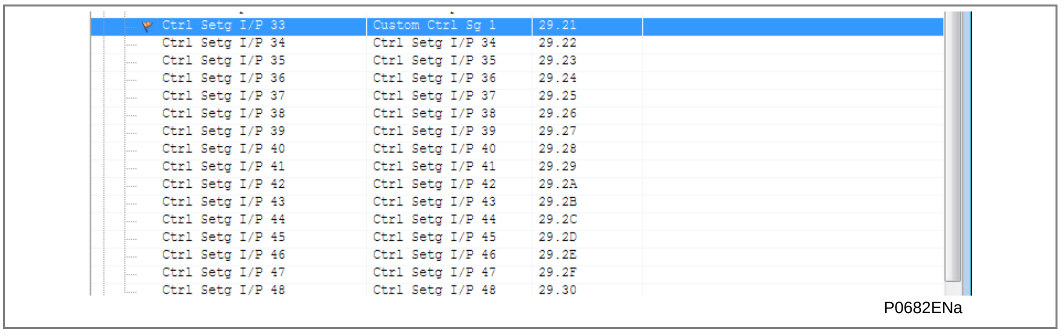


Figure 26 - Easergy Studio (MiCOM S1 Studio) Control I/P Labels (Ctl Setg I/P 33) tree

The above "Custom Ctrl Sg 1" label text will now be used in place of "Ctrl Setg I/P 33" in the Disturbance / Event Records after the settings file is downloaded to the relay.

6 MAKING A RECORD OF MICOM PX40 DEVICE SETTINGS

6.1 Using Easergy Studio (MiCOM S1 Studio) to Manage Device Settings

An engineer often needs to create a record of what settings have been applied to a device. In the past, they could have used paper printouts of all the available settings, and mark up the ones they had used. Keeping such a paper-based Settings Records could be time-consuming and prone to error (e.g. due to being settings written down incorrectly). The Easergy Studio (MiCOM S1 Studio) software lets you read from or write to MiCOM devices.

- **Extract** lets you download all the settings from a MiCOM Px40 device. A summary is given in the ***Extract Settings from a MiCOM Px40 Device*** section.
- **Send** lets you send the settings you currently have open in Easergy Studio (MiCOM S1 Studio). A summary is given in the ***Send Settings to a MiCOM Px40 Device*** section.

In most cases, it will be quicker and less error prone to extract settings electronically and store them in a settings file on a memory stick. In this way, there will be a digital record which is certain to be accurate. It is also possible to archive these settings files in a repository; so they can be used again or adapted for another use.

Full details of how to do this is provided in the Easergy Studio (MiCOM S1 Studio) help.

A quick summary of the main steps is given here. In each case, you need to make sure that:

- Your computer includes the Easergy Studio (MiCOM S1 Studio) software.
- Your computer and the MiCOM device are powered on.
- You have used a suitable cable to connect your computer to the MiCOM device (Front Port, Rear Port, Ethernet port or Modem as available).

6.2 Extract Settings from a MiCOM Px40 Device

Full details of how to do this is provided in the Easergy Studio (MiCOM S1 Studio) help.

As a quick guide, you need to do the following:

1. In Easergy Studio (MiCOM S1 Studio), click the Quick Connect… button.
2. Select the relevant Device Type in the Quick Connect dialog box.
3. Click the relevant port in the Port Selection dialog box.
4. Enter the relevant connection parameters in the Connection Parameters dialog box and click the Finish button
5. Studio will try to communicate with the Px40 device. It will display a connected message if the connection attempt is successful.
6. The device will appear in the Studio Explorer pane on the top-left hand side of the interface.
7. Click the + button to expand the options for the device, then click on the Settings folder.
8. Right-click on Settings and select the Extract Settings link to read the settings on the device and store them on your computer or a memory stick attached to your computer.
9. After retrieving the settings file, close the dialog box by clicking the Close button.

6.3 Send Settings to a MiCOM Px40 Device

Full details of how to do this is provided in the Easergy Studio (MiCOM S1 Studio) help.

As a quick guide, you need to do the following:

1. In Easergy Studio (MiCOM S1 Studio), click the Quick Connect… button.
2. Select the relevant Device Type in the Quick Connect dialog box.
3. Click the relevant port in the Port Selection dialog box.
4. Enter the relevant connection parameters in the Connection Parameters dialog box and click the Finish button
5. Studio will try to communicate with the Px40 device. It will display a connected message if the connection attempt is successful.
6. The device will appear in the Studio Explorer pane on the top-left hand side of the interface.
7. Click the + button to expand the options for the device, then click on the Settings link.
8. Right-click on the device name and select the Send link.

Note	*When you send settings to a MiCOM Px40 device, the data is stored in a temporary location at first. This temporary data is tested to make sure it is complete. If the temporary data is complete, it will be programmed into the MiCOM Px40 device. This avoids the risk of a device being programmed with incomplete or corrupt settings.*

9. In the Send To dialog box, select the settings file(s) you wish to send, then click the Send button.
10. Close the the Send To dialog box by clicking the Close button.

PROGRAMMABLE LOGIC

CHAPTER 8

Date:	04/2017
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.
Hardware suffix:	L (P241) & M (P242 & P243)
Software version:	D1
Connection diagrams:	10P241xx (xx = 01 to 02) 10P242xx (xx = 01) 10P243xx (xx = 01)

CONTENTS

FIGURES

TABLES

1 OVERVIEW

The purpose of the Programmable Scheme Logic (PSL) is to allow the user to configure an individual protection scheme to suit their own particular application. This is achieved through the use of programmable logic gates and delay timers.

The input to the PSL is any combination of the status of opto inputs. It is also used to assign the mapping of functions to the opto inputs and output contacts, the outputs of the protection elements, e.g. protection starts and trips, and the outputs of the fixed protection scheme logic. The fixed scheme logic provides the relay's standard protection schemes.

The PSL itself consists of software logic gates and timers. The logic gates can be programmed to perform a range of different logic functions and can accept any number of inputs. The timers are used either to create a programmable delay, and/or to condition the logic outputs, e.g. to create a pulse of fixed duration on the output regardless of the length of the pulse on the input. The outputs of the PSL are the LEDs on the front panel of the relay and the output contacts at the rear.

The execution of the PSL logic is event driven; the logic is processed whenever any of its inputs change, for example as a result of a change in one of the digital input signals. Also, only the part of the PSL logic that is affected by the particular input change that has occurred is processed. This reduces the amount of processing time that is used by the PSL. This means that even with large, complex PSL schemes the device trip time will not lengthen.

This system provides flexibility for the user to create their own scheme logic design. It also means that the PSL can be configured into a very complex system, hence setting of the PSL is implemented through the PC support package MiCOM S1 Studio.

How to edit the PSL schemes is described in the "Using the PSL Editor" chapter.

This chapter contains details of the logic nodes which are specific to this product, together with any PSL diagrams which we have published for this product.

2 DESCRIPTION OF LOGIC NODES

DDB No	English Text	Element Name	Source	Type	Description
0	Relay 1	DDB_OUTPUT_RELAY_1	SW	RELAY	Output Relay 1 is on
1	Relay 2	DDB_OUTPUT_RELAY_2	SW	RELAY	Output Relay 2 is on
2	Relay 3	DDB_OUTPUT_RELAY_3	SW	RELAY	Output Relay 3 is on
3	Relay 4	DDB_OUTPUT_RELAY_4	SW	RELAY	Output Relay 4 is on
4	Relay 5	DDB_OUTPUT_RELAY_5	SW	RELAY	Output Relay 5 is on
5	Relay 6	DDB_OUTPUT_RELAY_6	SW	RELAY	Output Relay 6 is on
6	Relay 7	DDB_OUTPUT_RELAY_7	SW	RELAY	Output Relay 7 is on
7	Relay 8	DDB_OUTPUT_RELAY_8	SW	RELAY	Output Relay 8 is on
8	Relay 9	DDB_OUTPUT_RELAY_9	SW	RELAY	Output Relay 9 is on
9	Relay 10	DDB_OUTPUT_RELAY_10	SW	RELAY	Output Relay 10 is on
10	Relay 11	DDB_OUTPUT_RELAY_11	SW	RELAY	Output Relay 11 is on
11	Relay 12	DDB_OUTPUT_RELAY_12	SW	RELAY	Output Relay 12 is on
12	Relay 13	DDB_OUTPUT_RELAY_13	SW	RELAY	Output Relay 13 is on
13	Relay 14	DDB_OUTPUT_RELAY_14	SW	RELAY	Output Relay 14 is on
14	Relay 15	DDB_OUTPUT_RELAY_15	SW	RELAY	Output Relay 15 is on
15	Relay 16	DDB_OUTPUT_RELAY_16	SW	RELAY	Output Relay 16 is on
16	Not Used	DDB_OUTPUT_RELAY_17	SW	UNUSED	
17	Not Used	DDB_OUTPUT_RELAY_18	SW	UNUSED	
18	Not Used	DDB_OUTPUT_RELAY_19	SW	UNUSED	
19	Not Used	DDB_OUTPUT_RELAY_20	SW	UNUSED	
20	Not Used	DDB_OUTPUT_RELAY_21	SW	UNUSED	
21	Not Used	DDB_OUTPUT_RELAY_22	SW	UNUSED	
22	Not Used	DDB_OUTPUT_RELAY_23	SW	UNUSED	
23	Not Used	DDB_OUTPUT_RELAY_24	SW	UNUSED	
24	Not Used	DDB_OUTPUT_RELAY_25	SW	UNUSED	
25	Not Used	DDB_OUTPUT_RELAY_26	SW	UNUSED	
26	Not Used	DDB_OUTPUT_RELAY_27	SW	UNUSED	
27	Not Used	DDB_OUTPUT_RELAY_28	SW	UNUSED	
28	Not Used	DDB_OUTPUT_RELAY_29	SW	UNUSED	
29	Not Used	DDB_OUTPUT_RELAY_30	SW	UNUSED	
30	Not Used	DDB_OUTPUT_RELAY_31	SW	UNUSED	
31	Not Used	DDB_OUTPUT_RELAY_32	SW	UNUSED	
32	Not Used	DDB_OUTPUT_RELAY_33	SW	UNUSED	
33	Not Used	DDB_OUTPUT_RELAY_34	SW	UNUSED	
34	Not Used	DDB_OUTPUT_RELAY_35	SW	UNUSED	
35	Not Used	DDB_OUTPUT_RELAY_36	SW	UNUSED	
36	Not Used	DDB_OUTPUT_RELAY_37	SW	UNUSED	
37	Not Used	DDB_OUTPUT_RELAY_38	SW	UNUSED	
38	Not Used	DDB_OUTPUT_RELAY_39	SW	UNUSED	
39	Not Used	DDB_OUTPUT_RELAY_40	SW	UNUSED	
40	Not Used	DDB_OUTPUT_RELAY_41	SW	UNUSED	
41	Not Used	DDB_OUTPUT_RELAY_42	SW	UNUSED	

DDB No	English Text	Element Name	Source	Type	Description
42	Not Used	DDB_OUTPUT_RELAY_43	SW	UNUSED	
43	Not Used	DDB_OUTPUT_RELAY_44	SW	UNUSED	
44	Not Used	DDB_OUTPUT_RELAY_45	SW	UNUSED	
45	Not Used	DDB_OUTPUT_RELAY_46	SW	UNUSED	
46	Not Used	DDB_OUTPUT_RELAY_47	SW	UNUSED	
47	Not Used	DDB_OUTPUT_RELAY_48	SW	UNUSED	
48	Not Used	DDB_OUTPUT_RELAY_49	SW	UNUSED	
49	Not Used	DDB_OUTPUT_RELAY_50	SW	UNUSED	
50	Not Used	DDB_OUTPUT_RELAY_51	SW	UNUSED	
51	Not Used	DDB_OUTPUT_RELAY_52	SW	UNUSED	
52	Not Used	DDB_OUTPUT_RELAY_53	SW	UNUSED	
53	Not Used	DDB_OUTPUT_RELAY_54	SW	UNUSED	
54	Not Used	DDB_OUTPUT_RELAY_55	SW	UNUSED	
55	Not Used	DDB_OUTPUT_RELAY_56	SW	UNUSED	
56	Not Used	DDB_OUTPUT_RELAY_57	SW	UNUSED	
57	Not Used	DDB_OUTPUT_RELAY_58	SW	UNUSED	
58	Not Used	DDB_OUTPUT_RELAY_59	SW	UNUSED	
59	Not Used	DDB_OUTPUT_RELAY_60	SW	UNUSED	
60	Not Used	DDB_OUTPUT_RELAY_61	SW	UNUSED	
61	Not Used	DDB_OUTPUT_RELAY_62	SW	UNUSED	
62	Not Used	DDB_OUTPUT_RELAY_63	SW	UNUSED	
63	Not Used	DDB_OUTPUT_RELAY_64	SW	UNUSED	
64	Opto 1	DDB_OPTO_ISOLATOR_1	SW	OPTO	Opto Input 1 is on
65	Opto 2	DDB_OPTO_ISOLATOR_2	SW	OPTO	Opto Input 2 is on
66	Opto 3	DDB_OPTO_ISOLATOR_3	SW	OPTO	Opto Input 3 is on
67	Opto 4	DDB_OPTO_ISOLATOR_4	SW	OPTO	Opto Input 4 is on
68	Opto 5	DDB_OPTO_ISOLATOR_5	SW	OPTO	Opto Input 5 is on
69	Opto 6	DDB_OPTO_ISOLATOR_6	SW	OPTO	Opto Input 6 is on
70	Opto 7	DDB_OPTO_ISOLATOR_7	SW	OPTO	Opto Input 7 is on
71	Opto 8	DDB_OPTO_ISOLATOR_8	SW	OPTO	Opto Input 8 is on
72	Opto 9	DDB_OPTO_ISOLATOR_9	SW	OPTO	Opto Input 9 is on
73	Opto 10	DDB_OPTO_ISOLATOR_10	SW	OPTO	Opto Input 10 is on
74	Opto 11	DDB_OPTO_ISOLATOR_11	SW	OPTO	Opto Input 11 is on
75	Opto 12	DDB_OPTO_ISOLATOR_12	SW	OPTO	Opto Input 12 is on
76	Opto 13	DDB_OPTO_ISOLATOR_13	SW	OPTO	Opto Input 13 is on
77	Opto 14	DDB_OPTO_ISOLATOR_14	SW	OPTO	Opto Input 14 is on
78	Opto 15	DDB_OPTO_ISOLATOR_15	SW	OPTO	Opto Input 15 is on
79	Opto 16	DDB_OPTO_ISOLATOR_16	SW	OPTO	Opto Input 16 is on
80	Not Used	DDB_OPTO_ISOLATOR_17	SW	UNUSED	
81	Not Used	DDB_OPTO_ISOLATOR_18	SW	UNUSED	
82	Not Used	DDB_OPTO_ISOLATOR_19	SW	UNUSED	
83	Not Used	DDB_OPTO_ISOLATOR_20	SW	UNUSED	
84	Not Used	DDB_OPTO_ISOLATOR_21	SW	UNUSED	
85	Not Used	DDB_OPTO_ISOLATOR_22	SW	UNUSED	

DDB No	English Text	Element Name	Source	Type	Description
86	Not Used	DDB_OPTO_ISOLATOR_23	SW	UNUSED	
87	Not Used	DDB_OPTO_ISOLATOR_24	SW	UNUSED	
88	Not Used	DDB_OPTO_ISOLATOR_25	SW	UNUSED	
89	Not Used	DDB_OPTO_ISOLATOR_26	SW	UNUSED	
90	Not Used	DDB_OPTO_ISOLATOR_27	SW	UNUSED	
91	Not Used	DDB_OPTO_ISOLATOR_28	SW	UNUSED	
92	Not Used	DDB_OPTO_ISOLATOR_29	SW	UNUSED	
93	Not Used	DDB_OPTO_ISOLATOR_30	SW	UNUSED	
94	Not Used	DDB_OPTO_ISOLATOR_31	SW	UNUSED	
95	Not Used	DDB_OPTO_ISOLATOR_32	SW	UNUSED	
96	LED 1 Red	DDB_OUTPUT_LED_1	SW	LED	Programmable LED 1 Red is on (P241 Only
97	LED 2 Red	DDB_OUTPUT_LED_2	SW	LED	Programmable LED 2 Red is on (P241 Only
98	LED 3 Red	DDB_OUTPUT_LED_3	SW	LED	Programmable LED 3 Red is on (P241 Only
99	LED 4 Red	DDB_OUTPUT_LED_4	SW	LED	Programmable LED 4 Red is on (P241 Only
100	LED 5 Red	DDB_OUTPUT_LED_5	SW	LED	Programmable LED 5 Red is on (P241 Only
101	LED 6 Red	DDB_OUTPUT_LED_6	SW	LED	Programmable LED 6 Red is on (P241 Only
102	LED 7 Red	DDB_OUTPUT_LED_7	SW	LED	Programmable LED 7 Red is on (P241 Only
103	LED 8 Red	DDB_OUTPUT_LED_8	SW	LED	Programmable LED 8 Red is on (P241 Only
104	Speed Input	DDB_VITESSE	PSL	PFSI	Allows to detect if motor is stopped or not
105	CB Aux 3ph - 52A	DDB_DISJONCTEUR_FERME	PSL	PFSI	Three phase Circuit Breaker closed Status
106	CB Aux 3ph - 52B	DDB_DISJONCTEUR_OUVERT	PSL	PFSI	Three phase Circuit Breaker open Status
107	Setting Group	DDB_CHANGEMENT_CONFIGURATION	PSL	PFSI	Setting Group change (Off = Group1, On = Group 2)
108	Emergency Rest.	DDB_DEMARRAGE_URGENCE	PSL	PFSI	Initiates Emergency Restart of motor
109	Reset Thermal	DDB_RAZ_ETAT_THERMIQUE	PSL	PFSI	Resets Thermal Ttate to 0%
110	Dist Rec.Trig.	DDB_DEM_EXTERNE_PERTURBO	PSL	PFSI	Triggers the Disturbance Recorder
111	Close	DDB_ENCLENCHEMENT	PSL	PFSI	Initiates a breaker close command
112	Trip	DDB_DECLENCHEMENT	PSL	PFSI	Initiates a breaker trip command
113	Reset Latches	DDB_RESET_LATCH_RELAY	PSL	PFSI	Reset all latched LEDs and output relays
114	Test Mode	DDB_TEST_MODE	PSL	PFSI	Not used
115	External Trip	DDB_DECLENCHEMENT_EXTERNE	PSL	PFSI	External Trip 3 phase - allows external protection to initiate breaker fail and circuit breaker condition monitoring counters.
116	Time Synch	DDB_INP_TIMESYNC	PSL	PFSI	Time Synchronism by opto Input pulse
117	FFail Block	DDB_FFAIL_BLOCK	PSL	PFSI	Blocks operation of the Field Failure protection
118	Trip LED	DDB_TRIP_LED	PSL	PFSI	Trip LED is on
119	MCB/VTS	MPR_INPUT_FFUS	PSL	PFSI	VT Supervision, Fuse Failure
120	Monitor Blocking DDB	DDB_CS103_BLOCK	PSL	PFSI	Monitor Blocking DDB
121	Command Blocking DDB	DDB_CS103_CMD_BLOCK	PSL	PFSI	Command Blocking DDB
122	RP1 Read Only DDB	DDB_REMOTEREADONLY_RP1	PSL	PFSI	RP1 Read Only DDB
123	RP2 Read Only DDB	DDB_REMOTEREADONLY_RP2	PSL	PFSI	RP2 Read Only DDB
124	NIC Read Only DDB	DDB_REMOTEREADONLY_NIC	PSL	PFSI	NIC Read Only DDB
125	Not Used	DDB_UNUSED_125	SW	UNUSED	
126	Not Used	DDB_UNUSED_126	SW	UNUSED	

DDB No	English Text	Element Name	Source	Type	Description
127	Not Used	DDB_UNUSED_127	SW	UNUSED	
128	Not Used	DDB_UNUSED_128	SW	UNUSED	
129	Not Used	DDB_UNUSED_129	SW	UNUSED	
130	Not Used	DDB_UNUSED_130	SW	UNUSED	
131	Not Used	DDB_UNUSED_131	SW	UNUSED	
132	Not Used	DDB_UNUSED_132	SW	UNUSED	
133	Not Used	DDB_UNUSED_133	SW	UNUSED	
134	Not Used	DDB_UNUSED_134	SW	UNUSED	
135	Not Used	DDB_UNUSED_135	SW	UNUSED	
136	Not Used	DDB_UNUSED_136	SW	UNUSED	
137	Not Used	DDB_UNUSED_137	SW	UNUSED	
138	Not Used	DDB_UNUSED_138	SW	UNUSED	
139	Not Used	DDB_UNUSED_139	SW	UNUSED	
140	Not Used	DDB_UNUSED_140	SW	UNUSED	
141	Not Used	DDB_USER_ALARM_1	PSL	PFSI	
142	Not Used	DDB_USER_ALARM_2	PSL	PFSI	
143	Not Used	DDB_USER_ALARM_3	PSL	PFSI	
144	Not Used	DDB_USER_ALARM_4	PSL	PFSI	
145	Not Used	DDB_USER_ALARM_5	PSL	PFSI	
146	Not Used	DDB_USER_ALARM_6	PSL	PFSI	
147	Not Used	DDB_USER_ALARM_7	PSL	PFSI	
148	Not Used	DDB_USER_ALARM_8	PSL	PFSI	
149	Not Used	DDB_USER_ALARM_9	PSL	PFSI	
150	Not Used	DDB_USER_ALARM_10	PSL	PFSI	
151	Not Used	DDB_USER_ALARM_11	PSL	PFSI	
152	Not Used	DDB_USER_ALARM_12	PSL	PFSI	
153	Not Used	DDB_USER_ALARM_13	PSL	PFSI	
154	Not Used	DDB_USER_ALARM_14	PSL	PFSI	
155	Not Used	DDB_USER_ALARM_15	PSL	PFSI	
156	Not Used	DDB_USER_ALARM_16	PSL	PFSI	
157	Not Used	DDB_USER_ALARM_17	PSL	PFSI	
158	Not Used	DDB_USER_ALARM_18	PSL	PFSI	
159	Not Used	DDB_USER_ALARM_19	PSL	PFSI	
160	Not Used	DDB_USER_ALARM_20	PSL	PFSI	
161	Not Used	DDB_USER_ALARM_21	PSL	PFSI	
162	Not Used	DDB_USER_ALARM_22	PSL	PFSI	
163	Not Used	DDB_USER_ALARM_23	PSL	PFSI	
164	Not Used	DDB_USER_ALARM_24	PSL	PFSI	
165	Not Used	DDB_USER_ALARM_25	PSL	PFSI	
166	Not Used	DDB_USER_ALARM_26	PSL	PFSI	
167	Not Used	DDB_USER_ALARM_27	PSL	PFSI	
168	Not Used	DDB_USER_ALARM_28	PSL	PFSI	
169	Not Used	DDB_USER_ALARM_29	PSL	PFSI	
170	Not Used	DDB_USER_ALARM_30	PSL	PFSI	

DDB No	English Text	Element Name	Source	Type	Description
171	Not Used	DDB_USER_ALARM_31	PSL	PFSI	
172	Not Used	DDB_USER_ALARM_32	PSL	PFSI	
173	Not Used	DDB_ALARM_UNUSED0	SW	UNUSED	
174	General Alarm	DDB_ALARM_GENERAL	SW	PFSO	Any Alarm is operated
175	Prot'n Disabled	DDB_ALARM_PROT_DISABLED	SW	PFSO	Protection Disabled - typically out of service due to test mode
176	F Out of Range	MCA_ALARM_VALIDITE_FREQUENCE	SW	PFSO	Frequency Out of bandwidth Range (45-60Hz)
177	3Ph Volt.Alarm	MPR_ALARM_INV_PH	SW	PFSO	3 phases voltage checking before Motor start
178	Thermal Alarm	MPR_ALARM_TH	SW	PFSO	Thermal State has exceeded alarm threshold
179	Thermal Lockout	MPR_ALARM_INTERD_TH_DEM	SW	PFSO	Used to inhibit a motor start until Thermal State < Thermal Lockout threshold
180	Time Betwe Start	MPR_ALARM_INTERD_DEM	SW	PFSO	Time allowed between 2 starts isn't finished
181	Hot Start Nb.	MPR_ALARM_NB_DEM_A_CHAUD	SW	PFSO	Used to inhibit a motor start if Number of Hot Starts setting is exceeded
182	Cold Start Nb.	MPR_ALARM_NB_DEM_A_FROID	SW	PFSO	Used to inhibit a motor start if Number of Cold Ctarts setting is exceeded
183	Man CB Trip Fail	MPR_ALARM_CB_FAILED_TO_TRIP	SW	PFSO	Circuit Breaker Failed to Trip (after a manual/operator trip command)
184	Man CB Cls Fail	MPR_ALARM_CB_FAILED_TO_CLOSE	SW	PFSO	Circuit Breaker Failed to Close (after a manual/operator close command)
185	CB Status Alarm	MPR_ALARM_CB_STATUS	SW	PFSO	Indication of a fault with the Circuit Breaker state monitoring – example: defective auxiliary contacts
186	I^ Maint Alarm	MPR_ALARM_CB_RUPTURE_COURANT	SW	PFSO	Broken current setting is exceeded
187	CB OPs Maint	MPR_ALARM_CB_NB_OPERATIONS	SW	PFSO	Number of Circuit Breaker trips has exceeded maintenance alarm setting.
188	CB Op Time Maint	MPR_ALARM_CB_OPERATING_TIME	SW	PFSO	Circuit Breaker operating time has exceeded maintenance alarm setting (slow interruption time)
189	3Ph W Alarm	MPR_ALARM_MAX_PUISS_ACTIVE	SW	PFSO	3 Phases Watts Alarm
190	3Ph VAr Alarm	MPR_ALARM_MAX_PUISS_REACTIVE	SW	PFSO	3 Phase Var Alarm
191	RTD 1 Alarm	MPR_ALARM_SON_RTD_1	SW	PFSO	RTD 1 Alarm
192	RTD 2 Alarm	MPR_ALARM_SON_RTD_2	SW	PFSO	RTD 2 Alarm
193	RTD 3 Alarm	MPR_ALARM_SON_RTD_3	SW	PFSO	RTD 3 Alarm
194	RTD 4 Alarm	MPR_ALARM_SON_RTD_4	SW	PFSO	RTD 4 Alarm
195	RTD 5 Alarm	MPR_ALARM_SON_RTD_5	SW	PFSO	RTD 5 Alarm
196	RTD 6 Alarm	MPR_ALARM_SON_RTD_6	SW	PFSO	RTD 6 Alarm
197	RTD 7 Alarm	MPR_ALARM_SON_RTD_7	SW	PFSO	RTD 7 Alarm
198	RTD 8 Alarm	MPR_ALARM_SON_RTD_8	SW	PFSO	RTD 8 Alarm
199	RTD 9 Alarm	MPR_ALARM_SON_RTD_9	SW	PFSO	RTD 9 Alarm
200	RTD 10 Alarm	MPR_ALARM_SON_RTD_10	SW	PFSO	RTD 10 Alarm
201	RTD Short Cct	MPR_ALARM_SON_SHORT_CIRCUIT	SW	PFSO	RTD Short Circuit (the RTD cells in Measurements 3 indicates which RTD is short circuit)
202	RTD Open Cct	MPR_ALARM_SON_OPEN_CIRCUIT	SW	PFSO	RTD Open Circuit (the RTD cells in Measurements 3 indicates which RTD is open circuit)

DDB No	English Text	Element Name	Source	Type	Description
203	RTD Data Error	MPR_ALARM_SON_INCONSISTANT_DATA	SW	PFSO	Measured RTD are not in the normal range of the board (the RTD cells in Measurements 3 indicates which RTD have data error)
204	Invalid Set. Grp	DDB_ALARM_CHGT_CONF_INTERDIT	SW	PFSO	Invalid Setting Group
205	Dist. Rec. Conf.	MPR_ALARM_CONF_PERTURBO	SW	PFSO	Disturbance Recorder Configuration is not compliant with "connecting mode", for example if "VT connecting mode" = "2VT+antibackspin"
206	CB Fail Alarm	MPR_ALARM_BREAKER_FAIL	SW	PFSO	CBFail function is operating
207	W Fwd Alarm	MPR_ALARM_ENERGIE_ACT_ABSORBEE	SW	PFSO	Watt Forward Alarm
208	W Rev Alarm	MPR_ALARM_ENERGIE_ACT_GENEREE	SW	PFSO	Watt Reverse Alarm
209	VAr Fwd Alarm	MPR_ALARM_ENERGIE_REACT_ABSORBEE	SW	PFSO	Var Forward Alarm
210	VAr Rev Alarm	MPR_ALARM_ENERGIE_REACT_GENEREE	SW	PFSO	Var Reverse Alarm
211	Analo Inp1 Alarm	MPR_ALARM_CLIO_1	SW	PFSO	Current Loop Input (Transducer input) 1 Alarm
212	Analo Inp2 Alarm	MPR_ALARM_CLIO_2	SW	PFSO	Current Loop Input (Transducer input) 2 Alarm
213	Analo Inp3 Alarm	MPR_ALARM_CLIO_3	SW	PFSO	Current Loop Input (Transducer input) 3 Alarm
214	Analo Inp4 Alarm	MPR_ALARM_CLIO_4	SW	PFSO	Current Loop Input (Transducer input) 4 Alarm
215	Not Used	DDB_ALARM_UNUSED_215	PSL	UNUSED	
216	Not Used	DDB_ALARM_UNUSED_216	PSL	UNUSED	
217	Not Used	DDB_ALARM_UNUSED_217	PSL	UNUSED	
218	Not Used	DDB_ALARM_UNUSED_218	PSL	UNUSED	
219	Not Used	DDB_ALARM_UNUSED_219	PSL	UNUSED	
220	Not Used	DDB_ALARM_UNUSED_220	PSL	UNUSED	
221	Not Used	DDB_ALARM_UNUSED_221	PSL	UNUSED	
222	Not Used	DDB_ALARM_UNUSED_222	PSL	UNUSED	
223	Not Used	DDB_ALARM_UNUSED_223	PSL	UNUSED	
224	Not Used	DDB_ALARM_UNUSED_224	PSL	UNUSED	
225	Not Used	DDB_ALARM_UNUSED_225	PSL	UNUSED	
226	Not Used	DDB_ALARM_UNUSED_226	PSL	UNUSED	
227	Not Used	DDB_ALARM_UNUSED_227	PSL	UNUSED	
228	Not Used	DDB_ALARM_UNUSED_228	PSL	UNUSED	
229	CT-1 Fail Alarm	MPR_ALARM_CTS1	SW	PFSO	CT Supervision alarm, stage 1
230	CT-2 Fail Alarm	MPR_ALARM_CTS2	SW	HIDDEN	CT Supervision alarm, stage 2
231	Hour Run Alarm1	MPR_ALARM_HOUR_RUN_METER_1	SW	PFSO	Hour Run Alarm 1
232	Hour Run Alarm2	MPR_ALARM_HOUR_RUN_METER_2	SW	PFSO	Hour Run Alarm 2
233	Antibkspin Alarm	MPR_ALARM_ANTIBACKSPIN	SW	PFSO	Anti-Backspin Alarm
234	Field Fail Alarm	MPR_ALARM_FIELDF	SW	PFSO	Field Failure Alarm
235	VTS Block Alarm	MPR_ALARM_VTS_BLOCK	SW	PFSO	VT Supervision, confirmed block
236	Thermal Trip	MPR_DECL_TH	SW	PFSO	Thermal State has exceeded trip threshold
237	Trip I>1	MPR_ICC_1_INFO_DECL	SW	PFSO	1st stage Short Circuit Trip, 3-phase
238	I>1 A Phase	MPR_ICC_1_DEP_PH_A	SW	PFSO	As per DDB#242
239	I>1 B Phase	MPR_ICC_1_DEP_PH_B	SW	PFSO	As per DDB#243
240	I>1 C Phase	MPR_ICC_1_DEP_PH_C	SW	PFSO	As per DDB#244

DDB No	English Text	Element Name	Source	Type	Description
241	Start I>1	MPR_ICC_1_INFO_INST	SW	PFSO	1st stage Short Circuit Start, 3 Phase
242	Start I>1 A Ph	MPR_ICC_1_INFO_INST_PH_A	SW	PFSO	1st stage Short Circuit Start, A Phase
243	Start I>1 B Ph	MPR_ICC_1_INFO_INST_PH_B	SW	PFSO	1st stage Short Circuit Start, B Phase
244	Start I>1 C Ph	MPR_ICC_1_INFO_INST_PH_C	SW	PFSO	1st stage Short Circuit Start, C Phase
245	Trip I>1 A Ph	MPR_ICC_1_INFO_DECL_PH_A	SW	PFSO	1st stage Short Circuit Trip, A Phase
246	Trip I>1 B Ph	MPR_ICC_1_INFO_DECL_PH_B	SW	PFSO	1st stage Short Circuit Trip, B Phase
247	Trip I>1 C Ph	MPR_ICC_1_INFO_DECL_PH_C	SW	PFSO	1st stage Short Circuit Trip, C Phase
248	Trip I>2	MPR_ICC_2_INFO_DECL	SW	PFSO	2nd stage Short Circuit Trip, 3 Phase
249	I>2 A Phase	MPR_ICC_2_DEP_PH_A	SW	PFSO	As per DDB#253
250	I>2 B Phase	MPR_ICC_2_DEP_PH_B	SW	PFSO	As per DDB#254
251	I>2 C Phase	MPR_ICC_2_DEP_PH_C	SW	PFSO	As per DDB#255
252	Start I>2	MPR_ICC_2_INFO_INST	SW	PFSO	2nd stage Short Circuit start, 3 Phase
253	Start I>2 A Ph	MPR_ICC_2_INFO_INST_PH_A	SW	PFSO	2nd stage Short Circuit start, A Phase
254	Start I>2 B Ph	MPR_ICC_2_INFO_INST_PH_B	SW	PFSO	2nd stage Short Circuit start, B Phase
255	Start I>2 C Ph	MPR_ICC_2_INFO_INST_PH_C	SW	PFSO	2nd stage Short Circuit start, C Phase
256	Trip I>2 A Ph	MPR_ICC_2_INFO_DECL_PH_A	SW	PFSO	2nd stage Short Circuit trip, A Phase
257	Trip I>2 B Ph	MPR_ICC_2_INFO_DECL_PH_B	SW	PFSO	2nd stage Short Circuit trip, B Phase
258	Trip I>2 C Ph	MPR_ICC_2_INFO_DECL_PH_C	SW	PFSO	2nd stage Short Circuit trip, C Phase
259	Trip F<1	MPR_FREQ_SEUIL_1	SW	PFSO	1st stage Underfreqeuncy Trip
260	Trip F<2	MPR_FREQ_SEUIL_2	SW	PFSO	2nd stage Underfrequency Trip
261	Trip ISEF>1	MPR_IBT_INFO_DECL	SW	PFSO	1st stage Sensitive Earth Fault Trip
262	Start ISEF>1	MPR_IBT_INFO_INST	SW	PFSO	1st stage Sensitive Earth Fault Start
263	Trip ISEF>2	MPR_IHT_INFO_DECL	SW	PFSO	2nd stage Sensitive Earth Fault Trip
264	Start ISEF>2	MPR_IHT_INFO_INST	SW	PFSO	2nd stage Sensitive Earth Fault Start
265	Trip IN>1	MPR_IBTD_INFO_DECL	SW	PFSO	1st stage Derived Earth Fault Trip
266	Start IN>1	MPR_IBTD_INFO_INST	SW	PFSO	1st stage Derived Earth Fault Start
267	Trip IN>2	MPR_IHTD_INFO_DECL	SW	PFSO	2nd stage Derived Earth Fault Trip
268	Start IN>2	MPR_IHTD_INFO_INST	SW	PFSO	2nd stage Derived Earth Fault Start
269	Trip P<1	MPR_MIN_PB_INFO_DECL	SW	PFSO	1st stage Underpower Trip
270	Trip P<2	MPR_MIN_PH_INFO_DECL	SW	PFSO	2nd stage Underpower Trip
271	Trip PF< Lead	MPR_MIN_FP_LEAD_INFO_DECL	SW	PFSO	Out of Step Trip (leading power factor)
272	Trip PF< Lag	MPR_MIN_FP_LAG_INFO_DECL	SW	PFSO	Out of Step Trip (lagging power factor)
273	Trip Rev Power	MPR_RET_P_INFO_DECL	SW	PFSO	Reverse Power Trip
274	Trip I2>1	MPR_IBI_INFO_DECL	SW	PFSO	1st stage NPS Trip
275	Tip I2>2	MPR_IHI_INFO_DECL	SW	PFSO	2nd stage NPS Trip
276	V<1 AB Phase	MPR_UBC_DEP_PH_AB	SW	PFSO	1st stage Undervoltage Trip,AB Phase
277	V<1 BC Phase	MPR_UBC_DEP_PH_BC	SW	PFSO	1st stage Undervoltage Trip, BC Phase
278	V<1 CA Phase	MPR_UBC_DEP_PH_CA	SW	PFSO	1st stage Undervoltage Trip, CA Phase
279	Trip V<1	MPR_UBC_INFO_DECL	SW	PFSO	1st stage Undervoltage Trip, 3 Phase
280	V>1 AB Phase	MPR_MAX_UBC_DEP_PH_AB	SW	PFSO	1st stage Overvoltage Trip, AB Phase
281	V>1 BC Phase	MPR_MAX_UBC_DEP_PH_BC	SW	PFSO	1st stage Overvoltage Trip, BC Phase
282	V>1 CA Phase	MPR_MAX_UBC_DEP_PH_CA	SW	PFSO	1st stage Overvoltage Trip, CA Phase
283	Trip V>1	MPR_MAX_UBC_INFO_DECL	SW	PFSO	1st stage Overvoltage Trip, 3 Phase
284	V<2 AB Phase	MPR_UHC_DEP_PH_AB	SW	PFSO	2nd stage Undervoltage Trip, AB Phase

DDB No	English Text	Element Name	Source	Type	Description
285	V<2 BC Phase	MPR_UHC_DEP_PH_BC	SW	PFSO	2nd stage Undervoltage Trip, BC Phase
286	V<2 CA Phase	MPR_UHC_DEP_PH_CA	SW	PFSO	2nd stage Undervoltage Trip, CA Phase
287	Trip V<2	MPR_UHC_INFO_DECL	SW	PFSO	2nd stage Undervoltage Trip, 3 Phase
288	V>2 AB Phase	MPR_MAX_UHC_DEP_PH_AB	SW	PFSO	2nd stage Overvoltage Trip, AB Phase
289	V>2 BC Phase	MPR_MAX_UHC_DEP_PH_BC	SW	PFSO	2nd stage Overvoltage Trip, BC Phase
290	V>2 CA Phase	MPR_MAX_UHC_DEP_PH_CA	SW	PFSO	2nd stage Overvoltage Trip, CA Phase
291	Trip V>2	MPR_MAX_UHC_INFO_DECL	SW	PFSO	2nd stage Overvoltage Trip, 3 Phase
292	Trip NVD VN>1	MPR_VBT_INFO_DECL	SW	PFSO	1st stage Neutral Voltage Displacement/Residual Overvoltage Trip
293	Trip NVD VN>2	MPR_VHT_INFO_DECL	SW	PFSO	2nd Neutral Voltage Displacement/Residual Overvoltage Trip
294	Trip PO>	MPR_PWH_INFO_DECL	SW	PFSO	Wattmetric directional Earth Fault Trip
295	Start PO>	MPR_PWH_INFO_INST	SW	PFSO	Wattmetric directional Earth Fault Start
296	Reacc Low Volt	MPR_INFO_UCR	SW	PFSO	Voltage has dipped below 'Reacc Low Voltage Setting'
297	Strt in Progress	MPR_DEM_EN_COURS	SW	PFSO	Start in Progress
298	Strt Successful	MPR_DEM_REUSSI	SW	PFSO	Successful Start
299	Prolonged Start	MPR_DEM_TROP_LONG	SW	PFSO	Prolonged Start – stall condition when the motor is starting (current > Starting Current setting for time > Prolonged Start Time)
300	Reac in Progress	MPR_REAC_EN_COURS	SW	PFSO	Reacceleration in Progress
301	Stall Rotor-run	MPR_BLOC_ROTOR	SW	PFSO	Stall Rotor condition when the motor is running
302	Stall Rotor-Strt	MPR_BLOC_ROTOR_DEM	SW	PFSO	Stall Rotor condition when the motor is starting (current > Starting Current setting and Speed Input is off for time > Stall Time)
303	Control Trip	MPR_CB_CONTROL_TRIP	SW	PFSO	Manual Trip command
304	Control Close	MPR_CB_CONTROL_CLOSE	SW	PFSO	Manual Close command
305	RTD 1 Trip	MPR_SON_INFO_DECL_RTD_1	SW	PFSO	RTD 1 Trip
306	RTD 2 Trip	MPR_SON_INFO_DECL_RTD_2	SW	PFSO	RTD 2 Trip
307	RTD 3 Trip	MPR_SON_INFO_DECL_RTD_3	SW	PFSO	RTD 3 Trip
308	RTD 4 Trip	MPR_SON_INFO_DECL_RTD_4	SW	PFSO	RTD 4 Trip
309	RTD 5 Trip	MPR_SON_INFO_DECL_RTD_5	SW	PFSO	RTD 5 Trip
310	RTD 6 Trip	MPR_SON_INFO_DECL_RTD_6	SW	PFSO	RTD 6 Trip
311	RTD 7 Trip	MPR_SON_INFO_DECL_RTD_7	SW	PFSO	RTD 7 Trip
312	RTD 8 Trip	MPR_SON_INFO_DECL_RTD_8	SW	PFSO	RTD 8 Trip
313	RTD 9 Trip	MPR_SON_INFO_DECL_RTD_9	SW	PFSO	RTD 9 Trip
314	RTD 10 Trip	MPR_SON_INFO_DECL_RTD_10	SW	PFSO	RTD 10 Trip
315	Diff Trip A	MPR_DIFF_INFO_DECL_PH_A	SW	PFSO	Motor Differential Trip, A Phase. (P243)
316	Diff Trip B	MPR_DIFF_INFO_DECL_PH_B	SW	PFSO	Motor Differential Trip, B Phase. (P243)
317	Diff Trip C	MPR_DIFF_INFO_DECL_PH_C	SW	PFSO	Motor Differential Trip, C Phase. (P243)
318	Trip Diff	MPR_DIFF_INFO_DECL	SW	PFSO	Motor Differential Trip (P243)
319	Trip CBF 1	MPR_CBF_INFO_DECL_1	SW	PFSO	CB Fail Timer 1 Trip
320	Trip CBF 2	MPR_CBF_INFO_DECL_2	SW	PFSO	CB Fail Timer 2 Trip
321	Trip Analog Inp 1	MPR_CLIO_INFO_DECL_1	SW	PFSO	Current Loop Input (Analog/transducer input) 1 Trip

DDB No	English Text	Element Name	Source	Type	Description
322	Trip Analog Inp 2	MPR_CLIO_INFO_DECL_2	SW	PFSO	Current Loop Input (Analog/transducer input) 2 Trip
323	Trip Analog Inp 3	MPR_CLIO_INFO_DECL_3	SW	PFSO	Current Loop Input (Analog/transducer input) 3 Trip
324	Trip Analog Inp 4	MPR_CLIO_INFO_DECL_4	SW	PFSO	Current Loop Input (Analog/transducer input) 4 Trip
325	Pwd UI Level 0	DDB_UNUSED_325	SW	HIDDEN	Access Level 0 is enabled for the User Interface (HMI)
326	Pwd UI Level 1	DDB_UNUSED_326	SW	HIDDEN	Access Level 1 is enabled for the User Interface (HMI)
327	Pwd UI Level 2	DDB_UNUSED_327	SW	HIDDEN	Access Level 2 is enabled for the User Interface (HMI)
328	Pwd Front Level 0	DDB_UNUSED_328	SW	HIDDEN	Access Level 0 is enabled for the Front Comms Port
329	Pwd Front Level 1	DDB_UNUSED_329	SW	HIDDEN	Access Level 1 is enabled for the Front Comms Port
330	Pwd Front Level 2	DDB_UNUSED_330	SW	HIDDEN	Access Level 2 is enabled for the Front Comms Port
331	Pwd Rear Level 0	DDB_UNUSED_331	SW	HIDDEN	Access Level 0 is enabled for the Main Rear Comms Port
332	Pwd Rear Level 1	DDB_UNUSED_332	SW	HIDDEN	Access Level 1 is enabled for the Main Rear Comms Port
333	Pwd Rear Level 2	DDB_UNUSED_333	SW	HIDDEN	Access Level 2 is enabled for the Main Rear Comms Port
334	FFail1 Start	DDB_FIELDF_1_START	SW	PFSO	1st Stage Field Failure Start
335	FFail2 Start	DDB_FIELDF_2_START	SW	PFSO	2nd Stage Field Failure Start
336	FFail1 Trip	DDB_FIELDF_1_TRIP	SW	PFSO	1st Stage Field Failure Trip
337	FFail2 Trip	DDB_FIELDF_2_TRIP	SW	PFSO	2nd Stage Field Failure Trip
338	Trip I>3	MPR_ICC_3_INFO_DECL	SW	PFSO	3rd stage Short Circuit Trip, 3-phase
339	I>3 A Phase	MPR_ICC_3_DEP_PH_A	SW	PFSO	As per DDB#343
340	I>3 B Phase	MPR_ICC_3_DEP_PH_B	SW	PFSO	As per DDB#344
341	I>3 C Phase	MPR_ICC_3_DEP_PH_C	SW	PFSO	As per DDB#345
342	Start I>3	MPR_ICC_3_INFO_INST	SW	PFSO	3rd stage Short Circuit Start, 3 Phase
343	Start I>3 A Ph	MPR_ICC_3_INFO_INST_PH_A	SW	PFSO	3rd stage Short Circuit Start, A Phase
344	Start I>3 B Ph	MPR_ICC_3_INFO_INST_PH_B	SW	PFSO	3rd stage Short Circuit Start, B Phase
345	Start I>3 C Ph	MPR_ICC_3_INFO_INST_PH_C	SW	PFSO	3rd stage Short Circuit Start, C Phase
346	Trip I>3 A Ph	MPR_ICC_3_INFO_DECL_PH_A	SW	PFSO	3rd stage Short Circuit Trip, A Phase
347	Trip I>3 B Ph	MPR_ICC_3_INFO_DECL_PH_B	SW	PFSO	3rd stage Short Circuit Trip, B Phase
348	Trip I>3 C Ph	MPR_ICC_3_INFO_DECL_PH_C	SW	PFSO	3rd stage Short Circuit Trip, C Phase
349	Trip I>4	MPR_ICC_4_INFO_DECL	SW	PFSO	4th stage Short Circuit Trip, 3-phase
350	I>4 A Phase	MPR_ICC_4_DEP_PH_A	SW	PFSO	As per DDB#354
351	I>4 B Phase	MPR_ICC_4_DEP_PH_B	SW	PFSO	As per DDB#355
352	I>4 C Phase	MPR_ICC_4_DEP_PH_C	SW	PFSO	As per DDB#356
353	Start I>4	MPR_ICC_4_INFO_INST	SW	PFSO	4th stage Short Circuit Start, 3 Phase
354	Start I>4 A Ph	MPR_ICC_4_INFO_INST_PH_A	SW	PFSO	4th stage Short Circuit Start, A Phase
355	Start I>4 B Ph	MPR_ICC_4_INFO_INST_PH_B	SW	PFSO	4th stage Short Circuit Start, B Phase
356	Start I>4 C Ph	MPR_ICC_4_INFO_INST_PH_C	SW	PFSO	4th stage Short Circuit Start, C Phase
357	Trip I>4 A Ph	MPR_ICC_4_INFO_DECL_PH_A	SW	PFSO	4th stage Short Circuit Trip, A Phase

DDB No	English Text	Element Name	Source	Type	Description
358	Trip I>4 B Ph	MPR_ICC_4_INFO_DECL_PH_B	SW	PFSO	4th stage Short Circuit Trip, B Phase
359	Trip I>4 C Ph	MPR_ICC_4_INFO_DECL_PH_C	SW	PFSO	4th stage Short Circuit Trip, C Phase
360	CT-1 Block	MPR_CTS1_BLOCK	SW	PFSO	CT Supervision block, stage 1
361		MPR_CTS2_BLOCK	SW	HIDDEN	CT Supervision block, stage 2
362	VTS Fast	MPR_VTS_FAST	SW	PFSO	VT Supervision, Fuse Failure
363	Not Used	DDB_BLOCK_REMOTE_CB_OPS	SW	HIDDEN	Blk Remote CB OP
364	Not Used	DDB_DST_STATUS	SW	HIDDEN	
365	Not Used	DDB_UNUSED_365	SW	UNUSED	
366	Not Used	DDB_UNUSED_366	SW	UNUSED	
367	Not Used	DDB_UNUSED_367	SW	UNUSED	
368	Not Used	DDB_UNUSED_368	SW	UNUSED	
369	Any Start	DDB_PROTECTION_START	SW	PFSO	Any Start
370	Protection Trip	DDB_PROTECTION_TRIP	FL	PFSO	Any Protection Trip
371	Any Trip	DDB_ANY_TRIP	FL	PFSO	Any Trip
372	Not Used	DDB_MIN_F_1_START	SW	PFSO	1st Stage Under Frequency Start
373	Not Used	DDB_MIN_F_2_START	SW	PFSO	2nd Stage Under Frequency Start
374	Not Used	DDB_MIN_P_1_START	SW	PFSO	1st Stage Loss Of Load Start
375	Not Used	DDB_MIN_P_2_START	SW	PFSO	2nd Stage Loss Of Load Start
376	Not Used	DDB_PF_LEAD_START	SW	PFSO	Power Factor Lead Start
377	Not Used	DDB_PF_LAG_START	SW	PFSO	Power Factor Lag Start
378	Not Used	DDB_REV_P_START	SW	PFSO	Reverse Power Start
379	Not Used	DDB_MAX_I2_1_START	SW	PFSO	1st stage Negative Sequence O/C Start
380	Not Used	DDB_MAX_I2_2_START	SW	PFSO	2nd stage Negative Sequence O/C Start
381	Not Used	DDB_MAX_NVD_1_START	SW	PFSO	1st stage Residual O/V Start
382	Not Used	DDB_MAX_NVD_2_START	SW	PFSO	2nd stage Residual O/V Start
383	Not Used	DDB_UNUSED_383	SW	UNUSED	
384	Not Used	DDB_UNUSED_384	SW	UNUSED	
385	Not Used	DDB_UNUSED_385	SW	UNUSED	
386	Not Used	DDB_UNUSED_386	SW	UNUSED	
387	Not Used	DDB_UNUSED_387	SW	UNUSED	
388	Not Used	DDB_UNUSED_388	SW	UNUSED	
389	Not Used	DDB_UNUSED_389	SW	UNUSED	
390	Not Used	DDB_UNUSED_390	SW	UNUSED	
391	Not Used	DDB_UNUSED_391	SW	UNUSED	
392	Not Used	DDB_UNUSED_392	SW	UNUSED	
393	Not Used	DDB_UNUSED_393	SW	UNUSED	
394	Not Used	DDB_UNUSED_394	SW	UNUSED	
395	Not Used	DDB_UNUSED_395	SW	UNUSED	
396	Not Used	DDB_UNUSED_396	SW	UNUSED	
397	Not Used	DDB_UNUSED_397	SW	UNUSED	
398	Not Used	DDB_UNUSED_398	SW	UNUSED	
399	Not Used	DDB_UNUSED_399	SW	UNUSED	
400	Not Used	DDB_UNUSED_400	SW	UNUSED	
401	Not Used	DDB_UNUSED_401	SW	UNUSED	

DDB No	English Text	Element Name	Source	Type	Description
402	Not Used	DDB_UNUSED_402	SW	UNUSED	
403	Not Used	DDB_UNUSED_403	SW	UNUSED	
404	Not Used	DDB_UNUSED_404	SW	UNUSED	
405	Not Used	DDB_UNUSED_405	SW	UNUSED	
406	Not Used	DDB_UNUSED_406	SW	UNUSED	
407	Not Used	DDB_UNUSED_407	SW	UNUSED	
408	Not Used	DDB_UNUSED_408	SW	UNUSED	
409	Not Used	DDB_UNUSED_409	SW	UNUSED	
410	Not Used	DDB_UNUSED_410	SW	UNUSED	
411	Not Used	DDB_UNUSED_411	SW	UNUSED	
412	Not Used	DDB_UNUSED_412	SW	UNUSED	
413	Not Used	DDB_UNUSED_413	SW	UNUSED	
414	Not Used	DDB_UNUSED_414	SW	UNUSED	
415	Not Used	DDB_UNUSED_415	SW	UNUSED	
416	Not Used	DDB_UNUSED_416	SW	UNUSED	
417	Not Used	DDB_UNUSED_417	SW	UNUSED	
418	Not Used	DDB_UNUSED_418	SW	UNUSED	
419	Not Used	DDB_UNUSED_419	SW	UNUSED	
420	Not Used	DDB_UNUSED_420	SW	UNUSED	
421	Not Used	DDB_UNUSED_421	SW	UNUSED	
422	Not Used	DDB_UNUSED_422	SW	UNUSED	
423	Not Used	DDB_UNUSED_423	SW	UNUSED	
424	Not Used	DDB_UNUSED_424	SW	UNUSED	
425	Not Used	DDB_UNUSED_425	SW	UNUSED	
426	Not Used	DDB_UNUSED_426	SW	UNUSED	
427	Not Used	DDB_UNUSED_427	SW	UNUSED	
428	LED 1 Con	DDB_LED_CON_1	PSL	LED_CON	Input signal driving LED 1 Red is on (P241 only)
429	LED 2 Con	DDB_LED_CON_2	PSL	LED_CON	Input signal driving LED 2 Red is on (P241 only)
430	LED 3 Con	DDB_LED_CON_3	PSL	LED_CON	Input signal driving LED 3 Red is on (P241 only)
431	LED 4 Con	DDB_LED_CON_4	PSL	LED_CON	Input signal driving LED 4 Red is on (P241 only)
432	LED 5 Con	DDB_LED_CON_5	PSL	LED_CON	Input signal driving LED 5 Red is on (P241 only)
433	LED 6 Con	DDB_LED_CON_6	PSL	LED_CON	Input signal driving LED 6 Red is on (P241 only)
434	LED 7 Con	DDB_LED_CON_7	PSL	LED_CON	Input signal driving LED 7 Red is on (P241 only)
435	LED 8 Con	DDB_LED_CON_8	PSL	LED_CON	Input signal driving LED 8 Red is on (P241 only)
436	Timer in 1	DDB_TIMERIN_1	PSL	TIMERIN	Input to Auxiliary Timer 1 is on
437	Timer in 2	DDB_TIMERIN_2	PSL	TIMERIN	Input to Auxiliary Timer 2 is on
438	Timer in 3	DDB_TIMERIN_3	PSL	TIMERIN	Input to Auxiliary Timer 3 is on
439	Timer in 4	DDB_TIMERIN_4	PSL	TIMERIN	Input to Auxiliary Timer 4 is on
440	Timer in 5	DDB_TIMERIN_5	PSL	TIMERIN	Input to Auxiliary Timer 5 is on

DDB No	English Text	Element Name	Source	Type	Description
441	Timer in 6	DDB_TIMERIN_6	PSL	TIMERIN	Input to Auxiliary Timer 6 is on
442	Timer in 7	DDB_TIMERIN_7	PSL	TIMERIN	Input to Auxiliary Timer 7 is on
443	Timer in 8	DDB_TIMERIN_8	PSL	TIMERIN	Input to Auxiliary Timer 8 is on
444	Timer in 9	DDB_TIMERIN_9	PSL	TIMERIN	Input to Auxiliary Timer 9 is on
445	Timer in 10	DDB_TIMERIN_10	PSL	TIMERIN	Input to Auxiliary Timer 10 is on
446	Timer in 11	DDB_TIMERIN_11	PSL	TIMERIN	Input to Auxiliary Timer 11 is on
447	Timer in 12	DDB_TIMERIN_12	PSL	TIMERIN	Input to Auxiliary Timer 12 is on
448	Timer in 13	DDB_TIMERIN_13	PSL	TIMERIN	Input to Auxiliary Timer 13 is on
449	Timer in 14	DDB_TIMERIN_14	PSL	TIMERIN	Input to Auxiliary Timer 14 is on
450	Timer in 15	DDB_TIMERIN_15	PSL	TIMERIN	Input to Auxiliary Timer 15 is on
451	Timer in 16	DDB_TIMERIN_16	PSL	TIMERIN	Input to Auxiliary Timer 16 is on
452	Timer out 1	DDB_TIMEROUT_1	SW	TIMEROUT	Output from Auxiliary Timer 1 is on
453	Timer out 2	DDB_TIMEROUT_2	SW	TIMEROUT	Output from Auxiliary Timer 2 is on
454	Timer out 3	DDB_TIMEROUT_3	SW	TIMEROUT	Output from Auxiliary Timer 3 is on
455	Timer out 4	DDB_TIMEROUT_4	SW	TIMEROUT	Output from Auxiliary Timer 4 is on
456	Timer out 5	DDB_TIMEROUT_5	SW	TIMEROUT	Output from Auxiliary Timer 5 is on
457	Timer out 6	DDB_TIMEROUT_6	SW	TIMEROUT	Output from Auxiliary Timer 6 is on
458	Timer out 7	DDB_TIMEROUT_7	SW	TIMEROUT	Output from Auxiliary Timer 7 is on
459	Timer out 8	DDB_TIMEROUT_8	SW	TIMEROUT	Output from Auxiliary Timer 8 is on
460	Timer out 9	DDB_TIMEROUT_9	SW	TIMEROUT	Output from Auxiliary Timer 9 is on
461	Timer out 10	DDB_TIMEROUT_10	SW	TIMEROUT	Output from Auxiliary Timer 10 is on
462	Timer out 11	DDB_TIMEROUT_11	SW	TIMEROUT	Output from Auxiliary Timer 11 is on
463	Timer out 12	DDB_TIMEROUT_12	SW	TIMEROUT	Output from Auxiliary Timer 12 is on
464	Timer out 13	DDB_TIMEROUT_13	SW	TIMEROUT	Output from Auxiliary Timer 13 is on
465	Timer out 14	DDB_TIMEROUT_14	SW	TIMEROUT	Output from Auxiliary Timer 14 is on
466	Timer out 15	DDB_TIMEROUT_15	SW	TIMEROUT	Output from Auxiliary Timer 15 is on
467	Timer out 16	DDB_TIMEROUT_16	SW	TIMEROUT	Output from Auxiliary Timer 16 is on
468	Fault Recorder Trigger	DDB_FAULT_RECORD_TRIGGER	PSL	FRT	Trigger for Fault Recorder
469	Battery Fail	DDB_PLAT_BATTERY_FAIL_ALARM	SW	PFSO	Front panel miniature Battery Failure - either battery removed from slot, or low voltage.
470	Field Volt Fail	DDB_PLAT_FIELD_VOLT_FAIL_ALARM	SW	PFSO	48V Field Voltage Fail
471	Comm2 H/W FAIL	DDB_REAR_COMMS_FAIL_ALARM_66	SW	PFSO	Second Rear Comms port failure
472	GOOSE IED Absent	DDB_GOOSE_IED_MISSING_ALARM_67	SW	PFSO	The IED is not subscribed to a publishing IED in the current scheme
473	NIC Not Fitted	DDB_ECARD_NOT_FITTED_ALARM_68	SW	PFSO	Ethernet board not fitted
474	NIC No Response	DDB_NIC_NOT_RESPONDING_69	SW	PFSO	Ethernet board not responding
475	NIC Fatal Error	DDB_NIC_FATAL_ERROR_70	SW	PFSO	Ethernet board unrecoverable error
476	NIC Soft. Reload	DDB_NIC_SOFTWARE_RELOAD_71	SW	PFSO	Ethernet problem
477	Bad TCP/IP Cfg.	DDB_INVALID_NIC_TCP_IP_CONFIG_72	SW	PFSO	Ethernet problem
478	Bad OSI Config.	DDB_INVALID_NIC_OSI_CONFIG_73	SW	PFSO	Ethernet problem
479	NIC Link Fail	DDB_ALARM_UNUSED_479	SW	UNUSED	Platform Alarm 11
480	NIC SW Mis-Match	DDB_SW_MISMATCH_ALARM	SW	PFSO	Ethernet board software not compatible with main CPU
481	IP Addr Conflict	DDB_NIC_IP_ADDRESS_CONFLICT_76	SW	PFSO	The IP address of the IED is already used by another IED

DDB No	English Text	Element Name	Source	Type	Description
482	IM Loopback	DDB_INTERMICOM_LOOPBACK_ALARM_77	SW	PFSO	EIA(RS)232 InterMiCOM indication that Loopback testing is in progress
483	IM Message Fail	DDB_INTERMICOM_MESSAGE_ALARM_78	SW	PFSO	EIA(RS)232 InterMiCOM Message Failure alarm. Setting that is used to alarm for poor channel quality. If during the fixed 1.6 s rolling window the ratio of invalid messages to the total number of messages that should be received (based upon the ‘Baud Rate’ setting) exceeds the above threshold, a ‘Message Fail’ alarm will be issued
484	IM Data CD Fail	DDB_INTERMICOM_DCD_ALARM_79	SW	PFSO	EIA(RS)232 InterMiCOM Data Channel Detect Fail i.e. modem failure
485	IM Channel Fail	DDB_INTERMICOM_CHANNEL_ALARM_80	SW	PFSO	EIA(RS)232 InterMiCOM Channel Failure alarm. No messages were received during the alarm time setting
486	Backup Setting	DDB_BACKUP_SETTING_ALARM_81	SW	PFSO	This is an alarm that is ON if any setting fail during the setting changing process. If this happens, the relay will use the last known good setting
487	Not Used	DDB_ALARM_UNUSED_487	SW	HIDDEN	
488	Backup Usr Curve	DDB_USER_CURVE_BACKUP_ALARM_83	SW	PFSO	Backup user curve activated alarm
489	Invalid Config.	DDB_INVALID_CONFIG_ALARM	SW	PFSO	Invalid IEC 61850 Configuration Alarm
490	Test Mode Alm	DDB_TEST_MODE_ALARM	SW	UNUSED	Test Mode Activated Alarm
491	Contacts Blk Alm	DDB_CONT_BLK_ALARM	SW	UNUSED	Contacts Blocked Alarm
492	Not Used	#REF!	SW	PFSO	
493	Not Used	#REF!	SW	PFSO	
494	Not Used	#REF!	SW	PFSO	
495	Not Used	DDB_HW_MISMATCH_ALARM	SW	PFSO	
496	Not Used	DDB_IEC61850_VER_MISMATCH_ALARM	SW	PFSO	
497	Not Used	DDB_GS_ACEPT_SIMU_ALM	PSL	UNUSED	
498	Not Used	DDB_ALARM_UNUSED_498	PSL	UNUSED	
499	Not Used	DDB_ALARM_UNUSED_499	PSL	UNUSED	
500	Not Used	DDB_ALARM_UNUSED_500	PSL	UNUSED	
501	Not Used	DDB_UNUSED_501	PSL	UNUSED	
502	Not Used	DDB_UNUSED_502	PSL	UNUSED	
503	Not Used	DDB_UNUSED_503	PSL	UNUSED	
504	Not Used	DDB_UNUSED_504	PSL	UNUSED	
505	Not Used	DDB_UNUSED_505	PSL	UNUSED	
506	Not Used	DDB_UNUSED_506	PSL	UNUSED	
507	Not Used	DDB_UNUSED_507	PSL	UNUSED	
508	Not Used	DDB_UNUSED_508	PSL	UNUSED	
509	Not Used	DDB_UNUSED_509	PSL	UNUSED	
510	Not Used	DDB_IRIGB_SIGNAL_VALID	SW	PFSO	
511	Not Used	DDB_LOGIC_0	SW	PFSO	
512	GOOSE OUT 1	DDB_GOOSEOUT_1	PSL	GOOSEOUT	Virtual Output 1 - output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices
513	GOOSE OUT 2	DDB_GOOSEOUT_2	PSL	GOOSEOUT	Virtual Output 2 - output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices

DDB No	English Text	Element Name	Source	Type	Description
514	GOOSE OUT 3	DDB_GOOSEOUT_3	PSL	GOOSEOUT	Virtual Output 3 - output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices
515	GOOSE OUT 4	DDB_GOOSEOUT_4	PSL	GOOSEOUT	Virtual Output 4 - output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices
516	GOOSE OUT 5	DDB_GOOSEOUT_5	PSL	GOOSEOUT	Virtual Output 5 - output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices
517	GOOSE OUT 6	DDB_GOOSEOUT_6	PSL	GOOSEOUT	Virtual Output 6 - output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices
518	GOOSE OUT 7	DDB_GOOSEOUT_7	PSL	GOOSEOUT	Virtual Output 7 - output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices
519	GOOSE OUT 8	DDB_GOOSEOUT_8	PSL	GOOSEOUT	Virtual Output 8 - output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices
520	GOOSE OUT 9	DDB_GOOSEOUT_9	PSL	GOOSEOUT	Virtual Output 9 - output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices
521	GOOSE OUT 10	DDB_GOOSEOUT_10	PSL	GOOSEOUT	Virtual Output 10 - output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices
522	GOOSE OUT 11	DDB_GOOSEOUT_11	PSL	GOOSEOUT	Virtual Output 11 - output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices
523	GOOSE OUT 12	DDB_GOOSEOUT_12	PSL	GOOSEOUT	Virtual Output 12 - output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices
524	GOOSE OUT 13	DDB_GOOSEOUT_13	PSL	GOOSEOUT	Virtual Output 13 - output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices
525	GOOSE OUT 14	DDB_GOOSEOUT_14	PSL	GOOSEOUT	Virtual Output 14 - output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices
526	GOOSE OUT 15	DDB_GOOSEOUT_15	PSL	GOOSEOUT	Virtual Output 15 - output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices
527	GOOSE OUT 16	DDB_GOOSEOUT_16	PSL	GOOSEOUT	Virtual Output 16- output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices
528	GOOSE OUT 17	DDB_GOOSEOUT_17	PSL	GOOSEOUT	Virtual Output 17 - output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices
529	GOOSE OUT 18	DDB_GOOSEOUT_18	PSL	GOOSEOUT	Virtual Output 18 - output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices
530	GOOSE OUT 19	DDB_GOOSEOUT_19	PSL	GOOSEOUT	Virtual Output 19 - output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices
531	GOOSE OUT 20	DDB_GOOSEOUT_20	PSL	GOOSEOUT	Virtual Output 20 - output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices

DDB No	English Text	Element Name	Source	Type	Description
532	GOOSE OUT 21	DDB_GOOSEOUT_21	PSL	GOOSEOUT	Virtual Output 21 - output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices
533	GOOSE OUT 22	DDB_GOOSEOUT_22	PSL	GOOSEOUT	Virtual Output 22 - output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices
534	GOOSE OUT 23	DDB_GOOSEOUT_23	PSL	GOOSEOUT	Virtual Output 23 - output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices
535	GOOSE OUT 24	DDB_GOOSEOUT_24	PSL	GOOSEOUT	Virtual Output 24 - output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices
536	GOOSE OUT 25	DDB_GOOSEOUT_25	PSL	GOOSEOUT	Virtual Output 25 - output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices
537	GOOSE OUT 26	DDB_GOOSEOUT_26	PSL	GOOSEOUT	Virtual Output 26- output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices
538	GOOSE OUT 27	DDB_GOOSEOUT_27	PSL	GOOSEOUT	Virtual Output 27- output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices
539	GOOSE OUT 28	DDB_GOOSEOUT_28	PSL	GOOSEOUT	Virtual Output 28 - output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices
540	GOOSE OUT 29	DDB_GOOSEOUT_29	PSL	GOOSEOUT	Virtual Output 29 - output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices
541	GOOSE OUT 30	DDB_GOOSEOUT_30	PSL	GOOSEOUT	Virtual Output30 - output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices
542	GOOSE OUT 31	DDB_GOOSEOUT_31	PSL	GOOSEOUT	Virtual Output 31 - output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices
543	GOOSE OUT 32	DDB_GOOSEOUT_32	PSL	GOOSEOUT	Virtual Output 32 - output allows user to control a binary signal which can be mapped via SCADA protocol output to other devices
544	Not Used	DDB_UNUSED_544	SW	UNUSED	
545	Not Used	DDB_UNUSED_545	SW	UNUSED	
546	Not Used	DDB_UNUSED_546	SW	UNUSED	
547	Not Used	DDB_UNUSED_547	SW	UNUSED	
548	Not Used	DDB_UNUSED_548	SW	UNUSED	
549	Not Used	DDB_UNUSED_549	SW	UNUSED	
550	Not Used	DDB_UNUSED_550	SW	UNUSED	
551	Not Used	DDB_UNUSED_551	SW	UNUSED	
552	Not Used	DDB_UNUSED_552	SW	UNUSED	
553	Not Used	DDB_UNUSED_553	SW	UNUSED	
554	Not Used	DDB_UNUSED_554	SW	UNUSED	
555	Not Used	DDB_UNUSED_555	SW	UNUSED	
556	Not Used	DDB_UNUSED_556	SW	UNUSED	
557	Not Used	DDB_UNUSED_557	SW	UNUSED	
558	Not Used	DDB_UNUSED_558	SW	UNUSED	
559	Not Used	DDB_UNUSED_559	SW	UNUSED	

DDB No	English Text	Element Name	Source	Type	Description
560	Not Used	DDB_UNUSED_560	SW	UNUSED	
561	Not Used	DDB_UNUSED_561	SW	UNUSED	
562	Not Used	DDB_UNUSED_562	SW	UNUSED	
563	Not Used	DDB_UNUSED_563	SW	UNUSED	
564	Not Used	DDB_UNUSED_564	SW	UNUSED	
565	Not Used	DDB_UNUSED_565	SW	UNUSED	
566	Not Used	DDB_UNUSED_566	SW	UNUSED	
567	Not Used	DDB_UNUSED_567	SW	UNUSED	
568	Not Used	DDB_UNUSED_568	SW	UNUSED	
569	Not Used	DDB_UNUSED_569	SW	UNUSED	
570	Not Used	DDB_UNUSED_570	SW	UNUSED	
571	Not Used	DDB_UNUSED_571	SW	UNUSED	
572	Not Used	DDB_UNUSED_572	SW	UNUSED	
573	Not Used	DDB_UNUSED_573	SW	UNUSED	
574	Not Used	DDB_UNUSED_574	SW	UNUSED	
575	Not Used	DDB_UNUSED_575	SW	UNUSED	
576	Not Used	DDB_INTERIN_1	SW	INTERIN	
577	Not Used	DDB_INTERIN_2	SW	INTERIN	
578	Not Used	DDB_INTERIN_3	SW	INTERIN	
579	Not Used	DDB_INTERIN_4	SW	INTERIN	
580	Not Used	DDB_INTERIN_5	SW	INTERIN	
581	Not Used	DDB_INTERIN_6	SW	INTERIN	
582	Not Used	DDB_INTERIN_7	SW	INTERIN	
583	Not Used	DDB_INTERIN_8	SW	INTERIN	
584	Not Used	DDB_INTEROUT_1	PSL	INTEROUT	
585	Not Used	DDB_INTEROUT_2	PSL	INTEROUT	
586	Not Used	DDB_INTEROUT_3	PSL	INTEROUT	
587	Not Used	DDB_INTEROUT_4	PSL	INTEROUT	
588	Not Used	DDB_INTEROUT_5	PSL	INTEROUT	
589	Not Used	DDB_INTEROUT_6	PSL	INTEROUT	
590	Not Used	DDB_INTEROUT_7	PSL	INTEROUT	
591	Not Used	DDB_INTEROUT_8	PSL	INTEROUT	
592	Not Used	DDB_UNUSED_592	PSL	UNUSED	
593	Not Used	DDB_UNUSED_593	PSL	UNUSED	
594	Not Used	DDB_UNUSED_594	PSL	UNUSED	
595	Not Used	DDB_UNUSED_595	PSL	UNUSED	
596	Not Used	DDB_UNUSED_596	PSL	UNUSED	
597	Not Used	DDB_UNUSED_597	PSL	UNUSED	
598	Not Used	DDB_UNUSED_598	PSL	UNUSED	
599	Not Used	DDB_UNUSED_599	PSL	UNUSED	
600	Not Used	DDB_UNUSED_600	PSL	UNUSED	
601	Not Used	DDB_UNUSED_601	PSL	UNUSED	
602	Not Used	DDB_UNUSED_602	PSL	UNUSED	
603	Not Used	DDB_UNUSED_603	PSL	UNUSED	

DDB No	English Text	Element Name	Source	Type	Description
604	Not Used	DDB_UNUSED_604	PSL	UNUSED	
605	Not Used	DDB_UNUSED_605	PSL	UNUSED	
606	Not Used	DDB_UNUSED_606	PSL	UNUSED	
607	Not Used	DDB_UNUSED_607	PSL	UNUSED	
608	Control Input 1	DDB_CTRL_IP_1	SW	CONTROL	Control Input 1 - for SCADA and menu commands into PSL
609	Control Input 2	DDB_CTRL_IP_2	SW	CONTROL	Control Input 2 - for SCADA and menu commands into PSL
610	Control Input 32	DDB_CTRL_IP_3	SW	CONTROL	Control Input 3 - for SCADA and menu commands into PSL
611	Control Input 4	DDB_CTRL_IP_4	SW	CONTROL	Control Input 4 - for SCADA and menu commands into PSL
612	Control Input 5	DDB_CTRL_IP_5	SW	CONTROL	Control Input 5 - for SCADA and menu commands into PSL
613	Control Input 6	DDB_CTRL_IP_6	SW	CONTROL	Control Input 6 - for SCADA and menu commands into PSL
614	Control Input 7	DDB_CTRL_IP_7	SW	CONTROL	Control Input 7 - for SCADA and menu commands into PSL
615	Control Input 8	DDB_CTRL_IP_8	SW	CONTROL	Control Input 8 - for SCADA and menu commands into PSL
616	Control Input 9	DDB_CTRL_IP_9	SW	CONTROL	Control Input 9 - for SCADA and menu commands into PSL
617	Control Input 10	DDB_CTRL_IP_10	SW	CONTROL	Control Input 10 - for SCADA and menu commands into PSL
618	Control Input 11	DDB_CTRL_IP_11	SW	CONTROL	Control Input 11 - for SCADA and menu commands into PSL
619	Control Input 12	DDB_CTRL_IP_12	SW	CONTROL	Control Input 12 - for SCADA and menu commands into PSL
620	Control Input 13	DDB_CTRL_IP_13	SW	CONTROL	Control Input 13 - for SCADA and menu commands into PSL
621	Control Input 14	DDB_CTRL_IP_14	SW	CONTROL	Control Input 14 - for SCADA and menu commands into PSL
622	Control Input 15	DDB_CTRL_IP_15	SW	CONTROL	Control Input 15 - for SCADA and menu commands into PSL
623	Control Input 16	DDB_CTRL_IP_16	SW	CONTROL	Control Input 16 - for SCADA and menu commands into PSL
624	Control Input 17	DDB_CTRL_IP_17	SW	CONTROL	Control Input 17 - for SCADA and menu commands into PSL
625	Control Input 18	DDB_CTRL_IP_18	SW	CONTROL	Control Input 18 - for SCADA and menu commands into PSL
626	Control Input 19	DDB_CTRL_IP_19	SW	CONTROL	Control Input 19 - for SCADA and menu commands into PSL
627	Control Input 20	DDB_CTRL_IP_20	SW	CONTROL	Control Input 20 - for SCADA and menu commands into PSL
628	Control Input 21	DDB_CTRL_IP_21	SW	CONTROL	Control Input 21 - for SCADA and menu commands into PSL
629	Control Input 22	DDB_CTRL_IP_22	SW	CONTROL	Control Input 22 - for SCADA and menu commands into PSL
630	Control Input 23	DDB_CTRL_IP_23	SW	CONTROL	Control Input 23 - for SCADA and menu commands into PSL
631	Control Input 24	DDB_CTRL_IP_24	SW	CONTROL	Control Input 24 - for SCADA and menu commands into PSL

DDB No	English Text	Element Name	Source	Type	Description
632	Control Input 25	DDB_CTRL_IP_25	SW	CONTROL	Control Input 25 - for SCADA and menu commands into PSL
633	Control Input 26	DDB_CTRL_IP_26	SW	CONTROL	Control Input 26 - for SCADA and menu commands into PSL
634	Control Input 27	DDB_CTRL_IP_27	SW	CONTROL	Control Input 27 - for SCADA and menu commands into PSL
635	Control Input 28	DDB_CTRL_IP_28	SW	CONTROL	Control Input 28 - for SCADA and menu commands into PSL
636	Control Input 29	DDB_CTRL_IP_29	SW	CONTROL	Control Input 29 - for SCADA and menu commands into PSL
637	Control Input 30	DDB_CTRL_IP_30	SW	CONTROL	Control Input 30 - for SCADA and menu commands into PSL
638	Control Input 31	DDB_CTRL_IP_31	SW	CONTROL	Control Input 31 - for SCADA and menu commands into PSL
639	Control Input 32	DDB_CTRL_IP_32	SW	CONTROL	Control Input 32 - for SCADA and menu commands into PSL
640	LED1 Red	DDB_OUTPUT_TRI_LED_1_RED	SW	HIDDEN	Programmable LED 1 Red is on (P242/3 only)
641	LED1 Grn.	DDB_OUTPUT_TRI_LED_1_GRN	SW	HIDDEN	Programmable LED 1 Green is on (P242/3 only)
642	LED2 Red	DDB_OUTPUT_TRI_LED_2_RED	SW	HIDDEN	Programmable LED 2 Red is on (P242/3 only)
643	LED2 Grn.	DDB_OUTPUT_TRI_LED_2_GRN	SW	HIDDEN	Programmable LED 2 Green is on (P242/3 only)
644	LED3 Red	DDB_OUTPUT_TRI_LED_3_RED	SW	HIDDEN	Programmable LED 3 Red is on (P242/3 only)
645	LED3 Grn.	DDB_OUTPUT_TRI_LED_3_GRN	SW	HIDDEN	Programmable LED 3 Green is on (P242/3 only)
646	LED4 Red	DDB_OUTPUT_TRI_LED_4_RED	SW	HIDDEN	Programmable LED 4 Red is on (P242/3 only)
647	LED4 Grn.	DDB_OUTPUT_TRI_LED_4_GRN	SW	HIDDEN	Programmable LED 4 Green is on (P242/3 only)
648	LED5 Red	DDB_OUTPUT_TRI_LED_5_RED	SW	HIDDEN	Programmable LED 5 Red is on (P242/3 only)
649	LED5 Grn.	DDB_OUTPUT_TRI_LED_5_GRN	SW	HIDDEN	Programmable LED 5 Green is on (P242/3 only)
650	LED6 Red	DDB_OUTPUT_TRI_LED_6_RED	SW	HIDDEN	Programmable LED 6 Red is on (P242/3 only)
651	LED6 Grn.	DDB_OUTPUT_TRI_LED_6_GRN	SW	HIDDEN	Programmable LED 6 Green is on (P242/3 only)
652	LED7 Red	DDB_OUTPUT_TRI_LED_7_RED	SW	HIDDEN	Programmable LED 7 Red is on (P242/3 only)
653	LED7 Grn.	DDB_OUTPUT_TRI_LED_7_GRN	SW	HIDDEN	Programmable LED 7 Green is on (P242/3 only)
654	LED8 Red	DDB_OUTPUT_TRI_LED_8_RED	SW	HIDDEN	Programmable LED 8 Red is on (P242/3 only)
655	LED8 Grn.	DDB_OUTPUT_TRI_LED_8_GRN	SW	HIDDEN	Programmable LED 8 Green is on (P242/3 only)
656	FnKey LED1 Red	DDB_OUTPUT_TRI_LED_9_RED	SW	HIDDEN	Programmable Function Key LED 1 Red is on (P242/3 only)
657	FnKey LED1 Grn.	DDB_OUTPUT_TRI_LED_9_GRN	SW	HIDDEN	Programmable Function Key LED 1 Green is on (P242/3 only)

DDB No	English Text	Element Name	Source	Type	Description
658	FnKey LED Red	DDB_OUTPUT_TRI_LED_10_RED	SW	HIDDEN	Programmable Function Key LED Red is on (P242/3 only)
659	FnKey LED Grn.	DDB_OUTPUT_TRI_LED_10_GRN	SW	HIDDEN	Programmable Function Key LED Green is on (P242/3 only)
660	FnKey LED Red	DDB_OUTPUT_TRI_LED_11_RED	SW	HIDDEN	Programmable Function Key LED Red is on (P242/3 only)
661	FnKey LED Grn.	DDB_OUTPUT_TRI_LED_11_GRN	SW	HIDDEN	Programmable Function Key LED Green is on (P242/3 only)
662	FnKey LED Red	DDB_OUTPUT_TRI_LED_12_RED	SW	HIDDEN	Programmable Function Key LED Red is on (P242/3 only)
663	FnKey LED Grn.	DDB_OUTPUT_TRI_LED_12_GRN	SW	HIDDEN	Programmable Function Key LED Green is on (P242/3 only)
664	FnKey LED Red	DDB_OUTPUT_TRI_LED_13_RED	SW	HIDDEN	Programmable Function Key LED Red is on (P242/3 only)
665	FnKey LED Grn.	DDB_OUTPUT_TRI_LED_13_GRN	SW	HIDDEN	Programmable Function Key LED Green is on (P242/3 only)
666	FnKey LED Red	DDB_OUTPUT_TRI_LED_14_RED	SW	HIDDEN	Programmable Function Key LED Red is on (P242/3 only)
667	FnKey LED Grn.	DDB_OUTPUT_TRI_LED_14_GRN	SW	HIDDEN	Programmable Function Key LED Green is on (P242/3 only)
668	FnKey LED Red	DDB_OUTPUT_TRI_LED_15_RED	SW	HIDDEN	Programmable Function Key LED Red is on (P242/3 only)
669	FnKey LED Grn.	DDB_OUTPUT_TRI_LED_15_GRN	SW	HIDDEN	Programmable Function Key LED Green is on (P242/3 only)
670	FnKey LED Red	DDB_OUTPUT_TRI_LED_16_RED	SW	HIDDEN	Programmable Function Key LED Red is on (P242/3 only)
671	FnKey LED Grn.	DDB_OUTPUT_TRI_LED_16_GRN	SW	HIDDEN	Programmable Function Key LED Green is on (P242/3 only)
672	FnKey LED Red	DDB_OUTPUT_TRI_LED_17_RED	SW	HIDDEN	Programmable Function Key LED Red is on (P242/3 only)
673	FnKey LED Grn.	DDB_OUTPUT_TRI_LED_17_GRN	SW	HIDDEN	Programmable Function Key LED Green is on (P242/3 only)
674	FnKey LED Red	DDB_OUTPUT_TRI_LED_18_RED	SW	HIDDEN	Programmable Function Key LED Red is on (P242/3 only)
675	FnKey LED10 Grn.	DDB_OUTPUT_TRI_LED_18_GRN	SW	HIDDEN	Programmable Function Key LED 10 Green is on (P242/3 only)
676	Function Key 1	DDB_FN_KEY_1	SW	HIDDEN	Function Key 1 is on. In ‘Normal’ mode it is high on keypress and in ‘Toggle’ mode remains high/low on single keypress (P242/3 only)
677	Function Key 2	DDB_FN_KEY_2	SW	HIDDEN	Function Key is on. In ‘Normal’ mode it is high on keypress and in ‘Toggle’ mode remains high/low on single keypress (P242/3 only)
678	Function Key 3	DDB_FN_KEY_3	SW	HIDDEN	Function Key is on. In ‘Normal’ mode it is high on keypress and in ‘Toggle’ mode remains high/low on single keypress (P242/3 only)
679	Function Key 4	DDB_FN_KEY_4	SW	HIDDEN	Function Key is on. In ‘Normal’ mode it is high on keypress and in ‘Toggle’ mode remains high/low on single keypress (P242/3 only)

DDB No	English Text	Element Name	Source	Type	Description
680	Function Key 5	DDB_FN_KEY_5	SW	HIDDEN	Function Key is on. In 'Normal' mode it is high on keypress and in 'Toggle' mode remains high/low on single keypress (P242/3 only)
681	Function Key 6	DDB_FN_KEY_6	SW	HIDDEN	Function Key is on. In 'Normal' mode it is high on keypress and in 'Toggle' mode remains high/low on single keypress (P242/3 only)
682	Function Key 7	DDB_FN_KEY_7	SW	HIDDEN	Function Key is on. In 'Normal' mode it is high on keypress and in 'Toggle' mode remains high/low on single keypress (P242/3 only)
683	Function Key 8	DDB_FN_KEY_8	SW	HIDDEN	Function Key is on. In 'Normal' mode it is high on keypress and in 'Toggle' mode remains high/low on single keypress (P242/3 only)
684	Function Key 9	DDB_FN_KEY_9	SW	HIDDEN	Function Key is on. In 'Normal' mode it is high on keypress and in 'Toggle' mode remains high/low on single keypress (P242/3 only)
685	Function Key 10	DDB_FN_KEY_10	SW	HIDDEN	Function Key 10 is on. In 'Normal' mode it is high on keypress and in 'Toggle' mode remains high/low on single keypress (P242/3 only)
686	Not Used	DDB_UNUSED_686	PSL	UNUSED	
687	Not Used	DDB_UNUSED_687	PSL	UNUSED	
688	Not Used	DDB_UNUSED_688	PSL	UNUSED	
689	Not Used	DDB_UNUSED_689	PSL	UNUSED	
690	Not Used	DDB_UNUSED_690	PSL	UNUSED	
691	Not Used	DDB_UNUSED_691	PSL	UNUSED	
692	Not Used	DDB_UNUSED_692	PSL	UNUSED	
693	Not Used	DDB_UNUSED_693	PSL	UNUSED	
694	Not Used	DDB_UNUSED_694	PSL	UNUSED	
695	Not Used	DDB_UNUSED_695	PSL	UNUSED	
696	Not Used	DDB_UNUSED_696	PSL	UNUSED	
697	Not Used	DDB_UNUSED_697	PSL	UNUSED	
698	Not Used	DDB_UNUSED_698	PSL	UNUSED	
699	Not Used	DDB_UNUSED_699	PSL	UNUSED	
700	Output Con 1	DDB_OUTPUT_CON_1	PSL	OUTPUT_CON	Input signal driving Relay 1 is on
701	Output Con 2	DDB_OUTPUT_CON_2	PSL	OUTPUT_CON	Input signal driving Relay is on
702	Output Con 3	DDB_OUTPUT_CON_3	PSL	OUTPUT_CON	Input signal driving Relay is on
703	Output Con 4	DDB_OUTPUT_CON_4	PSL	OUTPUT_CON	Input signal driving Relay is on
704	Output Con 5	DDB_OUTPUT_CON_5	PSL	OUTPUT_CON	Input signal driving Relay is on
705	Output Con 6	DDB_OUTPUT_CON_6	PSL	OUTPUT_CON	Input signal driving Relay is on
706	Output Con 7	DDB_OUTPUT_CON_7	PSL	OUTPUT_CON	Input signal driving Relay is on

DDB No	English Text	Element Name	Source	Type	Description
707	Output Con 8	DDB_OUTPUT_CON_8	PSL	OUTPUT_CON	Input signal driving Relay is on
708	Output Con 9	DDB_OUTPUT_CON_9	PSL	OUTPUT_CON	Input signal driving Relay is on
709	Output Con 10	DDB_OUTPUT_CON_10	PSL	OUTPUT_CON	Input signal driving Relay is on
710	Output Con 11	DDB_OUTPUT_CON_11	PSL	OUTPUT_CON	Input signal driving Relay is on
711	Output Con 12	DDB_OUTPUT_CON_12	PSL	OUTPUT_CON	Input signal driving Relay is on
712	Output Con 13	DDB_OUTPUT_CON_13	PSL	OUTPUT_CON	Input signal driving Relay is on
713	Output Con 14	DDB_OUTPUT_CON_14	PSL	OUTPUT_CON	Input signal driving Relay is on
714	Output Con 15	DDB_OUTPUT_CON_15	PSL	OUTPUT_CON	Input signal driving Relay is on
715	Output Con 16	DDB_OUTPUT_CON_16	PSL	OUTPUT_CON	Input signal driving Relay 16 is on
716	Not Used	DDB_OUTPUT_CON_17	PSL	OUTPUT_CON	
717	Not Used	DDB_OUTPUT_CON_18	PSL	OUTPUT_CON	
718	Not Used	DDB_OUTPUT_CON_19	PSL	OUTPUT_CON	
719	Not Used	DDB_OUTPUT_CON_20	PSL	OUTPUT_CON	
720	Not Used	DDB_OUTPUT_CON_21	PSL	OUTPUT_CON	
721	Not Used	DDB_OUTPUT_CON_22	PSL	OUTPUT_CON	
722	Not Used	DDB_OUTPUT_CON_23	PSL	OUTPUT_CON	
723	Not Used	DDB_OUTPUT_CON_24	PSL	OUTPUT_CON	
724	Not Used	DDB_OUTPUT_CON_25	PSL	OUTPUT_CON	
725	Not Used	DDB_OUTPUT_CON_26	PSL	OUTPUT_CON	
726	Not Used	DDB_OUTPUT_CON_27	PSL	OUTPUT_CON	
727	Not Used	DDB_OUTPUT_CON_28	PSL	OUTPUT_CON	
728	Not Used	DDB_OUTPUT_CON_29	PSL	OUTPUT_CON	
729	Not Used	DDB_OUTPUT_CON_30	PSL	OUTPUT_CON	
730	Not Used	DDB_OUTPUT_CON_31	PSL	OUTPUT_CON	
731	Not Used	DDB_OUTPUT_CON_32	PSL	OUTPUT_CON	
732	Not Used	DDB_OUTPUT_CON_33	PSL	OUTPUT_CON	

DDB No	English Text	Element Name	Source	Type	Description
733	Not Used	DDB_OUTPUT_CON_34	PSL	OUTPUT_CON	
734	Not Used	DDB_OUTPUT_CON_35	PSL	OUTPUT_CON	
735	Not Used	DDB_OUTPUT_CON_36	PSL	OUTPUT_CON	
736	Not Used	DDB_OUTPUT_CON_37	PSL	OUTPUT_CON	
737	Not Used	DDB_OUTPUT_CON_38	PSL	OUTPUT_CON	
738	Not Used	DDB_OUTPUT_CON_39	PSL	OUTPUT_CON	
739	Not Used	DDB_OUTPUT_CON_40	PSL	OUTPUT_CON	
740	Not Used	DDB_OUTPUT_CON_41	PSL	OUTPUT_CON	
741	Not Used	DDB_OUTPUT_CON_42	PSL	OUTPUT_CON	
742	Not Used	DDB_OUTPUT_CON_43	PSL	OUTPUT_CON	
743	Not Used	DDB_OUTPUT_CON_44	PSL	OUTPUT_CON	
744	Not Used	DDB_OUTPUT_CON_45	PSL	OUTPUT_CON	
745	Not Used	DDB_OUTPUT_CON_46	PSL	OUTPUT_CON	
746	Not Used	DDB_OUTPUT_CON_47	PSL	OUTPUT_CON	
747	Not Used	DDB_OUTPUT_CON_48	PSL	OUTPUT_CON	
748	Not Used	DDB_OUTPUT_CON_49	PSL	OUTPUT_CON	
749	Not Used	DDB_OUTPUT_CON_50	PSL	OUTPUT_CON	
750	Not Used	DDB_OUTPUT_CON_51	PSL	OUTPUT_CON	
751	Not Used	DDB_OUTPUT_CON_52	PSL	OUTPUT_CON	
752	Not Used	DDB_OUTPUT_CON_53	PSL	OUTPUT_CON	
753	Not Used	DDB_OUTPUT_CON_54	PSL	OUTPUT_CON	
754	Not Used	DDB_OUTPUT_CON_55	PSL	OUTPUT_CON	
755	Not Used	DDB_OUTPUT_CON_56	PSL	OUTPUT_CON	
756	Not Used	DDB_OUTPUT_CON_57	PSL	OUTPUT_CON	
757	Not Used	DDB_OUTPUT_CON_58	PSL	OUTPUT_CON	
758	Not Used	DDB_OUTPUT_CON_59	PSL	OUTPUT_CON	

DDB No	English Text	Element Name	Source	Type	Description
759	Not Used	DDB_OUTPUT_CON_60	PSL	OUTPUT_CON	
760	Not Used	DDB_OUTPUT_CON_61	PSL	OUTPUT_CON	
761	Not Used	DDB_OUTPUT_CON_62	PSL	OUTPUT_CON	
762	Not Used	DDB_OUTPUT_CON_63	PSL	OUTPUT_CON	
763	Not Used	DDB_OUTPUT_CON_64	PSL	OUTPUT_CON	
764	LED1 Con Red	DDB_TRI_LED_RED_CON_1	PSL	HIDDEN	Input signal driving LED 1 Red is on (P242/3 only)
765	LED1 Con Green	DDB_TRI_LED_GRN_CON_1	PSL	HIDDEN	Input signal driving LED 1 Green is on. To make LED 1 Yellow DDB 640 and DDB 641 must on at the same time. (P242/3 only))
766	LED2 Con Red	DDB_TRI_LED_RED_CON_2	PSL	HIDDEN	Input signal driving LED2 Red is on (P242/3 only)
767	LED2 Con Green	DDB_TRI_LED_GRN_CON_2	PSL	HIDDEN	Input signal driving LED2 Green is on. To make LED 2 Yellow DDB 640 and DDB 641 must on at the same time. (P242/3 only))
768	LED3 Con Red	DDB_TRI_LED_RED_CON_3	PSL	HIDDEN	Input signal driving LED3 Red is on (P242/3 only)
769	LED3 Con Green	DDB_TRI_LED_GRN_CON_3	PSL	HIDDEN	Input signal driving LED3 Green is on. To make LED 3 Yellow DDB 640 and DDB 641 must on at the same time. (P242/3 only))
770	LED4 Con Red	DDB_TRI_LED_RED_CON_4	PSL	HIDDEN	Input signal driving LED4 Red is on (P242/3 only)
771	LED4 Con Green	DDB_TRI_LED_GRN_CON_4	PSL	HIDDEN	Input signal driving LED4 Green is on. To make LED 4 Yellow DDB 640 and DDB 641 must on at the same time. (P242/3 only))
772	LED5 Con Red	DDB_TRI_LED_RED_CON_5	PSL	HIDDEN	Input signal driving LED5 Red is on (P242/3 only)
773	LED5 Con Green	DDB_TRI_LED_GRN_CON_5	PSL	HIDDEN	Input signal driving LED5 Green is on. To make LED 5 Yellow DDB 640 and DDB 641 must on at the same time. (P242/3 only))
774	LED6 Con Red	DDB_TRI_LED_RED_CON_6	PSL	HIDDEN	Input signal driving LED6 Red is on (P242/3 only)
775	LED6 Con Green	DDB_TRI_LED_GRN_CON_6	PSL	HIDDEN	Input signal driving LED6 Green is on. To make LED 6 Yellow DDB 640 and DDB 641 must on at the same time. (P242/3 only))
776	LED7 Con Red	DDB_TRI_LED_RED_CON_7	PSL	HIDDEN	Input signal driving LED7 Red is on (P242/3 only)
777	LED7 Con Green	DDB_TRI_LED_GRN_CON_7	PSL	HIDDEN	Input signal driving LED7 Green is on. To make LED 7 Yellow DDB 640 and DDB 641 must on at the same time. (P242/3 only))
778	LED8 Con Red	DDB_TRI_LED_RED_CON_8	PSL	HIDDEN	Input signal driving LED 8 Red is on (P242/3 only)
779	LED8 Con Green	DDB_TRI_LED_GRN_CON_8	PSL	HIDDEN	Input signal driving LED 8 Green is on. To make LED 8 Yellow DDB 778 and DDB 779 must be on at the same time (P242/3 only)
780	FnKey LED1 ConR	DDB_TRI_LED_RED_CON_9	PSL	HIDDEN	Input signal driving Function Key LED 8 Red is on (P242/3 only)

DDB No	English Text	Element Name	Source	Type	Description
781	FnKey LED1 ConG	DDB_TRI_LED_GRN_CON_9	PSL	HIDDEN	Input signal driving Function Key LED 1 Green is on. This LED is associated with Function Key 1. To make function key 1 LED yellow, DDB 780 and DDB 781 must be on at the same time (P242/3 only)
782	FnKey LED2 ConR	DDB_TRI_LED_RED_CON_10	PSL	HIDDEN	Input signal driving Function Key LED 2 Red is on (P242/3 only)
783	FnKey LED2 ConG	DDB_TRI_LED_GRN_CON_10	PSL	HIDDEN	Input signal driving Function Key LED 2 Green is on. This LED is associated with Function Key 2. To make function key 2 LED yellow, DDB 782 and DDB 783 must be on at the same time (P242/3 only)
784	FnKey LED3 ConR	DDB_TRI_LED_RED_CON_11	PSL	HIDDEN	Input signal driving Function Key LED 3 Red is on (P242/3 only)
785	FnKey LED3 ConG	DDB_TRI_LED_GRN_CON_11	PSL	HIDDEN	Input signal driving Function Key LED 3 Green is on. This LED is associated with Function Key 3. To make function key 3 LED yellow, DDB 784 and DDB 785 must be on at the same time (P242/3 only)
786	FnKey LED4 ConR	DDB_TRI_LED_RED_CON_12	PSL	HIDDEN	Input signal driving Function Key LED 4 Red is on (P242/3 only)
787	FnKey LED4 ConG	DDB_TRI_LED_GRN_CON_12	PSL	HIDDEN	Input signal driving Function Key LED 4 Green is on. This LED is associated with Function Key 4. To make function key 4 LED yellow, DDB 786 and DDB 787 must be on at the same time (P242/3 only)
788	FnKey LED5 ConR	DDB_TRI_LED_RED_CON_13	PSL	HIDDEN	Input signal driving Function Key LED 5 Red is on (P242/3 only)
789	FnKey LED5 ConG	DDB_TRI_LED_GRN_CON_13	PSL	HIDDEN	Input signal driving Function Key LED 5 Green is on. This LED is associated with Function Key 5. To make function key 5 LED yellow, DDB 788 and DDB 789 must be on at the same time (P242/3 only)
790	FnKey LED6 ConR	DDB_TRI_LED_RED_CON_14	PSL	HIDDEN	Input signal driving Function Key LED 6 Red is on (P242/3 only)
791	FnKey LED6 ConG	DDB_TRI_LED_GRN_CON_14	PSL	HIDDEN	Input signal driving Function Key LED 6 Green is on. This LED is associated with Function Key 6. To make function key 6 LED yellow, DDB 790 and DDB 791 must be on at the same time (P242/3 only)
792	FnKey LED7 ConR	DDB_TRI_LED_RED_CON_15	PSL	HIDDEN	Input signal driving Function Key LED 7 Red is on (P242/3 only)
793	FnKey LED7 ConG	DDB_TRI_LED_GRN_CON_15	PSL	HIDDEN	Input signal driving Function Key LED 7 Green is on. This LED is associated with Function Key 7. To make function key 7 LED yellow, DDB 792 and DDB 793must be on at the same time (P242/3 only)
794	FnKey LED8 ConR	DDB_TRI_LED_RED_CON_16	PSL	HIDDEN	Input signal driving Function Key LED 8 Red is on (P242/3 only)
795	FnKey LED8 ConG	DDB_TRI_LED_GRN_CON_16	PSL	HIDDEN	Input signal driving Function Key LED 8 Green is on. This LED is associated with Function Key 8. To make function key 1 LED yellow, DDB 794 and DDB 795 must be on at the same time (P242/3 only)
796	FnKey LED9 ConR	DDB_TRI_LED_RED_CON_17	PSL	HIDDEN	Input signal driving Function Key LED 9 Red is on (P242/3 only)

DDB No	English Text	Element Name	Source	Type	Description
797	FnKey LED9 ConG	DDB_TRI_LED_GRN_CON_17	PSL	HIDDEN	Input signal driving Function Key LED 9 Green is on. This LED is associated with Function Key 9. To make function key 9 LED yellow, DDB 796 and DDB 797 must be on at the same time (P242/3 only)
798	FnKey LED10 ConR	DDB_TRI_LED_RED_CON_18	PSL	HIDDEN	Input signal driving Function Key LED 10 Red is on (P242/3 only)
799	FnKey LED10 ConG	DDB_TRI_LED_GRN_CON_18	PSL	HIDDEN	Input signal driving Function Key LED 10 Green is on. This LED is associated with Function Key 10. To make function key 10 LED yellow, DDB 798 and DDB 799 must be on at the same time (P242/3 only)
800	Not Used	DDB_UNUSED_800	PSL	UNUSED	
801	Not Used	DDB_UNUSED_801	PSL	UNUSED	
802	Not Used	DDB_UNUSED_802	PSL	UNUSED	
803	Not Used	DDB_UNUSED_803	PSL	UNUSED	
804	Not Used	DDB_UNUSED_804	PSL	UNUSED	
805	Not Used	DDB_UNUSED_805	PSL	UNUSED	
806	Not Used	DDB_UNUSED_806	PSL	UNUSED	
807	Not Used	DDB_UNUSED_807	PSL	UNUSED	
808	Not Used	DDB_UNUSED_808	PSL	UNUSED	
809	Not Used	DDB_UNUSED_809	PSL	UNUSED	
810	Not Used	DDB_UNUSED_810	PSL	UNUSED	
811	Not Used	DDB_UNUSED_811	PSL	UNUSED	
812	Not Used	DDB_UNUSED_812	PSL	UNUSED	
813	Not Used	DDB_UNUSED_813	PSL	UNUSED	
814	Not Used	DDB_UNUSED_814	PSL	UNUSED	
815	Not Used	DDB_UNUSED_815	PSL	UNUSED	
816	Not Used	DDB_UNUSED_816	PSL	UNUSED	
817	Not Used	DDB_UNUSED_817	PSL	UNUSED	
818	Not Used	DDB_UNUSED_818	PSL	UNUSED	
819	Not Used	DDB_UNUSED_819	PSL	UNUSED	
820	Not Used	DDB_UNUSED_820	PSL	UNUSED	
821	Not Used	DDB_UNUSED_821	PSL	UNUSED	
822	Not Used	DDB_UNUSED_822	PSL	UNUSED	
823	Not Used	DDB_UNUSED_823	PSL	UNUSED	
824	Not Used	DDB_UNUSED_824	PSL	UNUSED	
825	Not Used	DDB_UNUSED_825	PSL	UNUSED	
826	Not Used	DDB_UNUSED_826	PSL	UNUSED	
827	Not Used	DDB_UNUSED_827	PSL	UNUSED	
828	Not Used	DDB_UNUSED_828	PSL	UNUSED	
829	Not Used	DDB_UNUSED_829	PSL	UNUSED	
830	Not Used	DDB_UNUSED_830	PSL	UNUSED	
831	Not Used	DDB_UNUSED_831	PSL	UNUSED	
832	Not Used	DDB_UNUSED_832	PSL	UNUSED	
833	Not Used	DDB_UNUSED_833	PSL	UNUSED	
834	Not Used	DDB_UNUSED_834	PSL	UNUSED	

DDB No	English Text	Element Name	Source	Type	Description
835	Not Used	DDB_UNUSED_835	PSL	UNUSED	
836	Not Used	DDB_UNUSED_836	PSL	UNUSED	
837	Not Used	DDB_UNUSED_837	PSL	UNUSED	
838	Not Used	DDB_UNUSED_838	PSL	UNUSED	
839	Not Used	DDB_UNUSED_839	PSL	UNUSED	
840	Not Used	DDB_UNUSED_840	PSL	UNUSED	
841	Not Used	DDB_UNUSED_841	PSL	UNUSED	
842	Not Used	DDB_UNUSED_842	PSL	UNUSED	
843	Not Used	DDB_UNUSED_843	PSL	UNUSED	
844	Not Used	DDB_UNUSED_844	PSL	UNUSED	
845	Not Used	DDB_UNUSED_845	PSL	UNUSED	
846	Not Used	DDB_UNUSED_846	PSL	UNUSED	
847	Not Used	DDB_UNUSED_847	PSL	UNUSED	
848	Not Used	DDB_UNUSED_848	PSL	UNUSED	
849	Not Used	DDB_UNUSED_849	PSL	UNUSED	
850	Not Used	DDB_UNUSED_850	PSL	UNUSED	
851	Not Used	DDB_UNUSED_851	PSL	UNUSED	
852	Not Used	DDB_UNUSED_852	PSL	UNUSED	
853	Not Used	DDB_UNUSED_853	PSL	UNUSED	
854	Not Used	DDB_UNUSED_854	PSL	UNUSED	
855	Not Used	DDB_UNUSED_855	PSL	UNUSED	
856	Not Used	DDB_UNUSED_856	PSL	UNUSED	
857	Not Used	DDB_UNUSED_857	PSL	UNUSED	
858	Not Used	DDB_UNUSED_858	PSL	UNUSED	
859	Not Used	DDB_UNUSED_859	PSL	UNUSED	
860	Not Used	DDB_UNUSED_860	PSL	UNUSED	
861	Not Used	DDB_UNUSED_861	PSL	UNUSED	
862	Not Used	DDB_UNUSED_862	PSL	UNUSED	
863	Not Used	DDB_UNUSED_863	PSL	UNUSED	
864	Not Used	DDB_UNUSED_864	PSL	UNUSED	
865	Not Used	DDB_UNUSED_865	PSL	UNUSED	
866	Not Used	DDB_UNUSED_866	PSL	UNUSED	
867	Not Used	DDB_UNUSED_867	PSL	UNUSED	
868	Not Used	DDB_UNUSED_868	PSL	UNUSED	
869	Not Used	DDB_UNUSED_869	PSL	UNUSED	
870	Not Used	DDB_UNUSED_870	PSL	UNUSED	
871	Not Used	DDB_UNUSED_871	PSL	UNUSED	
872	Not Used	DDB_UNUSED_872	PSL	UNUSED	
873	Not Used	DDB_UNUSED_873	PSL	UNUSED	
874	Not Used	DDB_UNUSED_874	PSL	UNUSED	
875	Not Used	DDB_UNUSED_875	PSL	UNUSED	
876	Not Used	DDB_UNUSED_876	PSL	UNUSED	
877	Not Used	DDB_UNUSED_877	PSL	UNUSED	
878	Not Used	DDB_UNUSED_878	PSL	UNUSED	

DDB No	English Text	Element Name	Source	Type	Description
879	Not Used	DDB_UNUSED_879	PSL	UNUSED	
880	Not Used	DDB_UNUSED_880	PSL	UNUSED	
881	Not Used	DDB_UNUSED_881	PSL	UNUSED	
882	Not Used	DDB_UNUSED_882	PSL	UNUSED	
883	Not Used	DDB_UNUSED_883	PSL	UNUSED	
884	Not Used	DDB_UNUSED_884	PSL	UNUSED	
885	Not Used	DDB_UNUSED_885	PSL	UNUSED	
886	Not Used	DDB_UNUSED_886	PSL	UNUSED	
887	Not Used	DDB_UNUSED_887	PSL	UNUSED	
888	Not Used	DDB_UNUSED_888	PSL	UNUSED	
889	Not Used	DDB_UNUSED_889	PSL	UNUSED	
890	Not Used	DDB_UNUSED_890	PSL	UNUSED	
891	Not Used	DDB_UNUSED_891	PSL	UNUSED	
892	Not Used	DDB_UNUSED_892	PSL	UNUSED	
893	Not Used	DDB_UNUSED_893	PSL	UNUSED	
894	Not Used	DDB_UNUSED_894	PSL	UNUSED	
895	Not Used	DDB_UNUSED_895	PSL	UNUSED	
896	Not Used	DDB_UNUSED_896	PSL	UNUSED	
897	Not Used	DDB_UNUSED_897	PSL	UNUSED	
898	Not Used	DDB_UNUSED_898	PSL	UNUSED	
899	Not Used	DDB_UNUSED_899	PSL	UNUSED	
900	Not Used	DDB_UNUSED_900	PSL	UNUSED	
901	Not Used	DDB_UNUSED_901	PSL	UNUSED	
902	Not Used	DDB_UNUSED_902	PSL	UNUSED	
903	Not Used	DDB_UNUSED_903	PSL	UNUSED	
904	Not Used	DDB_UNUSED_904	PSL	UNUSED	
905	Not Used	DDB_UNUSED_905	PSL	UNUSED	
906	Not Used	DDB_UNUSED_906	PSL	UNUSED	
907	Not Used	DDB_UNUSED_907	PSL	UNUSED	
908	Not Used	DDB_UNUSED_908	PSL	UNUSED	
909	Not Used	DDB_UNUSED_909	PSL	UNUSED	
910	Not Used	DDB_UNUSED_910	PSL	UNUSED	
911	Not Used	DDB_UNUSED_911	PSL	UNUSED	
912	Not Used	DDB_UNUSED_912	PSL	UNUSED	
913	Not Used	DDB_UNUSED_913	PSL	UNUSED	
914	Not Used	DDB_UNUSED_914	PSL	UNUSED	
915	Not Used	DDB_UNUSED_915	PSL	UNUSED	
916	Not Used	DDB_UNUSED_916	PSL	UNUSED	
917	Not Used	DDB_UNUSED_917	PSL	UNUSED	
918	Not Used	DDB_UNUSED_918	PSL	UNUSED	
919	Not Used	DDB_UNUSED_919	PSL	UNUSED	
920	Not Used	DDB_UNUSED_920	PSL	UNUSED	
921	Not Used	DDB_UNUSED_921	PSL	UNUSED	
922	Not Used	DDB_UNUSED_922	PSL	UNUSED	

DDB No	English Text	Element Name	Source	Type	Description
923	PSL Int 1	DDB_PSLINT_1	PSL	PSLINT	PSL Internal Node
924	PSL Int 2	DDB_PSLINT_2	PSL	PSLINT	PSL Internal Node
925	PSL Int 3	DDB_PSLINT_3	PSL	PSLINT	PSL Internal Node
926	PSL Int 4	DDB_PSLINT_4	PSL	PSLINT	PSL Internal Node
927	PSL Int 5	DDB_PSLINT_5	PSL	PSLINT	PSL Internal Node
928	PSL Int 6	DDB_PSLINT_6	PSL	PSLINT	PSL Internal Node
929	PSL Int 7	DDB_PSLINT_7	PSL	PSLINT	PSL Internal Node
930	PSL Int 8	DDB_PSLINT_8	PSL	PSLINT	PSL Internal Node
931	PSL Int 9	DDB_PSLINT_9	PSL	PSLINT	PSL Internal Node
932	PSL Int 10	DDB_PSLINT_10	PSL	PSLINT	PSL Internal Node
933	PSL Int 11	DDB_PSLINT_11	PSL	PSLINT	PSL Internal Node
934	PSL Int 12	DDB_PSLINT_12	PSL	PSLINT	PSL Internal Node
935	PSL Int 13	DDB_PSLINT_13	PSL	PSLINT	PSL Internal Node
936	PSL Int 14	DDB_PSLINT_14	PSL	PSLINT	PSL Internal Node
937	PSL Int 15	DDB_PSLINT_15	PSL	PSLINT	PSL Internal Node
938	PSL Int 16	DDB_PSLINT_16	PSL	PSLINT	PSL Internal Node
939	PSL Int 17	DDB_PSLINT_17	PSL	PSLINT	PSL Internal Node
940	PSL Int 18	DDB_PSLINT_18	PSL	PSLINT	PSL Internal Node
941	PSL Int 19	DDB_PSLINT_19	PSL	PSLINT	PSL Internal Node
942	PSL Int 20	DDB_PSLINT_20	PSL	PSLINT	PSL Internal Node
943	PSL Int 21	DDB_PSLINT_21	PSL	PSLINT	PSL Internal Node
944	PSL Int 22	DDB_PSLINT_22	PSL	PSLINT	PSL Internal Node
945	PSL Int 23	DDB_PSLINT_23	PSL	PSLINT	PSL Internal Node
946	PSL Int 24	DDB_PSLINT_24	PSL	PSLINT	PSL Internal Node
947	PSL Int 25	DDB_PSLINT_25	PSL	PSLINT	PSL Internal Node
948	PSL Int 26	DDB_PSLINT_26	PSL	PSLINT	PSL Internal Node
949	PSL Int 27	DDB_PSLINT_27	PSL	PSLINT	PSL Internal Node
950	PSL Int 28	DDB_PSLINT_28	PSL	PSLINT	PSL Internal Node
951	PSL Int 29	DDB_PSLINT_29	PSL	PSLINT	PSL Internal Node
952	PSL Int 30	DDB_PSLINT_30	PSL	PSLINT	PSL Internal Node
953	PSL Int 31	DDB_PSLINT_31	PSL	PSLINT	PSL Internal Node
954	PSL Int 32	DDB_PSLINT_32	PSL	PSLINT	PSL Internal Node
955	PSL Int 33	DDB_PSLINT_33	PSL	PSLINT	PSL Internal Node
956	PSL Int 34	DDB_PSLINT_34	PSL	PSLINT	PSL Internal Node
957	PSL Int 35	DDB_PSLINT_35	PSL	PSLINT	PSL Internal Node
958	PSL Int 36	DDB_PSLINT_36	PSL	PSLINT	PSL Internal Node
959	PSL Int 37	DDB_PSLINT_37	PSL	PSLINT	PSL Internal Node
960	PSL Int 38	DDB_PSLINT_38	PSL	PSLINT	PSL Internal Node
961	PSL Int 39	DDB_PSLINT_39	PSL	PSLINT	PSL Internal Node
962	PSL Int 40	DDB_PSLINT_40	PSL	PSLINT	PSL Internal Node
963	PSL Int 41	DDB_PSLINT_41	PSL	PSLINT	PSL Internal Node
964	PSL Int 42	DDB_PSLINT_42	PSL	PSLINT	PSL Internal Node
965	PSL Int 43	DDB_PSLINT_43	PSL	PSLINT	PSL Internal Node
966	PSL Int 44	DDB_PSLINT_44	PSL	PSLINT	PSL Internal Node

DDB No	English Text	Element Name	Source	Type	Description
967	PSL Int 45	DDB_PSLINT_45	PSL	PSLINT	PSL Internal Node
968	PSL Int 46	DDB_PSLINT_46	PSL	PSLINT	PSL Internal Node
969	PSL Int 47	DDB_PSLINT_47	PSL	PSLINT	PSL Internal Node
970	PSL Int 48	DDB_PSLINT_48	PSL	PSLINT	PSL Internal Node
971	PSL Int 49	DDB_PSLINT_49	PSL	PSLINT	PSL Internal Node
972	PSL Int 50	DDB_PSLINT_50	PSL	PSLINT	PSL Internal Node
973	PSL Int 51	DDB_PSLINT_51	PSL	PSLINT	PSL Internal Node
974	PSL Int 52	DDB_PSLINT_52	PSL	PSLINT	PSL Internal Node
975	PSL Int 53	DDB_PSLINT_53	PSL	PSLINT	PSL Internal Node
976	PSL Int 54	DDB_PSLINT_54	PSL	PSLINT	PSL Internal Node
977	PSL Int 55	DDB_PSLINT_55	PSL	PSLINT	PSL Internal Node
978	PSL Int 56	DDB_PSLINT_56	PSL	PSLINT	PSL Internal Node
979	PSL Int 57	DDB_PSLINT_57	PSL	PSLINT	PSL Internal Node
980	PSL Int 58	DDB_PSLINT_58	PSL	PSLINT	PSL Internal Node
981	PSL Int 59	DDB_PSLINT_59	PSL	PSLINT	PSL Internal Node
982	PSL Int 60	DDB_PSLINT_60	PSL	PSLINT	PSL Internal Node
983	PSL Int 61	DDB_PSLINT_61	PSL	PSLINT	PSL Internal Node
984	PSL Int 62	DDB_PSLINT_62	PSL	PSLINT	PSL Internal Node
985	PSL Int 63	DDB_PSLINT_63	PSL	PSLINT	PSL Internal Node
986	PSL Int 64	DDB_PSLINT_64	PSL	PSLINT	PSL Internal Node
987	PSL Int 65	DDB_PSLINT_65	PSL	PSLINT	PSL Internal Node
988	PSL Int 66	DDB_PSLINT_66	PSL	PSLINT	PSL Internal Node
989	PSL Int 67	DDB_PSLINT_67	PSL	PSLINT	PSL Internal Node
990	PSL Int 68	DDB_PSLINT_68	PSL	PSLINT	PSL Internal Node
991	PSL Int 69	DDB_PSLINT_69	PSL	PSLINT	PSL Internal Node
992	PSL Int 70	DDB_PSLINT_70	PSL	PSLINT	PSL Internal Node
993	PSL Int71	DDB_PSLINT_71	PSL	PSLINT	PSL Internal Node
994	PSL Int 72	DDB_PSLINT_72	PSL	PSLINT	PSL Internal Node
995	PSL Int 73	DDB_PSLINT_73	PSL	PSLINT	PSL Internal Node
996	PSL Int 74	DDB_PSLINT_74	PSL	PSLINT	PSL Internal Node
997	PSL Int 75	DDB_PSLINT_75	PSL	PSLINT	PSL Internal Node
998	PSL Int 76	DDB_PSLINT_76	PSL	PSLINT	PSL Internal Node
999	PSL Int 77	DDB_PSLINT_77	PSL	PSLINT	PSL Internal Node
1000	PSL Int 78	DDB_PSLINT_78	PSL	PSLINT	PSL Internal Node
1001	PSL Int 79	DDB_PSLINT_79	PSL	PSLINT	PSL Internal Node
1002	PSL Int 80	DDB_PSLINT_80	PSL	PSLINT	PSL Internal Node
1003	PSL Int 81	DDB_PSLINT_81	PSL	PSLINT	PSL Internal Node
1004	PSL Int 82	DDB_PSLINT_82	PSL	PSLINT	PSL Internal Node
1005	PSL Int 83	DDB_PSLINT_83	PSL	PSLINT	PSL Internal Node
1006	PSL Int 84	DDB_PSLINT_84	PSL	PSLINT	PSL Internal Node
1007	PSL Int 85	DDB_PSLINT_85	PSL	PSLINT	PSL Internal Node
1008	PSL Int 86	DDB_PSLINT_86	PSL	PSLINT	PSL Internal Node
1009	PSL Int 87	DDB_PSLINT_87	PSL	PSLINT	PSL Internal Node
1010	PSL Int 88	DDB_PSLINT_88	PSL	PSLINT	PSL Internal Node

DDB No	English Text	Element Name	Source	Type	Description
1011	PSL Int 89	DDB_PSLINT_89	PSL	PSLINT	PSL Internal Node
1012	PSL Int 90	DDB_PSLINT_90	PSL	PSLINT	PSL Internal Node
1013	PSL Int 91	DDB_PSLINT_91	PSL	PSLINT	PSL Internal Node
1014	PSL Int 92	DDB_PSLINT_92	PSL	PSLINT	PSL Internal Node
1015	PSL Int 93	DDB_PSLINT_93	PSL	PSLINT	PSL Internal Node
1016	PSL Int 94	DDB_PSLINT_94	PSL	PSLINT	PSL Internal Node
1017	PSL Int 95	DDB_PSLINT_95	PSL	PSLINT	PSL Internal Node
1018	PSL Int 96	DDB_PSLINT_96	PSL	PSLINT	PSL Internal Node
1019	PSL Int 97	DDB_PSLINT_97	PSL	PSLINT	PSL Internal Node
1020	PSL Int 98	DDB_PSLINT_98	PSL	PSLINT	PSL Internal Node
1021	PSL Int 99	DDB_PSLINT_99	PSL	PSLINT	PSL Internal Node
1022	PSL Int 100	DDB_PSLINT_100	PSL	PSLINT	PSL Internal Node
1023	PSL Int 101	DDB_PSLINT_101	PSL	PSLINT	PSL Internal Node
1024	GOOSE VIP 1	DDB_GOOSEIN_1	SW	GOOSEIN	Virtual Input 1-allows binary signals that are maped to virtual inputs to interface into PSL
1025	GOOSE VIP 2	DDB_GOOSEIN_2	SW	GOOSEIN	Virtual Input 2-allows binary signals that are maped to virtual inputs to interface into PSL
1026	GOOSE VIP 3	DDB_GOOSEIN_3	SW	GOOSEIN	Virtual Input 3-allows binary signals that are maped to virtual inputs to interface into PSL
1027	GOOSE VIP 4	DDB_GOOSEIN_4	SW	GOOSEIN	Virtual Input 4-allows binary signals that are maped to virtual inputs to interface into PSL
1028	GOOSE VIP 5	DDB_GOOSEIN_5	SW	GOOSEIN	Virtual Input 5-allows binary signals that are maped to virtual inputs to interface into PSL
1029	GOOSE VIP 6	DDB_GOOSEIN_6	SW	GOOSEIN	Virtual Input 6-allows binary signals that are maped to virtual inputs to interface into PSL
1030	GOOSE VIP 7	DDB_GOOSEIN_7	SW	GOOSEIN	Virtual Input 7-allows binary signals that are maped to virtual inputs to interface into PSL
1031	GOOSE VIP 8	DDB_GOOSEIN_8	SW	GOOSEIN	Virtual Input 8-allows binary signals that are maped to virtual inputs to interface into PSL
1032	GOOSE VIP 9	DDB_GOOSEIN_9	SW	GOOSEIN	Virtual Input 9-allows binary signals that are maped to virtual inputs to interface into PSL
1033	GOOSE VIP 10	DDB_GOOSEIN_10	SW	GOOSEIN	Virtual Input 10-allows binary signals that are maped to virtual inputs to interface into PSL
1034	GOOSE VIP 11	DDB_GOOSEIN_11	SW	GOOSEIN	Virtual Input 11-allows binary signals that are maped to virtual inputs to interface into PSL
1035	GOOSE VIP 12	DDB_GOOSEIN_12	SW	GOOSEIN	Virtual Input 12-allows binary signals that are maped to virtual inputs to interface into PSL
1036	GOOSE VIP 13	DDB_GOOSEIN_13	SW	GOOSEIN	Virtual Input 13-allows binary signals that are maped to virtual inputs to interface into PSL
1037	GOOSE VIP 14	DDB_GOOSEIN_14	SW	GOOSEIN	Virtual Input 14-allows binary signals that are maped to virtual inputs to interface into PSL
1038	GOOSE VIP 15	DDB_GOOSEIN_15	SW	GOOSEIN	Virtual Input 15-allows binary signals that are maped to virtual inputs to interface into PSL
1039	GOOSE VIP 16	DDB_GOOSEIN_16	SW	GOOSEIN	Virtual Input 16-allows binary signals that are maped to virtual inputs to interface into PSL
1040	GOOSE VIP 17	DDB_GOOSEIN_17	SW	GOOSEIN	Virtual Input 17-allows binary signals that are maped to virtual inputs to interface into PSL
1041	GOOSE VIP 18	DDB_GOOSEIN_18	SW	GOOSEIN	Virtual Input 18-allows binary signals that are maped to virtual inputs to interface into PSL

DDB No	English Text	Element Name	Source	Type	Description
1042	GOOSE VIP 19	DDB_GOOSEIN_19	SW	GOOSEIN	Virtual Input 19-allows binary signals that are maped to virtual inputs to interface into PSL
1043	GOOSE VIP 20	DDB_GOOSEIN_20	SW	GOOSEIN	Virtual Input 20-allows binary signals that are maped to virtual inputs to interface into PSL
1044	GOOSE VIP 21	DDB_GOOSEIN_21	SW	GOOSEIN	Virtual Input 21-allows binary signals that are maped to virtual inputs to interface into PSL
1045	GOOSE VIP 22	DDB_GOOSEIN_22	SW	GOOSEIN	Virtual Input 22-allows binary signals that are maped to virtual inputs to interface into PSL
1046	GOOSE VIP 23	DDB_GOOSEIN_23	SW	GOOSEIN	Virtual Input 23-allows binary signals that are maped to virtual inputs to interface into PSL
1047	GOOSE VIP 24	DDB_GOOSEIN_24	SW	GOOSEIN	Virtual Input 24-allows binary signals that are maped to virtual inputs to interface into PSL
1048	GOOSE VIP 25	DDB_GOOSEIN_25	SW	GOOSEIN	Virtual Input 25-allows binary signals that are maped to virtual inputs to interface into PSL
1049	GOOSE VIP 26	DDB_GOOSEIN_26	SW	GOOSEIN	Virtual Input 26-allows binary signals that are maped to virtual inputs to interface into PSL
1050	GOOSE VIP 27	DDB_GOOSEIN_27	SW	GOOSEIN	Virtual Input 27-allows binary signals that are maped to virtual inputs to interface into PSL
1051	GOOSE VIP 28	DDB_GOOSEIN_28	SW	GOOSEIN	Virtual Input28-allows binary signals that are maped to virtual inputs to interface into PSL
1052	GOOSE VIP 29	DDB_GOOSEIN_29	SW	GOOSEIN	Virtual Input 29-allows binary signals that are maped to virtual inputs to interface into PSL
1053	GOOSE VIP 30	DDB_GOOSEIN_30	SW	GOOSEIN	Virtual Input 30-allows binary signals that are maped to virtual inputs to interface into PSL
1054	GOOSE VIP 31	DDB_GOOSEIN_31	SW	GOOSEIN	Virtual Input 31-allows binary signals that are maped to virtual inputs to interface into PSL
1055	GOOSE VIP 32	DDB_GOOSEIN_32	SW	GOOSEIN	Virtual Input 32-allows binary signals that are maped to virtual inputs to interface into PSL
1056	GOOSE VIP 33	DDB_GOOSEIN_33	SW	GOOSEIN	Virtual Input 33-allows binary signals that are maped to virtual inputs to interface into PSL
1057	GOOSE VIP 34	DDB_GOOSEIN_34	SW	GOOSEIN	Virtual Input 34-allows binary signals that are maped to virtual inputs to interface into PSL
1058	GOOSE VIP 35	DDB_GOOSEIN_35	SW	GOOSEIN	Virtual Input 35-allows binary signals that are maped to virtual inputs to interface into PSL
1059	GOOSE VIP 36	DDB_GOOSEIN_36	SW	GOOSEIN	Virtual Input 36-allows binary signals that are maped to virtual inputs to interface into PSL
1060	GOOSE VIP 37	DDB_GOOSEIN_37	SW	GOOSEIN	Virtual Input 37-allows binary signals that are maped to virtual inputs to interface into PSL
1061	GOOSE VIP 38	DDB_GOOSEIN_38	SW	GOOSEIN	Virtual Input 38-allows binary signals that are maped to virtual inputs to interface into PSL
1062	GOOSE VIP 39	DDB_GOOSEIN_39	SW	GOOSEIN	Virtual Input 39-allows binary signals that are maped to virtual inputs to interface into PSL
1063	GOOSE VIP 40	DDB_GOOSEIN_40	SW	GOOSEIN	Virtual Input 40-allows binary signals that are maped to virtual inputs to interface into PSL
1064	GOOSE VIP 41	DDB_GOOSEIN_41	SW	GOOSEIN	Virtual Input 41-allows binary signals that are maped to virtual inputs to interface into PSL
1065	GOOSE VIP 42	DDB_GOOSEIN_42	SW	GOOSEIN	Virtual Input 42-allows binary signals that are maped to virtual inputs to interface into PSL
1066	GOOSE VIP 43	DDB_GOOSEIN_43	SW	GOOSEIN	Virtual Input 43-allows binary signals that are maped to virtual inputs to interface into PSL
1067	GOOSE VIP 44	DDB_GOOSEIN_44	SW	GOOSEIN	Virtual Input 44-allows binary signals that are maped to virtual inputs to interface into PSL

DDB No	English Text	Element Name	Source	Type	Description
1068	GOOSE VIP 45	DDB_GOOSEIN_45	SW	GOOSEIN	Virtual Input 45-allows binary signals that are maped to virtual inputs to interface into PSL
1069	GOOSE VIP 46	DDB_GOOSEIN_46	SW	GOOSEIN	Virtual Input 46-allows binary signals that are maped to virtual inputs to interface into PSL
1070	GOOSE VIP 47	DDB_GOOSEIN_47	SW	GOOSEIN	Virtual Input 47-allows binary signals that are maped to virtual inputs to interface into PSL
1071	GOOSE VIP 48	DDB_GOOSEIN_48	SW	GOOSEIN	Virtual Input 48-allows binary signals that are maped to virtual inputs to interface into PSL
1072	GOOSE VIP 49	DDB_GOOSEIN_49	SW	GOOSEIN	Virtual Input 49-allows binary signals that are maped to virtual inputs to interface into PSL
1073	GOOSE VIP 50	DDB_GOOSEIN_50	SW	GOOSEIN	Virtual Input 50-allows binary signals that are maped to virtual inputs to interface into PSL
1074	GOOSE VIP 51	DDB_GOOSEIN_51	SW	GOOSEIN	Virtual Input 51-allows binary signals that are maped to virtual inputs to interface into PSL
1075	GOOSE VIP 52	DDB_GOOSEIN_52	SW	GOOSEIN	Virtual Input 52-allows binary signals that are maped to virtual inputs to interface into PSL
1076	GOOSE VIP 53	DDB_GOOSEIN_53	SW	GOOSEIN	Virtual Input 53-allows binary signals that are maped to virtual inputs to interface into PSL
1077	GOOSE VIP 54	DDB_GOOSEIN_54	SW	GOOSEIN	Virtual Input 54-allows binary signals that are maped to virtual inputs to interface into PSL
1078	GOOSE VIP 55	DDB_GOOSEIN_55	SW	GOOSEIN	Virtual Input 55-allows binary signals that are maped to virtual inputs to interface into PSL
1079	GOOSE VIP 56	DDB_GOOSEIN_56	SW	GOOSEIN	Virtual Input 56-allows binary signals that are maped to virtual inputs to interface into PSL
1080	GOOSE VIP 57	DDB_GOOSEIN_57	SW	GOOSEIN	Virtual Input 57-allows binary signals that are maped to virtual inputs to interface into PSL
1081	GOOSE VIP 58	DDB_GOOSEIN_58	SW	GOOSEIN	Virtual Input 58-allows binary signals that are maped to virtual inputs to interface into PSL
1082	GOOSE VIP 59	DDB_GOOSEIN_59	SW	GOOSEIN	Virtual Input 59-allows binary signals that are maped to virtual inputs to interface into PSL
1083	GOOSE VIP 60	DDB_GOOSEIN_60	SW	GOOSEIN	Virtual Input 60-allows binary signals that are maped to virtual inputs to interface into PSL
1084	GOOSE VIP 61	DDB_GOOSEIN_61	SW	GOOSEIN	Virtual Input 61-allows binary signals that are maped to virtual inputs to interface into PSL
1085	GOOSE VIP 62	DDB_GOOSEIN_62	SW	GOOSEIN	Virtual Input 62-allows binary signals that are maped to virtual inputs to interface into PSL
1086	GOOSE VIP 63	DDB_GOOSEIN_63	SW	GOOSEIN	Virtual Input 63-allows binary signals that are maped to virtual inputs to interface into PSL
1087	GOOSE VIP 64	DDB_GOOSEIN_64	SW	GOOSEIN	Virtual Input 64-allows binary signals that are maped to virtual inputs to interface into PSL
1088		DDB_UNUSED_1088	PSL	UNUSED	
1089		DDB_UNUSED_1089	PSL	UNUSED	
1090		DDB_UNUSED_1090	PSL	UNUSED	
1091		DDB_UNUSED_1091	PSL	UNUSED	
1092		DDB_UNUSED_1092	PSL	UNUSED	
1093		DDB_UNUSED_1093	PSL	UNUSED	
1094		DDB_UNUSED_1094	PSL	UNUSED	
1095		DDB_UNUSED_1095	PSL	UNUSED	
1096		DDB_UNUSED_1096	PSL	UNUSED	
1097		DDB_UNUSED_1097	PSL	UNUSED	

DDB No	English Text	Element Name	Source	Type	Description
1098		DDB_UNUSED_1098	PSL	UNUSED	
1099		DDB_UNUSED_1099	PSL	UNUSED	
1100		DDB_UNUSED_1100	PSL	UNUSED	
1101		DDB_UNUSED_1101	PSL	UNUSED	
1102		DDB_UNUSED_1102	PSL	UNUSED	
1103		DDB_UNUSED_1103	PSL	UNUSED	
1104		DDB_UNUSED_1104	PSL	UNUSED	
1105		DDB_UNUSED_1105	PSL	UNUSED	
1106		DDB_UNUSED_1106	PSL	UNUSED	
1107		DDB_UNUSED_1107	PSL	UNUSED	
1108		DDB_UNUSED_1108	PSL	UNUSED	
1109		DDB_UNUSED_1109	PSL	UNUSED	
1110		DDB_UNUSED_1110	PSL	UNUSED	
1111		DDB_UNUSED_1111	PSL	UNUSED	
1112		DDB_UNUSED_1112	PSL	UNUSED	
1113		DDB_UNUSED_1113	PSL	UNUSED	
1114		DDB_UNUSED_1114	PSL	UNUSED	
1115		DDB_UNUSED_1115	PSL	UNUSED	
1116		DDB_UNUSED_1116	PSL	UNUSED	
1117		DDB_UNUSED_1117	PSL	UNUSED	
1118		DDB_UNUSED_1118	PSL	UNUSED	
1119		DDB_UNUSED_1119	PSL	UNUSED	
1120		DDB_UNUSED_1120	PSL	UNUSED	
1121		DDB_UNUSED_1121	PSL	UNUSED	
1122		DDB_UNUSED_1122	PSL	UNUSED	
1123		DDB_UNUSED_1123	PSL	UNUSED	
1124		DDB_UNUSED_1124	PSL	UNUSED	
1125		DDB_UNUSED_1125	PSL	UNUSED	
1126		DDB_UNUSED_1126	PSL	UNUSED	
1127		DDB_UNUSED_1127	PSL	UNUSED	
1128		DDB_UNUSED_1128	PSL	UNUSED	
1129		DDB_UNUSED_1129	PSL	UNUSED	
1130		DDB_UNUSED_1130	PSL	UNUSED	
1131		DDB_UNUSED_1131	PSL	UNUSED	
1132		DDB_UNUSED_1132	PSL	UNUSED	
1133		DDB_UNUSED_1133	PSL	UNUSED	
1134		DDB_UNUSED_1134	PSL	UNUSED	
1135		DDB_UNUSED_1135	PSL	UNUSED	
1136		DDB_UNUSED_1136	PSL	UNUSED	
1137		DDB_UNUSED_1137	PSL	UNUSED	
1138		DDB_UNUSED_1138	PSL	UNUSED	
1139		DDB_UNUSED_1139	PSL	UNUSED	
1140		DDB_UNUSED_1140	PSL	UNUSED	
1141		DDB_UNUSED_1141	PSL	UNUSED	

DDB No	English Text	Element Name	Source	Type	Description
1142		DDB_UNUSED_1142	PSL	UNUSED	
1143		DDB_UNUSED_1143	PSL	UNUSED	
1144		DDB_UNUSED_1144	PSL	UNUSED	
1145		DDB_UNUSED_1145	PSL	UNUSED	
1146		DDB_UNUSED_1146	PSL	UNUSED	
1147		DDB_UNUSED_1147	PSL	UNUSED	
1148		DDB_UNUSED_1148	PSL	UNUSED	
1149		DDB_UNUSED_1149	PSL	UNUSED	
1150		DDB_UNUSED_1150	PSL	UNUSED	
1151		DDB_UNUSED_1151	PSL	UNUSED	
1152	Quality VIP 1	DDB_VIP_QUALITY_1	SW	PFSO	GOOSE virtual input 1 - provides the Quality attributes of any data object in an incoming GOOSE message
1153	Quality VIP 2	DDB_VIP_QUALITY_2	SW	PFSO	GOOSE virtual input 2 - provides the Quality attributes of any data object in an incoming GOOSE message
1154	Quality VIP 3	DDB_VIP_QUALITY_3	SW	PFSO	GOOSE virtual input 3 - provides the Quality attributes of any data object in an incoming GOOSE message
1155	Quality VIP 4	DDB_VIP_QUALITY_4	SW	PFSO	GOOSE virtual input 4 - provides the Quality attributes of any data object in an incoming GOOSE message
1156	Quality VIP 5	DDB_VIP_QUALITY_5	SW	PFSO	GOOSE virtual input 5 - provides the Quality attributes of any data object in an incoming GOOSE message
1157	Quality VIP 6	DDB_VIP_QUALITY_6	SW	PFSO	GOOSE virtual input 6 - provides the Quality attributes of any data object in an incoming GOOSE message
1158	Quality VIP 7	DDB_VIP_QUALITY_7	SW	PFSO	GOOSE virtual input 7 - provides the Quality attributes of any data object in an incoming GOOSE message
1159	Quality VIP 8	DDB_VIP_QUALITY_8	SW	PFSO	GOOSE virtual input 8 - provides the Quality attributes of any data object in an incoming GOOSE message
1160	Quality VIP 9	DDB_VIP_QUALITY_9	SW	PFSO	GOOSE virtual input 9 - provides the Quality attributes of any data object in an incoming GOOSE message
1161	Quality VIP 10	DDB_VIP_QUALITY_10	SW	PFSO	GOOSE virtual input 10 - provides the Quality attributes of any data object in an incoming GOOSE message
1162	Quality VIP 11	DDB_VIP_QUALITY_11	SW	PFSO	GOOSE virtual input 11 - provides the Quality attributes of any data object in an incoming GOOSE message
1163	Quality VIP 12	DDB_VIP_QUALITY_12	SW	PFSO	GOOSE virtual input 12 - provides the Quality attributes of any data object in an incoming GOOSE message
1164	Quality VIP 13	DDB_VIP_QUALITY_13	SW	PFSO	GOOSE virtual input 13 - provides the Quality attributes of any data object in an incoming GOOSE message
1165	Quality VIP 14	DDB_VIP_QUALITY_14	SW	PFSO	GOOSE virtual input 14 - provides the Quality attributes of any data object in an incoming GOOSE message

DDB No	English Text	Element Name	Source	Type	Description
1166	Quality VIP 15	DDB_VIP_QUALITY_15	SW	PFSO	GOOSE virtual input 15 - provides the Quality attributes of any data object in an incoming GOOSE message
1167	Quality VIP 16	DDB_VIP_QUALITY_16	SW	PFSO	GOOSE virtual input 16 - provides the Quality attributes of any data object in an incoming GOOSE message
1168	Quality VIP 17	DDB_VIP_QUALITY_17	SW	PFSO	GOOSE virtual input 17 - provides the Quality attributes of any data object in an incoming GOOSE message
1169	Quality VIP 18	DDB_VIP_QUALITY_18	SW	PFSO	GOOSE virtual input 18 - provides the Quality attributes of any data object in an incoming GOOSE message
1170	Quality VIP 19	DDB_VIP_QUALITY_19	SW	PFSO	GOOSE virtual input 19 - provides the Quality attributes of any data object in an incoming GOOSE message
1171	Quality VIP 20	DDB_VIP_QUALITY_20	SW	PFSO	GOOSE virtual input 20 - provides the Quality attributes of any data object in an incoming GOOSE message
1172	Quality VIP 21	DDB_VIP_QUALITY_21	SW	PFSO	GOOSE virtual input 21 - provides the Quality attributes of any data object in an incoming GOOSE message
1173	Quality VIP 22	DDB_VIP_QUALITY_22	SW	PFSO	GOOSE virtual input 22 - provides the Quality attributes of any data object in an incoming GOOSE message
1174	Quality VIP 23	DDB_VIP_QUALITY_23	SW	PFSO	GOOSE virtual input 23 - provides the Quality attributes of any data object in an incoming GOOSE message
1175	Quality VIP 24	DDB_VIP_QUALITY_24	SW	PFSO	GOOSE virtual input 24 - provides the Quality attributes of any data object in an incoming GOOSE message
1176	Quality VIP 25	DDB_VIP_QUALITY_25	SW	PFSO	GOOSE virtual input 25 - provides the Quality attributes of any data object in an incoming GOOSE message
1177	Quality VIP 26	DDB_VIP_QUALITY_26	SW	PFSO	GOOSE virtual input 26 - provides the Quality attributes of any data object in an incoming GOOSE message
1178	Quality VIP 27	DDB_VIP_QUALITY_27	SW	PFSO	GOOSE virtual input 27 - provides the Quality attributes of any data object in an incoming GOOSE message
1179	Quality VIP 28	DDB_VIP_QUALITY_28	SW	PFSO	GOOSE virtual input 28 - provides the Quality attributes of any data object in an incoming GOOSE message
1180	Quality VIP 29	DDB_VIP_QUALITY_29	SW	PFSO	GOOSE virtual input 29 - provides the Quality attributes of any data object in an incoming GOOSE message
1181	Quality VIP 30	DDB_VIP_QUALITY_30	SW	PFSO	GOOSE virtual input 30 - provides the Quality attributes of any data object in an incoming GOOSE message
1182	Quality VIP 31	DDB_VIP_QUALITY_31	SW	PFSO	GOOSE virtual input 31 - provides the Quality attributes of any data object in an incoming GOOSE message
1183	Quality VIP 32	DDB_VIP_QUALITY_32	SW	PFSO	GOOSE virtual input 32 - provides the Quality attributes of any data object in an incoming GOOSE message

DDB No	English Text	Element Name	Source	Type	Description
1184	Quality VIP 33	DDB_VIP_QUALITY_33	SW	PFSO	GOOSE virtual input 33 - provides the Quality attributes of any data object in an incoming GOOSE message
1185	Quality VIP 34	DDB_VIP_QUALITY_34	SW	PFSO	GOOSE virtual input 34 - provides the Quality attributes of any data object in an incoming GOOSE message
1186	Quality VIP 35	DDB_VIP_QUALITY_35	SW	PFSO	GOOSE virtual input 35 - provides the Quality attributes of any data object in an incoming GOOSE message
1187	Quality VIP 36	DDB_VIP_QUALITY_36	SW	PFSO	GOOSE virtual input 36 - provides the Quality attributes of any data object in an incoming GOOSE message
1188	Quality VIP 37	DDB_VIP_QUALITY_37	SW	PFSO	GOOSE virtual input 37 - provides the Quality attributes of any data object in an incoming GOOSE message
1189	Quality VIP 38	DDB_VIP_QUALITY_38	SW	PFSO	GOOSE virtual input 38 - provides the Quality attributes of any data object in an incoming GOOSE message
1190	Quality VIP 39	DDB_VIP_QUALITY_39	SW	PFSO	GOOSE virtual input 39 - provides the Quality attributes of any data object in an incoming GOOSE message
1191	Quality VIP 40	DDB_VIP_QUALITY_40	SW	PFSO	GOOSE virtual input 40 - provides the Quality attributes of any data object in an incoming GOOSE message
1192	Quality VIP 41	DDB_VIP_QUALITY_41	SW	PFSO	GOOSE virtual input 41 - provides the Quality attributes of any data object in an incoming GOOSE message
1193	Quality VIP 42	DDB_VIP_QUALITY_42	SW	PFSO	GOOSE virtual input 42 - provides the Quality attributes of any data object in an incoming GOOSE message
1194	Quality VIP 43	DDB_VIP_QUALITY_43	SW	PFSO	GOOSE virtual input 43 - provides the Quality attributes of any data object in an incoming GOOSE message
1195	Quality VIP 44	DDB_VIP_QUALITY_44	SW	PFSO	GOOSE virtual input 44 - provides the Quality attributes of any data object in an incoming GOOSE message
1196	Quality VIP 45	DDB_VIP_QUALITY_45	SW	PFSO	GOOSE virtual input 45 - provides the Quality attributes of any data object in an incoming GOOSE message
1197	Quality VIP 46	DDB_VIP_QUALITY_46	SW	PFSO	GOOSE virtual input 46 - provides the Quality attributes of any data object in an incoming GOOSE message
1198	Quality VIP 47	DDB_VIP_QUALITY_47	SW	PFSO	GOOSE virtual input 47 - provides the Quality attributes of any data object in an incoming GOOSE message
1199	Quality VIP 48	DDB_VIP_QUALITY_48	SW	PFSO	GOOSE virtual input 48 - provides the Quality attributes of any data object in an incoming GOOSE message
1200	Quality VIP 49	DDB_VIP_QUALITY_49	SW	PFSO	GOOSE virtual input 49 - provides the Quality attributes of any data object in an incoming GOOSE message
1201	Quality VIP 50	DDB_VIP_QUALITY_50	SW	PFSO	GOOSE virtual input 50 - provides the Quality attributes of any data object in an incoming GOOSE message

DDB No	English Text	Element Name	Source	Type	Description
1202	Quality VIP 51	DDB_VIP_QUALITY_51	SW	PFSO	GOOSE virtual input 51 - provides the Quality attributes of any data object in an incoming GOOSE message
1203	Quality VIP 52	DDB_VIP_QUALITY_52	SW	PFSO	GOOSE virtual input 52 - provides the Quality attributes of any data object in an incoming GOOSE message
1204	Quality VIP 53	DDB_VIP_QUALITY_53	SW	PFSO	GOOSE virtual input 53 - provides the Quality attributes of any data object in an incoming GOOSE message
1205	Quality VIP 54	DDB_VIP_QUALITY_54	SW	PFSO	GOOSE virtual input 54 - provides the Quality attributes of any data object in an incoming GOOSE message
1206	Quality VIP 55	DDB_VIP_QUALITY_55	SW	PFSO	GOOSE virtual input 55 - provides the Quality attributes of any data object in an incoming GOOSE message
1207	Quality VIP 56	DDB_VIP_QUALITY_56	SW	PFSO	GOOSE virtual input 56 - provides the Quality attributes of any data object in an incoming GOOSE message
1208	Quality VIP 57	DDB_VIP_QUALITY_57	SW	PFSO	GOOSE virtual input 57 - provides the Quality attributes of any data object in an incoming GOOSE message
1209	Quality VIP 58	DDB_VIP_QUALITY_58	SW	PFSO	GOOSE virtual input 58 - provides the Quality attributes of any data object in an incoming GOOSE message
1210	Quality VIP 59	DDB_VIP_QUALITY_59	SW	PFSO	GOOSE virtual input 59 - provides the Quality attributes of any data object in an incoming GOOSE message
1211	Quality VIP 60	DDB_VIP_QUALITY_60	SW	PFSO	GOOSE virtual input 60 - provides the Quality attributes of any data object in an incoming GOOSE message
1212	Quality VIP 61	DDB_VIP_QUALITY_61	SW	PFSO	GOOSE virtual input 61 - provides the Quality attributes of any data object in an incoming GOOSE message
1213	Quality VIP 62	DDB_VIP_QUALITY_62	SW	PFSO	GOOSE virtual input 62 - provides the Quality attributes of any data object in an incoming GOOSE message
1214	Quality VIP 63	DDB_VIP_QUALITY_63	SW	PFSO	GOOSE virtual input 63 - provides the Quality attributes of any data object in an incoming GOOSE message
1215	Quality VIP 64	DDB_VIP_QUALITY_64	SW	PFSO	GOOSE virtual input 64 - provides the Quality attributes of any data object in an incoming GOOSE message
1216		DDB_UNUSED_1216	PSL	UNUSED	
1217		DDB_UNUSED_1217	PSL	UNUSED	
1218		DDB_UNUSED_1218	PSL	UNUSED	
1219		DDB_UNUSED_1219	PSL	UNUSED	
1220		DDB_UNUSED_1220	PSL	UNUSED	
1221		DDB_UNUSED_1221	PSL	UNUSED	
1222		DDB_UNUSED_1222	PSL	UNUSED	
1223		DDB_UNUSED_1223	PSL	UNUSED	
1224		DDB_UNUSED_1224	PSL	UNUSED	
1225		DDB_UNUSED_1225	PSL	UNUSED	
1226		DDB_UNUSED_1226	PSL	UNUSED	

DDB No	English Text	Element Name	Source	Type	Description
1227		DDB_UNUSED_1227	PSL	UNUSED	
1228		DDB_UNUSED_1228	PSL	UNUSED	
1229		DDB_UNUSED_1229	PSL	UNUSED	
1230		DDB_UNUSED_1230	PSL	UNUSED	
1231		DDB_UNUSED_1231	PSL	UNUSED	
1232		DDB_UNUSED_1232	PSL	UNUSED	
1233		DDB_UNUSED_1233	PSL	UNUSED	
1234		DDB_UNUSED_1234	PSL	UNUSED	
1235		DDB_UNUSED_1235	PSL	UNUSED	
1236		DDB_UNUSED_1236	PSL	UNUSED	
1237		DDB_UNUSED_1237	PSL	UNUSED	
1238		DDB_UNUSED_1238	PSL	UNUSED	
1239		DDB_UNUSED_1239	PSL	UNUSED	
1240		DDB_UNUSED_1240	PSL	UNUSED	
1241		DDB_UNUSED_1241	PSL	UNUSED	
1242		DDB_UNUSED_1242	PSL	UNUSED	
1243		DDB_UNUSED_1243	PSL	UNUSED	
1244		DDB_UNUSED_1244	PSL	UNUSED	
1245		DDB_UNUSED_1245	PSL	UNUSED	
1246		DDB_UNUSED_1246	PSL	UNUSED	
1247		DDB_UNUSED_1247	PSL	UNUSED	
1248		DDB_UNUSED_1248	PSL	UNUSED	
1249		DDB_UNUSED_1249	PSL	UNUSED	
1250		DDB_UNUSED_1250	PSL	UNUSED	
1251		DDB_UNUSED_1251	PSL	UNUSED	
1252		DDB_UNUSED_1252	PSL	UNUSED	
1253		DDB_UNUSED_1253	PSL	UNUSED	
1254		DDB_UNUSED_1254	PSL	UNUSED	
1255		DDB_UNUSED_1255	PSL	UNUSED	
1256		DDB_UNUSED_1256	PSL	UNUSED	
1257		DDB_UNUSED_1257	PSL	UNUSED	
1258		DDB_UNUSED_1258	PSL	UNUSED	
1259		DDB_UNUSED_1259	PSL	UNUSED	
1260		DDB_UNUSED_1260	PSL	UNUSED	
1261		DDB_UNUSED_1261	PSL	UNUSED	
1262		DDB_UNUSED_1262	PSL	UNUSED	
1263		DDB_UNUSED_1263	PSL	UNUSED	
1264		DDB_UNUSED_1264	PSL	UNUSED	
1265		DDB_UNUSED_1265	PSL	UNUSED	
1266		DDB_UNUSED_1266	PSL	UNUSED	
1267		DDB_UNUSED_1267	PSL	UNUSED	
1268		DDB_UNUSED_1268	PSL	UNUSED	
1269		DDB_UNUSED_1269	PSL	UNUSED	
1270		DDB_UNUSED_1270	PSL	UNUSED	

DDB No	English Text	Element Name	Source	Type	Description
1271		DDB_UNUSED_1271	PSL	UNUSED	
1272		DDB_UNUSED_1272	PSL	UNUSED	
1273		DDB_UNUSED_1273	PSL	UNUSED	
1274		DDB_UNUSED_1274	PSL	UNUSED	
1275		DDB_UNUSED_1275	PSL	UNUSED	
1276		DDB_UNUSED_1276	PSL	UNUSED	
1277		DDB_UNUSED_1277	PSL	UNUSED	
1278		DDB_UNUSED_1278	PSL	UNUSED	
1279		DDB_UNUSED_1279	PSL	UNUSED	
1280	PubPres VIP 1	DDB_VIP_PUB_PRES_1	SW	PFSO	GOOSE virtual input 1- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1281	PubPres VIP 2	DDB_VIP_PUB_PRES_2	SW	PFSO	GOOSE virtual input 2- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1282	PubPres VIP 3	DDB_VIP_PUB_PRES_3	SW	PFSO	GOOSE virtual input 3- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1283	PubPres VIP 4	DDB_VIP_PUB_PRES_4	SW	PFSO	GOOSE virtual input 4- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1284	PubPres VIP 5	DDB_VIP_PUB_PRES_5	SW	PFSO	GOOSE virtual input 5- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1285	PubPres VIP 6	DDB_VIP_PUB_PRES_6	SW	PFSO	GOOSE virtual input 6- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1286	PubPres VIP 7	DDB_VIP_PUB_PRES_7	SW	PFSO	GOOSE virtual input 7- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1287	PubPres VIP 8	DDB_VIP_PUB_PRES_8	SW	PFSO	GOOSE virtual input 8- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1288	PubPres VIP 9	DDB_VIP_PUB_PRES_9	SW	PFSO	GOOSE virtual input 9- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1289	PubPres VIP 10	DDB_VIP_PUB_PRES_10	SW	PFSO	GOOSE virtual input 10- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1290	PubPres VIP 11	DDB_VIP_PUB_PRES_11	SW	PFSO	GOOSE virtual input 11- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1291	PubPres VIP 12	DDB_VIP_PUB_PRES_12	SW	PFSO	GOOSE virtual input 12- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1292	PubPres VIP 13	DDB_VIP_PUB_PRES_13	SW	PFSO	GOOSE virtual input 13- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1293	PubPres VIP 14	DDB_VIP_PUB_PRES_14	SW	PFSO	GOOSE virtual input 14- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.

DDB No	English Text	Element Name	Source	Type	Description
1294	PubPres VIP 15	DDB_VIP_PUB_PRES_15	SW	PFSO	GOOSE virtual input 15- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1295	PubPres VIP 16	DDB_VIP_PUB_PRES_16	SW	PFSO	GOOSE virtual input 16- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1296	PubPres VIP 17	DDB_VIP_PUB_PRES_17	SW	PFSO	GOOSE virtual input 17- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1297	PubPres VIP 18	DDB_VIP_PUB_PRES_18	SW	PFSO	GOOSE virtual input 18- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1298	PubPres VIP 19	DDB_VIP_PUB_PRES_19	SW	PFSO	GOOSE virtual input 19- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1299	PubPres VIP 20	DDB_VIP_PUB_PRES_20	SW	PFSO	GOOSE virtual input 20- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1300	PubPres VIP 21	DDB_VIP_PUB_PRES_21	SW	PFSO	GOOSE virtual input 21- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1301	PubPres VIP 22	DDB_VIP_PUB_PRES_22	SW	PFSO	GOOSE virtual input 22- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1302	PubPres VIP 23	DDB_VIP_PUB_PRES_23	SW	PFSO	GOOSE virtual input 23- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1303	PubPres VIP 24	DDB_VIP_PUB_PRES_24	SW	PFSO	GOOSE virtual input 24- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1304	PubPres VIP 25	DDB_VIP_PUB_PRES_25	SW	PFSO	GOOSE virtual input 25- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1305	PubPres VIP 26	DDB_VIP_PUB_PRES_26	SW	PFSO	GOOSE virtual input 26- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1306	PubPres VIP 27	DDB_VIP_PUB_PRES_27	SW	PFSO	GOOSE virtual input 27- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1307	PubPres VIP 28	DDB_VIP_PUB_PRES_28	SW	PFSO	GOOSE virtual input 28- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1308	PubPres VIP 29	DDB_VIP_PUB_PRES_29	SW	PFSO	GOOSE virtual input 29- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1309	PubPres VIP 30	DDB_VIP_PUB_PRES_30	SW	PFSO	GOOSE virtual input 30- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1310	PubPres VIP 31	DDB_VIP_PUB_PRES_31	SW	PFSO	GOOSE virtual input 31- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1311	PubPres VIP 32	DDB_VIP_PUB_PRES_32	SW	PFSO	GOOSE virtual input 32- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.

DDB No	English Text	Element Name	Source	Type	Description
1312	PubPres VIP 33	DDB_VIP_PUB_PRES_33	SW	PFSO	GOOSE virtual input 33- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1313	PubPres VIP 34	DDB_VIP_PUB_PRES_34	SW	PFSO	GOOSE virtual input 34- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1314	PubPres VIP 35	DDB_VIP_PUB_PRES_35	SW	PFSO	GOOSE virtual input 35- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1315	PubPres VIP 36	DDB_VIP_PUB_PRES_36	SW	PFSO	GOOSE virtual input 36- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1316	PubPres VIP 37	DDB_VIP_PUB_PRES_37	SW	PFSO	GOOSE virtual input 37- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1317	PubPres VIP 38	DDB_VIP_PUB_PRES_38	SW	PFSO	GOOSE virtual input 38- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1318	PubPres VIP 39	DDB_VIP_PUB_PRES_39	SW	PFSO	GOOSE virtual input 39- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1319	PubPres VIP 40	DDB_VIP_PUB_PRES_40	SW	PFSO	GOOSE virtual input 40- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1320	PubPres VIP 41	DDB_VIP_PUB_PRES_41	SW	PFSO	GOOSE virtual input 41- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1321	PubPres VIP 42	DDB_VIP_PUB_PRES_42	SW	PFSO	GOOSE virtual input 42- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1322	PubPres VIP 43	DDB_VIP_PUB_PRES_43	SW	PFSO	GOOSE virtual input 43- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1323	PubPres VIP 44	DDB_VIP_PUB_PRES_44	SW	PFSO	GOOSE virtual input 44- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1324	PubPres VIP 45	DDB_VIP_PUB_PRES_45	SW	PFSO	GOOSE virtual input 45- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1325	PubPres VIP 46	DDB_VIP_PUB_PRES_46	SW	PFSO	GOOSE virtual input 46- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1326	PubPres VIP 47	DDB_VIP_PUB_PRES_47	SW	PFSO	GOOSE virtual input 47- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1327	PubPres VIP 48	DDB_VIP_PUB_PRES_48	SW	PFSO	GOOSE virtual input 48- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1328	PubPres VIP 49	DDB_VIP_PUB_PRES_49	SW	PFSO	GOOSE virtual input 49- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1329	PubPres VIP 50	DDB_VIP_PUB_PRES_50	SW	PFSO	GOOSE virtual input 50- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.

DDB No	English Text	Element Name	Source	Type	Description
1330	PubPres VIP 51	DDB_VIP_PUB_PRES_51	SW	PFSO	GOOSE virtual input 51- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1331	PubPres VIP 52	DDB_VIP_PUB_PRES_52	SW	PFSO	GOOSE virtual input 52- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1332	PubPres VIP 53	DDB_VIP_PUB_PRES_53	SW	PFSO	GOOSE virtual input 53- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1333	PubPres VIP 54	DDB_VIP_PUB_PRES_54	SW	PFSO	GOOSE virtual input 54- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1334	PubPres VIP 55	DDB_VIP_PUB_PRES_55	SW	PFSO	GOOSE virtual input 55- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1335	PubPres VIP 56	DDB_VIP_PUB_PRES_56	SW	PFSO	GOOSE virtual input 56- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1336	PubPres VIP 57	DDB_VIP_PUB_PRES_57	SW	PFSO	GOOSE virtual input 57- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1337	PubPres VIP 58	DDB_VIP_PUB_PRES_58	SW	PFSO	GOOSE virtual input 58- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1338	PubPres VIP 59	DDB_VIP_PUB_PRES_59	SW	PFSO	GOOSE virtual input 59- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1339	PubPres VIP 60	DDB_VIP_PUB_PRES_60	SW	PFSO	GOOSE virtual input 60- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1340	PubPres VIP 61	DDB_VIP_PUB_PRES_61	SW	PFSO	GOOSE virtual input 61- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1341	PubPres VIP 62	DDB_VIP_PUB_PRES_62	SW	PFSO	GOOSE virtual input 62- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1342	PubPres VIP 63	DDB_VIP_PUB_PRES_63	SW	PFSO	GOOSE virtual input 63- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1343	PubPres VIP 64	DDB_VIP_PUB_PRES_64	SW	PFSO	GOOSE virtual input 64- indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.
1344		DDB_UNUSED_1344	SW	UNUSED	
1345		DDB_UNUSED_1345	SW	UNUSED	
1346		DDB_UNUSED_1346	SW	UNUSED	
1347		DDB_UNUSED_1347	SW	UNUSED	
1348		DDB_UNUSED_1348	SW	UNUSED	
1349		DDB_UNUSED_1349	SW	UNUSED	
1350		DDB_UNUSED_1350	SW	UNUSED	
1351		DDB_UNUSED_1351	SW	UNUSED	
1352		DDB_UNUSED_1352	SW	UNUSED	
1353		DDB_UNUSED_1353	SW	UNUSED	
1354		DDB_UNUSED_1354	SW	UNUSED	

DDB No	English Text	Element Name	Source	Type	Description
1355		DDB_UNUSED_1355	SW	UNUSED	
1356		DDB_UNUSED_1356	SW	UNUSED	
1357		DDB_UNUSED_1357	SW	UNUSED	
1358		DDB_UNUSED_1358	SW	UNUSED	
1359		DDB_UNUSED_1359	SW	UNUSED	
1360		DDB_UNUSED_1360	SW	UNUSED	
1361		DDB_UNUSED_1361	SW	UNUSED	
1362		DDB_UNUSED_1362	SW	UNUSED	
1363		DDB_UNUSED_1363	SW	UNUSED	
1364		DDB_UNUSED_1364	SW	UNUSED	
1365		DDB_UNUSED_1365	SW	UNUSED	
1366		DDB_UNUSED_1366	SW	UNUSED	
1367		DDB_UNUSED_1367	SW	UNUSED	
1368		DDB_UNUSED_1368	SW	UNUSED	
1369		DDB_UNUSED_1369	SW	UNUSED	
1370		DDB_UNUSED_1370	SW	UNUSED	
1371		DDB_UNUSED_1371	SW	UNUSED	
1372		DDB_UNUSED_1372	SW	UNUSED	
1373		DDB_UNUSED_1373	SW	UNUSED	
1374		DDB_UNUSED_1374	SW	UNUSED	
1375		DDB_UNUSED_1375	SW	UNUSED	
1376		DDB_UNUSED_1376	SW	UNUSED	
1377		DDB_UNUSED_1377	SW	UNUSED	
1378		DDB_UNUSED_1378	SW	UNUSED	
1379		DDB_UNUSED_1379	SW	UNUSED	
1380		DDB_UNUSED_1380	SW	UNUSED	
1381		DDB_UNUSED_1381	SW	UNUSED	
1382		DDB_UNUSED_1382	SW	UNUSED	
1383		DDB_UNUSED_1383	SW	UNUSED	
1384		DDB_UNUSED_1384	SW	UNUSED	
1385		DDB_UNUSED_1385	SW	UNUSED	
1386		DDB_UNUSED_1386	SW	UNUSED	
1387		DDB_UNUSED_1387	SW	UNUSED	
1388		DDB_UNUSED_1388	SW	UNUSED	
1389		DDB_UNUSED_1389	SW	UNUSED	
1390		DDB_UNUSED_1390	SW	UNUSED	
1391		DDB_UNUSED_1391	SW	UNUSED	
1392		DDB_UNUSED_1392	SW	UNUSED	
1393		DDB_UNUSED_1393	SW	UNUSED	
1394		DDB_UNUSED_1394	SW	UNUSED	
1395		DDB_UNUSED_1395	SW	UNUSED	
1396		DDB_UNUSED_1396	SW	UNUSED	
1397		DDB_UNUSED_1397	SW	UNUSED	
1398		DDB_UNUSED_1398	SW	UNUSED	

DDB No	English Text	Element Name	Source	Type	Description
1399		DDB_UNUSED_1399	SW	UNUSED	
1400		DDB_UNUSED_1400	SW	UNUSED	
1401		DDB_UNUSED_1401	SW	UNUSED	
1402		DDB_UNUSED_1402	SW	UNUSED	
1403		DDB_UNUSED_1403	SW	UNUSED	
1404		DDB_UNUSED_1404	SW	UNUSED	
1405		DDB_UNUSED_1405	SW	UNUSED	
1406		DDB_UNUSED_1406	SW	UNUSED	
1407		DDB_UNUSED_1407	SW	UNUSED	
1408		DDB_UNUSED_1408	SW	UNUSED	
1409		DDB_UNUSED_1409	SW	UNUSED	
1410		DDB_UNUSED_1410	SW	UNUSED	
1411		DDB_UNUSED_1411	SW	UNUSED	
1412		DDB_UNUSED_1412	SW	UNUSED	
1413		DDB_UNUSED_1413	SW	UNUSED	
1414		DDB_UNUSED_1414	SW	UNUSED	
1415		DDB_UNUSED_1415	SW	UNUSED	
1416		DDB_UNUSED_1416	SW	UNUSED	
1417		DDB_UNUSED_1417	SW	UNUSED	
1418		DDB_UNUSED_1418	SW	UNUSED	
1419		DDB_UNUSED_1419	SW	UNUSED	
1420		DDB_UNUSED_1420	SW	UNUSED	
1421		DDB_UNUSED_1421	SW	UNUSED	
1422		DDB_UNUSED_1422	SW	UNUSED	
1423		DDB_UNUSED_1423	SW	UNUSED	
1424		DDB_UNUSED_1424	SW	UNUSED	
1425		DDB_UNUSED_1425	SW	UNUSED	
1426		DDB_UNUSED_1426	SW	UNUSED	
1427		DDB_UNUSED_1427	SW	UNUSED	
1428		DDB_UNUSED_1428	SW	UNUSED	
1429		DDB_UNUSED_1429	SW	UNUSED	
1430		DDB_UNUSED_1430	SW	UNUSED	
1431		DDB_UNUSED_1431	SW	UNUSED	
1432		DDB_UNUSED_1432	SW	UNUSED	
1433		DDB_UNUSED_1433	SW	UNUSED	
1434		DDB_UNUSED_1434	SW	UNUSED	
1435		DDB_UNUSED_1435	SW	UNUSED	
1436		DDB_UNUSED_1436	SW	UNUSED	
1437		DDB_UNUSED_1437	SW	UNUSED	
1438		DDB_UNUSED_1438	SW	UNUSED	
1439		DDB_UNUSED_1439	SW	UNUSED	
1440		DDB_UNUSED_1440	SW	UNUSED	
1441		DDB_UNUSED_1441	SW	UNUSED	
1442		DDB_UNUSED_1442	SW	UNUSED	

DDB No	English Text	Element Name	Source	Type	Description
1443		DDB_UNUSED_1443	SW	UNUSED	
1444		DDB_UNUSED_1444	SW	UNUSED	
1445		DDB_UNUSED_1445	SW	UNUSED	
1446		DDB_UNUSED_1446	SW	UNUSED	
1447		DDB_UNUSED_1447	SW	UNUSED	
1448		DDB_UNUSED_1448	SW	UNUSED	
1449		DDB_UNUSED_1449	SW	UNUSED	
1450		DDB_UNUSED_1450	SW	UNUSED	
1451		DDB_UNUSED_1451	SW	UNUSED	
1452		DDB_UNUSED_1452	SW	UNUSED	
1453		DDB_UNUSED_1453	SW	UNUSED	
1454		DDB_UNUSED_1454	SW	UNUSED	
1455		DDB_UNUSED_1455	SW	UNUSED	
1456		DDB_UNUSED_1456	SW	UNUSED	
1457		DDB_UNUSED_1457	SW	UNUSED	
1458		DDB_UNUSED_1458	SW	UNUSED	
1459		DDB_UNUSED_1459	SW	UNUSED	
1460		DDB_UNUSED_1460	SW	UNUSED	
1461		DDB_UNUSED_1461	SW	UNUSED	
1462		DDB_UNUSED_1462	SW	UNUSED	
1463		DDB_UNUSED_1463	SW	UNUSED	
1464		DDB_UNUSED_1464	SW	UNUSED	
1465		DDB_UNUSED_1465	SW	UNUSED	
1466		DDB_UNUSED_1466	SW	UNUSED	
1467		DDB_UNUSED_1467	SW	UNUSED	
1468		DDB_UNUSED_1468	SW	UNUSED	
1469		DDB_UNUSED_1469	SW	UNUSED	
1470		DDB_UNUSED_1470	SW	UNUSED	
1471		DDB_UNUSED_1471	SW	UNUSED	
1472		DDB_UNUSED_1472	SW	UNUSED	
1473		DDB_UNUSED_1473	SW	UNUSED	
1474		DDB_UNUSED_1474	SW	UNUSED	
1475		DDB_UNUSED_1475	SW	UNUSED	
1476		DDB_UNUSED_1476	SW	UNUSED	
1477		DDB_UNUSED_1477	SW	UNUSED	
1478		DDB_UNUSED_1478	SW	UNUSED	
1479		DDB_UNUSED_1479	SW	UNUSED	
1480		DDB_UNUSED_1480	SW	UNUSED	
1481		DDB_UNUSED_1481	SW	UNUSED	
1482		DDB_UNUSED_1482	SW	UNUSED	
1483		DDB_UNUSED_1483	SW	UNUSED	
1484		DDB_UNUSED_1484	SW	UNUSED	
1485		DDB_UNUSED_1485	SW	UNUSED	
1486		DDB_UNUSED_1486	SW	UNUSED	

DDB No	English Text	Element Name	Source	Type	Description
1487		DDB_UNUSED_1487	SW	UNUSED	
1488		DDB_UNUSED_1488	SW	UNUSED	
1489		DDB_UNUSED_1489	SW	UNUSED	
1490		DDB_UNUSED_1490	SW	UNUSED	
1491		DDB_UNUSED_1491	SW	UNUSED	
1492		DDB_UNUSED_1492	SW	UNUSED	
1493		DDB_UNUSED_1493	SW	UNUSED	
1494		DDB_UNUSED_1494	SW	UNUSED	
1495		DDB_UNUSED_1495	SW	UNUSED	
1496		DDB_UNUSED_1496	SW	UNUSED	
1497		DDB_UNUSED_1497	SW	UNUSED	
1498		DDB_UNUSED_1498	SW	UNUSED	
1499		DDB_UNUSED_1499	SW	UNUSED	
1500		DDB_UNUSED_1500	SW	UNUSED	
1501		DDB_UNUSED_1501	SW	UNUSED	
1502		DDB_UNUSED_1502	SW	UNUSED	
1503		DDB_UNUSED_1503	SW	UNUSED	
1504		DDB_UNUSED_1504	SW	UNUSED	
1505		DDB_UNUSED_1505	SW	UNUSED	
1506		DDB_UNUSED_1506	SW	UNUSED	
1507		DDB_UNUSED_1507	SW	UNUSED	
1508		DDB_UNUSED_1508	SW	UNUSED	
1509		DDB_UNUSED_1509	SW	UNUSED	
1510		DDB_UNUSED_1510	SW	UNUSED	
1511		DDB_UNUSED_1511	SW	UNUSED	
1512		DDB_UNUSED_1512	SW	UNUSED	
1513		DDB_UNUSED_1513	SW	UNUSED	
1514		DDB_UNUSED_1514	SW	UNUSED	
1515		DDB_UNUSED_1515	SW	UNUSED	
1516		DDB_UNUSED_1516	SW	UNUSED	
1517		DDB_UNUSED_1517	SW	UNUSED	
1518		DDB_UNUSED_1518	SW	UNUSED	
1519		DDB_UNUSED_1519	SW	UNUSED	
1520		DDB_UNUSED_1520	SW	UNUSED	
1521		DDB_UNUSED_1521	SW	UNUSED	
1522		DDB_UNUSED_1522	SW	UNUSED	
1523		DDB_UNUSED_1523	SW	UNUSED	
1524		DDB_UNUSED_1524	SW	UNUSED	
1525		DDB_UNUSED_1525	SW	UNUSED	
1526		DDB_UNUSED_1526	SW	UNUSED	
1527		DDB_UNUSED_1527	SW	UNUSED	
1528		DDB_UNUSED_1528	SW	UNUSED	
1529		DDB_UNUSED_1529	SW	UNUSED	
1530		DDB_UNUSED_1530	SW	UNUSED	

DDB No	English Text	Element Name	Source	Type	Description
1531		DDB_UNUSED_1531	SW	UNUSED	
1532		DDB_UNUSED_1532	SW	UNUSED	
1533		DDB_UNUSED_1533	SW	UNUSED	
1534		DDB_UNUSED_1534	SW	UNUSED	
1535		DDB_UNUSED_1535	SW	UNUSED	
1536		DDB_UNUSED_1536	SW	UNUSED	
1537		DDB_UNUSED_1537	SW	UNUSED	
1538		DDB_UNUSED_1538	SW	UNUSED	
1539		DDB_UNUSED_1539	SW	UNUSED	
1540		DDB_UNUSED_1540	SW	UNUSED	
1541		DDB_UNUSED_1541	SW	UNUSED	
1542		DDB_UNUSED_1542	SW	UNUSED	
1543		DDB_UNUSED_1543	SW	UNUSED	
1544		DDB_UNUSED_1544	SW	UNUSED	
1545		DDB_UNUSED_1545	SW	UNUSED	
1546		DDB_UNUSED_1546	SW	UNUSED	
1547		DDB_UNUSED_1547	SW	UNUSED	
1548		DDB_UNUSED_1548	SW	UNUSED	
1549		DDB_UNUSED_1549	SW	UNUSED	
1550		DDB_UNUSED_1550	SW	UNUSED	
1551		DDB_UNUSED_1551	SW	UNUSED	
1552		DDB_UNUSED_1552	SW	UNUSED	
1553		DDB_UNUSED_1553	SW	UNUSED	
1554		DDB_UNUSED_1554	SW	UNUSED	
1555		DDB_UNUSED_1555	SW	UNUSED	
1556		DDB_UNUSED_1556	SW	UNUSED	
1557		DDB_UNUSED_1557	SW	UNUSED	
1558		DDB_UNUSED_1558	SW	UNUSED	
1559		DDB_UNUSED_1559	SW	UNUSED	
1560		DDB_UNUSED_1560	SW	UNUSED	
1561		DDB_UNUSED_1561	SW	UNUSED	
1562		DDB_UNUSED_1562	SW	UNUSED	
1563		DDB_UNUSED_1563	SW	UNUSED	
1564		DDB_UNUSED_1564	SW	UNUSED	
1565		DDB_UNUSED_1565	SW	UNUSED	
1566		DDB_UNUSED_1566	SW	UNUSED	
1567		DDB_UNUSED_1567	SW	UNUSED	
1568		DDB_UNUSED_1568	SW	UNUSED	
1569		DDB_UNUSED_1569	SW	UNUSED	
1570		DDB_UNUSED_1570	SW	UNUSED	
1571		DDB_UNUSED_1571	SW	UNUSED	
1572		DDB_UNUSED_1572	SW	UNUSED	
1573		DDB_UNUSED_1573	SW	UNUSED	
1574		DDB_UNUSED_1574	SW	UNUSED	

DDB No	English Text	Element Name	Source	Type	Description
1575		DDB_UNUSED_1575	SW	UNUSED	
1576		DDB_UNUSED_1576	SW	UNUSED	
1577		DDB_UNUSED_1577	SW	UNUSED	
1578		DDB_UNUSED_1578	SW	UNUSED	
1579		DDB_UNUSED_1579	SW	UNUSED	
1580		DDB_UNUSED_1580	SW	UNUSED	
1581		DDB_UNUSED_1581	SW	UNUSED	
1582		DDB_UNUSED_1582	SW	UNUSED	
1583		DDB_UNUSED_1583	SW	UNUSED	
1584		DDB_UNUSED_1584	SW	UNUSED	
1585		DDB_UNUSED_1585	SW	UNUSED	
1586		DDB_UNUSED_1586	SW	UNUSED	
1587		DDB_UNUSED_1587	SW	UNUSED	
1588		DDB_UNUSED_1588	SW	UNUSED	
1589		DDB_UNUSED_1589	SW	UNUSED	
1590		DDB_UNUSED_1590	SW	UNUSED	
1591		DDB_UNUSED_1591	SW	UNUSED	
1592		DDB_UNUSED_1592	SW	UNUSED	
1593		DDB_UNUSED_1593	SW	UNUSED	
1594		DDB_UNUSED_1594	SW	UNUSED	
1595		DDB_UNUSED_1595	SW	UNUSED	
1596		DDB_UNUSED_1596	SW	UNUSED	
1597		DDB_UNUSED_1597	SW	UNUSED	
1598		DDB_UNUSED_1598	SW	UNUSED	
1599		DDB_UNUSED_1599	SW	UNUSED	
1600		DDB_UNUSED_1600	SW	UNUSED	
1601		DDB_UNUSED_1601	SW	UNUSED	
1602		DDB_UNUSED_1602	SW	UNUSED	
1603		DDB_UNUSED_1603	SW	UNUSED	
1604		DDB_UNUSED_1604	SW	UNUSED	
1605		DDB_UNUSED_1605	SW	UNUSED	
1606		DDB_UNUSED_1606	SW	UNUSED	
1607		DDB_UNUSED_1607	SW	UNUSED	
1608		DDB_UNUSED_1608	SW	UNUSED	
1609		DDB_UNUSED_1609	SW	UNUSED	
1610		DDB_UNUSED_1610	SW	UNUSED	
1611		DDB_UNUSED_1611	SW	UNUSED	
1612		DDB_UNUSED_1612	SW	UNUSED	
1613		DDB_UNUSED_1613	SW	UNUSED	
1614		DDB_UNUSED_1614	SW	UNUSED	
1615		DDB_UNUSED_1615	SW	UNUSED	
1616		DDB_UNUSED_1616	SW	UNUSED	
1617		DDB_UNUSED_1617	SW	UNUSED	
1618		DDB_UNUSED_1618	SW	UNUSED	

DDB No	English Text	Element Name	Source	Type	Description
1619		DDB_UNUSED_1619	SW	UNUSED	
1620		DDB_UNUSED_1620	SW	UNUSED	
1621		DDB_UNUSED_1621	SW	UNUSED	
1622		DDB_UNUSED_1622	SW	UNUSED	
1623		DDB_UNUSED_1623	SW	UNUSED	
1624		DDB_UNUSED_1624	SW	UNUSED	
1625		DDB_UNUSED_1625	SW	UNUSED	
1626		DDB_UNUSED_1626	SW	UNUSED	
1627		DDB_UNUSED_1627	SW	UNUSED	
1628		DDB_UNUSED_1628	SW	UNUSED	
1629		DDB_UNUSED_1629	SW	UNUSED	
1630		DDB_UNUSED_1630	SW	UNUSED	
1631		DDB_UNUSED_1631	SW	UNUSED	
1632		DDB_UNUSED_1632	SW	UNUSED	
1633		DDB_UNUSED_1633	SW	UNUSED	
1634		DDB_UNUSED_1634	SW	UNUSED	
1635		DDB_UNUSED_1635	SW	UNUSED	
1636		DDB_UNUSED_1636	SW	UNUSED	
1637		DDB_UNUSED_1637	SW	UNUSED	
1638		DDB_UNUSED_1638	SW	UNUSED	
1639		DDB_UNUSED_1639	SW	UNUSED	
1640		DDB_UNUSED_1640	SW	UNUSED	
1641		DDB_UNUSED_1641	SW	UNUSED	
1642		DDB_UNUSED_1642	SW	UNUSED	
1643		DDB_UNUSED_1643	SW	UNUSED	
1644		DDB_UNUSED_1644	SW	UNUSED	
1645		DDB_UNUSED_1645	SW	UNUSED	
1646		DDB_UNUSED_1646	SW	UNUSED	
1647		DDB_UNUSED_1647	SW	UNUSED	
1648		DDB_UNUSED_1648	SW	UNUSED	
1649		DDB_UNUSED_1649	SW	UNUSED	
1650		DDB_UNUSED_1650	SW	UNUSED	
1651		DDB_UNUSED_1651	SW	UNUSED	
1652		DDB_UNUSED_1652	SW	UNUSED	
1653		DDB_UNUSED_1653	SW	UNUSED	
1654		DDB_UNUSED_1654	SW	UNUSED	
1655		DDB_UNUSED_1655	SW	UNUSED	
1656		DDB_UNUSED_1656	SW	UNUSED	
1657		DDB_UNUSED_1657	SW	UNUSED	
1658		DDB_UNUSED_1658	SW	UNUSED	
1659		DDB_UNUSED_1659	SW	UNUSED	
1660		DDB_UNUSED_1660	SW	UNUSED	
1661		DDB_UNUSED_1661	SW	UNUSED	
1662		DDB_UNUSED_1662	SW	UNUSED	

DDB No	English Text	Element Name	Source	Type	Description
1663		DDB_UNUSED_1663	SW	UNUSED	
1664		DDB_UNUSED_1664	SW	UNUSED	
1665		DDB_UNUSED_1665	SW	UNUSED	
1666		DDB_UNUSED_1666	SW	UNUSED	
1667		DDB_UNUSED_1667	SW	UNUSED	
1668		DDB_UNUSED_1668	SW	UNUSED	
1669		DDB_UNUSED_1669	SW	UNUSED	
1670		DDB_UNUSED_1670	SW	UNUSED	
1671		DDB_UNUSED_1671	SW	UNUSED	
1672		DDB_UNUSED_1672	SW	UNUSED	
1673		DDB_UNUSED_1673	SW	UNUSED	
1674		DDB_UNUSED_1674	SW	UNUSED	
1675		DDB_UNUSED_1675	SW	UNUSED	
1676		DDB_UNUSED_1676	SW	UNUSED	
1677		DDB_UNUSED_1677	SW	UNUSED	
1678		DDB_UNUSED_1678	SW	UNUSED	
1679		DDB_UNUSED_1679	SW	UNUSED	
1680		DDB_UNUSED_1680	SW	UNUSED	
1681		DDB_UNUSED_1681	SW	UNUSED	
1682		DDB_UNUSED_1682	SW	UNUSED	
1683		DDB_UNUSED_1683	SW	UNUSED	
1684		DDB_UNUSED_1684	SW	UNUSED	
1685		DDB_UNUSED_1685	SW	UNUSED	
1686		DDB_UNUSED_1686	SW	UNUSED	
1687		DDB_UNUSED_1687	SW	UNUSED	
1688		DDB_UNUSED_1688	SW	UNUSED	
1689		DDB_UNUSED_1689	SW	UNUSED	
1690		DDB_UNUSED_1690	SW	UNUSED	
1691		DDB_UNUSED_1691	SW	UNUSED	
1692		DDB_UNUSED_1692	SW	UNUSED	
1693		DDB_UNUSED_1693	SW	UNUSED	
1694		DDB_UNUSED_1694	SW	UNUSED	
1695		DDB_UNUSED_1695	SW	UNUSED	
1696		DDB_UNUSED_1696	SW	UNUSED	
1697		DDB_UNUSED_1697	SW	UNUSED	
1698		DDB_UNUSED_1698	SW	UNUSED	
1699		DDB_UNUSED_1699	SW	UNUSED	
1700		DDB_UNUSED_1700	SW	UNUSED	
1701		DDB_UNUSED_1701	SW	UNUSED	
1702		DDB_UNUSED_1702	SW	UNUSED	
1703		DDB_UNUSED_1703	SW	UNUSED	
1704		DDB_UNUSED_1704	SW	UNUSED	
1705		DDB_UNUSED_1705	SW	UNUSED	
1706		DDB_UNUSED_1706	SW	UNUSED	

DDB No	English Text	Element Name	Source	Type	Description
1707		DDB_UNUSED_1707	SW	UNUSED	
1708		DDB_UNUSED_1708	SW	UNUSED	
1709		DDB_UNUSED_1709	SW	UNUSED	
1710		DDB_UNUSED_1710	SW	UNUSED	
1711		DDB_UNUSED_1711	SW	UNUSED	
1712		DDB_UNUSED_1712	SW	UNUSED	
1713		DDB_UNUSED_1713	SW	UNUSED	
1714		DDB_UNUSED_1714	SW	UNUSED	
1715		DDB_UNUSED_1715	SW	UNUSED	
1716		DDB_UNUSED_1716	SW	UNUSED	
1717		DDB_UNUSED_1717	SW	UNUSED	
1718		DDB_UNUSED_1718	SW	UNUSED	
1719		DDB_UNUSED_1719	SW	UNUSED	
1720		DDB_UNUSED_1720	SW	UNUSED	
1721		DDB_UNUSED_1721	SW	UNUSED	
1722		DDB_UNUSED_1722	SW	UNUSED	
1723		DDB_UNUSED_1723	SW	UNUSED	
1724		DDB_UNUSED_1724	SW	UNUSED	
1725		DDB_UNUSED_1725	SW	UNUSED	
1726		DDB_UNUSED_1726	SW	UNUSED	
1727		DDB_UNUSED_1727	SW	UNUSED	
1728		DDB_UNUSED_1728	SW	UNUSED	
1729		DDB_UNUSED_1729	SW	UNUSED	
1730		DDB_UNUSED_1730	SW	UNUSED	
1731		DDB_UNUSED_1731	SW	UNUSED	
1732		DDB_UNUSED_1732	SW	UNUSED	
1733		DDB_UNUSED_1733	SW	UNUSED	
1734		DDB_UNUSED_1734	SW	UNUSED	
1735		DDB_UNUSED_1735	SW	UNUSED	
1736		DDB_UNUSED_1736	SW	UNUSED	
1737		DDB_UNUSED_1737	SW	UNUSED	
1738		DDB_UNUSED_1738	SW	UNUSED	
1739		DDB_UNUSED_1739	SW	UNUSED	
1740		DDB_UNUSED_1740	SW	UNUSED	
1741		DDB_UNUSED_1741	SW	UNUSED	
1742		DDB_UNUSED_1742	SW	UNUSED	
1743		DDB_UNUSED_1743	SW	UNUSED	
1744		DDB_UNUSED_1744	SW	UNUSED	
1745		DDB_UNUSED_1745	SW	UNUSED	
1746		DDB_UNUSED_1746	SW	UNUSED	
1747		DDB_UNUSED_1747	SW	UNUSED	
1748		DDB_UNUSED_1748	SW	UNUSED	
1749		DDB_UNUSED_1749	SW	UNUSED	
1750		DDB_UNUSED_1750	SW	UNUSED	

DDB No	English Text	Element Name	Source	Type	Description
1751		DDB_UNUSED_1751	SW	UNUSED	
1752		DDB_UNUSED_1752	SW	UNUSED	
1753		DDB_UNUSED_1753	SW	UNUSED	
1754		DDB_UNUSED_1754	SW	UNUSED	
1755		DDB_UNUSED_1755	SW	UNUSED	
1756		DDB_UNUSED_1756	SW	UNUSED	
1757		DDB_UNUSED_1757	SW	UNUSED	
1758		DDB_UNUSED_1758	SW	UNUSED	
1759		DDB_UNUSED_1759	SW	UNUSED	
1760		DDB_UNUSED_1760	SW	UNUSED	
1761		DDB_UNUSED_1761	SW	UNUSED	
1762		DDB_UNUSED_1762	SW	UNUSED	
1763		DDB_UNUSED_1763	SW	UNUSED	
1764		DDB_UNUSED_1764	SW	UNUSED	
1765		DDB_UNUSED_1765	SW	UNUSED	
1766		DDB_UNUSED_1766	SW	UNUSED	
1767		DDB_UNUSED_1767	SW	UNUSED	
1768		DDB_UNUSED_1768	SW	UNUSED	
1769		DDB_UNUSED_1769	SW	UNUSED	
1770		DDB_UNUSED_1770	SW	UNUSED	
1771		DDB_UNUSED_1771	SW	UNUSED	
1772		DDB_UNUSED_1772	SW	UNUSED	
1773		DDB_UNUSED_1773	SW	UNUSED	
1774		DDB_UNUSED_1774	SW	UNUSED	
1775		DDB_UNUSED_1775	SW	UNUSED	
1776		DDB_UNUSED_1776	SW	UNUSED	
1777		DDB_UNUSED_1777	SW	UNUSED	
1778		DDB_UNUSED_1778	SW	UNUSED	
1779		DDB_UNUSED_1779	SW	UNUSED	
1780		DDB_UNUSED_1780	SW	UNUSED	
1781		DDB_UNUSED_1781	SW	UNUSED	
1782		DDB_UNUSED_1782	SW	UNUSED	
1783		DDB_UNUSED_1783	SW	UNUSED	
1784		DDB_UNUSED_1784	SW	UNUSED	
1785		DDB_UNUSED_1785	SW	UNUSED	
1786		DDB_UNUSED_1786	SW	UNUSED	
1787		DDB_UNUSED_1787	SW	UNUSED	
1788		DDB_UNUSED_1788	SW	UNUSED	
1789		DDB_UNUSED_1789	SW	UNUSED	
1790		DDB_UNUSED_1790	SW	UNUSED	
1791		DDB_UNUSED_1791	SW	UNUSED	
1792		DDB_UNUSED_1792	SW	UNUSED	
1793		DDB_UNUSED_1793	SW	UNUSED	
1794		DDB_UNUSED_1794	SW	UNUSED	

DDB No	English Text	Element Name	Source	Type	Description
1795		DDB_UNUSED_1795	SW	UNUSED	
1796		DDB_UNUSED_DR	SW	UNUSED	
1797	ETH Link 1 Fail	DDB_NIC_LINK_1_FAIL	SW	PFSO	Network Interface Card link 1 fail indication
1798	ETH Link 2 Fail	DDB_NIC_LINK_2_FAIL	SW	PFSO	Network Interface Card link 2 fail indication
1799	ETH Link 3 Fail	DDB_NIC_LINK_3_FAIL	SW	PFSO	Network Interface Card link 3 fail indication
1800	Logged into UI	DDB_UI_LOGGEDIN	SW	PFSO	User logged into UI
1801	Logged into FP	DDB_FCUR_LOGGEDIN	SW	PFSO	User logged into front port courier
1802	Logged into RP1	DDB_RP1_LOGGEDIN	SW	PFSO	User logged into Rear Port1 courier
1803	Logged into RP2	DDB_RP2_LOGGEDIN	SW	PFSO	User logged into Rear Port2 courier
1804	Logged into TNL	DDB_TNL_LOGGEDIN	SW	PFSO	User logged into turnneled courier
1805	Logged into CPR	DDB_CPR_LOGGEDIN	SW	PFSO	User logged into co-processor courier
1806		DDB_UNUSED_1806	SW	UNUSED	
1807		DDB_UNUSED_1807	SW	UNUSED	
1808		DDB_UNUSED_1808	SW	UNUSED	
1809		DDB_UNUSED_1809	SW	UNUSED	
1810		DDB_UNUSED_1810	SW	UNUSED	
1811		DDB_UNUSED_1811	SW	UNUSED	
1812		DDB_UNUSED_1812	SW	UNUSED	
1813		DDB_UNUSED_1813	SW	UNUSED	
1814		DDB_UNUSED_1814	SW	UNUSED	
1815		DDB_UNUSED_1815	SW	UNUSED	
1816		DDB_UNUSED_1816	SW	UNUSED	
1817		DDB_UNUSED_1817	SW	UNUSED	
1818		DDB_UNUSED_1818	SW	UNUSED	
1819		DDB_UNUSED_1819	SW	UNUSED	
1820		DDB_UNUSED_1820	SW	UNUSED	
1821		DDB_UNUSED_1821	SW	UNUSED	
1822		DDB_UNUSED_1822	SW	UNUSED	
1823		DDB_UNUSED_1823	SW	UNUSED	
1824		DDB_UNUSED_1824	SW	UNUSED	
1825		DDB_UNUSED_1825	SW	UNUSED	
1826		DDB_UNUSED_1826	SW	UNUSED	
1827		DDB_UNUSED_1827	SW	UNUSED	
1828		DDB_UNUSED_1828	SW	UNUSED	
1829		DDB_UNUSED_1829	SW	UNUSED	
1830		DDB_UNUSED_1830	SW	UNUSED	
1831		DDB_UNUSED_1831	SW	UNUSED	
1832		DDB_UNUSED_1832	SW	UNUSED	
1833		DDB_UNUSED_1833	SW	UNUSED	
1834		DDB_UNUSED_1834	SW	UNUSED	
1835		DDB_UNUSED_1835	SW	UNUSED	
1836		DDB_UNUSED_1836	SW	UNUSED	
1837		DDB_UNUSED_1837	SW	UNUSED	
1838		DDB_UNUSED_1838	SW	UNUSED	

DDB No	English Text	Element Name	Source	Type	Description
1839		DDB_UNUSED_1839	SW	UNUSED	
1840		DDB_UNUSED_1840	SW	UNUSED	
1841		DDB_UNUSED_1841	SW	UNUSED	
1842		DDB_UNUSED_1842	SW	UNUSED	
1843		DDB_UNUSED_1843	SW	UNUSED	
1844		DDB_UNUSED_1844	SW	UNUSED	
1845		DDB_UNUSED_1845	SW	UNUSED	
1846		DDB_UNUSED_1846	SW	UNUSED	
1847		DDB_UNUSED_1847	SW	UNUSED	
1848		DDB_UNUSED_1848	SW	UNUSED	
1849		DDB_UNUSED_1849	SW	UNUSED	
1850		DDB_UNUSED_1850	SW	UNUSED	
1851		DDB_UNUSED_1851	SW	UNUSED	
1852		DDB_UNUSED_1852	SW	UNUSED	
1853		DDB_UNUSED_1853	SW	UNUSED	
1854		DDB_UNUSED_1854	SW	UNUSED	
1855		DDB_UNUSED_1855	SW	UNUSED	
1856		DDB_UNUSED_1856	SW	UNUSED	
1857		DDB_UNUSED_1857	SW	UNUSED	
1858		DDB_UNUSED_1858	SW	UNUSED	
1859		DDB_UNUSED_1859	SW	UNUSED	
1860		DDB_UNUSED_1860	SW	UNUSED	
1861		DDB_UNUSED_1861	SW	UNUSED	
1862		DDB_UNUSED_1862	SW	UNUSED	
1863		DDB_UNUSED_1863	SW	UNUSED	
1864		DDB_UNUSED_1864	SW	UNUSED	
1865		DDB_UNUSED_1865	SW	UNUSED	
1866		DDB_UNUSED_1866	SW	UNUSED	
1867		DDB_UNUSED_1867	SW	UNUSED	
1868		DDB_UNUSED_1868	SW	UNUSED	
1869		DDB_UNUSED_1869	SW	UNUSED	
1870		DDB_UNUSED_1870	SW	UNUSED	
1871		DDB_UNUSED_1871	SW	UNUSED	
1872		DDB_UNUSED_1872	SW	UNUSED	
1873		DDB_UNUSED_1873	SW	UNUSED	
1874		DDB_UNUSED_1874	SW	UNUSED	
1875		DDB_UNUSED_1875	SW	UNUSED	
1876		DDB_UNUSED_1876	SW	UNUSED	
1877		DDB_UNUSED_1877	SW	UNUSED	
1878		DDB_UNUSED_1878	SW	UNUSED	
1879		DDB_UNUSED_1879	SW	UNUSED	
1880		DDB_UNUSED_1880	SW	UNUSED	
1881		DDB_UNUSED_1881	SW	UNUSED	
1882		DDB_UNUSED_1882	SW	UNUSED	

DDB No	English Text	Element Name	Source	Type	Description
1883		DDB_UNUSED_1883	SW	UNUSED	
1884		DDB_UNUSED_1884	SW	UNUSED	
1885		DDB_UNUSED_1885	SW	UNUSED	
1886		DDB_UNUSED_1886	SW	UNUSED	
1887		DDB_UNUSED_1887	SW	UNUSED	
1888		DDB_UNUSED_1888	SW	UNUSED	
1889		DDB_UNUSED_1889	SW	UNUSED	
1890		DDB_UNUSED_1890	SW	UNUSED	
1891		DDB_UNUSED_1891	SW	UNUSED	
1892		DDB_UNUSED_1892	SW	UNUSED	
1893		DDB_UNUSED_1893	SW	UNUSED	
1894		DDB_UNUSED_1894	SW	UNUSED	
1895		DDB_UNUSED_1895	SW	UNUSED	
1896		DDB_UNUSED_1896	SW	UNUSED	
1897		DDB_UNUSED_1897	SW	UNUSED	
1898		DDB_UNUSED_1898	SW	UNUSED	
1899		DDB_UNUSED_1899	SW	UNUSED	
1900		DDB_UNUSED_1900	SW	UNUSED	
1901		DDB_UNUSED_1901	SW	UNUSED	
1902		DDB_UNUSED_1902	SW	UNUSED	
1903		DDB_UNUSED_1903	SW	UNUSED	
1904		DDB_UNUSED_1904	SW	UNUSED	
1905		DDB_UNUSED_1905	SW	UNUSED	
1906		DDB_UNUSED_1906	SW	UNUSED	
1907		DDB_UNUSED_1907	SW	UNUSED	
1908		DDB_UNUSED_1908	SW	UNUSED	
1909		DDB_UNUSED_1909	SW	UNUSED	
1910		DDB_UNUSED_1910	SW	UNUSED	
1911		DDB_UNUSED_1911	SW	UNUSED	
1912		DDB_UNUSED_1912	SW	UNUSED	
1913		DDB_UNUSED_1913	SW	UNUSED	
1914		DDB_UNUSED_1914	SW	UNUSED	
1915		DDB_UNUSED_1915	SW	UNUSED	
1916		DDB_UNUSED_1916	SW	UNUSED	
1917		DDB_UNUSED_1917	SW	UNUSED	
1918		DDB_UNUSED_1918	SW	UNUSED	
1919		DDB_UNUSED_1919	SW	UNUSED	
1920		DDB_UNUSED_1920	SW	UNUSED	
1921		DDB_UNUSED_1921	SW	UNUSED	
1922		DDB_UNUSED_1922	SW	UNUSED	
1923		DDB_UNUSED_1923	SW	UNUSED	
1924		DDB_UNUSED_1924	SW	UNUSED	
1925		DDB_UNUSED_1925	SW	UNUSED	
1926		DDB_UNUSED_1926	SW	UNUSED	

DDB No	English Text	Element Name	Source	Type	Description
1927		DDB_UNUSED_1927	SW	UNUSED	
1928		DDB_UNUSED_1928	SW	UNUSED	
1929		DDB_UNUSED_1929	SW	UNUSED	
1930		DDB_UNUSED_1930	SW	UNUSED	
1931		DDB_UNUSED_1931	SW	UNUSED	
1932		DDB_UNUSED_1932	SW	UNUSED	
1933		DDB_UNUSED_1933	SW	UNUSED	
1934		DDB_UNUSED_1934	SW	UNUSED	
1935		DDB_UNUSED_1935	SW	UNUSED	
1936		DDB_UNUSED_1936	SW	UNUSED	
1937		DDB_UNUSED_1937	SW	UNUSED	
1938		DDB_UNUSED_1938	SW	UNUSED	
1939		DDB_UNUSED_1939	SW	UNUSED	
1940		DDB_UNUSED_1940	SW	UNUSED	
1941		DDB_UNUSED_1941	SW	UNUSED	
1942		DDB_UNUSED_1942	SW	UNUSED	
1943		DDB_UNUSED_1943	SW	UNUSED	
1944		DDB_UNUSED_1944	SW	UNUSED	
1945		DDB_UNUSED_1945	SW	UNUSED	
1946		DDB_UNUSED_1946	SW	UNUSED	
1947		DDB_UNUSED_1947	SW	UNUSED	
1948		DDB_UNUSED_1948	SW	UNUSED	
1949		DDB_UNUSED_1949	SW	UNUSED	
1950		DDB_UNUSED_1950	SW	UNUSED	
1951		DDB_UNUSED_1951	SW	UNUSED	
1952		DDB_UNUSED_1952	SW	UNUSED	
1953		DDB_UNUSED_1953	SW	UNUSED	
1954		DDB_UNUSED_1954	SW	UNUSED	
1955		DDB_UNUSED_1955	SW	UNUSED	
1956		DDB_UNUSED_1956	SW	UNUSED	
1957		DDB_UNUSED_1957	SW	UNUSED	
1958		DDB_UNUSED_1958	SW	UNUSED	
1959		DDB_UNUSED_1959	SW	UNUSED	
1960		DDB_UNUSED_1960	SW	UNUSED	
1961		DDB_UNUSED_1961	SW	UNUSED	
1962		DDB_UNUSED_1962	SW	UNUSED	
1963		DDB_UNUSED_1963	SW	UNUSED	
1964		DDB_UNUSED_1964	SW	UNUSED	
1965		DDB_UNUSED_1965	SW	UNUSED	
1966		DDB_UNUSED_1966	SW	UNUSED	
1967		DDB_UNUSED_1967	SW	UNUSED	
1968		DDB_UNUSED_1968	SW	UNUSED	
1969		DDB_UNUSED_1969	SW	UNUSED	
1970		DDB_UNUSED_1970	SW	UNUSED	

DDB No	English Text	Element Name	Source	Type	Description
1971		DDB_UNUSED_1971	SW	UNUSED	
1972		DDB_UNUSED_1972	SW	UNUSED	
1973		DDB_UNUSED_1973	SW	UNUSED	
1974		DDB_UNUSED_1974	SW	UNUSED	
1975		DDB_UNUSED_1975	SW	UNUSED	
1976		DDB_UNUSED_1976	SW	UNUSED	
1977		DDB_UNUSED_1977	SW	UNUSED	
1978		DDB_UNUSED_1978	SW	UNUSED	
1979		DDB_UNUSED_1979	SW	UNUSED	
1980		DDB_UNUSED_1980	SW	UNUSED	
1981		DDB_UNUSED_1981	SW	UNUSED	
1982		DDB_UNUSED_1982	SW	UNUSED	
1983		DDB_UNUSED_1983	SW	UNUSED	
1984		DDB_UNUSED_1984	SW	UNUSED	
1985		DDB_UNUSED_1985	SW	UNUSED	
1986		DDB_UNUSED_1986	SW	UNUSED	
1987		DDB_UNUSED_1987	SW	UNUSED	
1988		DDB_UNUSED_1988	SW	UNUSED	
1989		DDB_UNUSED_1989	SW	UNUSED	
1990		DDB_UNUSED_1990	SW	UNUSED	
1991		DDB_UNUSED_1991	SW	UNUSED	
1992		DDB_UNUSED_1992	SW	UNUSED	
1993		DDB_UNUSED_1993	SW	UNUSED	
1994		DDB_UNUSED_1994	SW	UNUSED	
1995		DDB_UNUSED_1995	SW	UNUSED	
1996		DDB_UNUSED_1996	SW	UNUSED	
1997		DDB_UNUSED_1997	SW	UNUSED	
1998		DDB_UNUSED_1998	SW	UNUSED	
1999		DDB_UNUSED_1999	SW	UNUSED	
2000		DDB_UNUSED_2000	SW	UNUSED	
2001		DDB_UNUSED_2001	SW	UNUSED	
2002		DDB_UNUSED_2002	SW	UNUSED	
2003		DDB_UNUSED_2003	SW	UNUSED	
2004		DDB_UNUSED_2004	SW	UNUSED	
2005		DDB_UNUSED_2005	SW	UNUSED	
2006		DDB_UNUSED_2006	SW	UNUSED	
2007		DDB_UNUSED_2007	SW	UNUSED	
2008		DDB_UNUSED_2008	SW	UNUSED	
2009		DDB_UNUSED_2009	SW	UNUSED	
2010		DDB_UNUSED_2010	SW	UNUSED	
2011		DDB_UNUSED_2011	SW	UNUSED	
2012		DDB_UNUSED_2012	SW	UNUSED	
2013		DDB_UNUSED_2013	SW	UNUSED	
2014		DDB_UNUSED_2014	SW	UNUSED	

DDB No	English Text	Element Name	Source	Type	Description
2015		DDB_UNUSED_2015	SW	UNUSED	
2016		DDB_UNUSED_2016	SW	UNUSED	
2017		DDB_UNUSED_2017	SW	UNUSED	
2018		DDB_UNUSED_2018	SW	UNUSED	
2019		DDB_UNUSED_2019	SW	UNUSED	
2020		DDB_UNUSED_2020	SW	UNUSED	
2021		DDB_UNUSED_2021	SW	UNUSED	
2022		DDB_UNUSED_2022	SW	UNUSED	
2023		DDB_UNUSED_2023	SW	UNUSED	
2024		DDB_UNUSED_2024	SW	UNUSED	
2025		DDB_UNUSED_2025	SW	UNUSED	
2026		DDB_UNUSED_2026	SW	UNUSED	
2027		DDB_UNUSED_2027	SW	UNUSED	
2028		DDB_UNUSED_2028	SW	UNUSED	
2029		DDB_UNUSED_2029	SW	UNUSED	
2030		DDB_UNUSED_2030	SW	UNUSED	
2031		DDB_UNUSED_2031	SW	UNUSED	
2032		DDB_UNUSED_2032	SW	UNUSED	
2033		DDB_UNUSED_2033	SW	UNUSED	
2034		DDB_UNUSED_2034	SW	UNUSED	
2035		DDB_UNUSED_2035	SW	UNUSED	
2036		DDB_UNUSED_2036	SW	UNUSED	
2037		DDB_UNUSED_2037	SW	UNUSED	
2038		DDB_UNUSED_2038	SW	UNUSED	
2039		DDB_UNUSED_2039	SW	UNUSED	
2040		DDB_UNUSED_2040	SW	UNUSED	
2041		DDB_UNUSED_2041	SW	UNUSED	
2042		DDB_UNUSED_2042	SW	UNUSED	
2043		DDB_UNUSED_2043	SW	UNUSED	
2044		DDB_UNUSED_2044	SW	UNUSED	
2045		DDB_UNUSED_2045	SW	UNUSED	
2046		DDB_UNUSED_2046	SW	UNUSED	
2047		DDB_UNUSED_2047	SW	UNUSED	

Table 1 - Description of available logic nodes

2.1 Factory Default Programmable Scheme Logic (PSL)

The following section details the default settings of the PSL.

The P241/P242/P243 model options are as follows:

Model	Opto inputs	Relay outputs
P241xxxxxxxxxxJ	8	7
P242xxxxxxxxxxK	16	16
P243xxxxxxxxxxK	16	16

Table 2 - Default settings

2.2 Logic Input Mapping

The default mappings for each of the opto-isolated inputs are shown in Table 3 and Table 4:

Opto-Input number	P241 relay text	Function
1	Input L1	L1 CB Closed 3-Ph (52a), LED #1
2	Input L2	L2 CB Open 3-Ph (52b), LED #2
3	Input L3	L3 Speed Input, LED #3
4	Input L4	L4 Emergency Restart
5	Input L5	L5 Reset Thermal
6	Input L6	L6 Reset Latches
7	Input L7	L7 Close
8	Input L8	L8 Trip

Table 3 - P241 opto inputs default mappings

Opto-Input number	P242/P243 relay text	Function
1	Input L1	L1 CB Closed 3-Ph (52a), LED #1 (Green)
2	Input L2	L2 CB Open 3-Ph (52b), LED #1 (Red)
3	Input L3	L3 Speed Input, LED #3 (Yellow)
4	Input L4	L4 Not Used
5	Input L5	L5 Not Used
6	Input L6	L6 Not Used
7	Input L7	L7 Not Used
8	Input L8	L8 Not Used
9	Input L9	L9 Not Used
10	Input L10	L10 Not Used
11	Input L11	L11 Not Used
12	Input L12	L12 Not Used
13	Input L13	L13 Not Used
14	Input L14	L14 Not Used
15	Input L15	L15 Not Used
16	Input L16	L16 Not Used

Table 4 - P242/P243 opto inputs default mappings

2.3 Relay Output Contact Mapping

The default mappings for each of the relay output contacts are shown in Table 5 and Table 6:

Relay Contact No	P241 relay text	P241 relay conditioner	Function
1	Output R1	Straight Through	R1 Control Close
2	Output R2	Straight Through	R2 Any Protection Start

Relay Contact No	P241 relay text	P241 relay conditioner	Function
3	Output R3	Straight Through	R3 Any Protection Trip, Control Trip
4	Output R4	Straight Through	R4 Start Protection (Number of hot/cold starts, time between starts), Thermal Trip, 3Ph Volt Alarm
5	Output R5	N/A	R5 Not Used
6	Output R6	N/A	R6 Not Used
7	Output R7	N/A	R7 Not Used

Table 5 - P241 relay output contacts default mappings

Relay Contact No	P242/P243 relay text	P242/P243 relay conditioner	Function
1	Output R1	Straight Through	R1 Control Close
2	Output R2	Straight Through	R2 Any Protection Start
3	Output R3	Straight Through	R3 Any Protection Trip, Control Trip
4	Output R4	Straight Through	R4 Start Protection (Number of hot/cold starts, time between starts), Thermal Trip, 3Ph Volt Alarm
5	Output R5	N/A	R5 Not Used
6	Output R6	N/A	R6 Not Used
7	Output R7	N/A	R7 Not Used
8	Output R8	N/A	R8 Not Used
9	Output R9	N/A	R9 Not Used
10	Output R10	N/A	R10 Not Used
11	Output R11	N/A	R11 Not Used
12	Output R12	N/A	R12 Not Used
13	Output R13	N/A	R13 Not Used
14	Output R14	N/A	R14 Not Used
15	Output R15	N/A	R15 Not Used
16	Output R16	N/A	R16 Not Used

Table 6 - P242/P243 relay output contacts default mappings

Note *A fault record can be generated by connecting one or a number of contacts to the “Fault Record Trigger” in PSL. It is recommended that the triggering contact be ‘self reset’ and not a latching. If a latching contact were chosen the fault record would not be generated until the contact had fully reset.*

2.4 Programmable LED Output Mapping

The default mappings for each of the programmable LEDs for the P241 are shown in Table 7 which have red LEDs:

LED No	LED input connection/text	Latched	P241 LED function indication
1	LED 1 Red	No	Opto Input 1 (CB Closed, 52a)
2	LED 2 Red	No	Opto Input 2 (CB Open, 52b)
3	LED 3 Red	No	Opto Input 3 (Speed Switch)
4	LED 4 Red	No	Start in Progress

LED No	LED input connection/text	Latched	P241 LED function indication
5	LED 5 Red	No	Re-acceleration in Progress
6	LED 6 Red	No	Start Successful
7	LED 7 Red	No	Re-acceleration Low Voltage Detected
8	LED 8 Red	No	Start Protection (Number of hot/cold starts, time between starts), Thermal Trip, 3Ph Volt Alarm

Table 7 - P241 programmable LED default mappings

The default mappings for each of the programmable LEDs for the P242/P243 are shown in Table 8 and have tri-colour LEDS (red/yellow/green):

LED No	LED input connection/text	Latched	P242/P243 LED function indication
1	LED 1 Green	No	Opto Input 1 (CB Closed, 52a)
1	LED 1 Red	No	Opto Input 2 (CB Open, 52b)
2	LED 2 Not Used		
3	LED 3 Yellow	No	Opto Input 3 (Speed Switch)
4	LED 4 Yellow	No	Start in Progress
5	LED 5 Yellow	No	Re-acceleration in Progress
6	LED 6 Green	No	Start Successful
7	LED 7 Yellow	No	Re-acceleration Low Voltage Detected
8	LED 8 Red	No	Start Protection (Number of hot/cold starts, time between starts), Thermal Trip, 3Ph Volt Alarm
9	FnKey LED1 (Yellow)	N/A	Emergency Restart
10	FnKey LED2 (Yellow)	N/A	Trip
11	FnKey LED3 (Yellow)	N/A	Close
12	FnKey LED4	N/A	Not Used
13	FnKey LED5 (Red)	N/A	Setting Group
14	FnKey LED6	N/A	Not Used
15	FnKey LED7	N/A	Not Used
16	FnKey LED8 (Yellow)	N/A	Reset Thermal
17	FnKey LED9 (Yellow)	N/A	Reset Latches
18	FnKey LED10 (Yellow)	N/A	Disturbance Recorder Trigger

Table 8 - P242/P243 programmable LED default mappings

2.5 Fault Recorder Start Mapping

The default mapping for the signal which initiates a fault record is as shown in Table 9:

Initiating signal	Fault trigger
Any Trip (DDB 371)	Initiate fault recording from any protection trip

Table 9 - Default fault record initiation

3 VIEWING AND PRINTING DEFAULT PSL DIAGRAMS

3.1 Typical Mappings

It is possible to view and print the default PSL diagrams for the device. Typically, these diagrams allow you to see these mappings:

- Opto Input Mappings
- Output Relay Mappings
- LED Mappings
- Start Indications
- Phase Trip Mappings
- System Check Mapping

3.2 Download and Print PSL Diagrams

To download and print the default PSL diagrams for the device:

1. Close MiCOM S1 Studio.
2. Select **Programs** > then navigate through to > **MiCOM S1 Studio** > **Data Model Manager**.
3. Click **Add** then **Next**.
4. Click **Internet** then **Next**.
5. Select your language then click **Next**.
6. From the tree view, select the model and software version.
7. Click **Install**. When complete click **OK**.
8. Close the Data Model Manager and start MiCOM S1 Studio.
9. Select Tools > PSL Editor (Px40).
10. In the PSL Editor select **File** > **Open**. The downloaded PSL files are in C:\Program Files\ directory located in the \MiCOM S1\Courier\PSL\Defaults sub-directory.
11. Highlight the required PSL diagram and select **File** > **Print**.

4 P24X PROGRAMMABLE SCHEME LOGIC (PSL)

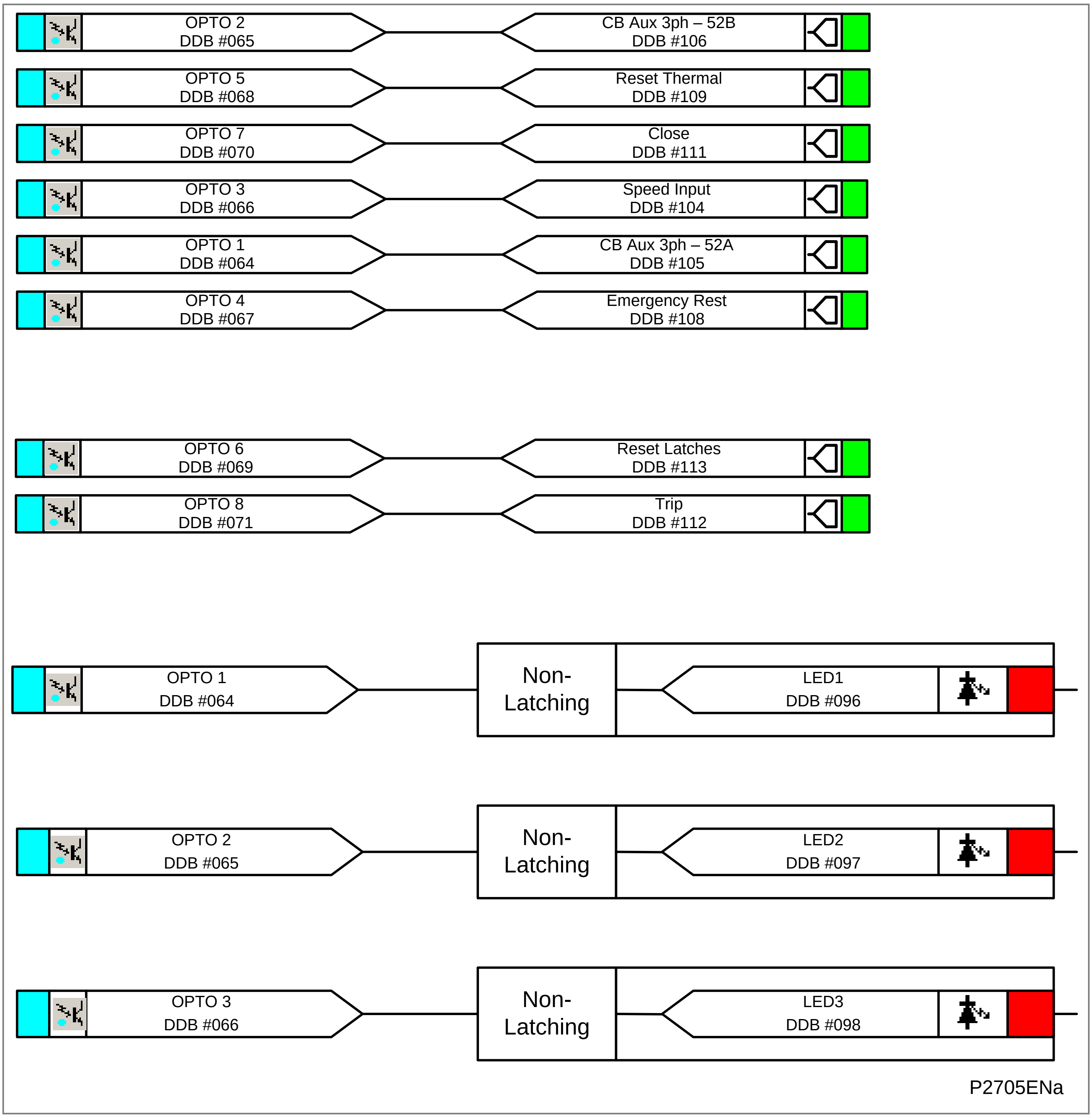


Figure 1 - P241 Opto Input Mappings

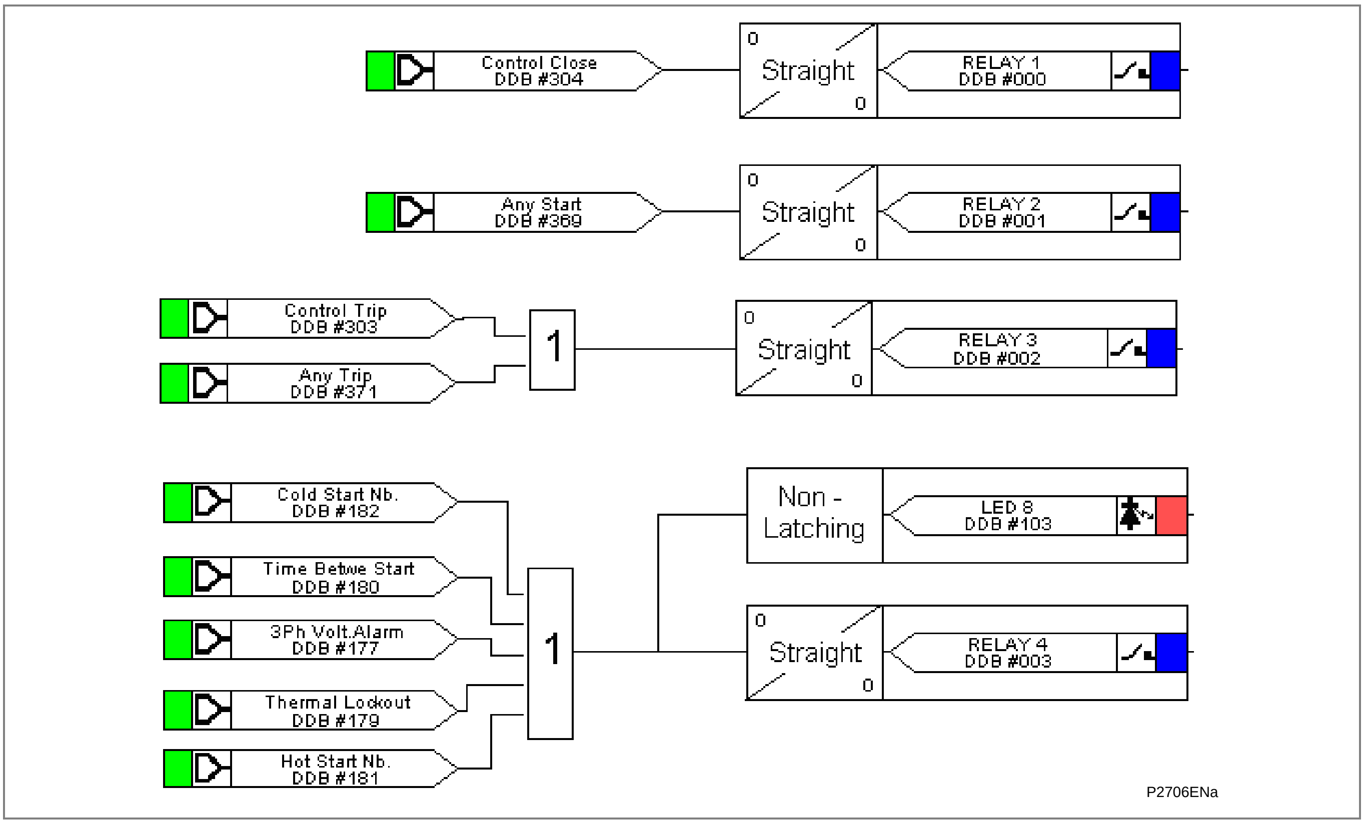


Figure 2 - P241 Output Relay Mappings

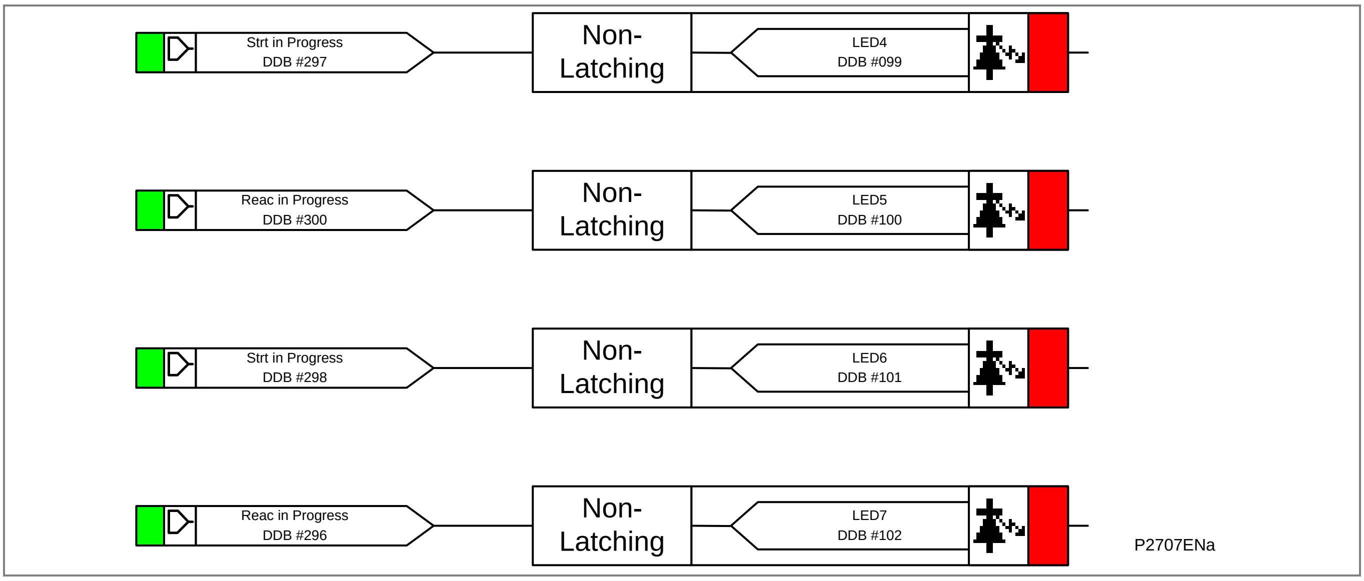


Figure 3 - P241 LED Mappings

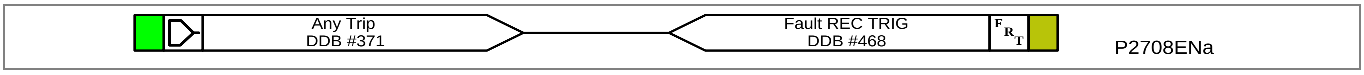


Figure 4 - Fault Recorder Trigger Mapping

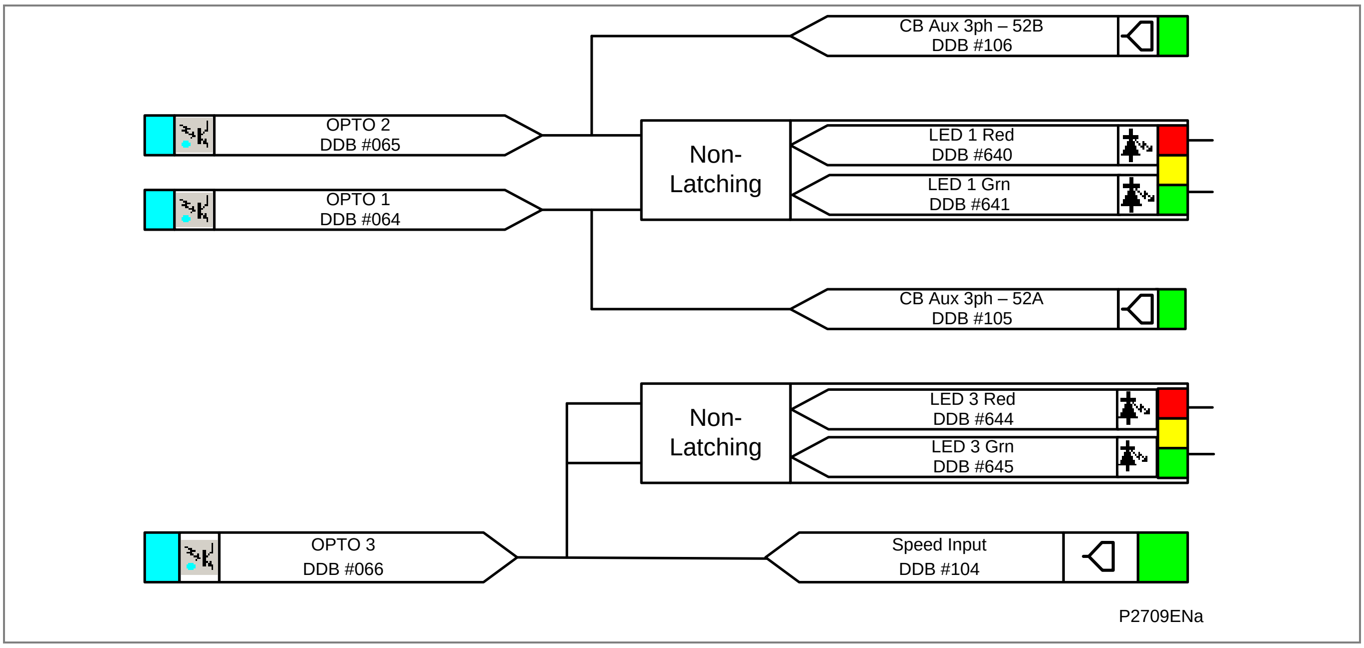


Figure 5 - P242/P243 Opto Input Mappings

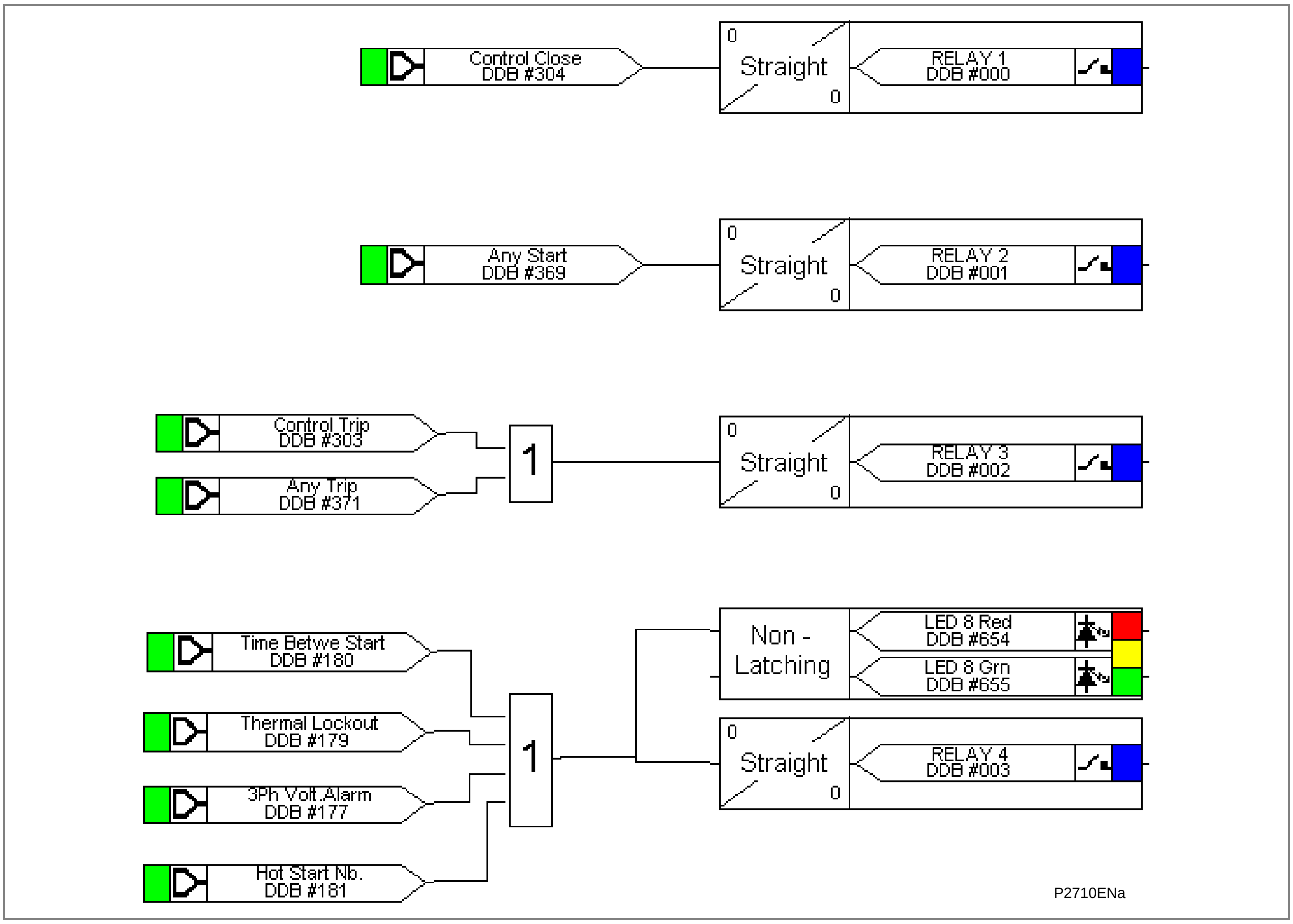


Figure 6 - P242/P243 Output Relay Mappings

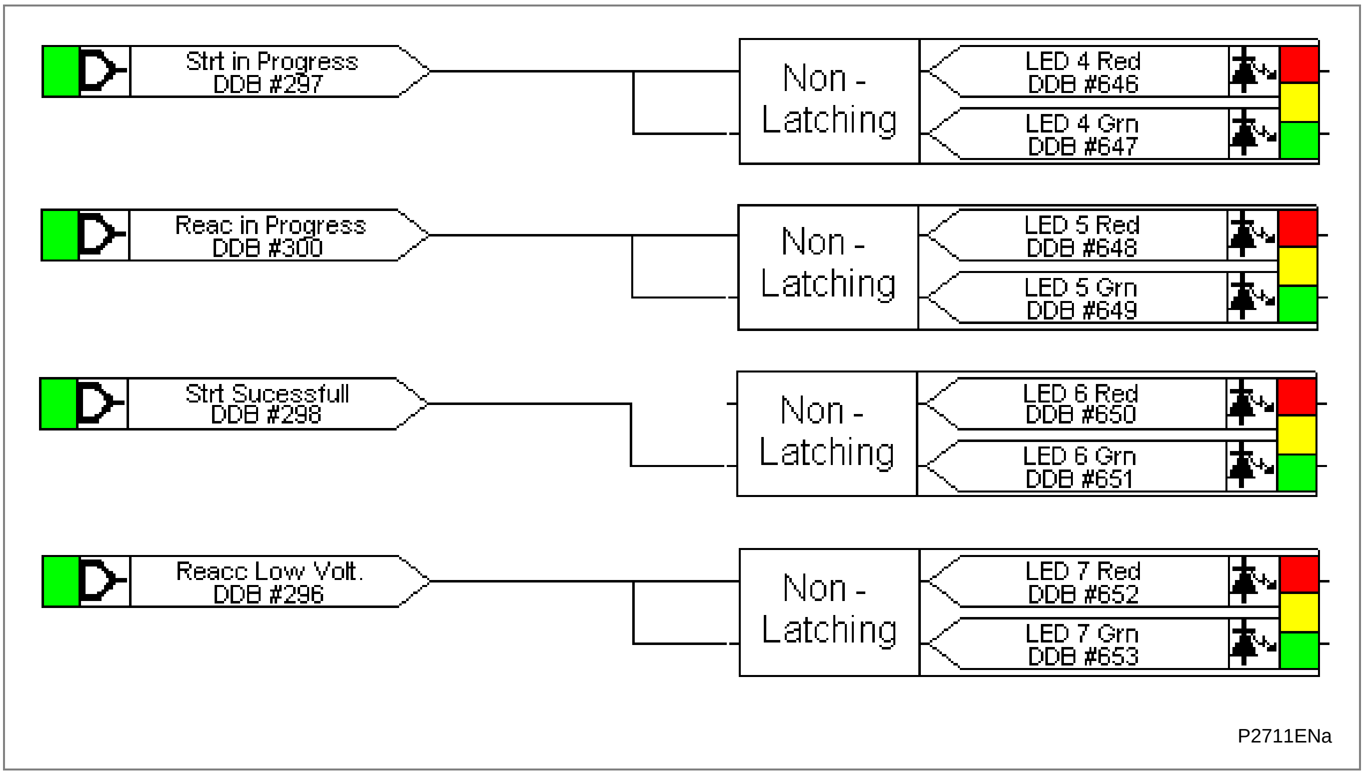


Figure 7 - P242/P243 LED Mappings

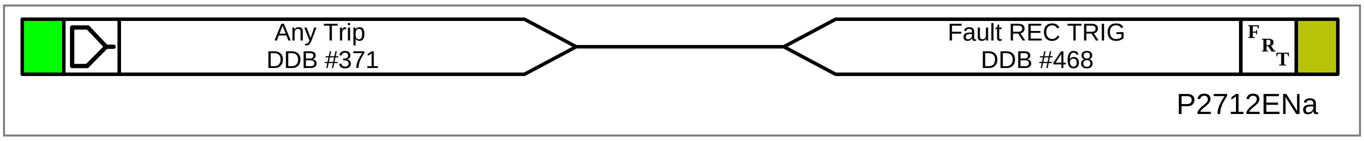


Figure 8 - Fault Recorder Trigger Mapping

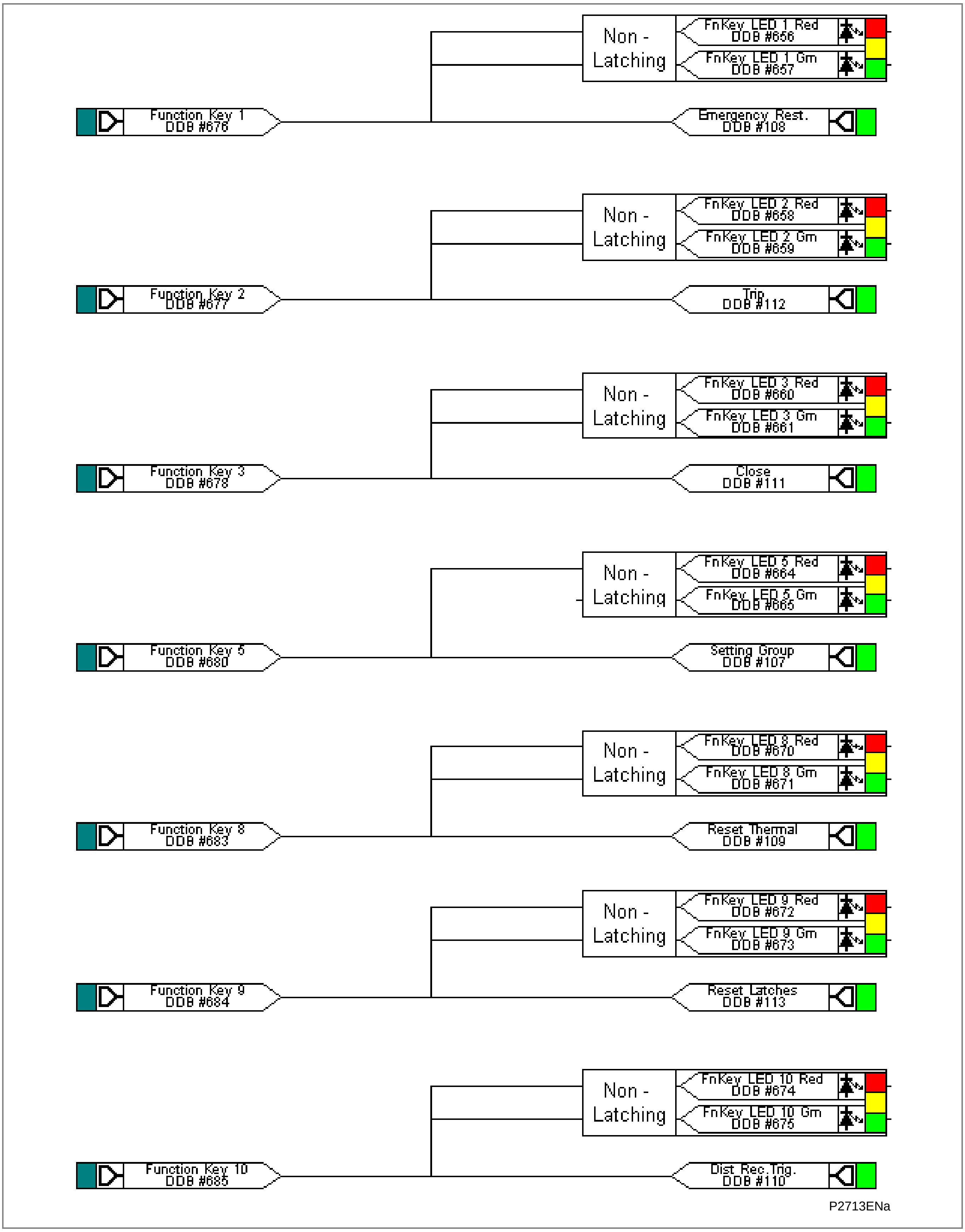


Figure 9 - Function Key Mapping

MEASUREMENTS AND RECORDING

CHAPTER 9

Date:	05/2017
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.
Hardware suffix:	L (P241) & M (P242 & P243)
Software version:	D1
Connection diagrams:	10P241xx (xx = 01 to 02) 10P242xx (xx = 01) 10P243xx (xx = 01)

CONTENTS

TABLES

1 INTRODUCTION

The relay is equipped with integral measurements, event, fault and disturbance recording facilities suitable for analysis of complex system disturbances.

The relay is flexible enough to allow for the programming of these facilities to specific user application requirements. These requirements are discussed in the sections which follow.

2 EVENT AND FAULT RECORDS

2.1 Event Recorder (“View Records” Menu)

The relay records and time tags up to 512 events and stores them in non-volatile (battery-backed up) memory. This lets the system operator establish the sequence of events that occurred in the relay following a particular power system condition or switching sequence. When the available space is used up, the oldest event is automatically overwritten by the new one (i.e. first in, first out).

The relay’s real-time clock provides the time tag to each event, to a resolution of 1 ms.

The event records can be viewed either from the front plate LCD or remotely using the communications ports (using any available protocols, such as Courier or MODBUS).

For local viewing on the LCD of event, fault and maintenance records, select the **VIEW RECORDS** menu column.

For extraction from a remote source using communications, see the *SCADA Communications* chapter or the MiCOM S1 Studio instructions.

For a full list of all the event types and the meaning of their values, see the Menu Database document.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
VIEW RECORDS	01	00		
This column contains event, fault and maintenance records				
Select Event	01	01	0	From 0 to 511 step 1
This selects the required event record from all the possible ones that may be stored. A value of 0 corresponds to the latest event, with the maximum value the oldest.				
Event Type	01	02		Not Settable
Indicates type of event				
Time & Date	01	03		Not Settable
Time & Date Stamp for the event given by the internal Real Time Clock.				
Event Text	01	04		Not Settable
Up to 16 Character description of the Event (refer to following sections).				
Event Value	01	05		Not Settable
Up to 32 Bit Binary Flag or integer representative of the Event (refer to following sections).				
Select Fault	01	06	0	From 0 to 4 step 1
This selects the required fault record from the possible 5 that may be stored. A value of 0 corresponds to the latest fault and so on.				
Start Elements	01	07		Not Settable
Displays the status of the first 32 start signals.				
Trip Elements(1)	01	08		Not Settable
Displays the status of the first 32 trip signals.				
Trip Elements(2)	01	09		Not Settable
Displays the status of the second 32 trip signals.				
Fault Alarms	01	0C		Not Settable
Displays the status of the fault alarm signals.				
Active Group	01	0D		Not Settable
Displays the active setting group when fault occurred.				
Time Stamp	01	0E		Not Settable

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Displays fault time and date.				
System Frequency	01	0F		Not Settable
Displays the system frequency				
IA	01	17		Not Settable
Measured parameter				
IB	01	18		Not Settable
Measured parameter				
IC	01	19		Not Settable
Measured parameter				
VAB	01	1A		Not Settable
Measured parameter				
VBC	01	1B		Not Settable
Measured parameter				
VCA	01	1C		Not Settable
Measured parameter				
IN Derived	01	1D		Not Settable
Measured parameter				
I0 Sensitive	01	1E		Not Settable
Measured parameter				
Thermal State	01	1F		Not Settable
Measured parameter				
I2 Magnitude	01	22		Not Settable
Measured parameter				
3Ph Power Factor	01	23		Not Settable
Measured parameter				
Zero Seq Power	01	24		Not Settable
Measured parameter				
VN Magnitude	01	25		Not Settable
Measured parameter				
3 Phase Watts	01	26		Not Settable
Measured parameter				
RTD1 Temperature	01	2A		Not Settable
Measured parameter				
RTD2 Temperature	01	2B		Not Settable
Measured parameter				
RTD3 Temperature	01	2C		Not Settable
Measured parameter				
RTD4 Temperature	01	2D		Not Settable
Measured parameter				
RTD5 Temperature	01	2E		Not Settable
Measured parameter				
RTD6 Temperature	01	2F		Not Settable
Measured parameter				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
RTD7 Temperature	01	30		Not Settable
Measured parameter				
RTD8 Temperature	01	31		Not Settable
Measured parameter				
RTD9 Temperature	01	32		Not Settable
Measured parameter				
RTD10 Temperatur	01	33		Not Settable
Measured parameter				
IA-2	01	34		Not Settable
Measured parameter				
IB-2	01	35		Not Settable
Measured parameter				
IC-2	01	36		Not Settable
Measured parameter				
IA Differential	01	37		Not Settable
Measured parameter				
IB Differential	01	38		Not Settable
Measured parameter				
IC Differential	01	39		Not Settable
Measured parameter				
IA Bias	01	3A		Not Settable
Measured parameter				
IB Bias	01	3B		Not Settable
Measured parameter				
IC Bias	01	3C		Not Settable
Measured parameter				
Analog Input 1	01	3D		Not Settable
Measured parameter				
Analog Input 2	01	3E		Not Settable
Measured parameter				
Analog Input 3	01	3F		Not Settable
Measured parameter				
Analog Input 4	01	40		Not Settable
Measured parameter				
Select Maint	01	F0	0	From 0 to 9 step 1
This selects the required maintenance report from those stored. A value of 0 corresponds to the latest report and so on.				
Maint Text	01	F1		Not Settable
Up to 16 Character description of the occurrence (refer to following sections).				
Maint Type	01	F2		Not Settable
These cells are numbers representative of the occurrence. They form a specific error code which should be quoted in any related correspondence to Report Data.				
Maint Data	01	F3		Not Settable
These cells are numbers representative of the occurrence. They form a specific error code which should be quoted in any related correspondence to Report Data.				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Evt Iface Source	01	FA		Not Settable
Interface on which the event was logged				
Evt Access Level	01	FB		Not Settable
Any security event that indicates that it came from an interface action, such as disabling a port, will also record the access level of the interface that initiated the event. This will be recorded in the ‘Event State’ field of the event.				
Evt Extra Info	01	FC		Not Settable
This cell provides supporting information for the event and can vary between the different event types.				
Evt Unique Id	01	FE		Not Settable
Each event will have a unique event id. The event id is a 32 bit unsigned integer that is incremented for each new event record and is stored in the record in battery-backed memory (BBRAM). The current event id must be non-volatile so as to preserve it du				
Reset Indication	01	FF	No	0=No 1=Yes
This serves to reset the trip LED indications provided that the relevant protection element has reset, to reset all LED and relays latched in the PSL, and to reset the latched alarms.				

Table 1 - Local viewing of records

2.2 Types of Event

An event may be a change of state of a control input or output relay, an alarm condition, or a setting change. The following sections show the various items that constitute an event:

2.3 Change of State of Opto-Isolated Inputs

If one or more of the opto (logic) inputs has changed state since the last time the protection algorithm ran, the new status is logged as an event. When this event is selected to be viewed on the LCD, three cells appear, as in shown here:

```
Time & date of event
“LOGIC INPUTS1”
“Event Value 0101010101010101”
```

The Event Value is a multi-bit word (see note) showing the status of the opto inputs, where the least significant bit (extreme right) corresponds to opto input 1. The same information is present if the event is extracted and viewed using a PC.

Note	*For P24x or P44x the Event Value is an 8 or 16 bit word.* *For P34x or P64x it is an 8, 12, 16, 24 or 32-bit word.* *For P445 it is an 8, 12 or 16-bit word.* *For P44y, P54x, P547 or P841, it is an 8, 12, 16 or 24-bit word.* *For P74x it is a 12, 16, 24 or 32-bit word.* *For P746 or P849 it is a 32-bit word.*

2.4 Change of State of One or More Output Relay Contacts

If one or more of the output relay contacts have changed state since the last time the protection algorithm ran, the new status is logged as an event. When this event is selected to be viewed on the LCD, three cells appear, as shown here:

```
Time and Date of Event
Output Contacts
Event Value 010101010101010101010
```

The Event Value is a multi-bit word (see Note) showing the status of the output contacts, where the least significant bit (extreme right) corresponds to output contact 1, etc. The same information is present if the event is extracted and viewed using a PC.

Note *For P24x the Event Value is is a 7 or 16-bit word.*
For P34x or P64x it is an 7, 11, 14, 15, 16, 22, 24 or 32-bit word.
For P445 it is an 8, 12 or 16-bit word.
For P44x it is a 7, 14 or 21 bit word.
For P44y, P54x, P547 or P841, it is an 8, 12, 16, 24 or 32 bit word.
For P74x it is a 12, 16, 24 or 32 bit word.
For P746 or P849 it is a 24-bit word.

2.5 Relay Alarm Conditions

Any alarm conditions generated by the relays are logged as individual events. This table shows examples of some of the alarm conditions and how they appear in the event list:

Bit Position in 32 bit field	Alarm Status 1	Alarm Status 2	Alarm Status 3	USR Alarm Status
0	Not Used	Invalid Set. Grp	Battery fail	SR User Alarm 1
1	Not Used	Dist. Rec. Conf.	Field Volt Fail	SR User Alarm 2
2	General Alarm	CB Fail Alarm	Rear Comms fail	SR User Alarm 3
3	Prot'n Disabled	W Fwd Alarm	GOOSE IED Absent	SR User Alarm 4
4	F out of Range	W Rev Alarm	NIC Not Fitted	SR User Alarm 5
5	3Ph Volt.Alarm	VAr Fwd Alarm	NIC No Response	SR User Alarm 6
6	Thermal Alarm	VAr Rev Alarm	NIC Fatal Error	SR User Alarm 7
7	Thermal Lockout	Analo Inp1 Alarm	Unused	SR User Alarm 8
8	Time Betwe Start	Analo Inp2 Alarm	Unused	SR User Alarm 9
9	Hot Start Nb.	Analo Inp3 Alarm	Unused	SR User Alarm 10
10	Cold Start Nb.	Analo Inp4 Alarm	Unused	SR User Alarm 11
11	Man CB Trip Fail	Not Used	NIC SW Mis-Match	SR User Alarm 12
12	Man CB Cls Fail	Not Used	IP Addr Conflict	SR User Alarm 13
13	CB Status Alarm	Not Used	IM Loopback	SR User Alarm 14
14	I^ Maint Alarm	Not Used	IM Message Fail	SR User Alarm 15
15	CB OPs Maint	Not Used	IM Data CD Fail	SR User Alarm 16
16	CB Op Time Maint	Not Used	IM Channel Fail	MR User Alarm 17
17	3Ph W Alarm	Not Used	Backup Setting	MR User Alarm 18
18	3Ph VAr Alarm	Not Used	Bad DNP Settings	MR User Alarm 19
19	RTD 1 Alarm	Not Used	Unused	MR User Alarm 20
20	RTD 2 Alarm	Not Used	Unused	MR User Alarm 21
21	RTD 3 Alarm	Not Used	Invalid DNPoE IP	MR User Alarm 22
22	RTD 4 Alarm	Not Used	Invalid Config.	MR User Alarm 23

Bit Position in 32 bit field	Alarm Status 1	Alarm Status 2	Alarm Status 3	USR Alarm Status
23	RTD 5 Alarm	Not Used	Test Mode Alm	MR User Alarm 24
24	RTD 6 Alarm	Not Used	Contacts Blk Alm	MR User Alarm 25
25	RTD 7 Alarm	Not Used	NIC HW Mismatch	MR User Alarm 26
26	RTD 8 Alarm	Not Used	NIC APP Mismatch	MR User Alarm 27
27	RTD 9 Alarm	Hour Run Alarm1	Simul.GOOSE Alm	MR User Alarm 28
28	RTD 10 Alarm	Hour Run Alarm2	Unused	MR User Alarm 29
29	RTD Short Cct	Antibkspin Alarm	Unused	MR User Alarm 30
30	RTD Open Cct	Field Fail Alarm	Unused	MR User Alarm 31
31	RTD Data Error	Not Used	Unused	MR User Alarm 32

Table 2 - Examples of alarm conditions in the event list

The previous table shows the abbreviated description given to the various alarm conditions and a corresponding value between 0 and 31. This value is appended to each alarm event in a similar way to the input and output events described previously. It is used by the event extraction software, such as MiCOM S1 Studio, to identify the alarm and is therefore invisible if the event is viewed on the LCD. ON or OFF is shown after the description to signify whether the particular condition has become operated or has reset.

The User Alarms can be operated from an opto input or a control input using the PSL. They give an alarm LED and message on the LCD display and an alarm indication via the communications of an external condition, for example trip circuit supervision alarm, rotor earth fault alarm. The menu text editor in MiCOM S1 Studio can be used to edit the user alarm text to give a more meaningful description on the LCD display.

2.6 Protection Element Starts and Trips

Any operation of protection elements, (either a start or a trip condition) is logged as an event record, consisting of a text string indicating the operated element and an event value. This value is intended for use by the event extraction software, such as MiCOM S1 Studio, rather than for the user, and is invisible when the event is viewed on the LCD.

2.7 General (Platform) Events

Several events come under the heading of **General Events**. An example appears here.

Nature of event	Displayed text in event record	Displayed value
Password modified, either from the front or the rear port.	PW modified F, R or R2	0 F=11, R=16, R2=38. For P44x, the value displayed is 0.

A complete list of the General Events is in the Relay Menu Database document. This is a separate document, for each MiCOM Px4x product or product range. They are normally available for download from www.schneider-electric.com

2.8 Fault Records

Each time a fault record is generated, an event is also created. The event states that a fault record was generated, with a corresponding time stamp.

Further down the **VIEW RECORDS** column, select the **Select Fault** cell to view the actual fault record, which is selectable from up to 5, 15 or 20 records (see Note). These records consist of fault flags, fault location, fault measurements, etc. The time stamp given in the fault record is more accurate than the corresponding stamp given in the event record as the event is logged some time after the actual fault record is generated.

Note *Up to 5 records for the P14x, P24x, P34x, P44x and P74x.*
Up to 15 records for the P445, P44y, P54x, P547 and P841.
Up to 20 records for the P746.

The fault record is triggered from the **Fault REC. TRIG.** signal assigned in the default programmable scheme logic. Normally this is assigned to relay 3, protection trip, but in the P746 it is assigned to Any Start or Any Trip. The fault measurements in the fault record are given at the time of the protection start.

The fault recorder does not stop recording until any start or relay 3 (protection trip) resets in order to record all the protection flags during the fault.

It is recommended that the triggering contact (relay 3 for example) be 'self reset' and not latching. If a latching contact were chosen the fault record would not be generated until the contact had fully reset.

2.9 Maintenance Reports

Internal failures detected by the self-monitoring circuitry, such as watchdog failure, field voltage failure etc. are logged into a maintenance report. The maintenance report holds up to 10 such 'events' and is accessed from the "Select Maint" cell at the bottom of the "VIEW RECORDS" column.

Each entry consists of a self explanatory text string and a '**Type**' and '**Data**' cell, which are explained in the menu extract at the beginning of this section.

Each time a Maintenance Report is generated, an event is also created. The event simply states that a report was generated, with a corresponding time stamp.

2.10 Setting Changes

Changes to any setting in the relay are logged as an event. For example:

Type of setting change	Displayed text in event record	Displayed value
Control/Support Setting	C & S Changed	22
Group # Change	Group # Changed	#
Where # = 1 to 4		

Note *Control/Support settings are communications, measurement, CT/VT ratio settings etc, which are not duplicated in the setting groups. When any of these settings are changed, the event record is created simultaneously. Changes to protection or disturbance recorder settings only generate an event once the settings have been confirmed at the 'setting trap'.*

2.11 Viewing Event Records via MiCOM S1 Studio Support Software

When the event records are extracted and viewed on a PC they look slightly different than when viewed on the LCD. The following shows an example of how various events appear when displayed using MiCOM S1 Studio:

Thursday 25 August 2016 16:00:36.501 CB Status Aalarm ON

SCHNEIDER ELECTRIC:	MiCOM P24x
Model Number:	P242214C2M0330C
Address:	001 Column: 00 Row: 50
Event Type:	Alarm event
Event Value:	00000000000000000001000000000000
OFF 0	External Trip
OFF 1	Field Volt Fail
OFF 2	F Out of Range
OFF 3	3 Ph Volt Alarm
OFF 4	Thermal Alarm
OFF 5	Thermal Lockout
OFF 6	Time Between Start
OFF 7	Hot Start Nb
OFF 8	Cold Start Nb
OFF 9	Man CB Trip Fail
OFF 10	Man CB Cls Fail
ON 11	CB Status Alarm
OFF 12	I^ Maint Alarm
OFF 13	CB Ops Maint
OFF 14	CB Op Time Maint
OFF 15	3 Ph Watt Alarm
OFF 16	3 Ph Var Alarm
OFF 17	Invalid Set. Grp
OFF 18	Prot’n Disabled
OFF 19	RTD 1 Alarm
OFF 20	RTD 2 Alarm
OFF 21	RTD 3 Alarm
OFF 22	RTD 4 Alarm
OFF 23	RTD 5 Alarm
OFF 24	RTD 6 Alarm
OFF 25	RTD 7 Alarm
OFF 26	RTD 8 Alarm
OFF 27	RTD 9 Alarm
OFF 28	RTD 10 Alarm
OFF 29	RTD Short Cct
OFF 30	RTD Open Cct
OFF 31	RTD Data Error

Friday 26 August 2016 07:32:28.634 Output Contacts

SCHNEIDER ELECTRIC:	MiCOM P24x
Model Number:	P242214C2M0330C
Address:	001 Column: 00 Row: 21
Event Type:	Device output changed state
Event Value:	0000000000000100
OFF 0	RELAY 1
OFF 1	RELAY 2
OFF 2	RELAY 3
ON 3	RELAY 4
OFF 4	RELAY 5
OFF 5	RELAY 6
OFF 6	RELAY 7
OFF 7	RELAY 8
OFF 8	RELAY 9

OFF 9	RELAY 10
OFF 10	RELAY 11
OFF 11	RELAY 12
OFF 12	RELAY 13
OFF 13	RELAY 14
OFF 14	RELAY 15
OFF 15	RELAY 16

The first line gives the description and time stamp for the event, while the additional information displayed below may be collapsed using the +/– symbol.

For further information regarding events and their specific meaning, refer to the *Relay Menu Database* document. This standalone document not included in this manual.

2.12 Event Filtering

Event reporting can be disabled from all interfaces that support setting changes. The settings that control the various types of events are in the RECORD CONTROL column. The effect of setting each to disabled is in shown in the following table:

> *Note* *Some occurrences can result in more than one type of event, e.g. a battery failure will produce an alarm event and a maintenance record event.*

If the Protection Event setting is Enabled, a further set of settings is revealed which allow the event generation by individual DDB signals to be enabled or disabled.

For further information on events and their specific meaning, see the *Relay Menu Database* document.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
RECORD CONTROL	0B	00		
This column contains settings for Record Controls				
Clear Events	0B	01	No	0 = No or 1 = Yes
Selecting “Yes” will cause the existing event log to be cleared and an event will be generated indicating that the events have been erased.				
Clear Faults	0B	02	No	0 = No or 1 = Yes
Selecting “Yes” will cause the existing fault records to be erased from the relay.				
Clear Maint	0B	03	No	0 = No or 1 = Yes
Selecting “Yes” will cause the existing maintenance records to be erased from the relay.				
Alarm Event	0B	04	Enabled	0 = Disabled or 1 = Enabled
Disabling this setting means that no event is generated for alarms				
Relay O/P Event	0B	05	Enabled	0 = Disabled or 1 = Enabled
Disabling this setting means that no event will be generated for any change in logic output state.				
Opto Input Event	0B	06	Enabled	0 = Disabled or 1 = Enabled
Disabling this setting means that no event will be generated for any change in logic input state.				
General Event	0B	07	Enabled	0 = Disabled or 1 = Enabled
Disabling this setting means that no General Events are generated				
Fault Rec Event	0B	08	Enabled	0 = Disabled or 1 = Enabled
Disabling this setting means that no event will be generated for any fault that produces a fault record				
Maint Rec Event	0B	09	Enabled	0 = Disabled or 1 = Enabled
Disabling this setting means that no event will be generated for any occurrence that produces a maintenance record.				
Protection Event	0B	0A	Enabled	0 = Disabled or 1 = Enabled
Disabling this setting means that any operation of protection elements will not be logged as an event				
Clear Dist Recs	0B	30	No	0 = No or 1 = Yes
Selecting “Yes” will cause the existing disturbance records to be cleared and an event will be generated indicating that the disturbance records have been erased.				
Security Event	0B	31	Enabled	0 = Disabled or 1 = Enabled
Disabling this setting means that any operation of security elements will not be logged as an event				
DDB 31 - 0	0B	40	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 63 - 32	0B	41	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Choose whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 95 - 64	0B	42	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 127 - 96	0B	43	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 159 - 128	0B	44	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 191 - 160	0B	45	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 223 - 192	0B	46	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 255 - 224	0B	47	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 287 - 256	0B	48	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 319 - 288	0B	49	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 351 - 320	0B	4A	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 383 - 352	0B	4B	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 415 - 384	0B	4C	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 447 - 416	0B	4D	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
DDB 479 - 448	0B	4E	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 511 - 480	0B	4F	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 543 - 512	0B	50	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 575 - 544	0B	51	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 607 - 576	0B	52	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 639 - 608	0B	53	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 671 - 640	0B	54	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 703 - 672	0B	55	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 735 - 704	0B	56	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 767 - 736	0B	57	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 799 - 768	0B	58	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 831 - 800	0B	59	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 863 - 832	0B	5A	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Choose whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 895 - 864	0B	5B	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 927 - 896	0B	5C	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 959 - 928	0B	5D	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 991 - 960	0B	5E	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1022 - 992	0B	5F	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1055 - 1024	0B	60	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1087 - 1056	0B	61	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1119 - 1088	0B	62	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1151 - 1120	0B	63	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1183 - 1152	0B	64	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1215 - 1184	0B	65	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1247 - 1216	0B	66	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
DDB 1279 - 1248	0B	67	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1311 - 1280	0B	68	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1343 - 1312	0B	69	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1375 - 1344	0B	6A	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1407 - 1376	0B	6B	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1439 - 1408	0B	6C	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1471 - 1440	0B	6D	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1503 - 1472	0B	6E	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1535 - 1504	0B	6F	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1567 - 1536	0B	70	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1599 - 1568	0B	71	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1631 - 1600	0B	72	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1663 - 1632	0B	73	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Choose whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1695 - 1664	0B	74	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1727 - 1696	0B	75	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1759 - 1728	0B	76	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1791 - 1760	0B	77	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1823 - 1792	0B	78	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1855 - 1824	0B	79	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1887 - 1856	0B	7A	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1919 - 1888	0B	7B	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1951 - 1920	0B	7C	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 1983 - 1952	0B	7D	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 2015 - 1984	0B	7E	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
DDB 2047 - 2016	0B	7F	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				

Table 3 - Filtering of event logs

3 DISTURBANCE RECORDER

The integral enhanced disturbance recorder has an area of memory specifically set aside for record storage. The number of records that may be stored by the relay is dependent on the selected recording duration and the installed software release.

The relay can typically store a pre-set minimum number of records, each of a pre-set duration. These may vary between different MiCOM products.

Disturbance records continue to be recorded until the available memory is exhausted, at which time the oldest record(s) are overwritten to make space for the newest one.

The recorder stores actual samples that are taken at a rate of pre-defined number of samples per cycle. Again, this may vary between different MiCOM products.

Each disturbance record consists of a number of analog data channels and digital data channels.

The relevant CT and VT ratios for the analog channels are also extracted to enable scaling to primary quantities. If a CT ratio is set less than unity, the relay will choose a scaling factor of zero for the appropriate channel.

The relay can typically store a minimum of 50 records, each of 1.5 seconds duration (8 analogue channels and 32 digital channels).

VDEW relays, however, have the same total record length but the VDEW protocol dictates that only 8 records can be extracted via the rear port.

The recorder stores actual samples that are taken at a rate of 24 samples per cycle.

Each disturbance record consists of a maximum of 8 analog data channels for P241/P242/P243 and 32 digital data channels.

The **DISTURBANCE RECORDER** menu column is shown in the following table:

Courier Text	Col	Row	Default Setting	Available Setting
Description				
DISTURB RECORDER	0C	00		
This column contains settings for the Disturbance Recorder				
Duration	0C	01	1.5s	From 100ms to 10.5s step 10ms
This sets the overall recording time.				
TriggerPosition	0C	02	0.3	From 0% to 100% step 0.1%
This sets the trigger point as a percentage of the duration. For example, the default settings show that the overall recording time is set to 1.5 s with the trigger point being at 33.3% of this, giving 0.5 s pre-fault and 1s post fault recording times.				
TriggerMode	0C	03	Single	0 = Single or 1 = Extended
If set to single mode, if a further trigger occurs whilst a recording is taking place, the recorder will ignore the trigger. However, if this has been set to Extended, the post trigger timer will be reset to zero, thereby extending the recording time.				
AnalogChannel1	0C	04	VA	0 - VA, 1 - VB, 2 - VC, 3 - IA, 4 - IB, 5 - IC, 6 - IN, 7 - IA2, 8 - IB2, 9 - IC2, 10 - VAB, 11 - VBC, 12 - VN, 13 - VRM
Selects any available analogue input to be assigned to this channel.				
AnalogChannel2	0C	05	VB	0 - VA, 1 - VB, 2 - VC, 3 - IA, 4 - IB, 5 - IC, 6 - IN, 7 - IA2, 8 - IB2, 9 - IC2, 10 - VAB, 11 - VBC, 12 - VN, 13 - VRM
Selects any available analogue input to be assigned to this channel.				
AnalogChannel3	0C	06	VC	0 - VA, 1 - VB, 2 - VC, 3 - IA, 4 - IB, 5 - IC, 6 - IN, 7 - IA2, 8 - IB2, 9 - IC2, 10 - VAB, 11 - VBC, 12 - VN, 13 - VRM
Selects any available analogue input to be assigned to this channel.				
AnalogChannel4	0C	07	IA	0 - VA, 1 - VB, 2 - VC, 3 - IA, 4 - IB, 5 - IC, 6 - IN, 7 - IA2, 8 - IB2, 9 - IC2, 10 - VAB, 11 - VBC, 12 - VN, 13 - VRM
Selects any available analogue input to be assigned to this channel.				
AnalogChannel5	0C	08	IB	0 - VA, 1 - VB, 2 - VC, 3 - IA, 4 - IB, 5 - IC, 6 - IN, 7 - IA2, 8 - IB2, 9 - IC2, 10 - VAB, 11 - VBC, 12 - VN, 13 - VRM

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Selects any available analogue input to be assigned to this channel.				
AnalogChannel6	0C	09	IC	0 - VA, 1 - VB, 2 - VC, 3 - IA, 4 - IB, 5 - IC, 6 - IN, 7 - IA2, 8 - IB2, 9 - IC2, 10 - VAB, 11 - VBC, 12 - VN, 13 - VRM
Selects any available analogue input to be assigned to this channel.				
AnalogChannel7	0C	0A	IN	0 - VA, 1 - VB, 2 - VC, 3 - IA, 4 - IB, 5 - IC, 6 - IN, 7 - IA2, 8 - IB2, 9 - IC2, 10 - VAB, 11 - VBC, 12 - VN, 13 - VRM
Selects any available analogue input to be assigned to this channel.				
AnalogChannel8	0C	0B	IN	0 - VA, 1 - VB, 2 - VC, 3 - IA, 4 - IB, 5 - IC, 6 - IN, 7 - IA2, 8 - IB2, 9 - IC2, 10 - VAB, 11 - VBC, 12 - VN, 13 - VRM
Selects any available analogue input to be assigned to this channel.				
DigitalInput1	0C	0C	Relay Label 01	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input1Trigger	0C	0D	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput2	0C	0E	Relay Label 02	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input2Trigger	0C	0F	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput3	0C	10	Relay Label 03	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input3Trigger	0C	11	Trigger L/H	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput4	0C	12	Relay Label 04	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input4Trigger	0C	13	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput5	0C	14	Relay Label 05	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input5Trigger	0C	15	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput6	0C	16	Relay Label 06	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input6Trigger	0C	17	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput7	0C	18	Relay Label 07	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input7Trigger	0C	19	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput8	0C	1A	Unused	See Data Types - G32

Courier Text	Col	Row	Default Setting	Available Setting
Description				
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input8Trigger	0C	1B	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput9	0C	1C	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input9Trigger	0C	1D	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput10	0C	1E	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input10Trigger	0C	1F	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput11	0C	20	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input11Trigger	0C	21	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput12	0C	22	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input12Trigger	0C	23	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput13	0C	24	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input13Trigger	0C	25	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput14	0C	26	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input14Trigger	0C	27	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput15	0C	28	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input15Trigger	0C	29	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput16	0C	2A	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input16Trigger	0C	2B	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput17	0C	2C	Unused	See Data Types - G32

Courier Text	Col	Row	Default Setting	Available Setting
Description				
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input17Trigger	0C	2D	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput18	0C	2E	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input18Trigger	0C	2F	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput19	0C	30	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input19Trigger	0C	31	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput20	0C	32	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input20Trigger	0C	33	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput21	0C	34	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input21Trigger	0C	35	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput22	0C	36	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input22Trigger	0C	37	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput23	0C	38	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input23Trigger	0C	39	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput24	0C	3A	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input24Trigger	0C	3B	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput25	0C	3C	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input25Trigger	0C	3D	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput26	0C	3E	Unused	See Data Types - G32

Courier Text	Col	Row	Default Setting	Available Setting
Description				
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input26Trigger	0C	3F	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput27	0C	40	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input27Trigger	0C	41	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput28	0C	42	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input28Trigger	0C	43	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput29	0C	44	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input29Trigger	0C	45	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput30	0C	46	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input30Trigger	0C	47	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput31	0C	48	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input31Trigger	0C	49	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
DigitalInput32	0C	4A	Unused	See Data Types - G32
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
Input32Trigger	0C	4B	No trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				

Table 4 - Disturbance Record (DR) settings

The pre and post fault recording times are set by a combination of the **Duration** and **Trigger Position** cells. **Duration** sets the overall recording time and the **Trigger Position** sets the trigger point as a percentage of the duration.

- For example, the default settings show that the overall recording time is set to 1.5 s with the trigger point being at 33.3% of this, giving 0.5 s pre-fault and 1 s post-fault recording times.

If a further trigger occurs while a recording is taking place, the recorder ignores the trigger if the **Trigger Mode** is set to **Single**. However, if this is set to **Extended**, the post-trigger timer is reset to zero, extending the recording time.

As can be seen from the menu, each of the analog channels is selectable from the available analog inputs to the relay. The digital channels may be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals, such as protection starts and LEDs. The complete list of these signals may be found by viewing the available settings in the relay menu or using a setting file in MiCOM S1 Studio. Any of the digital channels may be selected to trigger the disturbance recorder on either a low-to-high or a high-to-low transition, using the **Input Trigger** cell. The default trigger settings are that any dedicated trip output contacts, such as relay 3, trigger the recorder.

It is not possible to view the disturbance records locally using the LCD; they must be extracted using suitable software such as MiCOM S1 Studio. This process is fully explained in the *SCADA Communications* chapter.

4 MEASUREMENTS

The relay produces a variety of both directly measured and calculated power system quantities. These measurement values are updated every second and can be viewed in the **Measurements** columns (up to three) of the relay or using the MiCOM S1 Studio Measurement viewer.

The relay can measure and display these quantities:

- Phase Voltages and Currents
- Phase to Phase Voltage and Currents
- Sequence Voltages and Currents
- Power and Energy Quantities
- Rms. Voltages and Currents
- Peak and Fixed Demand Values

There are also measured values from the protection functions, which are also displayed under the measurement columns of the menu; these are described in the section on the relevant protection function.

4.1 Measured Voltages and Currents

The relay produces both phase-to-ground and phase-to-phase voltage and current values. They are produced directly from the Discrete Fourier Transform (DFT) used by the relay protection functions and present both magnitude and phase angle measurement.

4.2 Sequence Voltages and Currents

Sequence quantities are produced by the relay from the measured Fourier values; these are displayed as magnitude and phase angle values.

4.3 Power and Energy Quantities

Using the measured voltages and currents the relay calculates the apparent, real and reactive power quantities. These are produced phase-by-phase. Three-phase values are based on the sum of the three individual phase values. The signing of the real and reactive power measurements can be controlled using the measurement mode setting. The options are as follows.

Measurement mode	Parameter	Signing
0 (Default)	Export Power Import Power Lagging Vars Leading VArs	+ – + –
1	Export Power Import Power Lagging Vars Leading VArs	– + + –
2	Export Power Import Power Lagging Vars Leading VArs	+ – – +
3	Export Power Import Power Lagging Vars Leading VArs	– + – +

In addition to the measured power quantities, the relay calculates the power factor phase-by-phase, in addition to a three-phase power factor.

These power values are also used to increment the total real and reactive energy measurements. Separate energy measurements are maintained for the total exported and imported energy. The energy measurements are incremented up to maximum values of 1000 GWhr or 1000 GVARhr, at which point they reset to zero. It is also possible to reset these values using the menu or remote interfaces using the **Reset Demand** cell.

4.4 RMS. Voltages and Currents

RMS phase voltage and current values are calculated by the relay using the sum of the samples squared over a cycle of sampled data.

4.5 Demand Values

The relay produces fixed, rolling and peak demand values. Using the reset demand menu cell it is possible to reset these quantities from the user interface or the remote communications.

4.5.1 Fixed Demand Values

The fixed demand value is the average value of a quantity over the specified interval; values are produced for each phase current and for three-phase real and reactive power. The fixed demand values displayed by the relay are those for the previous interval. The values are updated at the end of the fixed demand period.

4.5.2 Peak Demand Values

Peak demand values are produced for each phase current and the real and reactive power quantities. These display the maximum value of the measured quantity since the last reset of the demand values.

4.6 Settings

The settings shown under the heading **MEASURE’T SETUP** can be used to configure the relay measurement function. See the following Measurements table for more details:

4.7 Measurement Display Quantities

The relay has Measurement columns for viewing measurement quantities. These can also be viewed with MiCOM S1 Studio and are shown below.

Courier Text	Col	Row	Default Setting	Available Setting
Description				
MEASURE'T SETUP	0D	00		
This column contains settings for the measurement setup				
Default Display	0D	01	Banner	Not Settable
This displays the default display which is possible to change whilst at the default level using the arrow keys. Only visible on UI.				
Local Values	0D	02	Primary	0 = Primary, 1 = Secondary
Local Measurement Values.This setting controls whether measured values via the front panel user interface and the front courier port are displayed as primary or secondary quantities.				
Remote Values	0D	03	Primary	0 = Primary, 1 = Secondary
Remote Measurement Values.This setting controls whether measured values via the rear communication port are displayed as primary or secondary quantities.				
Measurement Ref	0D	04	VA	0 = VA, 1 = VB, 2 = VC, 3 = IA, 4 = IB, 5 = IC
Using this setting the phase reference for all angular measurements by the IED can be selected. This reference is for Measurements 1. Measurements 3 uses always IA local as a reference				
Demand Interval	0D	06	30min	From 1min to 99min step 1min

Courier Text	Col	Row	Default Setting	Available Setting
Description				
This setting defines the length of the fixed demand window				
Alarm Fix Dem.	0D	07	Invisible	0 = Invisible, 1 = Visible
Sets the Fixed demand alarm status to visible or invisible.				
3Ph W Thresh.	0D	08	50*Vn*In W	From 1*Vn*In W to 120*Vn*In W step 1*Vn*In W
Three phase threshold (in Watt)				
3Ph VAr Thresh.	0D	09	50*Vn*In VAr	From 1*Vn*In VAr to 120*Vn*In VAr step 1*Vn*In VAr
Three phase threshold (in Vars)				
Alarm Energies	0D	0A	Invisible	0 = Invisible, 1 = Visible
Sets the Alarm Energies to visible or invisible.				
W Fwd Thresh.	0D	0B	50*Vn*In Wh	From 1*Vn*In Wh to 1000*Vn*In Wh step 1*Vn*In Wh
W forward threshold (in Watt/h)				
W Rev Thresh.	0D	0C	50*Vn*In Wh	From 1*Vn*In Wh to 1000*Vn*In Wh step 1*Vn*In Wh
W Reverse threshold (in Watt/h)				
VAr Fwd Thresh.	0D	0D	50*Vn*In VArh	From 1*Vn*In VArh to 1000*Vn*In Varh step 1*Vn*In Varh
VAr Forward threshold (in Var/h)				
VAr Rev Thresh.	0D	0E	50*Vn*In VArh	From 1*Vn*In VArh to 1000*Vn*In Varh step 1*Vn*In Varh
VAr Reverse threshold (in Var/h)				
Motor Hour Run>1	0D	0F	Disabled	0 = Disabled, 1 = Enabled
Set Motor Hour Run >1 status.				
Motor Hour Run>1	0D	10	500hr	From 1 to 9999 step 1
Set Motor Hour Run>1 threshold (in h).				
Motor Hour Run>2	0D	11	Disabled	0 = Disabled, 1 = Enabled
Set Motor Hour Run >2 status.				
Motor Hour Run>2	0D	12	500hr	From 1 to 9999 step 1
Set Motor Hour Run>2 threshold (in h).				
Remote2 Values	0D	1B	Primary	0 = Primary or 1 = Secondary
The setting defines whether the values measured via the Second Rear Communication port are displayed in primary or secondary terms.				

Table 5 - Available measurement entities and corresponding settings

4.8 Measurements 1

Courier Text	Col	Row	Default Setting	Available Setting
Description				
MEASUREMENTS 1	02	00		
This column contains measurement parameters				
IA Magnitude	02	01		Not Settable
IA Magnitude				
IA Phase Angle	02	02		Not Settable
IA Phase Angle				
IB Magnitude	02	03		Not Settable
IB Magnitude				
IB Phase Angle	02	04		Not Settable
IB Phase Angle				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
IC Magnitude	02	05		Not Settable
IC Magnitude				
IC Phase Angle	02	06		Not Settable
IC Phase Angle				
IN Derived Mag	02	09		Not Settable
IN Derived Mag				
IN Derived Angle	02	0A		Not Settable
IN Derived Angle				
IN Magnitude	02	0B		Not Settable
IN Magnitude				
IN Angle	02	0C		Not Settable
IN Angle				
I1 Magnitude	02	0D		Not Settable
I1 Magnitude				
I2 Magnitude	02	0E		Not Settable
I2 Magnitude				
I0 Magnitude	02	0F		Not Settable
I0 Magnitude				
IA RMS	02	10		Not Settable
IA RMS				
IB RMS	02	11		Not Settable
IB RMS				
IC RMS	02	12		Not Settable
IC RMS				
IN RMS	02	13		Not Settable
IN RMS				
VAB Magnitude	02	14		Not Settable
VAB Magnitude				
VAB Phase Angle	02	15		Not Settable
VAB Phase Angle				
VBC Magnitude	02	16		Not Settable
VBC Magnitude				
VBC Phase Angle	02	17		Not Settable
VBC Phase Angle				
VCA Magnitude	02	18		Not Settable
VCA Magnitude				
VCA Phase Angle	02	19		Not Settable
VCA Phase Angle				
VAN Magnitude	02	1A		Not Settable
VAN Magnitude				
VAN Phase Angle	02	1B		Not Settable
VAN Phase Angle				
VBN Magnitude	02	1C		Not Settable

Courier Text	Col	Row	Default Setting	Available Setting
Description				
VBN Magnitude				
VBN Phase Angle	02	1D		Not Settable
VBN Phase Angle				
VCN Magnitude	02	1E		Not Settable
VCN Magnitude				
VCN Phase Angle	02	1F		Not Settable
VCN Phase Angle				
VN Magnitude	02	20		Not Settable
VN Magnitude				
VN Phase Angle	02	21		Not Settable
VN Angle				
Vr Antibacks Mag	02	22		Not Settable
Vr Antibacks Mag				
V1 Magnitude	02	24		Not Settable
V1 Magnitude				
V2 Magnitude	02	25		Not Settable
V2 Magnitude				
VA RMS Magnitude	02	27		Not Settable
VAN RMS				
VB RMS Magnitude	02	28		Not Settable
VBN RMS				
VC RMS Magnitude	02	29		Not Settable
VCN RMS				
VAB RMS	02	2A		Not Settable
VAB RMS				
VBC RMS	02	2B		Not Settable
VBC RMS				
VCA RMS	02	2C		Not Settable
VCA RMS				
Frequency	02	2D		Not Settable
Frequency				
Ratio I2/I1	02	2E		Not Settable
Ratio I2/I1				
IA-2 Magnitude	02	30		Not Settable
IA2 Magnitude				
IA-2 Phase Angle	02	31		Not Settable
IA2 Phase Angle				
IB-2 Magnitude	02	32		Not Settable
IB2 Magnitude				
IB-2 Phase Angle	02	33		Not Settable
IB2 Phase Angle				
IC-2 Magnitude	02	34		Not Settable
IC2 Magnitude				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
IC-2 Phase Angle	02	35		Not Settable
IC2 Phase Angle				
IA Differential	02	36		Not Settable
IA Differential Magnitude				
IB Differential	02	37		Not Settable
IB Differential Magnitude				
IC Differential	02	38		Not Settable
IC Differential Magnitude				
IA Bias	02	39		Not Settable
IA Bias Magnitude				
IB Bias	02	3A		Not Settable
IB Bias Magnitude				
IC Bias	02	3B		Not Settable
IC Bias Magnitude				

Table 6 - List of Measurement 1 menu

4.9 Measurements 2

Courier Text	Col	Row	Default Setting	Available Setting
Description				
MEASUREMENTS 2	03	00		
This column contains measurement parameters				
3 Phase Watts	03	0A		Not Settable
3 Phase Watts				
3 Phase VArs	03	0B		Not Settable
3 Phase VArs				
3 Phase VA	03	0C		Not Settable
3 Phase VA				
Zero Seq Power	03	0D		Not Settable
Zero Seq Power				
3Ph Power Factor	03	0E		Not Settable
3Ph Power Factor				
3Ph WHours Fwd	03	12		Not Settable
3 Phase Watt - Hours (Forward)				
3Ph WHours Rev	03	13		Not Settable
3 Phase Watts - Hours (Reverse)				
3Ph VArHours Fwd	03	14		Not Settable
3 Phase VAr - Hours (Forward)				
3Ph VArHours Rev	03	15		Not Settable
3 Phase VAr - Hours (Reverse)				
Reset Energies	03	16	No	0 = No or 1 = Yes
Reset Energies				
3Ph W Fix Dem	03	17		Not Settable

Courier Text	Col	Row	Default Setting	Available Setting
Description				
3 Phase Watts - Fixed Demand				
3Ph VArs Fix Dem	03	18		Not Settable
3 Phase VArs - Fixed Demand				
3Ph W Peak Dem	03	20		Not Settable
3 Phase Watts - Peak Demand				
3Ph VArs PeakDem	03	21		Not Settable
3 Phase VArs - Peak Demand				
Reset Demand	03	25	No	0 = No or 1 = Yes
Reset Demand				
3Ph I Maximum	03	26		Not Settable
3 Ph I Maximum				
3Ph V Maximum	03	27		
3 Ph V Maximum				
Reset max. I / V	03	28	No	0 = No or 1 = Yes
Reset Max I/V				

Table 7 - List of Measurement 2 menu

4.10 Measurements 3 (Product Specific Measurements)

Courier Text	Col	Row	Default Setting	Available Setting
Description				
MEASUREMENTS 3	04	00		
This column contains measurement parameters				
Thermal Load	04	01		Not Settable
Load as ratio of full load				
Thermal State	04	02		Not Settable
Thermal state				
Time to Th. Trip	04	03		Not Settable
Time to Th trip				
Reset Th. State	04	04	No	0 = No or 1 = Yes
Send reset thermal state command				
RTD 1	04	05		Not Settable
RTD#1 Temperature				
RTD 2	04	06		Not Settable
RTD#2 Temperature				
RTD 3	04	07		Not Settable
RTD#3 Temperature				
RTD 4	04	08		Not Settable
RTD#4 Temperature				
RTD 5	04	09		Not Settable
RTD#5 Temperature				
RTD 6	04	0A		Not Settable
RTD#6 Temperature				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
RTD 7	04	0B		Not Settable
RTD#7 Temperature				
RTD 8	04	0C		Not Settable
RTD#8 Temperature				
RTD 9	04	0D		Not Settable
RTD#9 Temperature				
RTD 10	04	0E		Not Settable
RTD#10 Temperature				
Nb.Hot St.Allow.	04	0F		Not Settable
Nb hot St Allow				
Nb.Cold St.Allow	04	10		Not Settable
Nb Cold St Allow				
Time to Next St.	04	11		Not Settable
Time to Next St				
Emergency Rest.	04	12	No	0 = No or 1 = Yes
Send Energency Restart Command				
Last Start Time	04	13		Not Settable
Last start time				
Last St. Current	04	14		Not Settable
Last St current				
Nb. of Starts	04	15		Not Settable
Nb of starts				
Reset Nb of St.	04	16	No	0 = No or 1 = Yes
Send Reset Number of Starts Command				
Nb Emergency Rst	04	17		Not Settable
Nb Emergency Rst				
Reset Nb.Em.Rst.	04	18	No	0 = No or 1 = Yes
Send Reset Number of Energency Restarts Command				
Nb.Reaccelerat.	04	19		Not Settable
Nb Reacc				
Reset Nb.Reacc.	04	1A	No	0 = No or 1 = Yes
Send Reset Number of Reacceleration Command				
Motor Run. Time	04	1B		Not Settable
Motor Run Time				
Reset Mot.Run.T.	04	1C	No	0 = No or 1 = Yes
Send Reset Motor Run Time Command				
RTD Open Cct	04	1D		Not Settable
RTD Open Cct				
RTD Short Cct	04	1E		Not Settable
RTD Short Cct				
RTD Data Error	04	1F		Not Settable
RTD data error				
Reset RTD Flags	04	20	No	0 = No or 1 = Yes

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Set Reset RTD flags Command				
Nb Hotest RTD	04	21		Not Settable
Nb Hottest RTD				
Hotest RTD Temp.	04	22		Not Settable
Hottest RTD Temp				
Reset Max RTD T.	04	23		0 = No or 1 = Yes
Send Reset Max RTD Temperature Command				
ANALOG INPUT 1	04	24		Not Settable
Analog Input 1				
ANALOG INPUT 2	04	25		Not Settable
Analog Input 2				
ANALOG INPUT 3	04	26		Not Settable
Analog Input 3				
ANALOG INPUT 4	04	27		Not Settable
Analog Input 4				

Table 8 - List of Measurement 3 menu

4.11 Measurements 4 (Product Specific Measurements)

Courier Text	Col	Row	Default Setting	Available Setting
Description				
MEASUREMENTS 4	05	00		
This column contains measurement parameters				
Nb.Control Trips	05	01		Not Settable
Nb Control trips				
Nb. Thermal Trip	05	02		Not Settable
Nb Thermal Trip				
Nb. Trip I>1	05	03		Not Settable
Nb Trip I > 1				
Nb. Trip I>2	05	04		Not Settable
Nb Trip I > 2				
Nb. Trip ISEF>1	05	05		Not Settable
Nb Trip ISEF > 1				
Nb. Trip ISEF>2	05	06		Not Settable
Nb Trip ISEF > 2				
Nb. Trip IN>1	05	07		Not Settable
Nb Trip IN > 1				
Nb. Trip IN>2	05	08		Not Settable
Nb Trip IN > 2				
Nb. Trip I2>1	05	09		Not Settable
Nb Trip I2 > 1				
Nb. Trip I2>2	05	0A		Not Settable
Nb Trip I2 > 2				

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Nb. Trip P0>	05	0B		Not Settable
Nb Trip P0 >				
Nb. Trip V<1	05	0C		Not Settable
Nb Trip V < 1				
Nb. Trip V<2	05	0D		Not Settable
Nb Trip V < 2				
Nb. Trip F<1	05	0E		Not Settable
Nb Trip F < 1				
Nb. Trip F<2	05	0F		Not Settable
Nb Trip F < 2				
Nb. Trip P<1	05	10		Not Settable
Nb Trip P < 1				
Nb. Trip P<2	05	11		Not Settable
Nb Trip P < 2				
Nb.Trip PF<Lead	05	12		Not Settable
Nb Trip PF < Lead				
Nb.Trip PF< Lag	05	13		Not Settable
Nb Trip PF < Lag				
Nb. Trip Rev. P	05	14		Not Settable
Nb Trip Rev P >				
Nb. Trip V>1	05	15		Not Settable
Nb Trip V > 1				
Nb. Trip V>2	05	16		Not Settable
Nb Trip V > 2				
Nb.Trip NVD VN > 1	05	17		Not Settable
Nb Trip NVD VN > 1				
Nb.Trip NVD VN > 2	05	18		Not Settable
Nb Trip NVD VN > 2				
Nb. Prolong. St.	05	19		Not Settable
Nb Prolong St				
Nb.Lock Rot-sta.	05	1A		Not Settable
Nb Lock Rot-Sta				
Nb.Lock.Rot-run	05	1B		Not Settable
Nb Lock rotor-run				
Nb. Trip RTD 1	05	1C		Not Settable
Nb Trip RTD#1				
Nb. Trip RTD 2	05	1D		Not Settable
Nb Trip RTD#2				
Nb. Trip RTD 3	05	1E		Not Settable
Nb Trip RTD#3				
Nb. Trip RTD 4	05	1F		Not Settable
Nb Trip RTD#4				
Nb. Trip RTD 5	05	20		Not Settable

Courier Text	Col	Row	Default Setting	Available Setting
Description				
Nb Trip RTD#5				
Nb. Trip RTD 6	05	21		Not Settable
Nb Trip RTD#6				
Nb. Trip RTD 7	05	22		Not Settable
Nb Trip RTD#7				
Nb. Trip RTD 8	05	23		Not Settable
Nb Trip RTD#8				
Nb. Trip RTD 9	05	24		Not Settable
Nb Trip RTD#9				
Nb. Trip RTD 10	05	25		Not Settable
Nb Trip RTD#10				
Nb. Diff Trip	05	26		Not Settable
Nb Trip Diff				
Nb.A.Input 1Trip	05	27		Not Settable
Nb A Input1 Trip				
Nb.A.Input 2Trip	05	28		Not Settable
Nb A Input2 Trip				
Nb.A.Input 3Trip	05	29		Not Settable
Nb A Input3 Trip				
Nb.A.Input 4Trip	05	2A		Not Settable
Nb A Input4 Trip				
Nb. FFail1 Trip	05	2B		Not Settable
Nb FFail1 Trip				
Nb. FFail2 Trip	05	2C		Not Settable
Nb FFail2 Trip				
Nb. Trip I>3	05	2D		Not Settable
Nb Trip I > 3				
Nb. Trip I>4	05	2E		Not Settable
Nb Trip I > 4				
Reset Trip Stat.	05	40	No	No or Yes
Reset Trip Stat				

Table 9 - List of Measurement 4 menu

Notes:

PRODUCT DESIGN

CHAPTER 10

Date:	05/2017
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.
Hardware suffix:	L (P241) & M (P242 & P243)
Software version:	D1
Connection diagrams:	10P241xx (xx = 01 to 02) 10P242xx (xx = 01) 10P243xx (xx = 01)

CONTENTS

FIGURES

TABLES

1 RELAY SYSTEM OVERVIEW

1.1 Hardware Overview

The relay is based on a modular hardware design where each module performs a separate function. This section describes the functional operation of the various hardware modules. Some modules are essential while others are optional depending on the user's requirements (see *Product Specific Options* and *Hardware Communications Options*).

All modules are connected by a parallel data and address bus which allows the processor board to send and receive information to and from the other modules as required.

There is also a separate serial data bus for transferring sample data from the input module to the processor. See the *Relay modules* diagram.

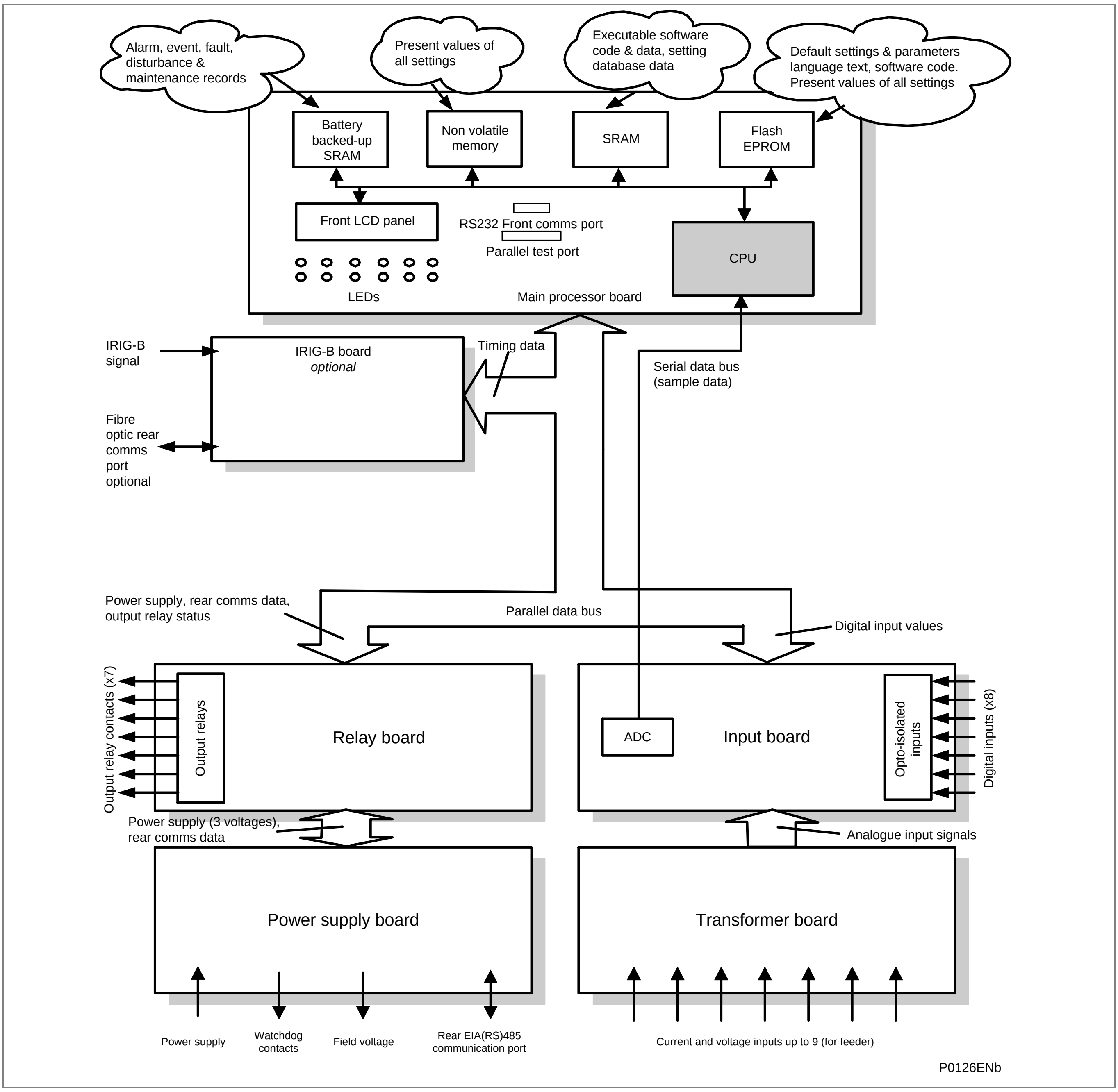


Figure 1 - Relay modules and information flow

1.2 Mechanical Layout

The relay case is pre-finished steel with a conductive covering of aluminum and zinc. This provides good earthing at all joints with a low impedance path to earth that is essential for shielding from external noise. The boards and modules use multi-point grounding (earthing) to improve immunity to external noise and minimize the effect of circuit noise. Ground planes are used on boards to reduce impedance paths and spring clips are used to ground the module metalwork.

Heavy duty terminal blocks are used at the rear of the relay for the current and voltage signal connections. Medium duty terminal blocks are used for the digital logic input signals, output relay contacts, power supply and rear communication port. A BNC connector is used for the optional IRIG-B signal. 9-pin and 25-pin female D-connectors are used at the front of the relay for data communication.

Inside the relay the boards plug into the connector blocks at the rear, and can be removed from the front of the relay only. The connector blocks to the relay’s CT inputs have internal shorting links inside the relay. These automatically short the current transformer circuits before they are broken when the board is removed.

The front panel consists of a membrane keypad with tactile dome keys, an LCD and 12 or 22 LEDs (depending on the model) mounted on an aluminum backing plate.

1.3 Processor Board

The processor board performs all calculations for the relay and controls the operation of all other modules in the relay. The processor board also contains and controls the user interfaces (LCD, LEDs, keypad and communication interfaces).

The relay is based around a TMS320VC33-150MHz (peak speed), floating-point, 32-bit Digital Signal Processor (DSP) operating at a clock frequency of half this speed. This processor performs all of the calculations for the relay, including the protection functions, control of the data communication and user interfaces including the operation of the LCD, keypad and LEDs.

The processor board is directly behind the relay’s front panel. This allows the LCD and LEDs and front panel communication ports to be mounted on the processor board. These ports are:

- The 9-pin D-connector for EIA(RS)232 serial communications used for MiCOM S1 Studio and Courier communications.
- The 25-pin D-connector relay test port for parallel communication.

All serial communication is handled using a Field Programmable Gate Array (FPGA).

The memory provided on the main processor board is split into two categories, volatile and non-volatile; the volatile memory is fast access (zero wait state) SRAM which is used for the storage and execution of the processor software, and data storage as required during the processor’s calculations.

The non-volatile memory is sub-divided into thesegroups:

- 4 MB of flash memory for non-volatile storage of software code and text, together with default settings
- 4 MB of battery backed-up SRAM for the storage of disturbance, event, fault and maintenance record data
- 64 kB of E2PROM memory for the storage of configuration data, including the present setting values.

1.4 Internal Communication Buses

The relay has two internal buses for the communication of data between different modules. The main bus is a parallel link that is part of a 64-way ribbon cable. The ribbon cable carries the data and address bus signals in addition to control signals and all power supply lines. Operation of the bus is driven by the main processor board that operates as a master while all other modules in the relay are slaves.

The second bus is a serial link that is used exclusively for communicating the digital sample values from the input module to the main processor board. The DSP has a built-in serial port that is used to read the sample data from the serial bus. The serial bus is also carried on the 64-way ribbon cable.

1.5 Input Module

The input module provides the interface between the relay processor board(s) and the analog and digital signals coming into the relay.

The P241/P242 input module consists of two PCBs; the main input board and the transformer board.
The P243 input module contains an additional transformer board.

This P241/P242 input module provides three voltage inputs and four current inputs.
The P243 input module provides a total of three voltage inputs and seven current inputs.

1.5.1 Transformer Board

The standard transformer board holds up to four Voltage Transformers (VTs) and up to five Current Transformers (CTs). The auxiliary transformer board adds up to four more CTs.

The current inputs accept either 1 A or 5 A nominal current (selected using relay menu) and the voltage inputs are specified for 110 V nominal voltage. The transformers are used both to step down the currents and voltages to levels appropriate to the relay's electronic circuitry and to provide effective isolation between the relay and the power system. The connection arrangements of both the current and voltage transformer secondaries provide differential input signals to the main input board to reduce noise..

1.5.2 Input Board

The main input board is shown as a block diagram in the *Main input board* diagram. It provides the circuitry for the digital input signals and the Analog-to-Digital (A-D) conversion for the analog signals. It takes the differential analog signals from the CTs and VTs on the transformer board(s), converts these to digital samples and transmits the samples to the main processor board through the serial data bus. On the input board, the analog signals are converted using a dedicated sigma-delta A-D convertor for each channel. This allows all of the channels to be sampled concurrently with no sampling skew between channels. The sampled signals are then digitally filtered prior to the data being sent to the main processor via the serial link. In relay models using the second transformer board, a second input board is also fitted to provide the A-D conversion for the additional channels

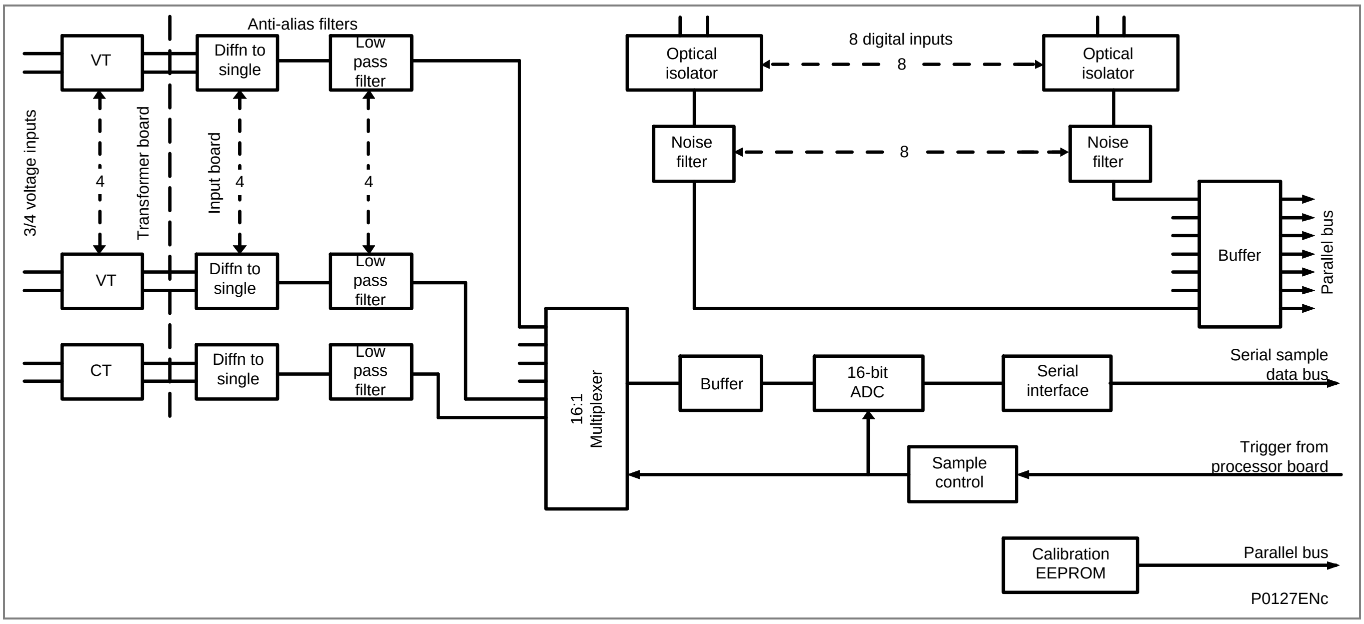


Figure 2 - Main input board

The signal multiplexing arrangement provides for 16 analog channels to be sampled. This allows for up to 9 current inputs and 4 voltage inputs to be accommodated. The 3 spare channels are used to sample 3 different reference voltages for the purpose of continually checking the operation of the multiplexer and the accuracy of the A-D converter.

The sample rate is kept at 24 samples per cycle of the power waveform by a logic control circuit driven by the frequency tracking function on the main processor board. The calibration non-volatile memory holds the calibration coefficients that are used by the processor board to correct for any amplitude or phase error introduced by the transformers and analog circuitry.

The other function of the input board is to read the signals on the digital inputs and send them through the parallel data bus to the processor board. The input board holds eight optical isolators for connecting up to eight digital input signals. Opto-isolators are used with digital signals for the same reason as transformers are used with analog signals: to isolate the relay's electronics from the power system environment. A 48 V 'field voltage' supply at the back of the relay is used to drive the digital opto-inputs. The input board has hardware filters to remove noise from the digital signals. The digital signals are then buffered so they can be read on the parallel data bus. Depending on the relay model, more than eight digital input signals can be accepted by the relay. This is done using an additional opto-board that contains the same provision for eight isolated digital inputs as the main input board, but does not contain any of the circuits for analog signals which are provided on the main input board.

1.5.3 Universal Opto Isolated Logic Inputs

This series of relays have universal opto-isolated logic inputs that can be programmed for the nominal battery voltage of the circuit of which they are a part. This allows different voltages for different circuits such as signaling and tripping. They can also be programmed as Standard 60% - 80% or 50% - 70% to satisfy different operating constraints.
Threshold levels are shown in this table:

Nominal battery voltage (Vdc)	Standard 60% - 80%		50% - 70%	
	No operation (Logic 0) Vdc	Operation (Logic 1) Vdc	No operation (Logic 0) Vdc	Operation (Logic 1) Vdc
24/27	<16.2	>19.2	<12.0	>16.8
30/34	<20.4	>24.0	<15.0	>21.0
48/54	<32.4	>38.4	<24.0	>33.6
110/125	<75.0	>88.0	<55.0	>77.0
220/250	<150.0	>176.0	<110	>154

Table 1 - Threshold levels

This lower value eliminates fleeting pick-ups that may occur during a battery earth fault, when stray capacitance may present up to 50% of battery voltage across an input.

Each input also has selectable filtering. This allows a pre-set ½ cycle filter to be used to prevent induced noise on the wiring. However, although the ½ cycle filter is secure it can be slow, particularly for intertripping. If the ½ cycle filter is switched off to improve speed, double pole switching or screened twisted cable may be needed on the input to reduce ac noise.

1.6 Power Supply Module (including Output Relays)

The power supply module contains two boards, one for the power supply unit and the other for the output relays. It provides power to all of the other modules in the relay, as well as the EIA(RS)485 electrical connection for the rear communication port. The second board of the power supply module contains the relays that provide the output contacts.

1.6.1 Power Supply Board (including EIA(RS)485 Communication Interface)

One of three different configurations of the power supply board can be fitted to the relay. This will be specified at the time of order and depends on the nature of the supply voltage that will be connected to the relay. The options are shown in the following table:

Nominal dc range	Nominal ac range
24 - 32 V dc	dc only
48 - 110 V dc	dc only
110 - 250 V dc	100 - 240 V ac rms

Table 2 - Power supply options

The output from all versions of the power supply module are used to provide isolated power supply rails to all of the other modules in the relay. Three voltage levels are used in the relay: 5.1 V for all of the digital circuits, ±16 V for the analog electronics such as on the input board, and 22 V for driving the output relay coils and the RTD board if fitted. All power supply voltages including the 0 V earth line are distributed around the relay through the 64-way ribbon cable. The power supply board also provides the 48 V field voltage. This is brought out to terminals on the back of the relay so that it can be used to drive the optically-isolated digital inputs.

The two other functions provided by the power supply board are the EIA(RS)485 communications interface and the watchdog contacts for the relay. The EIA(RS)485 interface is used with the relay's rear communication port to provide communication using one of either Courier, MODBUS, IEC60870-5-103, or DNP3.0 protocols. The EIA(RS)485 hardware supports half-duplex communication and provides optical isolation of the serial data that is transmitted and received. All internal communication of data from the power supply board is through the output relay board connected to the parallel bus.

The watchdog facility has two output relay contacts, one Normally Open (N/O)and one Normally Closed (N/C). These are driven by the main processor board and indicate that the relay is in a healthy state.

The power supply board incorporates inrush current limiting. This limits the peak inrush current, during energization, to approximately 10 A.

1.6.2 Output Relay Board

There are two versions of the output relay board:

- one with seven relays, three normally open contacts and four changeover contacts
- one with eight relays, six normally open contacts and two changeover contacts

For relay models with Hardware Suffix A, only the seven output relay boards were available. For equivalent relay models in Hardware Suffix C or greater the base numbers of output contacts, using the seven output relay boards, is being maintained for compatibility. The eight output relay board is only used for new relay models or existing relay models available in new case sizes or to provide additional output contacts to existing models for Hardware Suffix C or greater.

The relays are driven from the 22 V power supply line. The relays' state is written to or read from using the parallel data bus. Depending on the relay model, more than seven output contacts may be provided, through the use of up to three extra relay boards. Each additional relay board provides a further seven or eight output relays.

1.7 Product Specific Options

Product Specific Options may mean that an additional board may be present if it was specified when the relay was ordered. The product specific options commonly allow a choice of RTD, CLIO, different numbers of Optos, Relays (including High Break relays). These options are shown in the *Ordering Options* section in *Chapter 1 – Introduction*.

The options are described in more details in the following sections

- Resistance Temperature Detectors (RTD) Board Option
- Current Loop Input Output (CLIO) Board Option

1.8 Resistance Temperature Detectors (RTD) Board Option

The optional Resistance Temperature Detectors (RTD) board is used to monitor the winding and ambient temperature readings from up to ten PT100 RTD that are each connected using a 3-wire connection. The board is powered from the 22 V power rail that is used to drive the output relays. The RTD board includes two redundant channels that are connected to high stability resistors to provide reference readings. These are used to check the operation of the RTD board. The temperature data is read by the processor through the parallel data bus, and is used to provide thermal protection of the windings.

1.9 Current Loop Input Output (CLIO Board Option)

The Current Loop Input Output (CLIO) board is an order option. The CLIO board is powered from the 22 V power rail that is used to drive the output relays.

Four analog (or current loop) inputs are provided for transducers with ranges of 0 to 1 mA, 0 to 10 mA, 0 to 20 mA or 4 to 20 mA. The input current data is read by the processor through the parallel data bus, and is used to provide measurements from various transducers such as vibration monitors, tachometers and pressure transducers.

For each of the four current loop inputs there are two separate input circuits, 0 to 1 mA and 0 to 20 mA. The latter is also used for 0 to 10 mA and 4 to 20 mA transducer inputs. The anti-alias filters have a nominal cut-off frequency (3 dB point) of 23 Hz to reduce power system interference from the incoming signals. Four analog current outputs are provided with ranges of 0 to 1 mA, 0 to 10 mA, 0 to 20 mA or 4 to 20 mA which can alleviate the need for separate transducers. These may be used to feed standard moving coil ammeters for analog indication of certain measured quantities or into a SCADA using an existing analog RTU.

Each of the four current loop outputs provides one 0 to 1 mA output, one 0 to 20 mA output and one common return. Suitable software scaling of the value written to the board allows the 0 to 20 mA output to also provide 0 to 10 mA and 4 to 20 mA. Screened leads are recommended for use on the current loop output circuits.

The refresh interval for the outputs is nominally 200 ms.
Any measurements that do not fit this timing are updated once every second.

All external connections to the current loop I/O board are made using the same 15-way light duty I/O connector SL3.5/15/90F used on the RTD board. Two such connectors are used, one for the current loop outputs and one for the current loop inputs.

The I/O connectors accommodate wire sizes in the range 1/0.85 mm (0.57 mm^2) to 1/1.38 mm (1.5 mm^2) and their multiple conductor equivalents. The use of screened cable is recommended. The screen terminations should be connected to the case earth of the relay.

Basic Insulation (300 V) is provided between analog inputs or outputs and earth, and between analog inputs and outputs. However, there is no insulation between one input and another or one output and another.

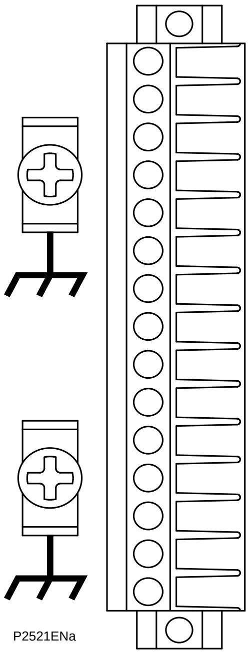
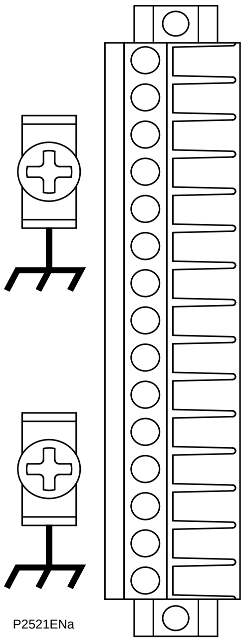
Connection	IO blocks	Connection
Outputs		
Screen channel 1		0 - 10/0 - 20/4 - 20 mA channel 1 0 - 1 mA channel 1 Common return channel 1
Screen channel 2		0 - 10/0 - 20/4 - 20 mA channel 2 0 - 1 mA channel 2 Common return channel 2
Screen channel 3		0 - 10/0 - 20/4 - 20 mA channel 3 0 - 1 mA channel 3 Common return channel 3
Screen channel 4		0 - 10/0 - 20/4 - 20 mA channel 4 0 - 1 mA channel 4 Common return channel 4
Inputs		
Screen channel 1		0 - 10/0 - 20/4 - 20 mA channel 1 0 - 1 mA channel 1 Common channel 1
Screen channel 2		0 - 10/0 - 20/4 - 20 mA channel 2 0 - 1 mA channel 2 Common channel 2
Screen channel 3		0 - 10/0 - 20/4 - 20 mA channel 3 0 - 1 mA channel 3 Common channel 3
Screen channel 4		0 - 10/0 - 20/4 - 20 mA channel 4 0 - 1 mA channel 4 Common channel 4

Figure 3 - Current loop input output board

1.9.1 IRIG-B Modulated or Unmodulated Board

The optional IRIG-B board is an order option that can be fitted to provide an accurate timing reference for the relay. This can be used wherever an IRIG-B signal is available. The IRIG-B signal is connected to the board with a BNC connector on the back of the relay. The timing information is used to synchronize the relay’s internal real-time clock to an accuracy of 1 ms. The internal clock is then used for the time tagging of the event, fault maintenance and disturbance records. The IRIG-B board can also be specified with a fiber optic or Ethernet rear communication port.

1.9.2 Second Rear Communications Board (Optional)

For relays with Courier, MODBUS, IEC60870-5-103 or DNP3.0 protocol on the first rear communications port there is the hardware option of a second rear communications port, which runs the Courier language. This can be used over one of three physical links: twisted pair K-BUS (non-polarity sensitive), twisted pair EIA(RS)485 (connection polarity sensitive) or EIA(RS)232.

This optional second rear port is designed typically for dial-up modem access by protection engineers and operators, when the main port is reserved for SCADA traffic.

The port supports full local or remote protection and control access by MiCOM S1 Studio software. The second rear port is also available with an on board IRIG-B input.

The second rear communications board, Ethernet and IRIG-B boards are mutually exclusive since they use the same hardware slot. For this reason two versions of second rear communications and Ethernet boards are available; one with an IRIG-B input and one without. The second rear communications board is shown in the following diagram.

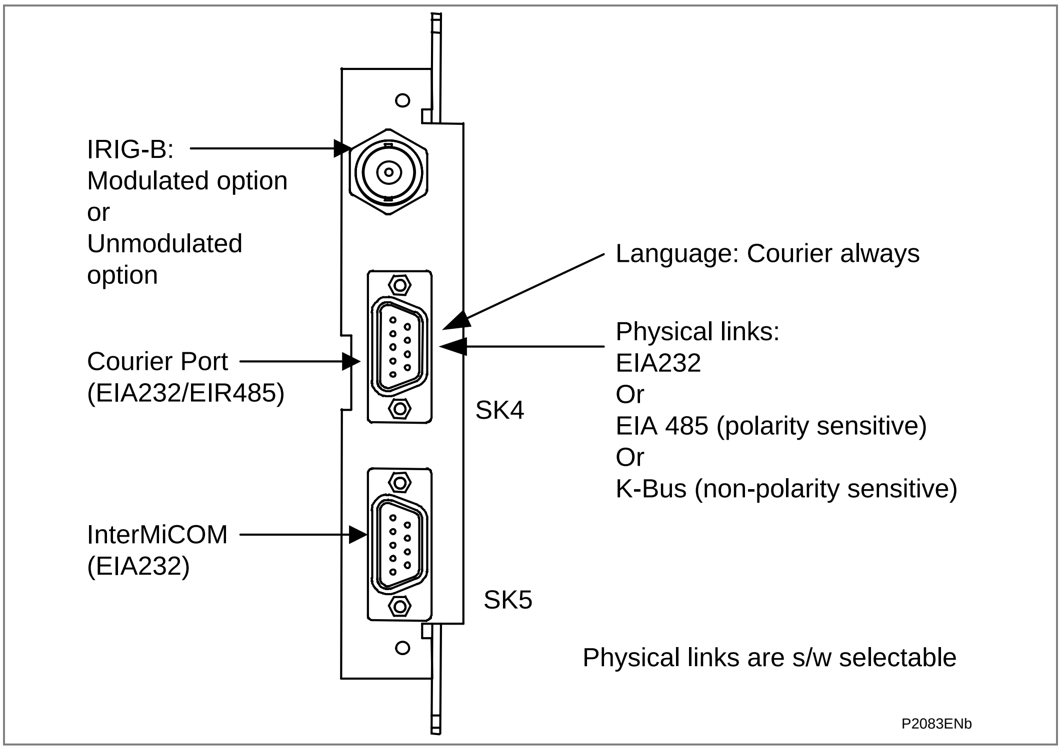


Figure 4 - Rear comms. port

1.10 Ethernet Board (Options)

This is a mandatory board for IEC 61850 enabled relays. It provides network connectivity through either copper or fiber media at rates of 10Mb/s (copper only) or 100Mb/s. There is also an option on this board to specify IRIG-B board port (modulated and/or un-modulated). This board, the IRIG-B board mentioned in the Hardware Communications Options section and second rear comms. board mentioned in the IRIG-B Board section are mutually exclusive as they all use slot A within the relay case.

All modules are connected by a parallel data and address bus that allows the processor board to send and receive information to and from the other modules as required. There is also a separate serial data bus for conveying sample data from the input module to the processor. The relay modules and information flow diagram shows the modules of the relay and the flow of information between them.

This optional board is required for providing network connectivity using IEC 61850. There are a variety of different boards which provide Ethernet connectivity.

Important	**The choice of communication board options varies according to the Hardware Suffix and the Software Version of the MiCOM product. These are shown in the *Ordering Options* section in *Chapter 1 – Introduction*.**

By way of example, the board options may include:

- single-port Ethernet boards (which use 10/100 Mbits/s Copper and modulated/unmodulated IRIG-B connectivity)
- single-port Ethernet boards (which use 100MBits/s optical fibre connectivity)
- Redundant Ethernet Self-Healing Ring with one or more multi-mode fibre optic ports and modulated/unmodulated IRIG-B connectivity
- Redundant Ethernet RSTP with one or more multi-mode fibre optic ports and modulated/unmodulated IRIG-B connectivity
- Redundant Ethernet Dual Homing Star with one or more multi-mode fibre optic ports and modulated/unmodulated IRIG-B connectivity
- Redundant Ethernet Parallel Redundancy Protocol (PRP) with one or more multi-mode fibre optic ports and modulated/unmodulated IRIG-B connectivity
- Redundant Ethernet with PRP/HSR/Dual IP and a mixture of LC/RJ45 ports and modulated/unmodulated IRIG-B connectivity

These options are mutually exclusive as they all use slot A in the relay case.

Note	*Each Ethernet board has a unique MAC address used for each Ethernet communication interface. The MAC address is printed on the rear of the board, next to the Ethernet sockets.*

Note	*The 100 Mbits/s Fiber Optic ports use ST/LC type connectors and are suitable for 1310 nm multi-mode fiber type.*

Copper ports use RJ45 type connectors. When using copper Ethernet, it is important to use Shielded Twisted Pair (STP) or Foil Twisted Pair (FTP) cables, to shield the IEC 61850 communications against electromagnetic interference. The RJ45 connector at each end of the cable must be shielded, and the cable shield must be connected to this RJ45 connector shield, so that the shield is grounded to the relay case. Both the cable and the RJ45 connector at each end of the cable must be Category 5 minimum, as specified by the IEC 61850 standard.

It is recommended that each copper Ethernet cable is limited to a maximum length of 3 m and confined to one bay or cubicle.

When using IEC 61850 communications through the Ethernet board, the rear EIA(RS)485 and front EIA(RS)232 ports are also available for simultaneous use, both using the Courier protocol.

One example of an Ethernet board is shown in this *Ethernet board connectors* diagram:

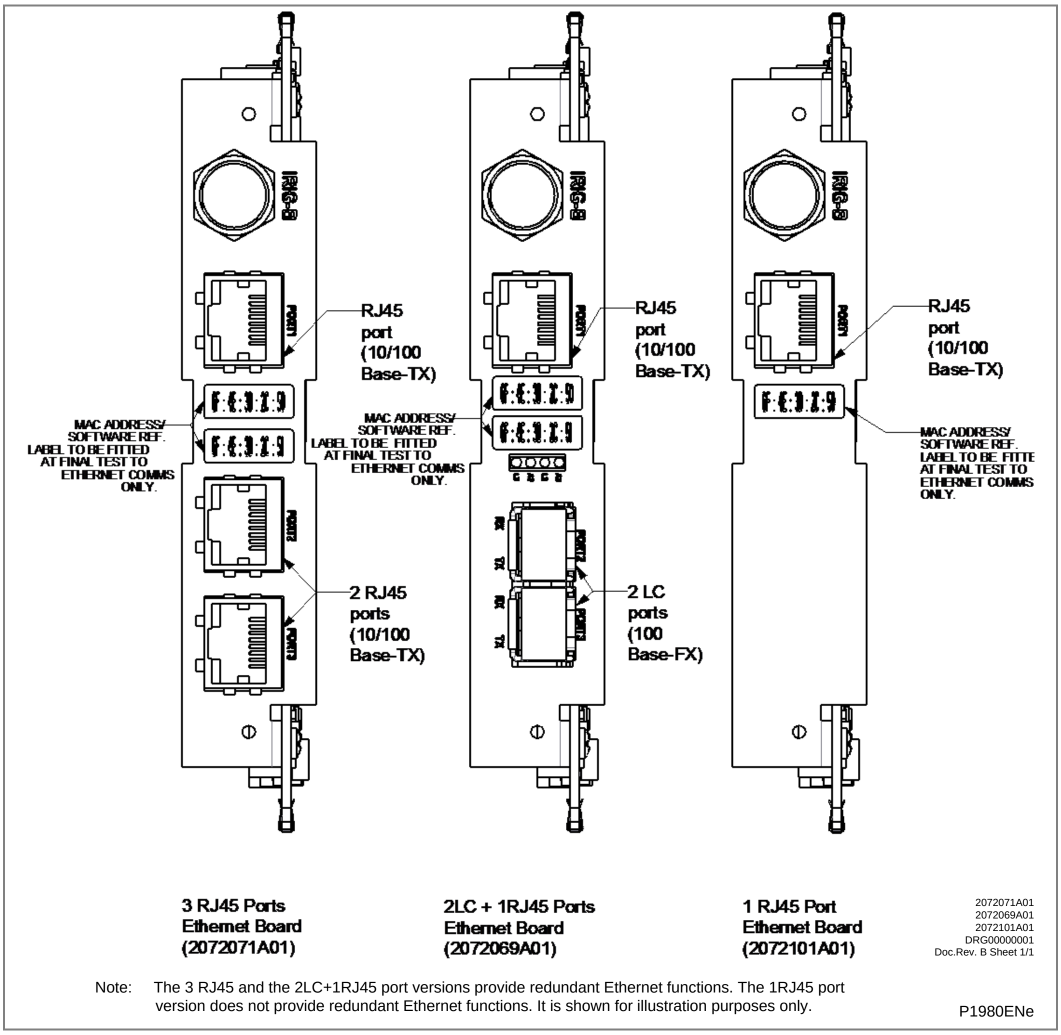


Figure 5 - Ethernet board connectors (3 RJ45 or 2 LC + RJ45 or 1 RJ45)

2 RELAY SOFTWARE

The relay software was introduced in the overview of the relay at the start of this chapter. The software can be considered to be made up of these sections:

- The real-time operating system
- The system services software
- The platform software
- The protection and control software

These four elements are all processed by the same processor board.This section describes in detail the ***platform software*** and the ***protection and control software***, which between them control the functional behavior of the relay. The following *Relay software structure* diagram shows the structure of the relay software.

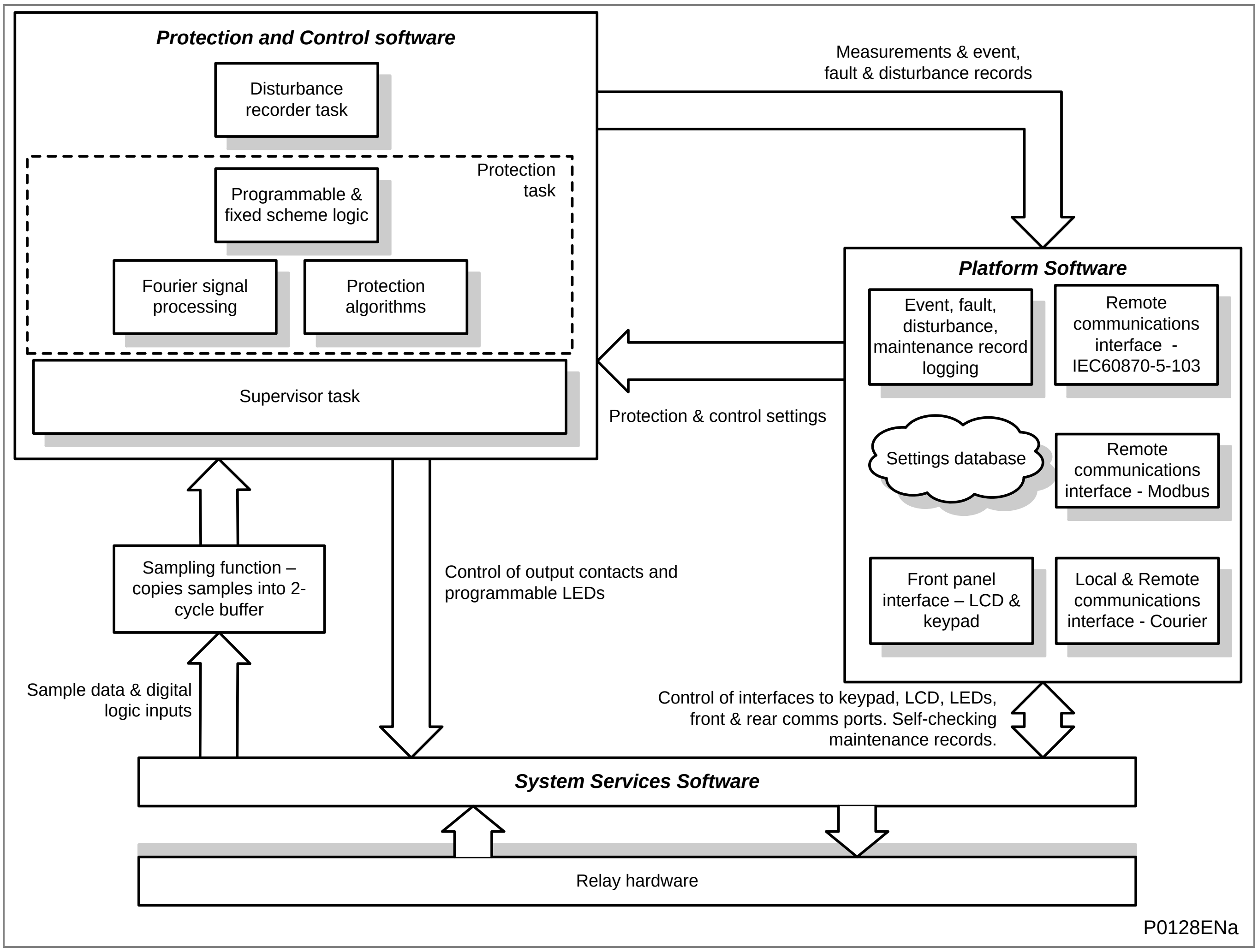


Figure 6 - Relay software structure

2.1 Real-Time Operating System

The real-time operating system provides a framework for the different parts of the relay's software to operate in.

The software is split into tasks; the real-time operating system is used to schedule the processing of the tasks to ensure that they are processed in the time available and in the desired order of priority. The operating system is also responsible in part for controlling the communication between the software tasks through the use of operating system messages.

2.2 System Services Software

As shown in the above *Relay software structure* diagram, the system services software provides the low-level control of the relay hardware. It also provides the interface between the relay's hardware and the higher-level functionality of the platform software and the protection and control software.

For example, the system services software provides drivers for items such as the LCD display, the keypad and the remote communication ports. It also controls the boot of the processor and downloading of the processor code into SRAM from non-volatile flash EPROM at power up.

2.3 Platform Software

The platform software has these main functions:

- To deal with the management of the relay settings.
- To control the logging of all records that are generated by the protection software, including alarms and event, fault, disturbance and maintenance records.
- To store and maintain a database of all of the relay's settings in non-volatile memory.
- To provide the internal interface between the settings database and each of the relay's user interfaces. These interfaces are the front panel interface and the front and rear communication ports, using whichever communication protocol has been specified (Courier, MODBUS, IEC60870-5-103 and DNP3.0). The platform software converts the information from the database into the format required.

The platform software notifies the protection and control software of all settings changes and logs data as specified by the protection and control software.

2.3.1 Record Logging

The logging function is provided to store all alarms, events, faults and maintenance records. The records for all of these incidents are logged in battery backed-up SRAM in order to provide a non-volatile log of what has happened. The relay maintains four logs: one each for up to 32 alarms, 512 event records, 5 fault records and 10 maintenance records. The logs are maintained such that the oldest record is overwritten with the newest record.

The logging function can be initiated from the protection software or the platform software, and is responsible for logging of a maintenance record in the event of a relay failure. This includes errors that have been detected by the platform software itself or error that are detected by either the system services or the protection software functions. See also the section on *Self-Testing and Diagnostics* later in this section.

2.3.2 Settings Database

The settings database contains all of the settings and data for the relay, including the protection, disturbance recorder and control and support settings. The settings are maintained in non-volatile memory. The platform software's management of the settings database make sure that only one user interface modifies the database settings at any one time. This feature is used to avoid confusion between different parts of the software during a setting change. For changes to protection settings and disturbance recorder settings, the platform software operates a 'scratchpad' in SRAM memory. This allows a number of setting changes to be made in any order but applied to the protection elements, disturbance recorder and saved in the database in non-volatile memory, at the same time. If a setting change affects the protection and control task, the database advises it of the new values.

The database is directly compatible with Courier communications.

2.3.3 Database Interface

The other function of the platform software is to implement the relay's internal interface between the database and each of the relay's user interfaces. The database of settings and measurements must be accessible from all of the relay's user interfaces to allow read and modify operations. The platform software presents the data in the appropriate format for each user interface.

2.4 Protection and Control Software

The protection and control software interfaces with the platform software for settings changes and logging of records, and with the system services software for acquisition of sample data and access to output relays and digital opto-isolated inputs. It also performs the calculations for all of the protection algorithms of the relay. This includes digital signal processing such as Fourier filtering and ancillary tasks such as the disturbance recorder.

The protection and control software task processes all of the protection elements and measurement functions of the relay. It has to communicate with both the system services software and the platform software, and organize its own operations. The protection software has the highest priority of any of the software tasks in the relay, to provide the fastest possible protection response. It also has a supervisor task that controls the start-up of the task and deals with the exchange of messages between the task and the platform software.

2.4.1 Overview - Protection and Control Scheduling

The protection and control software interfaces with the platform software for settings changes and logging of records, and with the system services software for acquisition of sample data and access to output relays and digital opto-isolated inputs. It also performs the calculations for all of the protection algorithms of the relay. This includes digital signal processing such as Fourier filtering and ancillary tasks such as the disturbance recorder.

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After initialization at start-up, the protection and control task waits until there are enough samples to process. The sampling function is called by the system services software and takes each set of new samples from the input module and stores them in a two-cycle buffer. The protection & control software resumes execution when the number of unprocessed samples in the buffer reaches a certain number. For the P24x motor protection relays, the protection task is executed four times per cycle, i.e. after every 2 samples for the sample rate of 24 samples per power cycle used by the relay. The protection elements are split into groups so that different elements are processed each time, with every element being processed at least once per cycle. The protection and control software is suspended again when all of its processing on a set of samples is complete. This allows operations by other software tasks to take place.

2.4.2 Signal Processing

The sampling function filters the digital input signals from the opto-isolators and tracks the frequency of the analog signals. The digital inputs are checked against their previous value over a period of half a cycle. Therefore a change in the state of one of the inputs must be maintained over at least half a cycle before it is registered with the protection and control software.

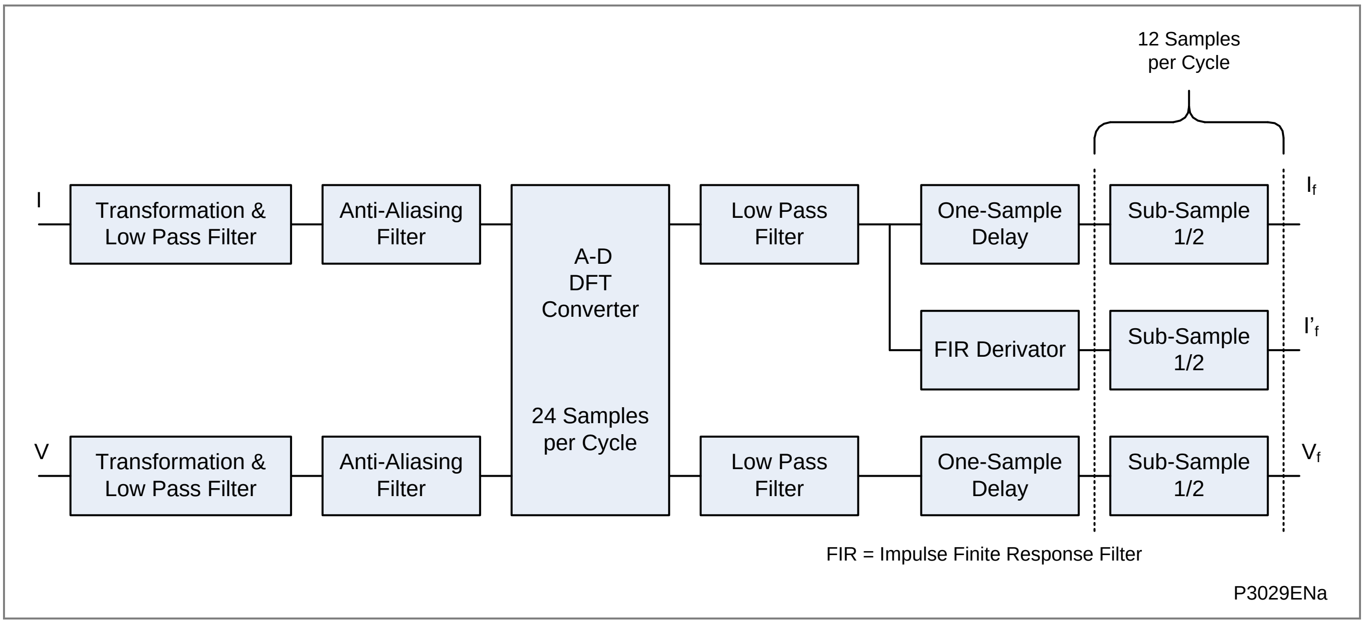


Figure 7 – Signal acquisition and processing

The frequency tracking of the analog input signals is achieved by a recursive Fourier algorithm which is applied to one of the input signals, and works by detecting a change in the measured signal’s phase angle. The calculated value of the frequency is used to modify the sample rate being used by the input module to achieve a constant sample rate of 24 samples per cycle of the power waveform. The value of the frequency is also stored for use by the protection and control task.

When the protection and control task is re-started by the sampling function, it calculates the Fourier components for the analog signals. The Fourier components are calculated using a one-cycle, 24-sample Discrete Fourier Transform (DFT). The DFT is always calculated using the last cycle of samples from the 2-cycle buffer, which is the most recent data. Used in this way, the DFT extracts the power frequency fundamental component from the signal and produces the magnitude and phase angle of the fundamental in rectangular component format. The DFT provides an accurate measurement of the fundamental frequency component, and effective filtering of harmonic frequencies and noise. This performance is achieved with the relay input module which provides hardware anti-alias filtering to attenuate frequencies above the half sample rate, and frequency tracking to maintain a sample rate of 24 samples per cycle. The Fourier components of the input current and voltage signals are stored in memory so they can be accessed by all of the protection elements’ algorithms. The samples from the input module are also used in an unprocessed form by the disturbance recorder for waveform recording and to calculate true RMS values of current, voltage and power for metering purposes.

2.4.3 Frequency Response

With the exception of the RMS measurements, all other measurements and protection functions are based on the Fourier-derived fundamental component. The fundamental component is extracted by using a 24-sample DFT. This gives good harmonic rejection for frequencies up to the 23rd harmonic. The 23rd is the first predominant harmonic that is not attenuated by the Fourier filter and this is known as an ‘Alias’. However, the Alias is attenuated by approximately 85% by an additional, analog, ‘anti-aliasing’ filter (low pass filter). The combined affect of the anti-aliasing and Fourier filters is shown in the following *Frequency response* diagram.

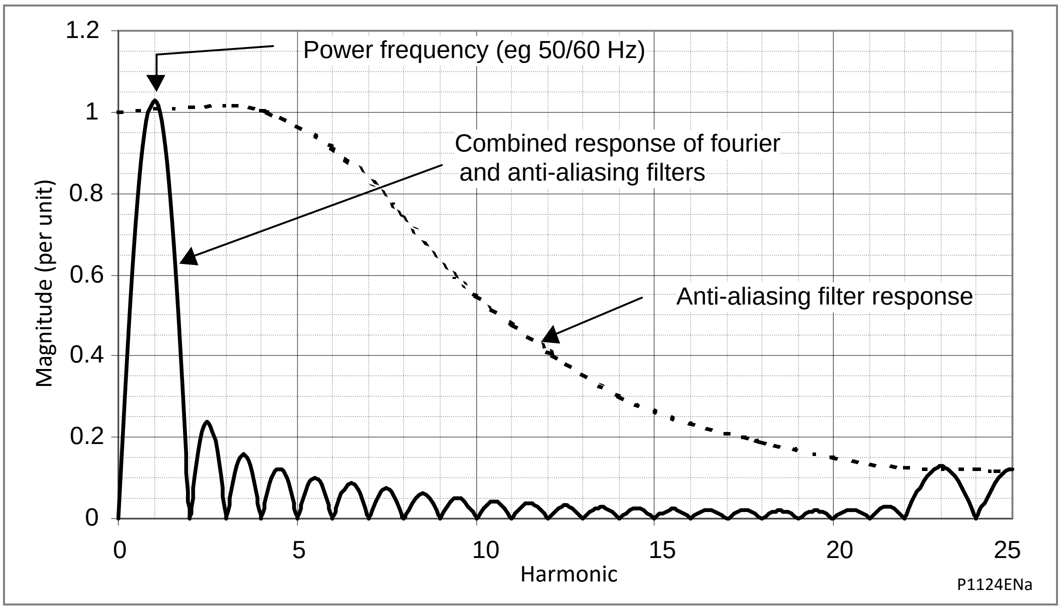


Figure 8 - Frequency response

For power frequencies that are not equal to the selected rated frequency, the harmonics are attenuated to zero amplitude. For small deviations of ±1Hz, this is not a problem but to allow for larger deviations, frequency tracking is used.

Frequency tracking automatically adjusts the sampling rate of the analog to digital conversion to match the applied signal. In the absence of a suitable signal to amplitude track, the sample rate defaults to the selected rated frequency (Fn). If the a signal is in the tracking range of 45 to 66 Hz, the relay locks onto the signal and the measured frequency coincides with the power frequency as shown in the above *Frequency response* diagram. The outputs for harmonics up to the 23rd are zero. The relay frequency tracks off any voltage or current in the order VA/VB/VC/IA/IB/IC down to 10% Vn for voltage and 5%In for current.

2.4.4 Programmable Scheme Logic (PSL)

The Programmable Scheme Logic (PSL) allows the relay user to configure an individual protection scheme to suit their own particular application. This is done with programmable logic gates and delay timers.

The input to the PSL is any combination of the status of the digital input signals from the opto-isolators on the input board, the outputs of the protection elements such as protection starts and trips, and the outputs of the fixed PSL. The fixed PSL provides the relay's standard protection schemes. The PSL consists of software logic gates and timers. The logic gates can be programmed to perform a range of different logic functions and can accept any number of inputs. The timers are used either to create a programmable delay or to condition the logic outputs, such as to create a pulse of fixed duration on the output, regardless of the length of the pulse on the input. The outputs of the PSL are the LEDs on the front panel of the relay and the output contacts at the rear.

The execution of the PSL logic is event driven: the logic is processed whenever any of its inputs change, for example as a result of a change in one of the digital input signals or a trip output from a protection element. Also, only the part of the PSL logic that is affected by the particular input change that has occurred is processed. This reduces the amount of processing time that is used by the PSL. The protection and control software updates the logic delay timers and checks for a change in the PSL input signals every time it runs.

This system provides flexibility for the user to create their own scheme logic design. However, it also means that the PSL can be configured into a very complex system, and because of this setting of the PSL is implemented through the PC support package Easergy Studio/MiCOM S1 Studio.

2.4.5 Function Key Interface (P242/P243 only)

The ten function keys interface directly into the PSL as digital input signals and are processed based on the PSLs event-driven execution. However, a change of state is only recognized when a key press is executed, on average for longer than 200 ms. The time to register a change of state depends on whether the function key press is executed at the start or the end of a protection task cycle, with the additional hardware and software scan time included. A function key press can provide a latched (toggled mode) or output on key press only (normal mode) depending on how it is programmed and can be configured to individual protection scheme requirements. The latched state signal for each function key is written to non-volatile memory and read from non-volatile memory during relay power up, allowing the function key state to be reinstated after power-up if the relay power is lost.

2.4.6 Event, Fault & Maintenance Recording

A change in any digital input signal or protection element output signal is used to indicate that an event has taken place. When this happens, the protection and control task sends a message to the supervisor task to show that an event is available to be processed. The protection and control task writes the event data to a fast buffer in SRAM that is controlled by the supervisor task. When the supervisor task receives either an event or fault record message, it instructs the platform software to create the appropriate log in battery backed-up SRAM. The supervisor’s buffer is faster than battery backed-up SRAM, therefore the protection software is not delayed waiting for the records to be logged by the platform software. However, if a large number of records to be logged are created in a short time, some may be lost if the supervisor’s buffer is full before the platform software is able to create a new log in battery backed-up SRAM. If this occurs, an event is logged to indicate this loss of information.

Maintenance records are created in a similar manner with the supervisor task instructing the platform software to log a record when it receives a maintenance record message. However, it is possible that a maintenance record may be triggered by a fatal error in the relay, in which case it may not be possible to successfully store a maintenance record, depending on the nature of the problem. See the *Self-Testing and Diagnostics* section.

Fault records are stored in the sequence of events. They can be viewed locally or remotely and include:

- Faulty phase(s)
- Protection Tripped
- Protection Started
- Fault type (internal or external fault)
- Primary or Secondary values of phase and neutral currents and voltages
- Primary or Secondary RMS values of differential and biased current of each phase

2.5 Disturbance Recorder

The analog values and logic signals are routed from the protection and control software to the disturbance recorder software. The platform software interfaces with the disturbance recorder to allow the stored records to be extracted.

The enhanced disturbance recorder operates as a separate task from the protection and control task. It can record the waveforms for up to 8 calibrated analog channels and the values of up to 32 digital signals. The recording time is user selectable up to a maximum of 10 seconds.

The enhanced disturbance recorder is supplied with data by the protection and control task once per cycle. The enhanced disturbance recorder collates the data that it receives into the required length disturbance record. The enhanced disturbance records can be extracted by Easergy Studio/MiCOM S1 Studio that can also store the data in COMTRADE format, thus allowing the use of other packages to view the recorded data.

3 FAULT LOCATOR

The relay has an integral fault locator (which is separate from the protection and control task). The fault locator samples data from analog current and voltage inputs and writes it to a cyclic 12-cycle buffer until a fault condition is detected. . It then uses this data to provide a distance to fault location feature.

The data in the input buffer is then held to allow the fault calculation to be made and to calculate a distance to fault location. The calculated location of the fault is sent to the protection and control task which includes it in the fault record for the fault. When the fault record is complete (i.e. includes the fault location), the protection and control task can send a message to the supervisor task to log the fault record.

4 SELF TESTING AND DIAGNOSTICS

The relay includes several self-monitoring functions to check the operation of its hardware and software when it is in service. These are included so that if an error or fault occurs in the relay's hardware or software, the relay is able to detect and report the problem and attempt to resolve it by performing a reboot. The relay must therefore be out of service for a short time, during which the **Healthy** LED on the front of the relay is OFF and, the watchdog contact at the rear is ON. If the reboot fails to resolve the problem, the relay takes itself permanently out of service; the **Healthy** LED stays OFF and watchdog contact stays ON.

If a problem is detected by the self-monitoring functions, the relay stores a maintenance record in battery backed-up SRAM.

The self-monitoring is implemented in two stages:

- firstly a thorough diagnostic check that is performed when the relay is booted-up
- secondly a continuous self-checking operation that checks the operation of the relay's critical functions while it is in service.

4.1 Start-Up Self-Testing

The self-testing that is carried out when the relay is started takes a few seconds to complete, during which time the relay's protection is unavailable. This is shown by the **Healthy** LED on the front of the relay which is ON when the relay has passed all tests and entered operation. If the tests detect a problem, the relay remains out of service until it is manually restored to working order.

The operations that are performed at start-up are:

- System BootInitialization Software
- Initialization Software
- Initialization Software

4.1.1 System Boot

The integrity of the flash memory is verified using a checksum before the program code and data are copied into SRAM and executed by the processor. When the copy is complete the data then held in SRAM is checked against that in flash memory to ensure they are the same and that no errors have occurred in the transfer of data from flash memory to SRAM. The entry point of the software code in SRAM is then called which is the relay initialization code.

4.1.2 Initialization Software

The initialization process includes the operations of initializing the processor registers and interrupts, starting the watchdog timers (used by the hardware to determine whether the software is still running), starting the real-time operating system and creating and starting the supervisor task.

In the initialization process the relay checks the following.

- The status of the battery
- The integrity of the battery backed-up SRAM that stores event, fault and disturbance records
- The voltage level of the field voltage supply that drives the opto-isolated inputs
- The operation of the LCD controller
- The watchdog operation

When the initialization software routine is complete, the supervisor task starts the platform software.

4.1.3 Platform Software Initialization and Monitoring

In starting the platform software, the relay checks the integrity of the data held in non-volatile memory with a checksum, the operation of the real-time clock, and the IRIG-B board if fitted. The final test that is made concerns the input and output of data; the presence and healthy condition of the input board is checked and the analog data acquisition system is checked through sampling the reference voltage.

At the successful conclusion of all of these tests the relay is entered into service and the protection started-up.

4.2 Continuous Self-Testing

When the relay is in service, it continually checks the operation of the critical parts of its hardware and software. The checking is carried out by the system services software (see section on relay software earlier in this section) and the results reported to the platform software.

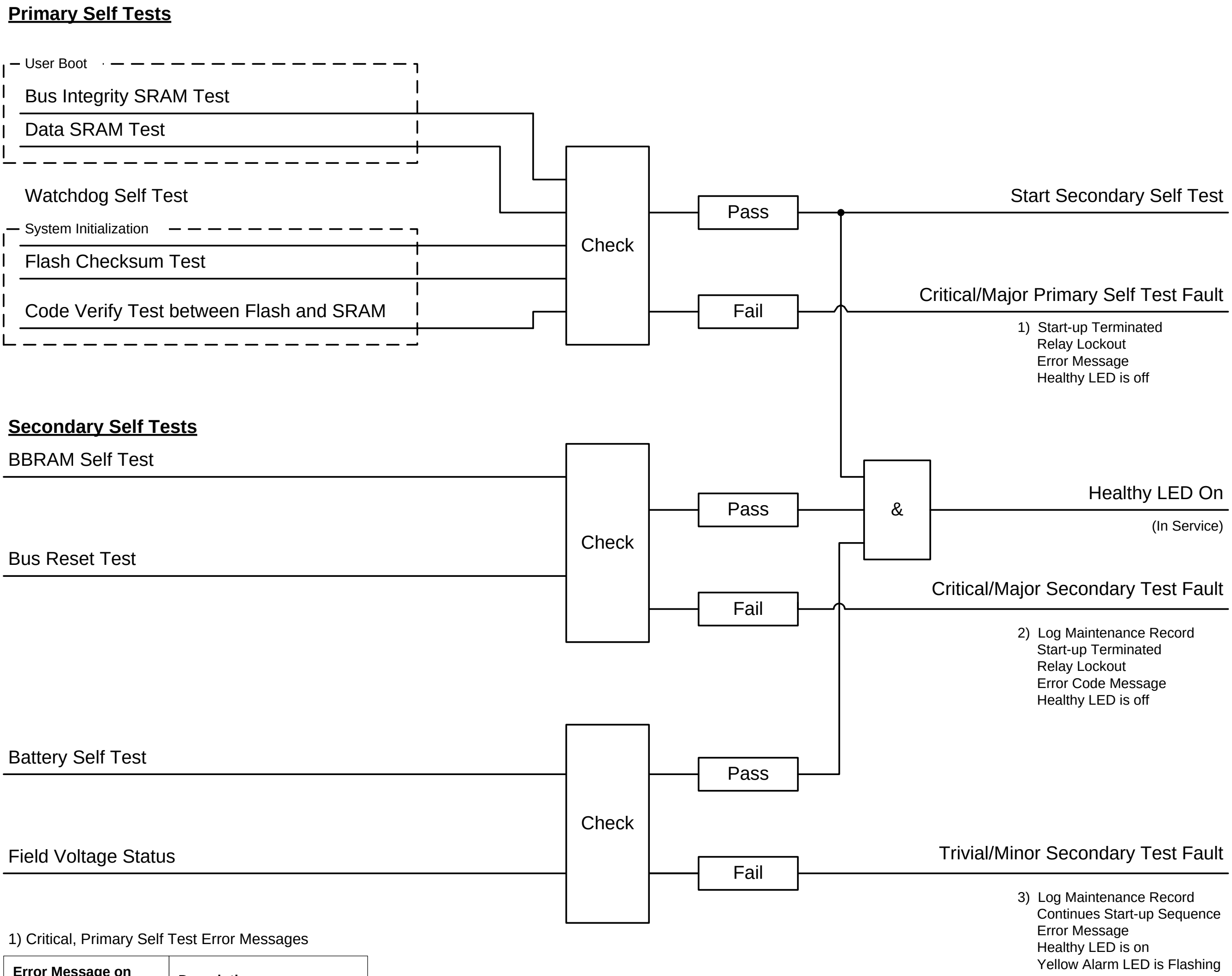
The functions that are checked are as follows:

- The flash EPROM containing all program code and language text is verified by a checksum
- The code and constant data held in SRAM is checked against the corresponding data in flash EPROM to check for data corruption
- The SRAM containing all data other than the code and constant data is verified with a checksum
- The non-volatile memory containing setting values is verified by a checksum, whenever its data is accessed
- The battery status
- The level of the field voltage
- The integrity of the digital signal I/O data from the opto-isolated inputs and the relay contacts, is checked by the data acquisition function every time it is executed. The operation of the analog data acquisition system is checked by the acquisition function every time it is executed. This is done by sampling the reference voltage on a spare multiplexed channel
- The operation of the IRIG-B board is checked, where it is fitted, by the software that reads the time and date from the board

If the Ethernet board is fitted, it is checked by the software on the main processor board. If the Ethernet board fails to respond, an alarm is raised and the board is reset in an attempt to resolve the problem

Also, the correct operation of the CLIO board is checked, where it is fitted.

In the unlikely event that one of the checks detects an error in the relay’s subsystems, the platform software is notified and it will attempt to log a maintenance record in battery backed-up SRAM. If the problem is with the battery status or the IRIG-B board, the relay continues in operation. However, for problems detected in any other area the relay shuts down and reboots. This result in a period of up to 5 seconds when protection is unavailable, but the complete restart of the relay including all initializations should clear most problems that could occur. An integral part of the start-up procedure is a thorough diagnostic self-check. If this detects the same problem that caused the relay to restart, the restart has not cleared the problem and the relay takes itself permanently out of service. This is indicated by the **Healthy** LED on the front of the relay which goes OFF, and the watchdog contact that goes ON.



1) Critical, Primary Self Test Error Messages

Error Message on User Interface	Description
Bus Fail	Integrity Bus Test Error
SRAM Fail	SRAM Test Error
Flash Fail (Checksum)	Flash Test Error detected in the flash structure
Code Verify Fail	Error in code comparison test flash
Watchdog fail	Watchdog circuit fails to operate

2) Critical, Secondary Self Test Error Messages

Error Code	Description
0x0C170017	The secondary self tests detected an error in the Battery Backed SRAM (BBRAM)
0x0C170018	The secondary self tests detected an error in the Bus Curcuit

3) Trivial, Secondary Power on Self Tests Alarm Indications

Alarm	Description
Battery Failure	The secondary self tests detected battery self test has failed
Field Volt Fail	The secondary self tests detected Field Voltage failure

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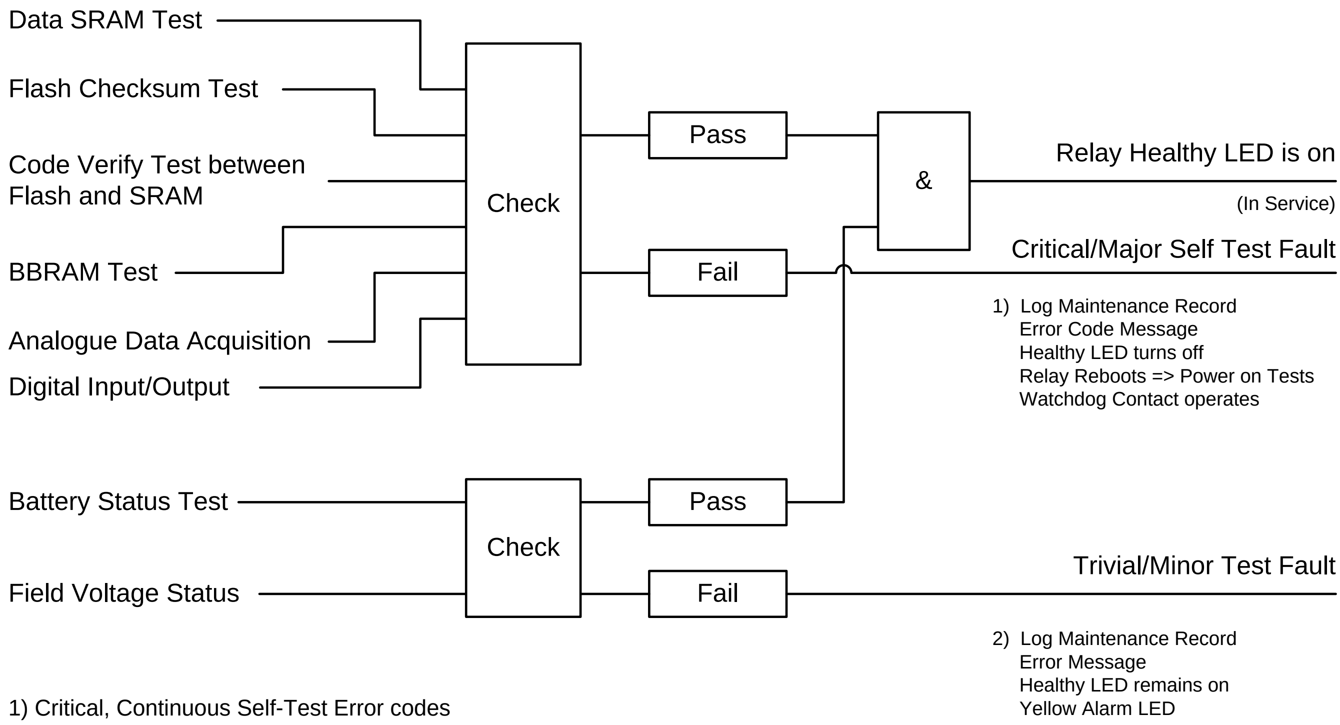
Figure 9 - Start-up self-testing logic



1) Critical, Continuous Self-Test Error codes

Error Code	Description
0x0C160011	The continuous self tests detected an error in SRAM
0x0C160012	The continuous self tests detected an error in the Flash memory checksum
0x0C160013	The continuous self tests detected an error in the code comparison
0x0C160014	The continuous self tests detected an error in the Battery Backed RAM
0x0C1600A0	The continuous self tests detected an error in the acquisition card
0x0C1600Bn	The continuous self tests detected an error in relay card n (number from 0)
0x0C1600Cn	The continuous self tests detected an error in opto card n (number from 0)

2) Trivial, Continuous Self-Test alarm indications

Error Code	Description
Battery Failure	The secondary self tests detected battery self test has failed
Field Volt Fail	The secondary self tests detected Field Voltage failure

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Figure 10 - Continuous self-testing logic

COMMISSIONING

CHAPTER 11

Date:	05/2017
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.
Hardware suffix:	L (P241) & M (P242 & P243)
Software version:	D1
Connection diagrams:	10P241xx (xx = 01 to 02) 10P242xx (xx = 01) 10P243xx (xx = 01)

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TABLES

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FIGURES

Notes:

1 INTRODUCTION

About MiCOM Range

MiCOM is a comprehensive solution capable of meeting all electricity supply requirements. It comprises a range of components, systems and services from Schneider Electric.

Central to the MiCOM concept is flexibility. MiCOM provides the ability to define an application solution and, through extensive communication capabilities, integrate it with your power supply control system.

The components within MiCOM are:

- P range protection relays
- C range control products
- M range measurement products for accurate metering and monitoring
- S range versatile PC support and substation control packages

MiCOM products include extensive facilities for recording information on the state and behaviour of the power system using disturbance and fault records. They can also provide measurements of the system at regular intervals to a control centre enabling remote monitoring and control to take place.

For up-to-date information, please see:

www.schneider-electric.com

Note	*During 2011, the International Electrotechnical Commission classified the voltages into different levels (IEC 60038). The IEC defined LV, MV, HV and EHV as follows: LV is up to 1000V. MV is from 1000V up to 35 kV. HV is from 110 kV or 230 kV. EHV is above 230 KV.* *There is still ambiguity about where each band starts and ends. A voltage level defined as LV in one country or sector, may be described as MV in a different country or sector. Accordingly, LV, MV, HV and EHV suggests a possible range, rather than a fixed band. Please refer to your local Schneider Electric office for more guidance.*

The MiCOM P40 range of products includes various devices which have different functions. This chapter includes information related to the Commissioning of one or more of these devices. Many, although not all, of the commissioning tasks are common to these products.

This chapter applies to the MiCOM P40 products shown on the second page of this chapter. Where a particular section or paragraph relates only to one of more of the products, this is stated in the heading or at the beginning of the paragraph or section. If this states “Applicability: All”, this means the following information relates to all the products in shown on the second page of this chapter. Otherwise the Applicability statement will list the MiCOM P40 products which the information covers.

When using this chapter, you (i.e. in your role as the Commissioning Engineer), need to be aware of:

- The MiCOM product number you are commissioning
- The features associated with that MiCOM product number
- The subset of features which have been enabled for the specific piece of equipment you are commissioning
- Any work instructions which determine how the equipment should be installed and which of its functions have been enabled and how they should relate to other equipment
- You will then be able to select which of the following sections/subsections you need to follow. Some of these sections will not be relevant for the particular commissioning tasks you are performing. By way of example, if the MiCOM device you are commissioning has an Auto-Reclose function you need to refer to the sections which cover Auto-Reclose, otherwise you can ignore them.
- You should start using this chapter at the beginning and work your way through to the end. At key points in the chapter, you will have to know what technical functions have been enabled, as you will be asked to omit certains sections of this chapter if they are not relevant for your current commissioning task.

MiCOM P40 relays are fully numerical in their design, implementing all protection and non-protection functions in software. The relays use a high degree of self-checking and give an alarm in the unlikely event of a failure. Therefore, the commissioning tests do not need to be as extensive as with non-numeric electronic or electro-mechanical relays.

To commission numeric relays, it is only necessary to verify that the hardware is functioning correctly and the application-specific software settings have been applied to the relay. It is considered unnecessary to test every function of the relay if the settings have been verified by one of the following methods:

- Extracting the settings applied to the relay using appropriate setting software (preferred method)
- Using the operator interface

To confirm that the product is operating correctly once the application-specific settings have been applied, perform a test on a single protection element.

Unless previously agreed to the contrary, the customer is responsible for determining the application-specific settings to be applied to the relay and for testing any scheme logic applied by external wiring or configuration of the relay’s internal programmable scheme logic.

Blank commissioning test and setting records are provided within this manual for completion as required.

As the relay’s menu language is user-selectable, the Commissioning Engineer can change it to allow accurate testing as long as the menu is restored to the customer’s preferred language on completion.

To simplify the specifying of menu cell locations in these Commissioning Instructions, they are given in the form [courier reference: COLUMN HEADING, Cell Text]. For example, the cell for selecting the menu language (first cell under the column heading) is in the System Data column (column 00) so it is given as [0001: SYSTEM DATA, Language].

Warning	**Before carrying out any work on the equipment, you should be familiar with the contents of the Safety Information chapter/Safety Guide SFTY/5L M/L11 or later issue, the Technical Data chapter and the ratings on the equipment rating label.**

Caution	**The relay must not be disassembled in any way during commissioning.**

2 RELAY COMMISSIONING TOOLS

To help minimize the time needed to test MiCOM relays the relay provides several test facilities under the '**COMMISSION TESTS**' menu heading. There are menu cells which allow the status of the opto-isolated inputs, output relay contacts, internal Digital Data Bus (DDB) signals and user-programmable LEDs to be monitored. Additionally there are cells to test the operation of the output contacts, user-programmable LEDs and, where available, the auto-reclose cycles.

The following table shows the relay menu of commissioning tests, including the available setting ranges and factory defaults. Each of the main menu tests are described in more detail in the following sections.

COMMISSION TESTS for P24x		
Menu Text	**Default Setting**	**Settings**
Opto I/P Status	-	-
Relay O/P Status	-	-
Test Port Status	-	-
LED Status	-	-
Monitor Bit 1	96 (LED1) P241 640 (LED1(red)) P242/P243	0 to 2047
Monitor Bit 2	97 (LED2) P241 642 (LED2(red)) P242/P243	0 to 2047
Monitor Bit 3	98 (LED3) P241 644 (LED3(red)) P242/P243	0 to 2047
Monitor Bit 4	99 (LED4) P241 646 (LED4(red)) P242/P243	0 to 2047
Monitor Bit 5	100 (LED5) P241 648 (LED5(red)) P242/P243	-
Monitor Bit 6	101 (LED6) P241 650 (LED6(red)) P242/P243	-
Monitor Bit 7	102 (LED7) P241 652 (LED7(red)) P242/P243	-
Monitor Bit 8	103 (LED8) P241 654 (LED8(red) P242/P243	-
Test Mode	Disabled	Disabled, Test Mode, Contacts Blocked
Test Pattern	All bits set to 0	0 = Not Operated, 1 = Operated
Contact Test	No Operation	No Operation, Apply Test, Remove Test
Test LEDs	No Operation	No Operation, Apply Test
Test Auto-reclose	No Operation	No Operation, 3 Pole Test
Red LED Status	-	-
Green LED Status	-	-
Note *See Relay Menu Database for details of DDB signals*		

Table 1 - Commission Tests

2.1 Opto I/P Status

This menu cell displays the status of the relay's opto-isolated inputs as a binary string, a '**1**' indicating an energized opto-isolated input and a '**0**' a de-energized one. If the cursor is moved along the binary numbers the corresponding label text will be displayed for each logic input.

It can be used during commissioning or routine testing to monitor the status of the opto-isolated inputs whilst they are sequentially energized with a suitable dc voltage.

2.2 Relay O/P Status

This menu cell displays the status of the Digital Data Bus (DDB) signals that result in energization of the output relays as a binary string, a '**1**' indicating an operated state and '**0**' a non-operated state. If the cursor is moved along the binary numbers the corresponding label text will be displayed for each relay output.

The information displayed can be used during commissioning or routine testing to indicate the status of the output relays when the relay is '**in service**'. Additionally fault finding for output relay damage can be performed by comparing the status of the output contact under investigation with it's associated bit.

Note	*When the '**Test Mode**' cell is set to '**Enabled**' this cell will continue to indicate which contacts would operate if the relay was in-service, it does not show the actual status of the output relays.*

2.3 Test Port Status

This menu cell displays the status of the eight Digital Data Bus (DDB) signals that have been allocated in the '**Monitor Bit**' cells. If the cursor is moved along the binary numbers the corresponding DDB signal text string will be displayed for each monitor bit.

By using this cell with suitable monitor bit settings, the state of the DDB signals can be displayed as various operating conditions or sequences are applied to the relay. Thus the Programmable Scheme Logic (PSL) can be tested.

As an alternative to using this cell, the optional monitor/download port test box can be plugged into the monitor/download port located behind the bottom access cover. Details of the monitor/download port test box can be found in the *Using a Monitor/Download Port Test Box* section of this chapter.

2.4 LED Status

The '**LED Status**' is an eight bit binary strings that indicate which of the user-programmable LEDs on the relay are illuminated when accessing the relay from a remote location, a '**1**' indicating a particular LED is lit and a '**0**' not lit.

2.5 Monitor Bits 1 to 8

The eight '**Monitor Bit**' cells allow the user to select the status of which digital data bus signals can be observed in the '**Test Port Status**' cell or via the monitor/download port.

Each '**Monitor Bit**' is set by entering the required Digital Data Bus (DDB) signal number from the list of available DDB signals in the Programmable Logic chapter. The pins of the monitor/download port used for monitor bits are given in the following table. The signal ground is available on pins 18, 19, 22 and 25.

Monitor bit	1	2	3	4	5	6	7	8
Monitor/download port pin	11	12	15	13	20	21	23	24

The required DDB signal numbers are 0 – 2047.

Table 2 - Monitor bit pins

Warning	**The monitor/download port is not electrically isolated against induced voltages on the communications channel. It should therefore only be used for local communications.**

2.6 Test Mode

The Test Mode menu cell (in the Commissioning column) is used to allow secondary injection testing to be performed on the relay without operation of the trip contacts. It also enables a facility to directly test the output contacts by applying menu controlled test signals.

To select test mode set the Test Mode menu cell to '**Test Mode**' - this takes the relay out of service and blocks operation of output contacts and maintenance counters. It also causes an alarm condition to be recorded, the yellow '**Out of Service**' LED to light and an alarm message '**Prot'n. Disabled**' to be generated.

Test Mode also freezes any information stored in the CB CONDITION column and (in IEC60870-5-103 builds) changes the Cause Of Transmission (COT) to Test Mode. To enable testing of output contacts set the Test Mode cell to Contacts Blocked. This blocks the protection from operating the contacts and enables the test pattern and contact test functions which can be used to manually operate the output contacts.

Once testing is complete the cell must be set back to '**Disabled**' to restore the relay back to service.

WARNING	**When the 'Test Mode' cell is set to 'Blocked' the relay scheme logic does not drive the output relays and hence the protection will not trip the associated circuit breaker if a fault occurs.**

2.7 Test Pattern

The '**Test Pattern**' cell is used to select the output relay contacts that will be tested when the '**Contact Test**' cell is set to '**Apply Test**'. The cell has a binary string with one bit for each user-configurable output contact which can be set to '**1**' to operate the output under test conditions and '**0**' to not operate it.

2.8 Contact Test

When the ‘**Apply Test**’ command in this cell is issued the contacts set for operation (set to ‘**1**’) in the ‘**Test Pattern**’ cell change state. After the test has been applied the command text on the LCD will change to ‘**No Operation**’ and the contacts will remain in the Test State until reset issuing the ‘**Remove Test**’ command. The command text on the LCD will again revert to ‘**No Operation**’ after the ‘**Remove Test**’ command has been issued.

Note	*When the ‘**Test Mode**’ cell is set to ‘**Enabled**’ the ‘**Relay O/P Status**’ cell does not show the current status of the output relays and hence can not be used to confirm operation of the output relays. Therefore it will be necessary to monitor the state of each contact in turn.*

2.9 Test LEDs

When the ‘**Apply Test**’ command in this cell is issued the eight/eighteen user-programmable LEDs will illuminate for approximately 2 seconds before they extinguish and the command text on the LCD reverts to ‘**No Operation**’.

2.10 Red LED Status and Green LED Status (P242/P243)

The **Red LED Status** and **Green LED Status** cells are 18-bit binary strings that show which of the user-programmable LEDs on the relay are ON when accessing the relay from a remote location. **1** indicates a particular LED is ON and a **0** OFF. When the status of a particular LED in both cells is **1**, this means the LED is yellow.

2.11 Using a Monitor/Download Port Test Box

A monitor/download port test box containing 8 LEDs and a switchable audible indicator is available from Schneider Electric, or one of their regional sales offices. It is housed in a small plastic box with a 25-pin male D-connector that plugs directly into the relay’s monitor/download port. There is also a 25-pin female D-connector which allows other connections to be made to the monitor/download port whilst the monitor/download port test box is in place.

Each LED corresponds to one of the monitor bit pins on the monitor/download port with ‘**Monitor Bit 1**’ being on the left hand side when viewing from the front of the relay. The audible indicator can either be selected to sound if a voltage appears on any of the eight monitor pins or remain silent so that indication of state is by LED alone.

3 SETTING FAMILIARIZATION

When first commissioning a relay, allow sufficient time to become familiar with how to apply the settings.

The *Relay Menu Database document* and the *Introduction* or *Settings* chapters contain a detailed description of the menu structure of Schneider Electric relays. The relay menu database is a separate document which can be downloaded from our website:

www.schneider-electric.com

With the secondary front cover in place, all keys except the ⏎ key are accessible. All menu cells can be read. LEDs and alarms can be reset. However, no protection or configuration settings can be changed, or fault and event records cleared.

Removing the secondary front cover allows access to all keys so that settings can be changed, LEDs and alarms reset, and fault and event records cleared. However, to make changes to menu cells, the appropriate user role and password is needed.

Alternatively, if a portable PC with suitable setting software is available (such as MiCOM S1 Studio), the menu can be viewed one page at a time, to display a full column of data and text. This PC software also allows settings to be entered more easily, saved to a file for future reference, or printed to produce a settings record. Refer to the PC software user manual for details. If the software is being used for the first time, allow sufficient time to become familiar with its operation.

4 EQUIPMENT REQUIRED FOR COMMISSIONING

4.1 Minimum Equipment Required

The minimum equipment needed varies slightly, depending on the features provided by each type of MiCOM product. The list of minimum equipment is given below:

- Multifunctional dynamic current and voltage injection test set.
- Multimeter with suitable ac current range, and ac and dc voltage ranges of 0 - 440V and 0 - 250V respectively.
- Continuity tester (if not included in multimeter).
- Phase angle meter.
- Phase rotation meter.

Note	*Modern test equipment may contain many of the above features in one unit.*

- Fiber optic power meter.
- Fiber optic test leads (type and number according to application).
- P594 Commissioning Instructions. If the scheme features P594 time synchronizing devices, these will need commissioning. Separate documentation containing commissioning instructions is available for the P594.
- Overcurrent test set with interval timer
- 110 V ac voltage supply (if stage 1 of the overcurrent function is set directional)
- 100 Ω precision wire wound or metal film resistor, 0.1% tolerance (0°C ±2°C)

4.2 Optional Equipment

- Multi-finger test plug type Easergy test plug (if Easergy test block type is installed)
- An electronic or brushless insulation tester with a dc output not exceeding 500 V (for insulation resistance testing when required)
- A portable PC, with an RS232 port as well as appropriate software. This allows the rear communications port to be tested. If this is used, and it can save considerable time during commissioning.
- K-Bus to EIA(RS)232 protocol converter (if the first rear EIA(RS)485 K-Bus port or second rear port configured for K-Bus is being tested and one is not already installed)
- EIA(RS)485 to EIA(RS)232 converter (if first rear EIA(RS)485 port or second rear port configured for EIA(RS)485 is being tested)
- A printer, for printing a setting record from the portable PC

5 PRODUCT CHECKS

5.1 Introduction to Product Checks

These product checks cover all aspects of the relay that need to be checked to ensure:

- that it has not been physically damaged before commissioning
- that it is functioning correctly and
- that all input quantity measurements are within the stated tolerances

If the application-specific settings have been applied to the relay before commissioning, it is advisable to make a copy of the settings to allow their restoration later.

If Programmable Scheme Logic (PSL) (other than the default settings with which the relay was supplied) has been applied, the default settings should be restored before commissioning. This can be done by:

- Obtaining a setting file from the customer. This requires a portable PC with appropriate setting software for transferring the settings from the PC to the relay.
- Extracting the settings from the relay itself. This requires a portable PC with appropriate setting software.
- Manually creating a setting record. This could be done by stepping through the front panel menu using the front panel user interface.

If password protection is enabled, and the customer has changed password 2 that prevents unauthorized changes to some of the settings, either the revised password 2 should be provided, or the customer should restore the original password before testing is started.

Note *If the password has been lost, a recovery password can be obtained from Schneider Electric by quoting the serial number of the relay. The recovery password is unique to that relay and will not work on any other relay.*

Warning **Before carrying out any work on the equipment, you should be familiar with the contents of the Safety Information chapter/Safety Guide SFTY/5L M/L11 or later issue, the Technical Data chapter and the ratings on the equipment rating label.**

5.2 With the Relay Re-Energized

The following group of tests should be carried out without the auxiliary supply applied to the relay and with the trip circuit isolated.

Before inserting the test plug, refer to the scheme diagram to ensure this will not cause damage or a safety hazard. For example, the test block may be associated with protection current transformer circuits. Before the test plug is inserted into the test block, make sure the sockets in the test plug which correspond to the current transformer secondary windings are linked.

Warning	**The current and voltage transformer connections must be isolated from the relay for these checks. If a MiCOM P991 or an Easergy test block is provided, insert the Easergy or MiCOM P992 test plug, which open-circuits all wiring routed through the test block.**

Danger	**Never open-circuit the secondary circuit of a current transformer because the high voltage produced may be lethal. It could also damage insulation.**

If a test block is not provided, isolate the voltage transformer supply to the relay using the panel links or connecting blocks. Short-circuit and disconnect the line current transformers from the relay terminals. Where means of isolating the auxiliary supply and trip circuit (such as isolation links, fuses and MCB) are provided, these should be used. If this is impossible, the wiring to these circuits must be disconnected and the exposed ends suitably terminated to prevent them from being a safety hazard.

5.2.1 Visual Inspection

Caution	**Check the rating information under the top access cover on the front of the relay. Check that the relay being tested is correct for the protected line or circuit. Ensure that the circuit reference and system details are entered onto the setting record sheet. Double-check the CT secondary current rating, and be sure to record the actual CT tap which is in use.**

Carefully examine the relay to see that no physical damage has occurred since installation.

Ensure that the case earthing connections, at the bottom left-hand corner at the rear of the relay case, are used to connect the relay to a local earth bar using an adequate conductor.

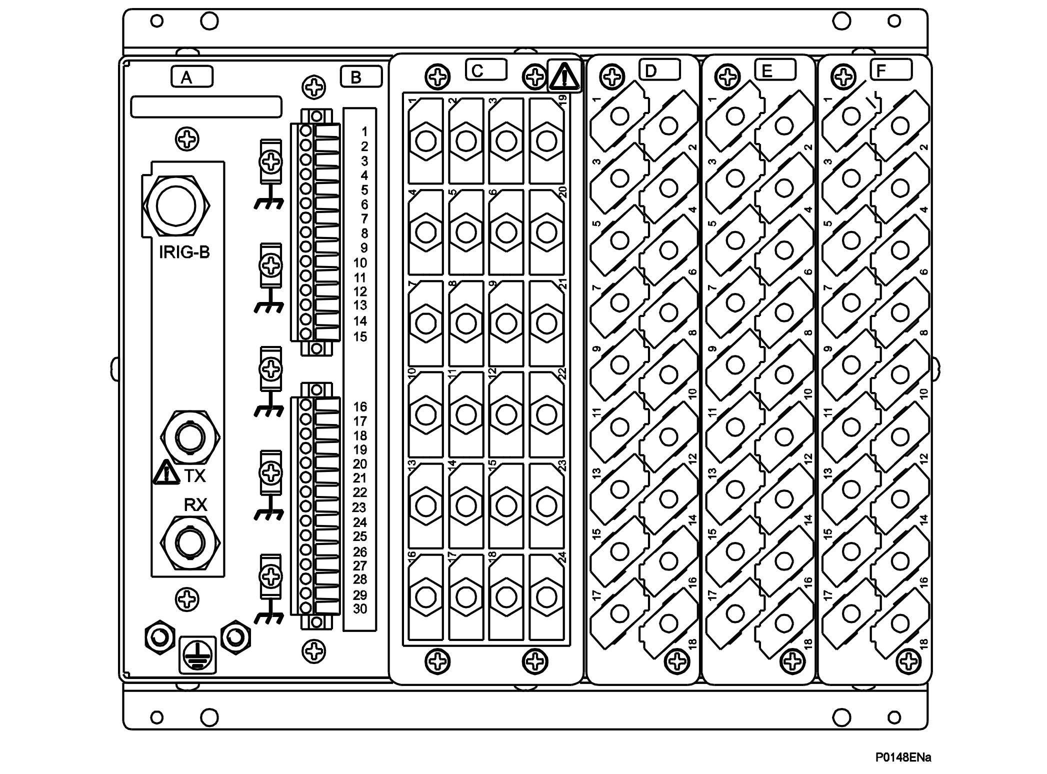

Figure 1 - Rear terminal blocks on size 40TE case

5.2.2 Current Transformer Shorting Contacts

If required, the current transformer shorting contacts can be checked to ensure that they close when the heavy duty terminal block shown in the following figure(s) is disconnected from the current input PCB. The heavy duty terminal block location depends on the relay model.

P24x	*For P241 relays block reference C (40TE case) are heavy duty terminal blocks.* *For P242/P243 relays they are located at block references D (60TE case) and D and F (80TE case).*

	Shorting contact between terminals			
Current input	**P241 (40TE)**		**P242 (60TE), P243 (80TE)**	
	1A CTs	**5A CTs**	**1A CTs**	**5A CTs**
IA	C3 - C2	C1 - C2	D3 - D2	D1 - D2
IB	C6 - C5	C4 - C5	D6 - D5	D4 - D5
IC	C9 - C8	C7 - C8	D9 - D8	D7 - D8
IN SENSITIVE	C15 - C14	C13 - C14	D15 - D14	D13 - D14
IA(2) (P243 only)			F3 - F2	F1 - F2
IB(2) (P243 only)			F6 - F5	F4 - F5
IC(2) (P243 only)			F9 - F8	F7 - F8

Table 3 - Current transformer shorting contact locations

Heavy duty terminal blocks are fastened to the rear panel using four Pozidriv or PZ1 screws. These are at the top and bottom between the first and second, and third and fourth, columns of terminals (see the *Location of Securing Screws for Terminal Blocks* diagram below).

Note	*Use a magnetic-bladed screwdriver to avoid losing screws or leaving them in the terminal block.*

Pull the terminal block away from the rear of the case and check with a continuity tester that all the shorting switches being used are closed. The following table(s) shows the terminals between which shorting contacts are fitted.

Warning	**If external test blocks are connected to the relay, take great care when using the associated test plugs such as MMLB and MiCOM P992 since their use may make hazardous voltages accessible. CT* shorting links must be in place before the insertion or removal of MMLB test plugs, to avoid potentially lethal voltages.**

Note	*When a MiCOM P992 Test Plug is inserted into the MiCOM P991 Test Block, the secondaries of the line CTs are automatically shorted, making them safe.*

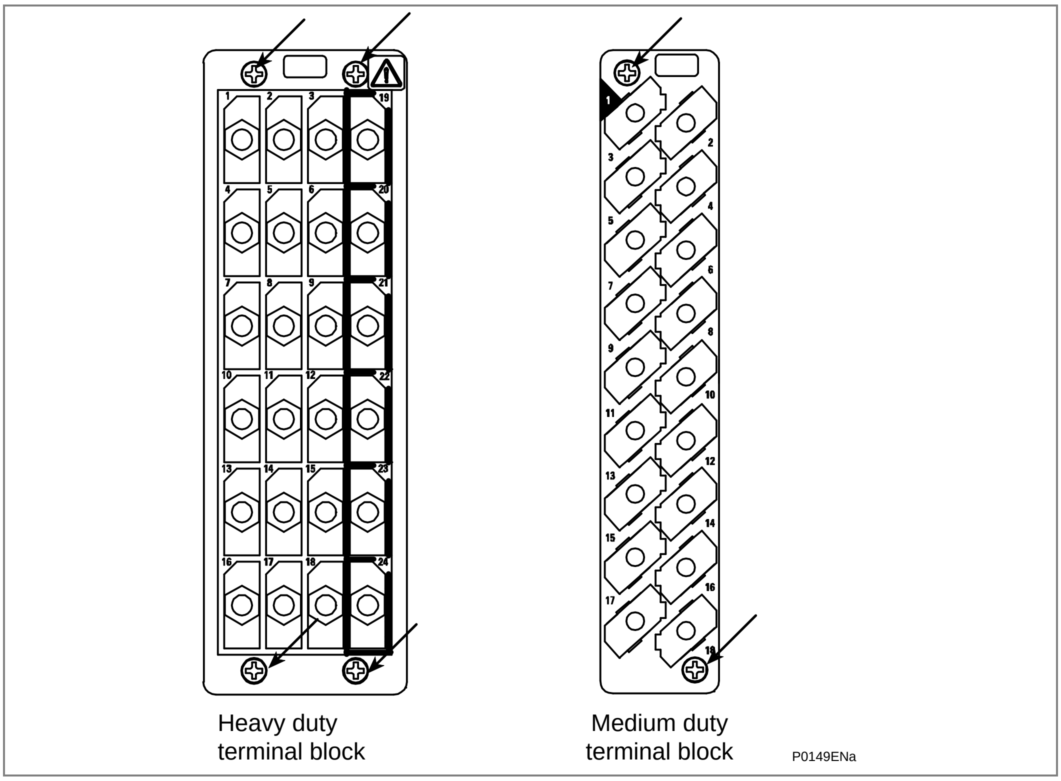

Figure 2 - Location of securing screws for heavy duty terminal blocks

5.2.3 Insulation

Insulation resistance tests are only necessary during commissioning if it is required for them to be done and they haven't been performed during installation.

Isolate all wiring from the earth and test the insulation with an electronic or brushless insulation tester at a dc voltage not exceeding 500 V. Terminals of the same circuits should be temporarily connected together.

The main groups of relay terminals are:

- Voltage transformer circuits
- Current transformer circuits
- Auxiliary voltage supply
- Field voltage output and opto-isolated control inputs
- Relay contacts
- First rear EIA(RS)485 communication port
- RTD inputs (where available)
- Current Loop (analog) Inputs and Outputs (CLIO) (where available)
- Case earth

The insulation resistance should be greater than 100 MΩ at 500 V.

On completion of the insulation resistance tests, ensure all external wiring is correctly reconnected to the unit.

5.2.4 External Wiring

Caution	**Check that the external wiring is correct to the relevant relay diagram and scheme diagram. Ensure as far as practical that phasing/phase rotation appears to be as expected. The relay diagram number appears on the rating label under the top access cover on the front of the relay.** **Schneider Electric supply the corresponding connection diagram with the order acknowledgement for the relay.**

If a MiCOM P991 or an Easergy test block is provided, check the connections against the wiring diagram. It is recommended that the supply connections are to the live side of the test block (colored orange with the odd numbered terminals 1, 3, 5, 7, and so on). The auxiliary supply is normally routed through terminals 13 (supply positive) and 15 (supply negative), with terminals 14 and 16 connected to the relay's positive and negative auxiliary supply terminals respectively. However, check the wiring against the schematic diagram for the installation to ensure compliance with the customer's normal practice.

5.2.5 Watchdog Contacts

Using a continuity tester, check that the watchdog contacts are in the states shown in the *Watchdog contact statu*s table for a de-energized relay.

Terminals and MiCOM Products		Contact State	
Terminals	**Products**	**De-energized**	**Energized**
F11 - F12	P241 40TE	Closed	Open
J11 - J12	P242 60TE	Closed	Open
M11 – M12	P243 80TE	Closed	Open
F13 - F14	P241 40TE	Open	Closed
J13 - J14	P242 60TE	Open	Closed
M13 – M14	P243 80TE	Open	Closed

Table 4 - Watchdog contact status

5.2.6 Auxiliary Supply

Caution **The relay can be operated from either a dc only or an ac/dc auxiliary supply depending on the relay's nominal supply rating. The incoming voltage must be within the operating range specified in the following table.**

Without energizing the relay, measure the auxiliary supply to ensure it is within the operating range.

Note *The relay can withstand an ac ripple of up to 12% of the upper rated voltage on the dc auxiliary supply.*

Nominal Supply Rating		Operating Ranges	
dc	**ac**	**dc**	**ac**
24 - 32V dc	-	19 - 38V dc	-
48 - 110V dc	-	37 - 150V dc	-
110 - 250V dc	100 - 240V ac rms	87 - 300V dc	80 - 265V ac

Table 5 - Operational range of auxiliary supply Vx

Caution **Do not energize the relay using the battery charger with the battery disconnected as this can irreparably damage the relay's power supply circuitry.**

Caution **Energize the relay only if the auxiliary supply is within the operating range. If a test block is provided, it may be necessary to link across the front of the test plug to connect the auxiliary supply to the relay.**

5.3 With the Relay Energized

The following group of tests verify that the relay hardware and software is functioning correctly and should be carried out with the auxiliary supply applied to the relay.

Caution	**The current and voltage transformer connections must remain isolated from the relay for these checks. The trip circuit should also remain isolated to prevent accidental operation of the associated circuit breaker.**

5.3.1 Watchdog Contacts

Using a continuity tester, check that the watchdog contacts are in the states shown in the *Watchdog contact statu*s table for a de-energized relay.

5.3.2 LCD Front Panel Display

The Liquid Crystal Display (LCD) is designed to operate in a wide range of substation ambient temperatures. For this purpose, the Px40 relays have an **LCD Contrast** setting. This allows the user to adjust the lightness or darkness of the displayed characters. The contrast is factory preset to account for a standard room temperature, however it may be necessary to adjust the contrast to give the best in-service display. To change the contrast, at the bottom of the **CONFIGURATION** column, use cell [09FF: LCD Contrast] to increment (darker) or decrement (lighter), as required.

Important	**Before applying a contrast setting, ensure that it does not make the display too light or dark so the menu text becomes unreadable. If this happens, it is possible to restore the display by downloading a MiCOM S1 Studio setting file, with the LCD Contrast set in the typical range of 7 to 11.**

5.3.3 Date and Time

Before setting the date and time, ensure that the factory-fitted battery isolation strip that prevents battery drain during transportation and storage has been removed. With the lower access cover open, the presence of the battery isolation strip can be checked by a red tab protruding from the positive side of the battery compartment. Lightly pressing the battery to prevent it falling out of the battery compartment, pull the red tab to remove the isolation strip.

The data and time should now be set to the correct values. The method of setting depends on whether accuracy is being maintained through the optional Inter-Range Instrumentation Group standard B (IRIG-B) port on the rear of the relay or by using SNTP via Ethernet.

5.3.3.1 With an IRIG-B Signal

Note *For P741 the IRIG-B signal may apply to the Central Unit only.*

If a satellite time clock signal conforming to IRIG-B is provided and the relay has the optional IRIG-B port fitted, the satellite clock equipment should be energized.

To allow the relay's time and date to be maintained from an external IRIG-B source cell [DATE and TIME, IRIG-B Sync.] must be set to **Enabled**.

Ensure the relay is receiving the IRIG-B signal by checking that cell [DATE and TIME, IRIG-B Status] reads **Active**.

Once the IRIG-B signal is active, adjust the time offset of the universal coordinated time (satellite clock time) on the satellite clock equipment so that local time is displayed.

Check the time, date and month are correct in cell [0801: DATE and TIME, Date/Time]. The IRIG-B signal does not contain the current year so needs to be set manually in this cell.

If the auxiliary supply fails, with a battery fitted in the compartment behind the bottom access cover, the time and date is maintained. Therefore, when the auxiliary supply is restored, the time and date are correct and need not be set again.

To test this, remove the IRIG-B signal, then remove the auxiliary supply from the relay. Leave the relay de-energized for approximately 30 seconds. On re-energization, the time in cell [DATE and TIME, Date/Time] should be correct. Then reconnect the IRIG-B signal.

5.3.3.2 Without an IRIG-B Signal

Note *For P741 the IRIG-B signal may not apply to the Central Unit only. For the P742/P743 it may apply to the Peripheral Unit only.*

If the time and date is not being maintained by an IRIG-B signal, ensure that cell [0804: DATE and TIME, IRIG-B Sync.] is set to **Disabled**.

Set the date and time to the correct local time and date using cell [0801: DATE and TIME, Date/Time].

If the auxiliary supply fails, with a battery fitted in the compartment behind the bottom access cover, the time and date are maintained. Therefore when the auxiliary supply is restored, the time and date are correct and need not be set again.

To test this, remove the auxiliary supply from the relay for approximately 30 seconds. On re-energization, the time in cell [0801: DATE and TIME, Date/Time] should be correct.

5.3.4 Light Emitting Diodes (LEDs)

On power-up, the green LED should switch on and stay on, indicating that the relay is healthy. The relay has non-volatile memory which stores the state (on or off) of the alarm, trip and, if configured to latch, user-programmable LED indicators when the relay was last energized from an auxiliary supply. Therefore, these indicators may also switch on when the auxiliary supply is applied.

If any of these LEDs are on, reset them before proceeding with further testing. If the LED successfully resets (the LED switches off), there is no testing required for that LED because it is known to be operational.

Note *It is likely that alarms related to the communications channels will not reset at this stage.*

5.3.4.1 Testing the Alarm and Out of Service LEDs

The alarm and out of service LEDs can be tested using the **COMMISSIONING TESTS** menu column. Set cell [0F0D: COMMISSIONING TESTS, Test Mode] to **Contacts Blocked**. Check that the out of service LED is on continuously and the alarm LED flashes.

It is not necessary to return cell [0F0D: COMMISSIONING TESTS, Test Mode] to **Disabled** at this stage because the test mode will be required for later tests.

5.3.4.2 Testing the Trip LED

The trip LED can be tested by initiating a manual circuit breaker trip from the relay. However, the trip LED will operate during the setting checks performed later. Therefore, no further testing of the trip LED is required at this stage.

5.3.4.3 Testing the User-Programmable LEDs

To test the user-programmable LEDs set cell [0F10: COMMISSIONING TESTS, Test LEDs] to **Apply Test**. Check that all the programmable LEDs on the relay switch on.

5.3.5 Field Voltage Supply

The relay generates a field voltage of nominally 48 V that can be used to energize the opto-isolated inputs (alternatively the substation battery may be used).

Measure the field voltage across terminals 7 and 9 on the terminal block shown in the following table. Check that the field voltage is in the range 40 V to 60 V when no load is connected and that the polarity is correct.

Repeat for terminals 8 and 10

Supply rail	Terminals		
	P241 (40TE)	P242 (60TE)	P243 (80TE)
+ve	F7 & F8	J7 & J8	M7 & M8
-ve	F9 & F10	J9 & J10	M9 & M10

Table 6 - Field voltage terminals

5.3.6 Input Opto-Isolators

This test checks that all the opto-isolated inputs on the relay are functioning correctly.

Model	Opto-Insulated Inputs
P241 (40TE Case)	8
P242 (60TE Case)	16
P243 (80TE Case)	16

Energize the opto-isolated inputs one at a time; see the external connection diagrams in the *Connection Diagrams* chapter for terminal numbers. Ensure that the correct opto input nominal voltage is set in the **Opto Config**. Menu. Ensure correct polarity and connect the field supply voltage to the appropriate terminals for the input being tested. Each opto input also has selectable filtering. This allows use of a pre-set filter of ½ cycle that renders the input immune to induced noise on the wiring.

Note *The opto-isolated inputs may be energized from an external dc auxiliary supply (such as the station battery) in some installations. Check that this is not the case before connecting the field voltage, otherwise damage to the relay may result. If an external 24/27 V, 30/34 V, 48/54 V, 110/125 V, 220/250 V supply is being used it will be connected to the relay's optically isolated inputs directly. If an external supply is used it must be energized for this test, but only after confirming that it is suitably rated, with less than 12% ac ripple.*

The status of each opto-isolated input can be viewed using either cell [0020: SYSTEM DATA, Opto I/P Status] or [0F01: COMMISSIONING TESTS, Opto I/P Status], a **1** indicating an energized input and a **0** indicating a de-energized input. When each opto-isolated input is energized, one of the characters on the bottom line of the display changes, to indicate the new state of the inputs.

5.3.7 Output Relays

This test checks that all the output relays are functioning correctly.

Model	Outputs
P241 (40TE Case)	7
P242 (60TE Case)	16
P243 (80TE Case)	16

Note *The high break output contacts fitted to I/O options “C” and “D” are polarity sensitive. External wiring should, wherever possible, be verified against polarity requirements described in the external connection diagram to ensure correct high break operation when in service.*

Ensure that the cell [xxxx: COMMISSIONING TESTS, Test Mode] is set to **Contacts Blocked**. (xxxx = 0F0E for P44x/P44y, 0F0D for P14x, P24x, P34x, P54x, P547, P64x or P841).

The output relays should be energized one at a time. To select output relay 1 for testing, set cell [xxxx: COMMISSIONING TESTS, Test Pattern] to 00000000000000000000000000000001. (xxxx = 0F0F for P44x/P44y, 0F0E for P14x, P24x, P34x, P445, P54x, P547, P64x or P841).

Connect a continuity tester across the terminals corresponding to output relay 1 as shown in the relevant external connection diagram in the *Installation* chapter.

To operate the output relay, set cell [xxxx: COMMISSIONING TESTS, Contact Test] to **Apply Test**. Operation is confirmed by the continuity tester operating for a normally open contact and ceasing to operate for a normally closed contact. Measure the resistance of the contacts in the closed state. (xxxx = 0F11 for P44x, 0F0F for P14x, P24x, P34x, P44y, P445, P54x, P547, P64x or P841).

Reset the output relay by setting cell [xxxx: COMMISSIONING TESTS, Contact Test] to **Remove Test**. (xxxx = 0F11 for P44x, 0F0F for P14x, P24x, P34x, P44y, P445, P54x, P547 or P64x).

Note	*Ensure that the thermal ratings of anything connected to the output relays during the contact test procedure are not exceeded by the associated output relay being operated for too long. Keep the time between application and removal of contact test to a minimum.*

Repeat the test for the rest of the relays (the numbers depend on the model).

Return the relay to service by setting cell [0F0D: COMMISSIONING TESTS, Test Mode] to **Disabled**.

5.3.8 RTD Inputs

This test checks that all the RTD inputs are functioning correctly and is only performed on relays with the RTD board fitted.

A 100 Ω resistor, preferably with a tolerance of 0.1%, should be connected across each RTD in turn for PT100 and Ni100 RTDs and a 120 Ω resistor for Ni120 RTDs. The resistor needs to have a very small tolerance as RTDs complying to BS EN 60751 : 1995 typically have a change of resistance of 0.39 Ω per °C, therefore the use of a precision wire wound or metal film resistor is recommended. It is essential to connect the RTD common return terminal to the appropriate RTD input otherwise the relay will report an RTD error as it will assume that the RTD wiring has been damaged. The connections required for testing each RTD input are given in Table 6.

Check that the corresponding temperature displayed in the **MEASUREMENTS 3** column of the menu is 0°C ±2°C. This range takes into account the 0.1% resistor tolerance and relay accuracy of ±1°C. If a resistor of lower accuracy is used during testing the acceptable setting range will need to be increased.

RTD	Terminal connections		Measurement cell (in “Measurements 3” Column (04) of Menu)
	Resistor between	Wire between	
1	B1 and B2	B2 and B3	[0405: RTD 1 Label]
2	B4 and B5	B5 and B6	[0406: RTD 2 Label]
3	B7 and B8	B8 and B9	[0407: RTD 3 Label]
4	B10 and B11	B11 and B12	[0408: RTD 4 Label]
5	B13 and B14	B14 and B15	[0409: RTD 5 Label]
6	B16 and B17	B17 and B18	[040A: RTD 6 Label]
7	B19 and B20	B20 and B21	[040B: RTD 7 Label]
8	B22 and B23	B23 and B24	[040C: RTD 8 Label]
9	B25 and B26	B26 and B27	[040D: RTD 9 Label]
10	B28 and B29	B29 and B30	[040E: RTD 10 Label]

Table 7 - RTD input terminals

5.3.9 Current Loop Inputs

This test checks that all the current loop (analog) inputs are functioning correctly and is only performed on relays with the Current Loop Input Output (CLIO) board fitted.

For details of the relay terminal connections see the connection diagrams in the *Installation* chapter. Note that for the current loop inputs, the physical connection of the 0 to 1 mA input is different to that of the 0 to 10, 0 to 20, and 4 to 20 mA inputs, as shown in the connection diagrams.

An accurate dc current source can be used to apply various current levels to the current loop inputs. Another approach is to use the current loop output as a convenient and flexible dc current source to test the input protection functionality. Externally the current loop outputs can be fed into their corresponding current loop inputs. Then by applying a certain level of analog signal, such as V_A, to the relay the required dc output level can be obtained from the current loop output which is feeding the current loop input.

Enable the current loop input to be tested. Set the CLIx minimum and maximum settings and the CLIx Input type for the application.

Apply a dc current to the relay current loop input at 50% of the CLI input maximum range, 0.5 mA (0 to 1 mA CLI), 5 mA (0 to 10 mA CLI) or 10 mA (0 to 20, 4 to 20 mA CLI).

Check the accuracy of the current loop input using the MEASUREMENTS 3 - CLIO Input 1/2/3/4 column of the menu. The display should show (CLIx maximum + CLIx minimum)/2 ±1% full scale accuracy.

5.3.10 Current Loop (Analog) Outputs

This test checks that all the current loop (analog) outputs are functioning correctly and is only performed on relays with the CLIO board fitted.

Relay terminal connections can be found by referring to the diagrams in the Connection Diagrams chapter.

Note	For the current loop outputs the physical connection of the 0 - 1 mA output is different from that of the 0 - 10, 0 - 20 and 4 - 20 mA outputs, as shown in the connection diagrams.

Enable the current loop output to be tested. Set the Analog Output parameter, Analog Outputx minimum and maximum settings and the Analogx Output type (range) for the application. Apply the appropriate analog input parameter to the relay equals to (Analogx maximum + Analogx minimum)/2. The current loop output should be at 50% of its maximum rated output. Using a precision resistive current shunt together with a high-resolution voltmeter, check that the analog (current loop) output is at 50% of its maximum rated output, 0.5 mA (0 - 1 mA CLO), 5 mA (0 - 10 mA CLO) or 10 mA (0 - 20, 4 - 20mA CLO). The accuracy should be within ±0.5% of full scale + meter accuracy.

5.3.11 First Rear Communications Port

This test should only be performed where the relay is to be accessed from a remote location and varies depending on the communications standard adopted.

It is not the intention of the test to verify the operation of the complete system from the relay to the remote location, just the relay's rear communications port and any protocol converter necessary.

A variety of communications protocols may be available. For further details, please see whichever of these sections are relevant for the device you are commissioning:

- Section 5.3.12.1 - K-Bus Configuration
- Section 5.3.12.2 - EIA(RS)485 Configuration
- Section 5.3.12.3 - EIA(RS)232 Configuration

5.3.11.1 Courier Communications

If a K-Bus to EIA(RS)232 KITZ protocol converter is installed, connect a portable PC running the appropriate software (such as MiCOM S1 Studio or PAS&T) to the incoming (remote from relay) side of the protocol converter.

If a KITZ protocol converter is not installed, it may not be possible to connect the PC to the relay installed. In this case a KITZ protocol converter and portable PC running appropriate software should be temporarily connected to the relay's first rear K-Bus port. The terminal numbers for the relay's first rear K-Bus port are shown in the following table. However, as the installed protocol converter is not being used in the test, only the correct operation of the relay's K-Bus port will be confirmed.

Connection		Terminal		
K-Bus	IEC 60870-5-103, MODBUS, VDEW or DNP3.0	P241	P242	P243
		(40TE)	(60TE)	(80TE)
Screen	Screen	F16	J16	M16
1	+ve	F17	J17	M17
2	-ve	F18	J18	M18

Table 8 - EIA(RS)485 terminals

Ensure that the communications baud rate and parity settings in the application software are set the same as those on the protocol converter (usually a KITZ but could be a SCADA RTU). The relay's Courier address in cell [0E02: COMMUNICATIONS, Remote Address] must be set to a value between 1 and 254.

Check that communications can be established with this relay using the portable PC.

If the relay has the optional fiber optic communications port fitted, the port to be used should be selected by setting cell [0E07: COMMUNICATIONS, Physical Link] to **Fiber Optic**. Ensure that the relay address and baud rate settings in the application software are set the same as those in cell [0E04 COMMUNICATIONS, Baud Rate] of the relay. Check, using the Master Station, that communications with the relay can be established.

5.3.11.2 MODBUS Communications

Connect a portable PC running the appropriate MODBUS Master Station software to the relay's first rear EIA(RS)485 port using an EIA(RS)485 to EIA(RS)232 interface converter. The terminal numbers for the relay's EIA(RS)485 port are shown in the *EIS(RS)485 terminals* table.

Ensure that the relay address, baud rate and parity settings in the application software are set the same as those in cells [xxxx: COMMUNICATIONS, Remote Address], [yyyy: COMMUNICATIONS, Baud Rate] and [zzzz: COMMUNICATIONS, Parity] of the relay.

- xxxx = 0E03 for P44x, 0E02 for P14x, P24x, P34x or P64x
- yyyy = 0E06 for P44x, 0E04 for P14x, P24x, P34x or P64x
- zzzz = 0E07 for P44x, 0E05 for P14x, P24x, P34x or P64x

Check that communications with this relay can be established.

If the relay has the optional fiber optic communications port fitted, the port to be used should be selected by setting cell [0E07: COMMUNICATIONS, Physical Link] to **Fiber Optic**. Ensure that the relay address and baud rate settings in the application software are set the same as those in cell [0E04: COMMUNICATIONS, Baud Rate] of the relay. Check, using the Master Station, that communications with the relay can be established.

5.3.11.3 IEC 60870-5-103 (VDEW) Communications

If the relay has the optional fiber optic communications port fitted, the port to be used should be selected by setting cell [xxxx: COMMUNICATIONS, Physical Link] to **Fiber Optic** or **EIA(RS)485**.

- xxxx = 0E07 for P14x, P24x, P34x, P44y, P445, P54x, P547, P64x or P841
  xxxx = 0E09 for P44x

IEC60870-5-103/VDEW communication systems are designed to have a local Master Station and this should be used to verify that the relay's rear fiber optic or EIA(RS)485 port, as appropriate, is working.

Ensure that the relay address and baud rate settings in the application software are set the same as those in cells [0E02: COMMUNICATIONS, Remote Address] and [0E04: COMMUNICATIONS, Baud Rate] of the relay.

Check, using the Master Station, that communications with the relay can be established.

5.3.11.4 IEC 61850 Communications

Connect a portable PC running the appropriate IEC61850 Master Station Software or MMS browser to the relay’s Ethernet port (RJ45 or ST fiber optic connection). The terminal numbers for the relay’s Ethernet port are shown in the following *Signals on the Ethernet connector* table.

Configuration of the relay IP parameters (IP Address, Subnet Mask, Gateway) and SNTP time synchronization parameters (SNTP Server 1, SNTP Server 2) is performed by the IED Configurator tool. If these parameters are not available from an SCL file, they must be configured manually.

If the assigned IP address is duplicated elsewhere on the same network, the remote communications operates in an indeterminate way. However, the relay checks for a conflict on every IP configuration change and at power-up. An alarm is raised if an IP conflict is detected. The relay can be configured to accept data from networks other than the local network by using the **Gateway** setting.

Check that communications with this relay can be established.

To communicate with an IEC 61850 IED on Ethernet, it is necessary only to know its IP address. This can then be configured in either of the following:

- An IEC 61850 client (or master), such as a PACiS computer (MiCOM C264) or HMI
- An MMS browser, with which the full data model can be retrieved from the IED without any previous knowledge

Setting changes such as protection settings are not supported in the current IEC 61850 implementation. Such setting changes are done using MiCOM S1 Studio using the front port serial connection of the relay, or over the Ethernet link if preferred. This is known as tunneling. See the *SCADA Communications* chapter for more information on IEC 61850.

The connector for the Ethernet port is a shielded RJ45. The following shows the signals and pins on the connector:

Pin	Signal name	Signal definition
1	TXP	Transmit (positive)
2	TXN	Transmit (negative)
3	RXP	Receive (positive)
4	-	Not used
5	-	Not used
6	RXN	Receive (negative)
7	-	Not used
8	-	Not used

Table 9 - Signals on the Ethernet connector

5.3.12 Second Rear Communications Port

This test should only be performed where the relay is to be accessed from a remote location and varies depending on the communications standard being adopted.

It is not the intention of the test to verify the operation of the complete system from the relay to the remote location, just the relay’s rear communications port and any protocol converter necessary.

A variety of communications protocols may be available. For further details, please see whichever of these sections are relevant for the device you are commissioning:

- Section 5.3.12.1 - K-Bus Configuration

- Section 5.3.12.2 - EIA(RS)485 Configuration
- Section 5.3.12.3 - EIA(RS)232 Configuration

5.3.12.1 K-Bus Configuration

If a K-Bus to EIA(RS)232 KITZ protocol converter is installed, connect a portable PC running the appropriate software (MiCOM S1 Studio or PAS&T) to the incoming (remote from relay) side of the protocol converter.

If a KITZ protocol converter is not installed, it may not be possible to connect the PC to the relay installed. In this case a KITZ protocol converter and portable PC running appropriate software should be temporarily connected to the relay's second rear communications port configured for K-Bus. The terminal numbers for the relay's K-Bus port are shown in the following table. However, as the installed protocol converter is not being used in the test, only the correct operation of the relay's K-Bus port is confirmed.

Pin*	Connection
4	EIA(RS)485 - 1 (+ ve)
7	EIA(RS)485 - 2 (- ve)
* All other pins unconnected.	

Table 10 - Second rear communications port K-Bus terminals

Ensure that the communications baud rate and parity settings in the application software are set the same as those on the protocol converter (usually a KITZ but could be a SCADA RTU). The relay's Courier address in cell [0E90: COMMUNICATIONS, RP2 Address] must be set to a value between 1 and 254. The second rear communication's port configuration [0E88: COMMUNICATIONS RP2 Port Config.] must be set to K-Bus.

Check that communications can be established with this relay using the portable PC.

5.3.12.2 EIA(RS)485 Configuration

If an EIA(RS)485 to EIA(RS)232 converter (Schneider Electric CK222) is installed, connect a portable PC running the appropriate software (Easergy Studio/MiCOM S1 Studio) to the EIA(RS)232 side of the converter and the second rear communications port of the relay to the EIA(RS)485 side of the converter.

The terminal numbers for the relay's EIA(RS)485 port are shown in the *Second rear communications port EIA(RS)232 terminals* table.

Ensure that the communications baud rate and parity settings in the application software are the same as those in the relay. The relay's Courier address in cell [0E90: COMMUNICATIONS, RP2 Address] must be set to a value between 1 and 254. The second rear communications port's configuration [0E88: COMMUNICATIONS RP2 Port Config.] must be set to EIA(RS)485.

Check that communications can be established with this relay using the portable PC.

5.3.12.3 EIA(RS)232 Configuration

Connect a portable PC running the appropriate software (MiCOM S1 Studio) to the rear EIA(RS)232 port of the relay. This port is actually compliant with EIA(RS)574; the 9-pin version of EIA(RS)232, see www.tiaonline.org.

The second rear communications port connects using the 9-way female D-type connector (SK4). The connection is compliant with EIA(RS)574.

Pin	Connection
1	No Connection
2	RxD
3	TxD
4	DTR[#]
5	Ground
6	No Connection
7	RTS[#]
8	CTS[#]
9	No Connection
[#] These pins are control lines for use with a modem.	

Table 11 - Second rear communications port EIA(RS)232 terminals

Connections to the second rear port configured for EIA(RS)232 operation can be made using a screened multi-core communication cable up to 15 m long, or a total capacitance of 2500 pF. Terminate the cable at the relay end with a 9-way, metal-shelled, D-type male plug. The terminal numbers for the relay's EIA(RS)232 port are shown in the previous table.

Ensure that the communications baud rate and parity settings in the application software are set the same as those in the relay. The relay's Courier address in cell [0E90: COMMUNICATIONS, RP2 Address] must be set to a value between 1 and 254. The second rear communication's port configuration [0E88: COMMUNICATIONS RP2 Port Config] must be set to EIA(RS)232.

Check that communications can be established with this relay using the portable PC.

5.3.13 Current Inputs

This test verifies that the accuracy of current measurement is within acceptable tolerances.

All relays leave the factory set for operation at a system frequency of 50 Hz. If operation at 60 Hz is required, this must be set in cell [0009: SYSTEM DATA, Frequency].

Caution	**To avoid spurious operation of protection elements during injection testing, ensure that current operated elements are disabled.**

Apply current equal to the line current transformer secondary winding rating to each current transformer input of the corresponding rating in turn, checking its magnitude using a multimeter. Refer to the *Current input terminals* table for the corresponding reading in the relay's **MEASUREMENTS 1** columns, as appropriate, and record the value displayed.

The measured current values displayed on the relay LCD, or on a portable PC connected to the front communication port, are either in primary or secondary Amperes. If cell [0D02: MEASURE'T SETUP, Local Values] is set to **Primary**, the values displayed should be equal to the applied current multiplied by the corresponding current transformer ratio set in the **CT and VT RATIOS** menu column (see the *CT ratio settings* table). If cell [0D02: MEASURE'T SETUP, Local Values] is set to **Secondary**, the value displayed should be equal to the applied current.

Measurements 1 Menu cell	P241 (40TE)		P242 / P243 (60TE)	
	Apply current to			
	1A CT	5A CT	1A CT	5A CT
[0201: IA1 Magnitude]	C3 - C2	C1 - C2	D3 - D2	D1 - D2
[0203: IB1 Magnitude]	C6 - C5	C4 - C5	D6 - D5	D4 - D5
[0205: IC1 Magnitude]	C9 - C8	C7 - C8	D9 - D8	D7 - D8
[020B: ISEF Magnitude]	C15 - C14	C13 - C14	D15 - D14	D13 - D14
[0230: IA-2 Magnitude]			F3 - F2 *	F1 - F2 *
[0232: IB-2 Magnitude]			F6 - F5 *	F4 - F5 *
[0234: IC-2 Magnitude]			F9 - F8 *	F7 - F8 *
*Note** *P243 only*				

Table 12 - Current input terminals

> *Note* — *If a PC connected to the relay's rear communications port is used to display the measured current, the process is similar. However, the setting of cell [0D03: MEASURE'T SETUP, Remote Values] determines whether the displayed values are in primary or secondary Amperes.*

The measurement accuracy of the relay is ±1% (5% for P741/P742/P743/P746). However, an additional allowance must be made for the accuracy of the test equipment being used.

Menu cell (Measurements 1 unless otherwise stated)	P24x
	Corresponding CT ratio (in 'VT and CT RATIO column (0A) of menu)
[0201: IA Magnitude] [0203: IB Magnitude] [0205: IC Magnitude]	$\frac{\text{[0A07 : Phase CT Primary]}}{\text{[0A08 : Phase CT Secondary]}}$ E0010ENa
[0230: IA 2 Magnitude] (P243 only) [0232: IB 2 Magnitude] (P243 only) [0234: IC 2 Magnitude] (P243 only)	$\frac{\text{[0A07 : Phase CT Primary]}}{\text{[0A08 : Phase CT Secondary]}}$ E0010ENa
[020B: ISEF Magnitude]	$\frac{\text{[0A0B : SEF CT Primary]}}{\text{[0A0C : SEF CT Sec'y]}}$ E0123ENa

Table 13 - CT ratio settings

5.3.14 Voltage Inputs

This test verifies that the accuracy of voltage measurement is within the acceptable tolerances.

For the P24x: Three modes of connection are available on the P24x relay: either 3VTs connection, or 2VTs plus residual VT connection or 2VTs plus remanent voltage VT connection (see the Connection Diagrams for detailed information).

The following tests will be realized with the VT Connecting Mode set to 3 VT which is the most used configuration.

Apply rated voltage to each voltage transformer input in turn, checking its magnitude using a multimeter. Refer to the *Voltage Input Terminals* table for the corresponding reading in the relay's **MEASUREMENTS 1** column and record the value displayed.

Cell in Measurements 1 Column (02)	Voltage applied to	
	P241 40TE	P242 60TE or P243 80TE
[021A: VAN Magnitude]	C19-C22	D19 - D22
[021C: VBN Magnitude]	C20-C22	D20 - D22
[021E: VCN Magnitude]	C21-C22	D21 - D22
[0220: VN Measured Mag]	C23 - C24	D23 - D24
* Voltage reference for synchrocheck		

Table 14 - Voltage input terminals

The measured voltage values displayed on the relay LCD or a portable PC connected to the front communication port are either in primary or secondary volts. If cell [0D02: MEASURE'T SETUP, Local Values] is set to **Primary**, the values displayed should be equal to the applied voltage multiplied by the corresponding voltage transformer ratio set in the **VT and CT RATIOS** menu column (see the following *VT ratio settings* table). If cell [0D02: MEASURE'T SETUP, Local Values] is set to **Secondary**, the value displayed should be equal to the applied voltage.

> *Note* *If a PC connected to the relay's rear communications port is used to display the measured voltage, the process is similar. However, the setting of cell [0D03: MEASURE'T SETUP, Remote Values] determines whether the displayed values are in primary or secondary volts.*

The measurement accuracy of the relay is ±1%. However, an additional allowance must be made for the accuracy of the test equipment being used.

Cell in Measurements 1 column (02)	P24x Corresponding CT Ratio (in 'CT and VT RATIO' column(0A) of menu)
[021A: VAN Magnitude] [021C: VBN Magnitude] [021E: VCN Magnitude]	$\frac{\text{[0A01 : Main VT Primary]}}{\text{[0A02 : Main VT Secondary]}}$ E0016ENa

Table 15 - VT ratio settings

6 SETTING CHECKS

The setting checks ensure that all of the application-specific relay settings (both the relay's function and Programmable Scheme Logic (PSL) settings) for the particular installation have been correctly applied to the relay.

If the application-specific settings are not available, ignore sections 6.1 - Apply Application-Specific Settings and 6.2 Check Application-Specific Settings

Caution	**The trip circuit should remain isolated during these checks to prevent accidental operation of the associated circuit breaker.**

6.1 Apply Application-Specific Settings

There are different methods of applying the settings:

- Transferring settings from a pre-prepared setting file to the relay using a laptop PC running the appropriate software (such as Easergy/MiCOM S1 Studio). Use the front EIA(RS)232 port (under the bottom access cover), or the first rear communications port (Courier protocol with a protocol converter connected), or the second rear communications port. This is the preferred method for transferring function settings as it is much faster and there is less margin for error. If PSL other than the default settings with which the relay is supplied is used, this is the only way of changing the settings.

  If a setting file has been created for the particular application and provided on a memory device, the commissioning time is further reduced, especially if application-specific PSL is applied to the relay.
- Enter the settings manually using the relay's operator interface. This method is not suitable for changing the PSL.

Caution	**When the installation needs application-specific Programmable Scheme Logic (PSL), it is essential that the appropriate .psl file is downloaded (sent) to the relay, for each setting group that will be used. If the user fails to download the required .psl file to any setting group that may be brought into service, the factory default PSL will still be resident. This may have severe operational and safety consequences.**

6.2 Check Application-Specific Settings

Carefully check applied settings against the required application-specific settings to ensure they have been entered correctly. However, this is not considered essential if a customer-prepared setting file on a memory device has been transferred to the relay using a portable PC.

There are two methods of checking the settings:

- Extract the settings from the relay using a portable PC running the appropriate software (MiCOM S1 Studio) using the front EIA(RS)232 port, under the bottom access cover, or the first rear communications port (Courier protocol with a KITZ protocol converter connected), or the second rear communications port. Compare the settings transferred from the relay with the original written application-specific setting record (for cases where the customer has only provided a printed copy of the required settings but a portable PC is available).
- Step through the settings using the relay's operator interface and compare them with the original application-specific setting record.

Unless previously agreed to the contrary, the application-specific PSL is not checked as part of the commissioning tests.

Due to the versatility and possible complexity of the PSL, it is beyond the scope of these commissioning instructions to detail suitable test procedures. Therefore, when PSL tests must be performed, written tests that satisfactorily demonstrate the correct operation of the application-specific scheme logic should be devised by the engineer who created it. These tests should be provided to the Commissioning Engineer with the memory device containing the PSL setting file.

6.3 Demonstrate Correct Relay Operation

The *Current Inputs* and *Voltage Inputs* checks detailed in the *Product Checks* section have already demonstrated that the relay is within calibration, so the purpose of these tests is as follows:

- To determine that the primary protection function of the P241/P242/P243 relay, the thermal protection, can trip according to the correct application settings.
- To determine that the differential protection function of the P243 relay can trip according to the correct application settings.
- To verify correct setting of the sensitive earth fault protection (P241/P242/P243).
- To verify correct assignment of the trip contacts, by monitoring the response to a selection of fault injections.

6.3.1 Motor Differential Protection (P243)

To avoid spurious operation of any other protection elements all protection elements except the motor differential protection should be disabled for the duration of the differential element tests. This is done in the relay's CONFIGURATION column. Make a note of which elements need to be re-enabled after testing.

For testing the biased differential protection select the **Percentage Bias** setting in the Diff Function, Differential menu and perform the tests described in these sections:

- Biased Differential Protection Lower Slope
- Biased Differential Protection Upper Slope
- Motor Differential Operation and Contact Assignment

For testing the high impedance differential protection select the **High Impedance** setting in the Diff Function, Differential menu and perform the tests described in the *Motor Differential Operation and Contact Assignment* section.

The P243 motor differential protection has three elements, one for each phase. The biased differential protection uses the maximum bias current in the three phases to bias the elements. The detailed bias characteristic is described in sub-document - Installation. The following instructions are for testing the bias characteristic of the B phase element. The bias current is applied to the A phase element.

6.3.1.1 Connect the Test Circuit

The following tests require a variable transformer and two resistors connected as shown in the *Connection for testing* diagram. Alternatively, an injection test set can be used to supply Ia and Ib currents.

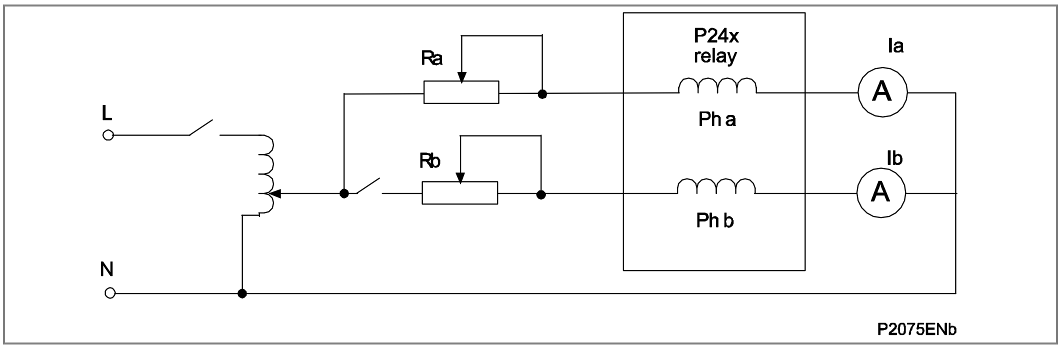

Figure 3 - Connection for testing

For the biased differential protection a current is injected into the A phase IA-2 input, F3 - F2 (1A), F1 - F2 (5A), which is used as the bias current, IBias = (IA + IA-2)/2 = IA-2/2 as IA=0. Another current is injected into the B phase IB-2 input F6 - F5 (1A), F4 - F5 (5A) which is used as the differential current, Differential = IB-2 - IB = IB-2 as IB=0. Ia is always greater than Ib.

6.3.1.2 Biased Differential Protection Lower Slope

If three LEDs have been assigned to give phase segregated trip information, Diff Trip A, Diff Trip B and Diff Trip C (DDB 315, 316, 317), these may be used to indicate correct per-phase operation. If not, monitor options will need to be used - see the next paragraph.

Go to the COMMISSION TESTS column in the menu, scroll down and change cells [0F05: Monitor Bit 1] to 315, [0F06: Monitor Bit 2] to 316 and [0F07: Monitor Bit 3] to 317. Cell [0F04: Test Port Status] will now appropriately set or reset the bits that now represent Phase A Trip (DDB 315), Phase B Trip (DDB 316) and Phase C Trip (DDB 317) with the rightmost bit representing Phase A Trip. From now on you should monitor the indication of [0F04: Test Port Status].

Adjust the variac and the resistor to inject 1 pu into IA-2 to give a bias current of 0.5 pu in the A-phase.

Note	*1 pu = 1 A into terminals, F3 - F2 for 1 A applications; or 1 pu = 5 A into terminals F1-F2 for 5 A applications.*

The relay will trip and any contacts associated with the A-phase will operate, and bit 1 (rightmost) of [0F04: Test Port Status] will be set to 1. Some LEDs, including the yellow alarm LED, will come on, but ignore them for the moment.

Slowly increase the current in the B-phase IB-2 input F6 - F5 (1A), F4 - F5 (5 A) until phase B trips (Bit 2 of [0F04: Test Port Status] is set to 1). Record the phase B current magnitude and check that it corresponds to the information below. Switch OFF the ac supply and reset the alarms.

Bias current (IA-2/2)		Differential current (IB)	
Phase	**Magnitude**	**Phase**	**Magnitude**
A	0.5 pu	B	0.05 pu +/-10%

Assumption: Is1 = 0.05 pu, k1 = 0%, Is2 = 1.2 pu

For other differential settings the formula below can be used (enter k1 slope in pu form, i.e. percentage/100):

B phase operate current is (Is1 + IBias x k1) pu +/- 10%

6.3.1.3 Biased Differential Protection Upper Slope

Repeat the test in 6.3.1.2 with the A phase, IA-2, current set to be 3.4 pu (Ibias = 1.7 pu). Slowly increase the current in the B phase until phase B trips (bit 2 of [0F04: Test Port

Status] is set to 1). Record the phase B current magnitude and check that it corresponds to the information below.

Switch OFF the ac supply and reset the alarms.

Bias current (IA-2/2)		Differential current (IB)	
Phase	**Magnitude**	**Phase**	**Magnitude**
A	1.7 pu	B	0.8 pu +/-20%

Assumption: Is1 = 0.05 pu, k1 = 0%, Is2 = 1.2 pu, k2 =150%as above

For other differential settings the formula below can be used (enter k1 and k2 slopes in pu form, i.e. percentage/100):

Operate current is [(IBias x k2) + {(k1 - k2) x Is2 } + Is1] pu +/- 20%

Note	*Particularly for 5 A applications the duration of current injections should be short to avoid overheating of the variac or injection test set.*

6.3.2 Motor Differential Operation and Contact Assignment

6.3.2.1 Phase A

Retaining the same test circuit as before, prepare for an instantaneous injection of 4 x I_{s1} pu current in the A phase, with no current in the B phase (B phase switch open). Connect a timer to start when the fault injection is applied, and to stop when the trip occurs.

Determine which output relay has been selected to operate when a Diff. Trip occurs by viewing the relay’s programmable scheme logic. The programmable scheme logic can only be changed using the appropriate software. If this software is not available then the default output relay allocations will still be applicable. In the default PSL, relay 3 is the designated protection trip contact and DDB 371 Any Trip is assigned to this contact.

Ensure that the timer is reset.

Apply a current of 4 x the setting in cell [3002: GROUP 1 DIFFERENTIAL, Diff Is1] to the relay and note the time displayed when the timer stops.

After applying the test check the red trip led and yellow alarm led turns on when the relay operates. Check ‘Alarms/Faults Present - Tripped Phase A, Diff Trip’ is on the display. Reset the alarms.

Three Pole Tripping		Single Pole Tripping	
DDB 318	Diff Trip	DDB 315: DDB 316: DDB 317:	Diff Trip A Diff Trip B Diff Trip C

Table 16 - Three-pole and single-pole tripping

6.3.2.2 Phase B

Reconfigure the test equipment to inject fault current into the B phase. Repeat the test in the above ***Phase A*** section, this time ensuring that the breaker trip contacts relative to B phase operation close correctly. Record the phase B trip time. Check the red trip led and yellow alarm led turns on when the relay operates. Check ‘Alarms/Faults Present - Tripped Phase B, Diff Trip’ is on the display. Reset the alarms.

6.3.2.3 Phase C

Repeat 0 for the C phase.

The average of the recorded operating times for the three phases should be less than 30 ms. Switch OFF the ac supply and reset the alarms.

On completion of the tests any protection elements which were disabled for testing purposes must have their original settings restored in the CONFIGURATION column.

6.3.3 Sensitive Earth Fault (SEF) Protection

This test, performed on stage 1 of the Sensitive Earth Fault (SEF) protection function in setting Group 1, demonstrates that the relay is operating correctly at the application-specific settings.

It is not considered necessary to check the boundaries of operation where cell [3202: SENSITIVE E/F GROUP 1, ISEF>1 Direction] is set to Directional Fwd as the test detailed already confirms the correct functionality between current and voltage inputs, processor and outputs and earlier checks confirmed the measurement accuracy is within the stated tolerance.

To avoid spurious operation of any other protection elements all protection elements except the overcurrent protection should be disabled for the duration of the overcurrent element tests. This is done in the relay’s CONFIGURATION column. Make a note of which elements need to be re-enabled after testing.

6.3.3.1 Connect the Test Circuit

Determine which output relay has been selected to operate when a ISEF>1 trip occurs by viewing the relay's Programmable Scheme Logic (PSL).

The PSL can only be changed using the appropriate software. If this software has not been available then the default output relay allocations will still be applicable.

If ISEF>1 trip (DDB 261) is not mapped directly to an output relay in the PSL, output relay 3 should be used for the test as it operates for any trip condition, DDB 371 Any Trip is assigned to this contact.

The associated terminal numbers can be found from the external connection diagrams in the Connection Diagrams chapter.

Connect the output relay so that its operation will trip the test set and stop the timer. Connect the current output of the test set to the 'ISensitive' phase current transformer input of the relay (terminals C15 - C14 (1 A, 40TE case), D15 - D14 (1 A, 60TE case), F15 - F14 (1 A, 80TE case), C13 - C14 (5 A, 40TE case), D13 - D14 (5 A, 60TE case) F13 - F14 (5 A, 80TE case)).

Ensure that the timer will start when the current is applied to the relay.

6.3.3.2 Perform the Test

Ensure that the timer is reset.

Apply a current of twice the setting in cell [3203: GROUP 1 SENSITIVE E/F, < SEF>1 Current Set] to the relay and note the time displayed when the timer stops.

Check the red trip led and yellow alarm led turns on when the relay operates. Check 'Alarms/Faults Present - Started Phase N, Tripped Phase N, Start ISEF>1, Trip ISEF>1' is on the display. Reset all alarms.

6.3.3.3 Check the Operating Time

Check that the operating time recorded by the timer is within the range shown in the following table.

Note	*Except for the definite time characteristic, the operating times given in the following table are for a time multiplier or time dial setting of 1. Therefore, to obtain the operating time at other time multiplier or time dial settings, the time given in the table must be multiplied by the setting of cell [3205: GROUP 1 SENSITIVE E/F, ISEF>1 TMS] for IEC and UK characteristics or cell [3207: GROUP 1 SENSITIVE E/F, ISEF>1 Time Dial] for IEEE and US characteristics.*

In addition, for definite time and inverse characteristics there is an additional delay of up to 0.02 second and 0.08 second respectively that may need to be added to the relays acceptable range of operating times.

For all characteristics, allowance must be made for the accuracy of the test equipment being used.

Characteristic	Operating time at twice current setting and time multiplier/time dial setting of 1.0	
	Nominal (seconds)	Range (seconds)
DT	[3504: ISEF>1 T Delay] setting	Setting ±5%
IEC S Inverse	10.03	9.53 - 10.53
IEC V Inverse	13.50	12.83 - 14.18
IEC E Inverse	26.67	25.34 - 28
UK LT Inverse	120.00	114.00 - 126.00
IEEE M Inverse	3.8	3.61 - 3.99
IEEE V Inverse	7.03	6.68 - 7.38
IEEE E Inverse	9.52	9.04 - 10
US Inverse	2.16	2.05 - 2.27
US ST Inverse	12.12	11.51 - 12.73

Table 17 - Characteristic operating times for I>1

On completion of the tests any protection elements that were disabled for testing purposes must have their original settings restored in the CONFIGURATION column.

6.3.4 Thermal Overload Protection

MiCOM P24x relays model the time-current thermal characteristic of a motor by internally generating a thermal replica of the machine. The aim of this test is to check :

- The presence of a thermal alarm as soon as the thermal state reaches the set threshold
- The time to a thermal trip in case of a thermal overload
- The measurements of the thermal load and thermal state

The settings of this function are listed in the **THERMAL OVERLOAD, GROUP 1** menu column. Check these settings before the test.

To avoid spurious operation of any other protection elements all protection elements except the thermal protection should be disabled for the duration of the thermal element tests. This is done in the relay's CONFIGURATION column. Make a note of which elements need to be re-enabled after testing.

6.3.4.1 Connect the Test Circuit

Determine which output relay has been selected to operate when a thermal trip occurs by viewing the relays Programmable Scheme Logic (PSL).

The PSL can only be changed using the appropriate software. If this software has not been available then the default output relay allocations will still be applicable.

If the **Thermal Trip** (DDB 236) is not mapped directly to an output relay in the PSL, output relay 3 should be used for the test as it operates for any trip condition, DDB 371 Any Trip is assigned to this contact. The **Thermal Alarm** (DDB 178) should be mapped directly to an output relay in the PSL if this feature is to be tested.

The associated terminal numbers can be found from the external connection diagrams in the *Connection Diagrams* chapter.

Connect the output relay so that its operation will trip the test set and stop the timer. Connect the current output of the test set to the **A** phase current transformer input of the relay (terminals C3 - C2 (1 A, 40TE case), D3 - D2 (1 A, 60TE case), F3 - F2 (1 A, 80TE case), C1 - C2 (5 A, 40TE case), D1 - D2 (5 A, 60TE case) F1 - F2 (5 A, 80TE case)). Ensure that the timer will start when the current is applied to the relay.

Note	*If the timer does not start when the current is applied, the connections may be incorrect for the direction of operation set. Try again with the current connections reversed.*

6.3.4.2 Perform the Test

Ensure that the timer on the test set is reset.

Ensure that the thermal state is reset (see in cell [0402: MEASUREMENTS 3, Thermal State]: if not, this reset can be done through the cell [0404: MEASUREMENTS 3, Reset Th State] by selecting YES.

Check the position of the interrupting device by viewing the status of the two opto-inputs (52a and 52b status inputs) used to indicate the device position. The 52a input must be energized to simulate the closed position of the interrupting device to enable the thermal protection heating time constants. The cooling time constant is used when the interrupting device is open.

Apply a current of twice the setting [in cell 3001 : THERMAL OVERLOAD, GROUP1, Ith Current Set] to the relay and note the time displayed when the timer stops. If it is required to repeat the test, make sure to disable Thermal Lockout [in cell 3009]. Also make sure to disable the inhibit during start setting **Inh Trip Dur St** [in cell 300B]. Since most portable secondary injection test sets have limited current output capability, it is suggested to change the **I_{th} Current Set** to 1 A (after the as found value is recorded) and use the 1 A phase current input terminals. In order to save time during testing, it is advisable to set all the thermal time constants to 5 minutes.

Ensure that the thermal state is reset to 0 (see cell [0402 : MEASUREMENTS 3, ThermalState]. If not, the thermal state can be reset through the cell [0404: MEASUREMENTS 3, Reset Th State] by selecting YES.

On completion of the tests any protection elements that were disabled for testing purposes must have their original settings restored in the CONFIGURATION column.

6.3.4.3 Verify the Operating Time

This test is done by a single-phase injection on the A phase current input, it results in that the relay sees equal current magnitudes for both positive and negative phase sequence quantities. Upon injection of a single phase current value equal to Iinject, the relay will see current magnitudes of Iinject/3 for both positive and negative phase sequences quantities and Iinject for I_{rms}. The equivalent thermal current value I_{eq} calculated by the relay will be given by the following:

$$I_{eq} = \sqrt{(I_1^2 + K\ L_2^2)}$$

Note	This equation is used in software version A4.x(09) and before.

or

$$I_{eq} = \sqrt{(I_{rms}^2 + K\ I_2^2)}$$

Note	This equation is used in software version B1.0(20) or later.

Where:

I_1 = Positive sequence current
I_{rms} : root mean square current
I_2 : negative sequence current
K is a constant proportional to the thermal capacity of the motor
(**K Coefficient** default setting = 3)

The equivalent motor heating current assuming K = 3 for (1) becomes:

$$I_{eq} = \sqrt{\ } [\ 4 * (\ I_{inject} / 3\ )\ \ 2\ ]$$
$$= (\ 2\ I_{inject} / 3\ )\quad (3)$$

The equivalent motor heating current assuming K = 3 for (2) becomes:

$I_{eq} = \sqrt{}$ [4/3 * (I_{inject}) 2]

$= (2 I_{inject} / \sqrt{3})$ (4)

The equation used to calculate the trip time at 100% of thermal state is:

$$t = \tau \ln \left(\frac{(k^2 - A)}{(k^2 - 1)} \right)$$

where the value of τ (thermal time constant) depends on the current value absorbed by the motor:

$\tau = T_1$ (**Thermal Const T1**) if $I_{th} < I_{eq} <= 2*I_{th}$ overload time constant

$\tau = T_2$ (**Thermal Const T2**) if $I_{eq} > 2*I_{th}$ start-up time constant

τ = Tr (**Cooling Const Tr**) if interrupting device is opened cooling time constant

I_{th} = thermal setting in cell [3001 : THERMAL OVERLOAD, GROUP1, **I_{th} Current Set**]

$k = I_{eq} / I_{th}$ = measured thermal load (or thermal capacity)

A = initial state of the machine, in percentage of the thermal state = 0 for this test.

The time to a thermal trip becomes:

$$t = \tau \ln \left(\frac{k^2}{(k^2 - 1)} \right)$$

The Negative Phase Sequence (NPS) Thermal Protection included in the relay provides a definite time alarm stage and a thermal trip stage.

The equation used to calculate the time to the thermal alarm is:

$$t_{alarm} = \tau \ln \left(\frac{(k^2 - A)}{(k^2 - \text{ThermalAlarm}/100)} \right)$$

Thermal alarm = (**Thermal Alarm**) thermal alarm setting in percentage of the thermal state

Since a current of twice the setting I_{th} is applied, consequently one of the following thermal constants will be used:

- T1 (overload time constant) if the interrupting device is closed.
- T_r (cooling time constant) if the interrupting device is opened.

Apply a current of twice the setting [in cell 3001: THERMAL OVERLOAD, GROUP1, I_{th} Current Set] to the relay and note the time displayed when the timer stops. Check that the operating time recorded by the timer is within the range (calculated trip time ±5% or 40ms whichever is the greater). For all characteristics, allowance must be made for the accuracy of the test equipment being used.

Example

For **I_{th} Current Set** = 0.5 A and **A** phase I_{inject} = 2 A, T1 = 5 mins

Using (3) $k = I_{eq} / I_{th}$ = (2 x 2 /3) / 0.5 = 8/3 A

top = 5 x 60 ln $((8/3)^2 / ((8/3)^2 - 1))$ = 45.465 s

Using (4) $k = I_{eq} / I_{th}$ = (2 x 2 /√3) / 0.5 = 8/√3 A

top = 5 x 60 ln $((8/\sqrt{3})^2 / ((8/\sqrt{3})^2 - 1))$ = 14.4 s

For a thermal alarm setting = 90% using (3) t_{alarm} = 40.59 s

For a thermal alarm setting = 90% using (4) t_{alarm} = 12.96 s

If the injection is done equally on the 3 phases current transformers, the equation used to evaluate I_{eq} will be:

$$I_{eq} = \sqrt{(I_1^2 + K\ L_2^2)}$$

Note	*This equation is used in software version A4.x(09) and before.*

or

$$I_{eq} = \sqrt{(I_{rms}^2 + K\ I_2^2)}$$

Note	*This equation is used in software version B1.0(20) or later.*

And provided the phase currents are balanced, then I2 will be zero.

On completion of the tests any protection elements that were disabled for testing purposes must have their original settings restored in the CONFIGURATION column.

7 ON-LOAD CHECKS

The objectives of the on-load checks are to:

- Confirm the external wiring to the current and voltage inputs is correct.
- Measure the magnitude of capacitive current
- Ensure the on-load differential current is well below the relay setting
- Check the polarity of the line current transformers at each end is consistent.
- Directionality check for directional elements.

Caution	Remove all test leads and temporary shorting leads, and replace any external wiring that was removed to allow testing.

Caution	If any of the external wiring was disconnected from the relay to run any tests, make sure that all connections are restored according to the external connection or scheme diagram.

The following on-load measuring checks ensure the external wiring to the current and voltage inputs is correct but can only be carried out if there are no restrictions preventing the energisation of the plant being protected.

7.1 Voltage Connections

Caution	Using a multimeter, measure the voltage transformer secondary voltages to ensure they are correctly rated. Check that the system phase rotation is correct using a phase rotation meter.

Compare the values of the secondary phase voltages with the relay's measured values, which can be found in the **MEASUREMENTS 1** menu column.

If cell [0D02: MEASURE'T SETUP, Local Values] is set to **Secondary**, the values displayed on the relay LCD or a portable PC connected to the front EIA(RS)232 communication port should be equal to the applied secondary voltage. The values should be within 1% of the applied secondary voltages/currents (5% for P74x). However, an additional allowance must be made for the accuracy of the test equipment being used.

If cell [0D02: MEASURE'T SETUP, Local Values] is set to **Primary**, the values displayed should be equal to the applied secondary voltage multiplied the corresponding voltage transformer ratio set in the **CT & VT RATIOS** menu column (see the following table). Again, the values should be within 1% of the expected value (5% for P74x), plus an additional allowance for the accuracy of the test equipment being used.

Voltage	Cell in MEASUREMENTS 1 Column (02)	Corresponding VT ratio (in 'VT and CT RATIO column (0A) of menu)
V_{AB}	[0214: VAB Magnitude]	[0A01: Main VT Primary] [0A02: Main VT Sec'y]
V_{BC}	[0216: VBC Magnitude]	
V_{CA}	[0218: VCA Magnitude]	
V_{AN}	[021A: VAN Magnitude]	
V_{BN}	[021C: VBN Magnitude]	
V_{CN}	[021E: VCN Magnitude]	
$V_{remanent}$	[0222: Vr AntiBacks Magnitude]	
V_{N}	[0220: VN Measured Mag]	[0A05: NVD VT Primary] [0A06: NVD VT Sec'y]

Table 18 - Measured voltages and VT ratio settings

7.2 Current Connections

Caution	**Measure the current transformer secondary values for each input using a multimeter connected in series with corresponding relay current input.**

Check that the current transformer polarities are correct by measuring the phase angle between the current and voltage, either against a phase meter already installed on site and known to be correct or by determining the direction of power flow by contacting the system control center.

Caution	**Ensure the current flowing in the neutral circuit of the current transformers is negligible.**

Compare the values of the secondary phase currents (and any phase angle) with the relay's measured values, which can be found in the **MEASUREMENTS 1** menu column.

Note	*Under normal load conditions the earth fault function measures little or no current. It is therefore necessary to simulate a phase-to-neutral fault. This can be achieved by temporarily disconnecting one or two of the line current transformer connections to the relay and shorting the terminals of these current transformer secondary windings.*

For P243, P34x and P64x, check that the IA/IB/IC Differential currents measured on the relay are less than 10% of the IA/IB/IC Bias currents, see the **MEASUREMENTS 3** menu. Check that the I2 Magnitude negative phase sequence current measured by the relay is not greater than expected for the particular installation, see the **MEASUREMENTS 1** menu. Check that the active and reactive power measured by the relay are correct, see the Measurements 2 menu. The power measurement modes are described in the *Measurements and Recording* chapter.

If cell [0D02: MEASURE'T SETUP, Local Values] is set to **Secondary**, the current displayed on the relay LCD or a portable PC connected to the front EIA(RS)232 communication port should be equal to the applied secondary current. The values should be within 1% (5% for the P741/P742/P743/P746) of the applied secondary currents. However, an additional allowance must be made for the accuracy of the test equipment being used.

If cell [0D02: MEASURE'T SETUP, Local Values] is set to **Primary**, the current displayed should be equal to the applied secondary current multiplied by the corresponding current transformer ratio set in the **CT & VT RATIOS** menu column (see the *Measured Voltages and VT Ratio Settings* table). Again the values should be within 10% (1% for the P34x, 5% for the P741/P742/P743/P746) of the expected value, plus an additional allowance for the accuracy of the test equipment being used.

Note	*If the relay is applied with a single dedicated current transformer for the earth fault function, it may not be possible to check the relay's measured values as the neutral current will be almost zero.*

8 FINAL CHECKS

The tests are now complete.

Caution	***Remove all test or temporary shorting leads. If it has been necessary to disconnect any of the external wiring from the relay to perform the wiring verification tests, make sure all connections are replaced according to the relevant external connection or scheme diagram.***

Ensure that the relay is restored to service by checking that cell [0F0F: COMMISSIONING TESTS, Test Mode] and [0F12: COMMISSION TESTS, Static Test] are set to '**Disabled**' (0F0D (not 0F0F) for P14x/P24x/P34x/P341/P44y/P54x/P841).

For P14x, P34x, P341, P44x, P44y, P445, P54x, P547 OR P841, if the relay is in a new installation or the circuit breaker has just been maintained, the circuit breaker maintenance and current counters should be zero. These counters can be reset using cell [xxxx: CB CONDITION, Reset All Values]. If the required access level is not active, the relay will prompt for a password to be entered so that the setting change can be made.
(xxxx = 0609 for P14x/P841A, P44y or P54x, xxxx = 0606 for P24x/P34x/P341, xxxx = 0608 for P44x, 0619 for P841B).

If the menu language was changed to allow accurate testing, it must now be restored to the customer's preferred language.

If a MiCOM P991 or Easergy test block is installed, remove the MiCOM P992 or Easergy test plug and replace the test block cover so that the protection is put into service.

Ensure that all event records, fault records, disturbance records, alarms and LEDs have been reset before leaving the relay.

If applicable, replace the secondary front cover on the relay.

Notes:

TEST AND SETTING RECORDS

CHAPTER 12

Date:	05/2017
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.
Hardware suffix:	L (P241) & M (P242 & P243)
Software version:	D1
Connection diagrams:	10P241xx (xx = 01 to 02) 10P242xx (xx = 01) 10P243xx (xx = 01)

CONTENTS

Notes:

1 COMMISSIONING TEST RECORD

1.1 About this Chapter

The Commissioning chapter provides instructions on how to commission the relay – including how to calibrate it and how to establish that it is functioning as intended.

This chapter provides you with a series of templates. You can use this to record the tests which have been made and the settings which have been used. You should use this chapter in conjunction with the Commissioning chapter and any work instructions you have as to what functionality and settings the relay should use.

1.2 Date Record

Date:		Engineer:	
Station:		Circuit:	
		System Frequency:	……… Hz
VT Ratio:	……… / ……… V	CT Ratio (tap in use):	……… /A

1.3 Front Plate Information

Relay type	MiCOM P…………
Model number	
Serial number	
Rated current In	
Rated voltage Vn	
Auxiliary voltage Vx	

1.4 Test Equipment Used

This section should be completed to allow future identification of protective devices that have been commissioned using equipment that is later found to be defective or incompatible but may not be detected during the commissioning procedure.

Overcurrent test set	Model: Serial No:	
Injection test set	Model: Serial No:	
Phase angle meter	Model: Serial No:	
Phase rotation meter	Model: Serial No:	
Optical power meter	Model: Serial No:	
Insulation tester	Model: Serial No:	
Setting software:	Type: Version:	

1.5 Checklist

	Have all relevant safety instructions been followed?	Yes ☐ No ☐
5.	**PRODUCT CHECKS**	
5.1	**With the relay de-energized**	
5.1.1	Visual inspection	
	Relay damaged?	Yes ☐ No ☐
	Rating information correct for installation?	Yes ☐ No ☐
	Case earth installed?	Yes ☐ No ☐
5.1.2	Current transformer shorting contacts close?	Yes ☐ No ☐ Not checked ☐
5.1.3	Insulation resistance >100 MΩ at 500 V dc	Yes ☐ No ☐ Not tested ☐
5.1.4	External wiring	
	Wiring checked against diagram?	Yes ☐ No ☐
	Test block connections checked?	Yes ☐ No ☐ N/A ☐
5.1.5	Watchdog contacts (auxiliary supply off)	
	Terminals 11 and 12 Contact closed?	Yes ☐ No ☐
	Contact resistance	Ω Not measured ☐
	Terminals 13 and 14 Contact open?	Yes ☐ No ☐
5.1.6	Measured auxiliary supply	V ac/dc
5.2	**With the relay energized**	
5.2.1	Watchdog contacts (auxiliary supply on)	
	Terminals 11 and 12 Contact open?	Yes ☐ No ☐
	Terminals 13 and 14 Contact closed?	Yes ☐ No ☐
	Contact resistance	Ω Not measured ☐
5.2.2	LCD front panel display	
	LCD contrast setting used	
5.2.3	Date and time	
	Clock set to local time?	Yes ☐ No ☐
	Time maintained when auxiliary supply removed?	Yes ☐ No ☐
5.2.4	Light emitting diodes	
	Relay healthy (green) LED working?	Yes ☐ No ☐
	Alarm (yellow) LED working?	Yes ☐ No ☐
	Out of service (yellow) LED working?	Yes ☐ No ☐
	Trip (red) LED working?	Yes ☐ No ☐
	All programmable LEDs working? (may be 8 or 18 depending on the model)	Yes ☐ No ☐
5.2.5	Field supply voltage	
	Value measured between terminals 7 and 9	V dc
	Value measured between terminals 8 and 10	V dc

5.2.6 Input opto-isolators (numbers vary depending on the product)

Opto input 1	working?	Yes	☐	No	☐		
Opto input 2	working?	Yes	☐	No	☐		
Opto input 3	working?	Yes	☐	No	☐		
Opto input 4	working?	Yes	☐	No	☐		
Opto input 5	working?	Yes	☐	No	☐		
Opto input 6	working?	Yes	☐	No	☐		
Opto input 7	working?	Yes	☐	No	☐		
Opto input 8	working?	Yes	☐	No	☐		
Opto input 9	working?	Yes	☐	No	☐	N/A	☐
Opto input 10	working?	Yes	☐	No	☐	N/A	☐
Opto input 11	working?	Yes	☐	No	☐	N/A	☐
Opto input 12	working?	Yes	☐	No	☐	N/A	☐
Opto input 13	working?	Yes	☐	No	☐	N/A	☐
Opto input 14	working?	Yes	☐	No	☐	N/A	☐
Opto input 15	working?	Yes	☐	No	☐	N/A	☐
Opto input 16	working?	Yes	☐	No	☐	N/A	☐

5.2.7 Output relays

Relay 1	working?		Yes ☐	No	☐	
	Contact resistance		Ω ☐	Not measured	☐	
Relay 2	working?		Yes ☐	No	☐	
	Contact resistance		Ω ☐	Not measured	☐	
Relay 3	working?		Yes ☐	No	☐	
	Contact resistance		Ω ☐	Not measured	☐	
Relay 4	working?		Yes ☐	No	☐	
	Contact resistance	(N/C)	Ω ☐	Not measured	☐	
		(N/O)	Ω ☐	Not measured	☐	
Relay 5	working?		Yes ☐	No	☐	
	Contact resistance	(N/C)	Ω ☐	Not measured	☐	
		(N/O)	Ω ☐	Not measured	☐	
Relay 6	working?		Yes ☐	No	☐	
	Contact resistance	(N/C)	Ω ☐	Not measured	☐	
		(N/O)	Ω ☐	Not measured	☐	
Relay 7	working?		Yes ☐	No	☐	
	Contact resistance	(N/C)	Ω ☐	Not measured	☐	
		(N/O)	Ω ☐	Not measured	☐	
Relay 8	working?		Yes ☐	No	☐	N/A ☐
	Contact resistance	(N/C)	Ω ☐	Not measured	☐	
		(N/O)	Ω ☐	Not measured	☐	

Relay 9	working?		Yes ☐ No ☐ N/A ☐
	Contact resistance		Ω ☐ Not measured ☐
Relay 10	working?		Yes ☐ No ☐ N/A ☐
	Contact resistance		Ω ☐ Not measured ☐
Relay 11	working?		Yes ☐ No ☐ N/A ☐
	Contact resistance	(N/C)	Ω ☐ Not measured ☐
		(N/O)	Ω ☐ Not measured ☐
Relay 12	working?		Yes ☐ No ☐ N/A ☐
	Contact resistance	(N/C)	Ω ☐ Not measured ☐
		(N/O)	Ω ☐ Not measured ☐
Relay 13	working?		Yes ☐ No ☐ N/A ☐
	Contact resistance	(N/C)	Ω ☐ Not measured ☐
		(N/O)	Ω ☐ Not measured ☐
Relay 14	working?		Yes ☐ No ☐ N/A ☐
	Contact resistance	(N/C)	Ω ☐ Not measured ☐
		(N/O)	Ω ☐ Not measured ☐
Relay 15	working?		Yes ☐ No ☐ N/A ☐
	Contact resistance	(N/C)	Ω ☐ Not measured ☐
		(N/O)	Ω ☐ Not measured ☐
Relay 16	working?		Yes ☐ No ☐ N/A ☐
	Contact resistance	(N/C)	Ω ☐ Not measured ☐
		(N/O)	Ω ☐ Not measured ☐

5.2.8 RTD inputs

Resistor tolerance		%
RTD 1 reading	[04C01: RTD 1 Label]	°C
RTD 2 reading	[04C02: RTD 2 Label]	°C
RTD 3 reading	[04C03: RTD 3 Label]	°C
RTD 4 reading	[04C04: RTD 4 Label]	°C
RTD 5 reading	[04C05: RTD 5 Label]	°C
RTD 6 reading	[04C06: RTD 6 Label]	°C
RTD 7 reading	[04C07: RTD 7 Label]	°C
RTD 8 reading	[04C08: RTD 8 Label]	°C
RTD 9 reading	[04C09: RTD 9 Label]	°C
RTD 10 reading	[04C0A: RTD 10 Label]	°C

5.2.9 Current loop inputs

CLI input type	0-1mA ☐ 0-10mA ☐ 0-20mA ☐ 4-20mA ☐
Analog Input 1 reading at 50% maximum range [4D01: CLI1 Input Label]	
Analog Input 2 reading at 50% maximum range [4D02: CLI2 Input Label]	
Analog Input 3 reading at 50% maximum range [4D03: CLI3 Input Label]	
Analog Input 4 reading at 50% maximum range [4D04: CLI4 Input Label]	

5.2.10 Current loop outputs

	0-1mA ☐ 0-10mA ☐ 0-20mA ☐ 4-20mA ☐
CLO output type	mA
Analog Output 1 current at 50% of rated output	mA
Analog Output 2 current at 50% of rated output	mA
Analog Output 3 current at 50% of rated output	mA
Analog Output 4 current at 50% of rated output	mA

5.2.11 First rear communications port

Communication standard	K-Bus ☐ MODBUS ☐ IEC60870-5-103 ☐ IEC61850 ☐ DNP3* ☐
Communications established?	Yes ☐ No ☐
Protocol converter tested?	Yes ☐ No ☐ N/A ☐

5.2.12	Second rear communications port	K-Bus ☐ EIA(RS)485 ☐ EIA(RS)232 ☐
	Communication port configuration	Yes ☐ No ☐
	Communications established?	Yes ☐ No ☐
	Protocol converter tested?	Yes ☐ No ☐ N/A ☐

5.2.13	Current inputs		
	Displayed current		Primary ☐ Secondary ☐
	Phase CT ratio	([Phase CT Primary] / [Phase CT Sec'y])	N/A ☐
	SEF CT ratio	([SEF CT Primary] / [SEF CT Sec'y])	N/A ☐

Input CT	Applied Value	Displayed Value
IA	A	A
IB	A	A
IC	A	A
IN	A N/A ☐	A N/A ☐
ISEF	A	A
IA (2)	A N/A ☐	A N/A ☐
IB (2)	A N/A ☐	A N/A ☐
IC (2)	A N/A ☐	A N/A ☐

5.2.14	Voltage inputs		
	Displayed voltage		Primary ☐ Secondary ☐
	Main VT ratio	([Main VT Primary] / [Main VT Sec'y])	N/A ☐
	NVD VT ratio	([NVD VT Primary] / [NVDVT Secondary])	N/A ☐

Input VT	Applied Value	Displayed value
Va	V	V
Vb	V	V
Vc	V	V
VN	V	V

6. SETTING CHECKS

6.1	Application-specific function settings applied?	Yes ☐ No ☐
	Application-specific PSL settings applied?	Yes ☐ No ☐ N/A ☐
6.2	Application-specific function settings verified?	Yes ☐ No ☐ N/A ☐
	Application-specific PSL tested?	Yes ☐ No ☐ N/A ☐

6.3	Demonstrate correct relay operation	
6.3.1	Motor differential protection (P243)	
6.3.1.2	Motor Differential lower slope pickup	A
6.3.1.3	Motor Differential upper slope pickup	A
6.3.2.1	Motor Differential Phase A contact routing OK?	Yes ☐ No ☐
	Motor Differential Phase A trip time	s
6.3.2.2	Motor Differential Phase B contact routing OK?	Yes ☐ No ☐
	Motor Differential Phase B trip time	s
6.3.2.3	Motor Differential Phase C contact routing OK?	Yes ☐ No ☐
	Motor Differential Phase C trip time	s
	Average trip time, Phases A, B and C	s

6.3.4 Thermal Overload protection (P241/P242/P243)

Protection function timing tested?	Yes ☐ No ☐
Thermal Trip	
Applied current	A
Expected trip operating time	s
Measured trip operating time	s
Thermal Alarm	
Applied current	A
Expected alarm operating time	s
Measured alarm operating time	s

7. ON-LOAD CHECKS

Test wiring removed?	Yes ☐ No ☐ N/A ☐
Disturbed customer wiring re-checked?	Yes ☐ No ☐ N/A ☐
On-load test performed?	Yes ☐ No ☐

7.1

VT wiring checked?	Yes ☐ No ☐ N/A ☐
Phase rotation correct?	Yes ☐ No ☐
Displayed voltage	Primary ☐ Secondary ☐
Main VT ratio ([Main VT Primary] / [Main VT Sec'y])	V N/A ☐
NVD VT ratio ([NVD VT Primary] / [NVDVT Secondary])	V N/A ☐

Voltages	Applied Value	Displayed value
VAN/VAB	V	V
VBN/VBC	V	V
VCN/VCA	V	V
VN	V	V

7.2

CT wiring checked?	Yes ☐ No ☐ N/A ☐
CT polarities correct?	Yes ☐ No ☐
Displayed current	Primary ☐ Secondary ☐
Phase CT ratio ([Phase CT Primary] / [Phase CT Sec'y])	A N/A ☐
SEF CT ratio ([SEF CT Primary] / [SEF CT Sec'y])	A N/A ☐

Currents	Applied Value	Displayed value
IA	A	A
IB	A	A
IC	A	A
IN	A N/A ☐	A N/A ☐
ISEF	A	A
IA (2) P243 only	A N/A ☐	A N/A ☐
IB (2) P244 only	A N/A ☐	A N/A ☐
IC (2) P245 only	A N/A ☐	A N/A ☐

8. FINAL CHECKS

Test wiring removed?	Yes	☐	No	☐	N/A	☐
Disturbed customer wiring re-checked?	Yes	☐	No	☐	N/A	☐
Test mode disabled?	Yes	☐	No	☐		
Circuit breaker operations counter reset?	Yes	☐	No	☐	N/A	☐
Current counters reset?	Yes	☐	No	☐	N/A	☐
Event records reset?	Yes	☐	No	☐		
Fault records reset?	Yes	☐	No	☐		
Disturbance records reset?	Yes	☐	No	☐		
Alarms reset?	Yes	☐	No	☐		
LEDs reset?	Yes	☐	No	☐		
Secondary front cover replaced?	Yes	☐	No	☐	N/A	☐

COMMENTS #
(# Optional, for site observations or utility-specific notes).

Commissioning Engineer	Customer Witness
Date:	Date:

2 CREATING A SETTING RECORD

You often need to create a record of what settings have been applied to a device. In the past, you could have used paper printouts of all the available settings, and mark up the ones you had used. Keeping such a paper-based Settings Records can be time-consuming and prone to error (e.g. due to being settings written down incorrectly).

The Easergy Studio (MiCOM S1 Studio) software lets you read/write MiCOM devices.

- **Extract** lets you download all the settings from a MiCOM Px40 device. A summary is given in Extract Settings from a MiCOM Px40 Device below.
- **Send** lets you send the settings you currently have open in the Studio software. A summary is given in Send Settings to a MiCOM Px40 Device below.

The Easergy Studio (MiCOM S1 Studio) product is updated periodically. These updates provide support for new features (such as allowing you to manage new MiCOM products, as well as using new software releases and hardware suffixes). The updates may also include fixes. **Accordingly, we strongly advise customers to use the latest Schneider Electric version of Easergy Studio (MiCOM S1 Studio).**

In most cases, it will be quicker and less error prone to extract settings electronically and store them in a settings file on a memory stick. In this way, there will be a digital record which is certain to be accurate. It is also possible to archive these settings files in a repository; so they can be used again or adapted for another use.

Full details of how to do these tasks is provided in the MiCOM S1 Studio help.

A quick summary of the main steps is given below.

In each case you need to make sure that:

- Your computer includes the MiCOM S1 Studio software.
- Your computer and the MiCOM device are powered on.
- You have used a suitable cable to connect your computer to the MiCOM device (Front Port, Rear Port, Ethernet port or Modem as available).

2.1 Extract Settings from a MiCOM Px40 Device

Full details of how to do this is provided in the MiCOM S1 Studio help.

As a quick guide, you need to do the following:

1. In MiCOM S1 Studio, click the Quick Connect… button.
2. Select the relevant Device Type in the Quick Connect dialog box.
3. Click the relevant port in the Port Selection dialog box.
4. Enter the relevant connection parameters in the Connection Parameters dialog box and click the Finish button
5. MiCOM S1 Studio will try to communicate with the Px40 device. It will display a connected message if the connection attempt is successful.
6. The device will appear in the Studio Explorer pane on the top-left of the interface.
7. Click the + button to expand the options for the device, then click on the Settings folder.
8. Right-click on Settings and select the Extract Settings link to read the settings on the device and store them on your computer or a memory stick.
9. After retrieving the settings file, close the dialog box by clicking the Close button.

2.2 Send Settings to a MiCOM Px40 Device

Full details of how to do this is provided in the MiCOM S1 Studio help.

As a quick guide, you need to do the following:

1. In MiCOM S1 Studio, click the Quick Connect… button.
2. Select the relevant Device Type in the Quick Connect dialog box.
3. Click the relevant port in the Port Selection dialog box.
4. Enter the relevant connection parameters in the Connection Parameters dialog box and click the Finish button
5. MiCOM S1 Studio will try to communicate with the Px40 device. It will display a connected message if the connection attempt is successful.
6. The device will appear in the Studio Explorer pane on the top-left hand side of the interface.
7. Click the + button to expand the options for the device and then right-click on the Settings link.
8. To add an existing file, right-click the settings folder and choose Add Existing File.
9. To create a new file, right-click the settings folder and select Add. A file with the next sequential number will be created. Double-click the file to edit.
10. Right-click on the device name and select the Send link.

Note	*When you send settings to a MiCOM Px40 device, the data is stored in a temporary location at first. This temporary data is tested to make sure it is complete. If the temporary data is complete, it will be programmed into the MiCOM Px40 device. This avoids the risk of a device being programmed with incomplete or corrupt settings.*

11. In the Send To dialog box, select the settings file(s) you wish to send, then click the Send button.
12. Close the Send To dialog box by clicking the Close button.

Notes:

MAINTENANCE

CHAPTER 13

Date:	09/2016	
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.	
Hardware suffix:	All MiCOM Px4x products	
Software version:	All MiCOM Px4x products	
Connection diagrams:	P14x (P141, P142, P143 & P145): 10P141xx (xx = 01 to 02) 10P142xx (xx = 01 to 05) 10P143xx (xx = 01 to 11) 10P145xx (xx = 01 to 11) P24x (P241, P242 & P243): 10P241xx (xx = 01 to 02) 10P242xx (xx = 01) 10P243xx (xx = 01) P34x (P342, P343, P344, P345 & P391): 10P342xx (xx = 01 to 17) 10P343xx (xx = 01 to 19) 10P344xx (xx = 01 to 12) 10P345xx (xx = 01 to 07) 10P391xx (xx = 01 to 02) P445: 10P445xx (xx = 01 to 04) P44x (P441, P442 & P444): 10P44101 (SH 1 & 2) 10P44201 (SH 1 & 2) 10P44202 (SH 1) 10P44203 (SH 1 & 2) 10P44401 (SH 1) 10P44402 (SH 1) 10P44403 (SH 1 & 2) 10P44404 (SH 1) 10P44405 (SH 1) 10P44407 (SH 1 & 2) P44y (P443 & P446): 10P44303 (SH 01 and 03) 10P44304 (SH 01 and 03) 10P44305 (SH 01 and 03) 10P44306 (SH 01 and 03) 10P44600 10P44601 (SH 1 to 2) 10P44602 (SH 1 to 2) 10P44603 (SH 1 to 2)	P54x (P543, P544, P545 & P546): 10P54302 (SH 1 to 2) 10P54303 (SH 1 to 2) 10P54400 10P54404 (SH 1 to 2) 10P54405 (SH 1 to 2) 10P54502 (SH 1 to 2) 10P54503 (SH 1 to 2) 10P54600 10P54604 (SH 1 to 2) 10P54605 (SH 1 to 2) 10P54606 (SH 1 to 2) P547: 10P54702xx (xx = 01 to 02) 10P54703xx (xx = 01 to 02) 10P54704xx (xx = 01 to 02) 10P54705xx (xx = 01 to 02) P64x (P642, P643 & P645): 10P642xx (xx = 1 to 10) 10P643xx (xx = 1 to 6) 10P645xx (xx = 1 to 9) P74x (P741, P742 & P743): 10P740xx (xx = 01 to 07) P746: 10P746xx (xx = 00 to 21) P841: 10P84100 10P84101 (SH 1 to 2) 10P84102 (SH 1 to 2) 10P84103 (SH 1 to 2) 10P84104 (SH 1 to 2) 10P84105 (SH 1 to 2) P849: 10P849xx (xx = 01 to 06)

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Notes:

1 MAINTENANCE PERIOD

Warning	**Before inspecting any wiring, performing any tests or carrying out any work on the equipment, you should be familiar with the contents of the Safety Information and Technical Data sections and the information on the equipment's rating label.**

It is recommended that products supplied by Schneider Electric receive periodic monitoring after installation. In view of the critical nature of protective and control equipment, and their infrequent operation, it is desirable to confirm that they are operating correctly at regular intervals.

Schneider Electric protection and control equipment is designed for a life in excess of 20 years.

MiCOM relays are self-supervising and so require less maintenance than earlier designs. Most problems will result in an alarm so that remedial action can be taken. However, some periodic tests should be done to ensure that the equipment is functioning correctly and the external wiring is intact.

If the customer's organization has a preventative maintenance policy, the recommended product checks should be included in the regular program. Maintenance periods depend on many factors, such as:

- The operating environment
- The accessibility of the site
- The amount of available manpower
- The importance of the installation in the power system
- The consequences of failure

2 MAINTENANCE CHECKS

Although some functionality checks can be performed from a remote location by using the communications ability of the equipment, these are predominantly restricted to checking that the equipment, is measuring the applied currents and voltages accurately, and checking the circuit breaker maintenance counters. Therefore it is recommended that maintenance checks are performed locally (i.e. at the equipment itself).

Warning	**Before carrying out any work on the equipment, you should be familiar with the contents of the Safety Information chapter/Safety Guide SFTY/5L M/L11 or later issue, the Technical Data chapter and the ratings on the equipment rating label.**

Warning	**If a P391 is used, you should also be familiar with the ratings and warning statements in the P391 technical manual.**

2.1 Alarms

The alarm status LED should first be checked to identify if any alarm conditions exist. If so, press the read key ( ) repeatedly to step through the alarms.

Clear the alarms to extinguish the LED.

2.2 Opto-Isolators

The opto-isolated inputs can be checked to ensure that the equipment responds to energization by repeating the commissioning test detailed in the Commissioning chapter.

2.3 Output Relays

The output relays can be checked to ensure that they operate by repeating the commissioning test detailed in the Commissioning chapter.

2.4 Measurement Accuracy

If the power system is energized, the values measured by the equipment can be compared with known system values to check that they are in the approximate range that is expected. If they are, the analog/digital conversion and calculations are being performed correctly by the relay. Suitable test methods can be found in the Commissioning chapter.

Alternatively, the values measured by the equipment can be checked against known values injected via the test block, if fitted, or injected directly into the equipment terminals. Suitable test methods can be found in the Commissioning chapter. These tests will prove the calibration accuracy is being maintained.

3 METHOD OF REPAIR

If the equipment should develop a fault whilst in service, depending on the nature of the fault, the watchdog contacts will change state and an alarm condition will be flagged. Due to the extensive use of surface-mount components, faulty Printed Circuit Boards (PCBs) should be replaced, as it is not possible to perform repairs on damaged PCBs. Therefore either the complete equipment module or just the faulty PCB (as identified by the in-built diagnostic software), can be replaced. Advice about identifying the faulty PCB can be found in the Troubleshooting chapter.

The preferred method is to replace the complete equipment module as it ensures that the internal circuitry is protected against electrostatic discharge and physical damage at all times and overcomes the possibility of incompatibility between replacement PCBs. However, it may be difficult to remove installed equipment due to limited access in the back of the cubicle and the rigidity of the scheme wiring.

Replacing PCBs can reduce transport costs but requires clean, dry conditions on site and higher skills from the person performing the repair. If the repair is not performed by an approved service center, the warranty will be invalidated.

Warning **Before carrying out any work on the equipment, you should be familiar with the contents of the Safety Information chapter/Safety Guide SFTY/5L M/L11 or later issue, the Technical Data chapter and the ratings on the equipment rating label.**

This should ensure that no damage is caused by incorrect handling of the electronic components.

3.1 Replacing the Complete Equipment IED/Relay

The case and rear terminal blocks have been designed to facilitate removal of the IED/relay should replacement or repair become necessary without having to disconnect the scheme wiring.

Warning	**Before working at the rear of the equipment, isolate all voltage and current supplies to the equipment.**

Note	*The MiCOM range has integral current transformer shorting switches which will close when the heavy duty terminal block is removed.*

1. Disconnect the equipment's earth, IRIG-B and fiber optic connections, as appropriate, from the rear of the device.

   There are two types of terminal block used on the equipment, medium and heavy duty, which are fastened to the rear panel using Pozidriv or PZ1 screws. The P24x/P34x/P64x ranges also includes an RTD/CLIO terminal block option. These block types are shown in the ***Commissioning*** chapter.

Important	*The use of a magnetic bladed screwdriver is recommended to minimize the risk of the screws being left in the terminal block or lost.*

2. Without exerting excessive force or damaging the scheme wiring, pull the terminal blocks away from their internal connectors.
3. Remove the screws used to fasten the equipment to the panel, rack, etc. These are the screws with the larger diameter heads that are accessible when the access covers are fitted and open.

Warning	**If the top and bottom access covers have been removed, do not remove the screws with the smaller diameter heads which are accessible. These screws secure the front panel to the equipment.**

4. Withdraw the equipment carefully from the panel, rack, etc. because it will be heavy due to the internal transformers.

To reinstall the repaired or replacement equipment, follow the above instructions in reverse, ensuring that each terminal block is relocated in the correct position and the case earth, IRIG-B and fiber optic connections are replaced. To facilitate easy identification of each terminal block, they are labeled alphabetically with 'A' on the left-hand side when viewed from the rear.

Once reinstallation is complete, the equipment should be re-commissioned using the instructions in the Commissioning chapter.

3.2 Replacing a PCB

Replacing PCBs and other internal components must be undertaken only by Service Centers approved by Schneider Electric. Failure to obtain the authorization of Schneider Electric after sales engineers prior to commencing work may invalidate the product warranty.

Warning **Before removing the front panel to replace a PCB, remove the auxiliary supply and wait at least 30 seconds for the capacitors to discharge.**
We strongly recommend that the voltage and current transformer connections and trip circuit are isolated.

Schneider Electric support teams are available world-wide. We strongly recommend that any repairs be entrusted to those trained personnel. For this reason, details on product disassembly and re-assembly are not included here.

4 RE-CALIBRATION

Re-calibration is not required when a PCB is replaced **unless it happens to be one of the boards in the input module;** the replacement of either directly affects the calibration.

Warning	**Although it is possible to carry out re-calibration on site, this requires test equipment with suitable accuracy and a special calibration program to run on a PC. It is therefore recommended that the work be carried out by the manufacturer, or entrusted to an approved service center.**

5 CHANGING THE BATTERY

Each relay/IED has a battery to maintain status data and the correct time when the auxiliary supply voltage fails. The data maintained includes event, fault and disturbance records and the thermal state at the time of failure.

This battery will periodically need changing, although an alarm will be given as part of the relay's/IED's continuous self-monitoring in the event of a low battery condition.

If the battery-backed facilities are not required to be maintained during an interruption of the auxiliary supply, the steps below can be followed to remove the battery, but do not replace with a new battery.

Warning	Before carrying out any work on the equipment, you should be familiar with the contents of the Safety Information chapter/Safety Guide SFTY/5L M/L11 or later issue, the Technical Data chapter and the ratings on the equipment rating label.

5.1 Instructions for Replacing the Battery

1. Open the bottom access cover on the front of the equipment.
2. Gently extract the battery from its socket. If necessary, use a small, insulated screwdriver to prize the battery free.
3. Ensure that the metal terminals in the battery socket are free from corrosion, grease and dust.
4. The replacement battery should be removed from its packaging and placed into the battery holder, taking care to ensure that the polarity markings on the battery agree with those adjacent to the socket.

Note	*Only use a type ½AA Lithium battery with a nominal voltage of 3.6 V and safety approvals such as UL (Underwriters Laboratory), CSA (Canadian Standards Association) or VDE (Vereinigung Deutscher Elektrizitätswerke).*

5. Ensure that the battery is securely held in its socket and that the battery terminals are making good contact with the metal terminals of the socket.
6. Close the bottom access cover.

5.2 Post Modification Tests

To ensure that the replacement battery will maintain the time and status data if the auxiliary supply fails, check cell [0806: DATE and TIME, Battery Status] reads 'Healthy'. If further confirmation that the replacement battery is installed correctly is required, the commissioning test is described in the Commissioning chapter, 'Date and Time', can be performed.

5.3 Battery Disposal

The battery that has been removed should be disposed of in accordance with the disposal procedure for Lithium batteries in the country in which the equipment is installed.

6 CLEANING

Warning **Before cleaning the equipment ensure that all ac and dc supplies, current transformer and voltage transformer connections are isolated to prevent any chance of an electric shock whilst cleaning.**

The equipment may be cleaned using a lint-free cloth moistened with clean water. The use of detergents, solvents or abrasive cleaners is not recommended as they may damage the relay’s surface and leave a conductive residue.

TROUBLESHOOTING

CHAPTER 14

Date:	09/2016	
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.	
Hardware Suffix:	All MiCOM Px4x products	
Software Version:	All MiCOM Px4x products	
Connection Diagrams:	P14x (P141, P142, P143 & P145): 10P141xx (xx = 01 to 02) 10P142xx (xx = 01 to 05) 10P143xx (xx = 01 to 11) 10P145xx (xx = 01 to 11) P24x (P241, P242 & P243): 10P241xx (xx = 01 to 02) 10P242xx (xx = 01) 10P243xx (xx = 01) P34x (P342, P343, P344, P345 & P391): 10P342xx (xx = 01 to 17) 10P343xx (xx = 01 to 19) 10P344xx (xx = 01 to 12) 10P345xx (xx = 01 to 07) 10P391xx (xx = 01 to 02) P445: 10P445xx (xx = 01 to 04) P44x(P442 & P444): 10P44101 (SH 1 & 2) 10P44201 (SH 1 & 2) 10P44202 (SH 1) 10P44203 (SH 1 & 2) 10P44401 (SH 1) 10P44402 (SH 1) 10P44403 (SH 1 & 2) 10P44404 (SH 1) 10P44405 (SH 1) 10P44407 (SH 1 & 2) P44y (P443 & P446): 10P44303 (SH 01 and 03) 10P44304 (SH 01 and 03) 10P44305 (SH 01 and 03) 10P44306 (SH 01 and 03) 10P44600 10P44601 (SH 1 to 2) 10P44602 (SH 1 to 2) 10P44603 (SH 1 to 2)	P54x (P543, P544, P545 & P546): 10P54302 (SH 1 to 2) 10P54303 (SH 1 to 2) 10P54400 10P54404 (SH 1 to 2) 10P54405 (SH 1 to 2) 10P54502 (SH 1 to 2) 10P54503 (SH 1 to 2) 10P54600 10P54604 (SH 1 to 2) 10P54605 (SH 1 to 2) 10P54606 (SH 1 to 2) P547: 10P54702xx (xx = 01 to 02) 10P54703xx (xx = 01 to 02) 10P54704xx (xx = 01 to 02) 10P54705xx (xx = 01 to 02) P64x (P642, P643 & P645): 10P642xx (xx = 1 to 10) 10P643xx (xx = 1 to 6) 10P645xx (xx = 1 to 9) P74x (P741, P742 & P743): 10P740xx (xx = 01 to 07) P746: 10P746xx (xx = 00 to 21) P841: 10P84100 10P84101 (SH 1 to 2) 10P84102 (SH 1 to 2) 10P84103 (SH 1 to 2) 10P84104 (SH 1 to 2) 10P84105 (SH 1 to 2) P849: 10P849xx (xx = 01 to 06)

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TABLES

Notes:

1 INTRODUCTION

Warning	**Before carrying out any work on the equipment, you should be familiar with the contents of the Safety Information chapter/Safety Guide SFTY/5L M/L11 or later issue, the Technical Data chapter and the ratings on the equipment rating label.**

The purpose of this chapter of the service manual is to allow an error condition on the relay to be identified so that appropriate corrective action can be taken.

If the relay has developed a fault, it should be possible in most cases to identify which relay module requires attention. The *Maintenance* chapter advises on the recommended method of repair where faulty modules need replacing. It is not possible to perform an on-site repair to a faulted module.

In cases where a faulty relay/module is being returned to the manufacturer or one of their approved service centers, completed copy of the Repair/Modification Return Authorization Form located at the end of this chapter should be included.

2 INITIAL PROBLEM IDENTIFICATION

Consult the following table to find the description that best matches the problem experienced, then consult the section referenced to perform a more detailed analysis of the problem.

Symptom	Refer To
Relay fails to power up	Power-Up Errors section
Relay powers up - but indicates error and halts during power-up sequence	Error Message/Code On Power-Up section
Relay Powers up but Out of Service LED is illuminated	Out of Service LED illuminated on Power Up section
Error during normal operation	Error Code During Operation section
Mal-operation of the relay during testing	Mal-Operation of the Relay during Testing section

Table 1 - Problem identification

3 POWER UP ERRORS

If the relay does not appear to power up then the following procedure can be used to determine whether the fault is in the external wiring, auxiliary fuse, power supply module of the relay or the relay front panel.

Test	Check	Action
1	Measure auxiliary voltage on terminals 1 and 2; verify voltage level and polarity against rating the label on front. Terminal 1 is –dc, 2 is +dc	If auxiliary voltage is present and correct, then proceed to test 2. Otherwise the wiring/fuses in auxiliary supply should be checked.
2	Do LEDs/and LCD backlight illuminate on power-up, also check the N/O watchdog contact for closing.	If they illuminate or the contact closes and no error code is displayed then error is probably in the main processor board (front panel). If they do not illuminate and the contact does not close then proceed to test 3.
3	Check Field voltage output (nominally 48V DC)	If field voltage is not present then the fault is probably in the relay power supply module.

Table 2 - Failure of relay to power up

4 ERROR MESSAGE/CODE ON POWER-UP

During the power-up sequence of the relay self-testing is performed as indicated by the messages displayed on the LCD. If an error is detected by the relay during these self-tests, an error message will be displayed and the power-up sequence will be halted. If the error occurs when the relay application software is executing, a maintenance record will be created and the relay will reboot.

Test	Check	Action
1	Is an error message or code permanently displayed during power up?	If relay locks up and displays an error code permanently then proceed to Test 2. If the relay prompts for input by the user proceed to Test 4. If the relay re-boots automatically then proceed to Test 5.
2	Record displayed error, then remove and re-apply relay auxiliary supply.	Record whether the same error code is displayed when the relay is rebooted. If no error code is displayed then contact the local service center stating the error code and relay information. If the same code is displayed proceed to Test 3.
3	Error code Identification Following text messages (in English) will be displayed if a fundamental problem is detected preventing the system from booting: Bus Fail address lines SRAM Fail data lines FLASH Fail format error FLASH Fail checksum Code Verify Fail These hex error codes relate to errors detected in specific relay modules:	These messages indicate that a problem has been detected on the main processor board of the relay (located in the front panel).
	0c140005/0c0d0000	Input Module (inc. Opto-isolated inputs)
	0c140006/0c0e0000	Output Relay Cards
	Last 4 digits provide details on the actual error.	Other error codes relate to problems within the main processor board hardware or software. It will be necessary to contact Schneider Electric with details of the problem for a full analysis.
4	Relay displays message for corrupt settings and prompts for restoration of defaults to the affected settings.	The power up tests have detected corrupted relay settings, it is possible to restore defaults to allow the power-up to be completed. It will then be necessary to re-apply the application-specific settings.
5	Relay resets on completion of power up - record error code displayed	Error 0x0E080000, Programmable Scheme Logic (PSL) error due to excessive execution time. Restore default settings by performing a power up with ⇦ and ⇨ keys depressed, confirm restoration of defaults at prompt using (↵) key. If relay powers up successfully, check PSL for feedback paths. Other error codes will relate to software errors on the main processor board, contact Schneider Electric.

Table 3 - Power-up self-test error

5 OUT OF SERVICE LED ILLUMINATED ON POWER UP

Test	Check	Action	
1	Using the relay menu confirm whether the Commission Test/Test Mode setting is Contact Blocked. Otherwise proceed to test 2.	If the setting is Contact Blocked then disable the test mode and, verify that the Out of Service LED is extinguished.	
2	Select and view the last maintenance record from the menu (in the View Records).	Check for H/W Verify Fail this indicates a discrepancy between the relay model number and the hardware; examine the "**Maint. Data**", this indicates the causes of the failure using bit fields:	
		Bit	**Meaning**
		0	The application type field in the model number does not match the software ID
		1	The application field in the model number does not match the software ID
		2	The variant 1 field in the model number does not match the software ID
		3	The variant 2 field in the model number does not match the software ID
		4	The protocol field in the model number does not match the software ID
		5	The language field in the model number does not match the software ID
		6	The VT type field in the model number is incorrect (110V VTs fitted)
		7	The VT type field in the model number is incorrect (440V VTs fitted)
		8	The VT type field in the model number is incorrect (no VTs fitted)

Table 4 - Out of service LED illuminated

6 ERROR CODE DURING OPERATION

The relay performs continuous self-checking, if an error is detected then an error message will be displayed, a maintenance record will be logged and the relay will reset (after a 1.6 second delay). A permanent problem (for example due to a hardware fault) will generally be detected on the power up sequence, following which the relay will display an error code and halt. If the problem was transient in nature then the relay should reboot correctly and continue in operation. The nature of the detected fault can be determined by examination of the maintenance record logged.

There are also two cases where a maintenance record will be logged due to a detected error where the relay will not reset. These are detection of a failure of either the field voltage or the lithium battery, in these cases the failure is indicated by an alarm message, however the relay will continue to operate.

If the field voltage is detected to have failed (the voltage level has dropped below threshold), then a scheme logic signal is also set. This allows the scheme logic to be adapted in the case of this failure (for example if a blocking scheme is being used).

In the case of a battery failure it is possible to prevent the relay from issuing an alarm using the setting under the Date and Time section of the menu. This setting '**Battery Alarm**' can be set to '**Disabled**' to allow the relay to be used without a battery, without an alarm message being displayed.

In the case of an RTD board failure, an alarm "RTD board fail" message is displayed, the RTD protection is disabled, but the operation of the rest of the relay functionality is unaffected.

7 MAL-OPERATION OF THE RELAY DURING TESTING

7.1 Failure of Output Contacts

An apparent failure of the relay output contacts may be caused by the relay configuration; the following tests should be performed to identify the real cause of the failure.

Note	*The relay self-tests verify that the coil of the contact has been energized, an error will be displayed if there is a fault in the output relay board.*

Test	Check	Action
1	Is the Out of Service LED illuminated?	Illumination of this LED may indicate that the relay is Contact Blocked or that the protection has been disabled due to a hardware verify error (see the *Out of service LED illuminated* table..
2	Examine the Contact status in the Commissioning section of the menu.	If the relevant bits of the contact status are operated, proceed to test 4, if not proceed to test 3.
3	Verify by examination of the fault record or by using the test port whether the protection element is operating correctly.	If the protection element does not operate verify whether the test is being correctly applied. If the protection element does operate, it will be necessary to check the PSL to ensure that the mapping of the protection element to the contacts is correct.
4	Using the Commissioning/Test mode function apply a test pattern to the relevant relay output contacts and verify whether they operate (note the correct external connection diagram should be consulted). A continuity tester can be used at the rear of the relay for this purpose.	If the output relay does operate, the problem must be in the external wiring to the relay. If the output relay does not operate this could indicate a failure of the output relay contacts (note that the self-tests verify that the relay coil is being energized). Ensure that the closed resistance is not too high for the continuity tester to detect.

Table 5 - Failure of output contacts

7.2 Failure of Opto-Isolated Inputs

The opto-isolated inputs are mapped onto the relay internal signals using the PSL. If an input does not appear to be recognized by the relay scheme logic the Commission Tests/Opto Status menu option can be used to verify whether the problem is in the opto-isolated input itself or the mapping of its signal to the scheme logic functions. If the opto-isolated input does appear to be read correctly then it will be necessary to examine its mapping within the PSL.

Ensure the voltage rating for the opto inputs has been configured correctly with applied voltage. If the opto-isolated input state is not being correctly read by the relay the applied signal should be tested. Verify the connections to the opto-isolated input using the correct wiring diagram and the correct nominal voltage settings in any standard or custom menu settings. Next, using a voltmeter verify that 80% opto setting voltage is present on the terminals of the opto-isolated input in the energized state. If the signal is being correctly applied to the relay then the failure may be on the input card itself. Depending on which opto-isolated input has failed this may require replacement of either the complete analog input module (the board within this module cannot be individually replaced without re-calibration of the relay) or a separate opto board.

7.3 Incorrect Analog Signals

The measurements may be configured in primary or secondary to assist. If it is suspected that the analog quantities being measured by the relay are not correct then the measurement function of the relay can be used to verify the nature of the problem. The measured values displayed by the relay should be compared with the actual magnitudes at the relay terminals. Verify that the correct terminals are being used (in particular the dual rated CT inputs) and that the CT and VT ratios set on the relay are correct. The correct 120 degree displacement of the phase measurements should be used to confirm that the inputs have been correctly connected.

7.4 PSL Editor Troubleshooting

A failure to open a connection could be because of one or more of the following:

- The relay address is not valid (note: this address is always 1 for the front port).
- Password is not valid
- Communication Set-up - COM port, Baud rate, or Framing - is not correct
- Transaction values are not suitable for the relay and/or the type of connection
- Modem configuration is not valid. Changes may be necessary when using a modem
- The connection cable is not wired correctly or broken. See MiCOM S1 connection configurations
- The option switches on any KITZ101/102 that is in use may be incorrectly set

7.4.1 Diagram Reconstruction after Recover from Relay

Although the extraction of a scheme from a relay is supported, the facility is provided as a way of recovering a scheme in the event that the original file is unobtainable.

The recovered scheme will be logically correct, but much of the original graphical information is lost. Many signals will be drawn in a vertical line down the left side of the canvas. Links are drawn orthogonally using the shortest path from A to B.

Any annotation added to the original diagram (titles, notes, etc.) are lost.

Sometimes a gate type may not be what was expected, e.g. a 1-input AND gate in the original scheme will appear as an OR gate when uploaded. Programmable gates with an inputs-to-trigger value of 1 will also appear as OR gates.

7.4.2 PSL Version Check

The PSL is saved with a version reference, time stamp and CRC check. This gives a visual check whether the default PSL is in place or whether a new application has been downloaded.

8 REPAIR AND MODIFICATION PROCEDURE

Please follow these steps to return an Automation product to us:

1. Get the Repair and Modification Authorization Form (RMA).

   A copy of the RMA form is shown at the end of this section.

2. Fill in the RMA form.

   Fill in only the white part of the form.

   Please ensure that all fields marked **(M)** are completed such as:

   Equipment model

   Model No. and Serial No.

   Description of failure or modification required (please be specific)

   Value for customs (in case the product requires export)

   Delivery and invoice addresses

   Contact details

3. Receive from local service contact, the information required to ship the product.

   Your local service contact will provide you with all the information:

   Pricing details

   RMA No

   Repair center address

   If required, an acceptance of the quote must be delivered before going to next stage.

4. Send the product to the repair center.

   Address the shipment to the repair center specified by your local contact.

   Ensure all items are protected by appropriate packaging: anti-static bag and foam protection.

   Ensure a copy of the import invoice is attached with the unit being returned.

   Ensure a copy of the RMA form is attached with the unit being returned.

   E-mail or fax a copy of the import invoice and airway bill document to your local contact.

Notes:

REPAIR/MODIFICATION RETURN AUTHORIZATION FORM

FIELDS IN GREY TO BE FILLED IN BY SCHNEIDER ELECTRIC PERSONNEL ONLY

Reference **RMA:**		Date:
Repair Center Address (for shipping)	**Service Type** ☐ Retrofit ☐ Warranty ☐ Paid service ☐ Under repair contract ☐ Wrong supply	LSC PO No.:
Schneider Electric - Local Contact Details Name: Telephone No.: Fax No.: E-mail:		

IDENTIFICATION OF UNIT

Fields marked (M) are mandatory, delays in return will occur if not completed.

Model No./Part No.: **(M)**	Site Name/Project:
Manufacturer Reference: **(M)**	Commissioning Date:
Serial No.: **(M)**	Under Warranty: ☐ Yes ☐ No
Software Version:	Additional Information:
Quantity:	Customer P.O (if paid):

FAULT INFORMATION

Type of Failure Hardware fail ☐ Mechanical fail/visible defect ☐ Software fail ☐ Other: **Fault Reproducibility** Fault persists after removing, checking on test bench ☐ Fault persists after re-energization ☐ Intermittent fault ☐	**Found Defective** During FAT/inspection ☐ On receipt ☐ During installation/commissioning ☐ During operation ☐ Other:

Description of Failure Observed or Modification Required - *Please be specific* **(M)**

FOR REPAIRS ONLY

Would you like us to install an updated firmware version after repair?	☐	Yes	☐	No

CUSTOMS & INVOICING INFORMATION

Required to allow return of repaired items

Value for Customs (M)	
Customer Invoice Address ((M) if paid)	**Customer Return Delivery Address (full street address) (M)** Part shipment accepted ☐ Yes ☐ No **OR** Full shipment required ☐ Yes ☐ No
Contact Name: Telephone No.: Fax No.: E-mail:	Contact Name: Telephone No.: Fax No.: E-mail:

REPAIR TERMS

1. **Please ensure that a copy of the import invoice is attached with the returned unit, together with the airway bill document.** Please fax/e-mail a copy of the appropriate documentation **(M)**.
2. Please ensure the Purchase Order is released, for paid service, to allow the unit to be shipped.
3. Submission of equipment to Schneider Electric is deemed as authorization to repair and acceptance of quote.
4. Please ensure all items returned are marked as Returned for 'Repair/Modification' and **protected by appropriate packaging** (anti-static bag for each board and foam protection).

SCADA COMMUNICATIONS

CHAPTER 15

Date:	05/2017
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.
Hardware suffix:	L (P241) & M (P242 & P243)
Software version:	D1
Connection diagrams:	10P241xx (xx = 01 to 02) 10P242xx (xx = 01) 10P243xx (xx = 01)

CONTENTS

FIGURES

TABLES

1 INTRODUCTION

This chapter describes the remote interfaces of the MiCOM relay in enough detail to allow integration in a substation communication network. The relay supports a choice of one of a number of protocols through the rear 2-wire EIA(RS)485 communication interface, selected using the model number when ordering. This is in addition to the front serial interface and second rear communications port, which supports the Courier protocol only. According to the protocol and hardware options selected, the interface may alternatively be presented over an optical fiber interface, or via an Ethernet connection.

The supported protocols include:

- Courier
- IEC-80870-5-103
- MODBUS
- IEC 61850 Ethernet Interface

The implementation of both Courier and IEC 60870-5-103 on RP1 can also, optionally, be presented over fiber as well as EIA(RS)485.

The DNP3.0 implementation is available via the EIA(RS)485 port.

The rear EIA(RS)-485 interface is isolated and is suitable for permanent connection whichever protocol is selected. The advantage of this type of connection is that up to 32 relays can be daisy-chained together using a simple twisted-pair electrical connection.

Note	*The second rear Courier port and the fiber optic interface are mutually exclusive as they occupy the same physical slot.*

2 CONNECTIONS TO THE COMMUNICATIONS PORT

2.1 Front Port

The front communications port is not intended for permanent connection. The front communications port supports the Courier protocol and is implemented on an EIA(RS)232 connection. A 9-pin connector type, as described in the 'Getting Started' (GS) chapter of this manual, is used, and the cabling requirements are detailed in the 'Connection Diagrams' (CD) chapter of this manual.

2.2 Rear Communication Port EIA(RS)485

The rear EIA(RS)-485 communication port is provided by a 3-terminal screw connector on the back of the relay. See the Connection Diagrams chapter for details of the connection terminals. The rear port provides K-Bus/EIA(RS)-485 serial data communication and is intended for use with a permanently-wired connection to a remote control center. Of the three connections, two are for the signal connection, and the other is for the earth shield of the cable.

When the K-Bus option is selected for the rear port, the two signal connections are not polarity conscious, however for MODBUS, IEC60870-5-103 and DNP3.0 care must be taken to observe the correct polarity.

The protocol provided by the relay is indicated in the relay menu in the **Communications** column. Using the keypad and LCD, first check that the **Comms. settings** cell in the **Configuration** column is set to **Visible**, then move to the **Communications** column. The first cell down the column shows the communication protocol that is being used by the rear port.

Note	*Unless the K-Bus option is chosen for the rear port, correct polarity must be observed for the signal connections. In all other respects (bus wiring, topology, connection, biasing and termination) K-Bus can be considered the same as EIA(RS)485.*

2.3 Second Rear Communication Port (RP2) (Courier)

Relays with Courier, MODBUS, IEC60870-5-103 or DNP3.0 protocol on the first rear communications port have the option of a second rear port, running the Courier language. The second port is intended typically for dial-up modem access by protection engineers or operators, when the main port is reserved for SCADA communication traffic. Communication is through one of three physical links: K-Bus, EIA(RS)-485 or EIA(RS)-232. The port supports full local or remote protection and control access using MiCOM S1 Studio.

When changing the port configuration between K-Bus, EIA(RS)-485 and EIA(RS)-232, reboot the relay to update the hardware configuration of the second rear port.

The EIA(RS)-485 and EIA(RS)-232 protocols can be configured to operate with a modem, using an IEC60870 10-bit frame.

If both rear communications ports are connected to the same bus, make sure their address settings are not the same to avoid message conflicts.

Port Configuration	Valid Communication Protocol
K-Bus	K-Bus
EIA(RS)-232	IEC60870 FT1.2, 11-bit frame IEC60870, 10-bit frame
EIA(RS)-485	IEC60870 FT1.2, 11-bit frame IEC60870, 10-bit frame

Table 1 – Port configurations and communication protocols

2.3.1 Courier Protocol

The second rear communications port is functionally the same as described in the previous section for a Courier rear communications port, with the following exceptions:

2.3.1.1 Event Extraction

Automatic event extraction is not supported when the first rear port protocol is Courier, MODBUS or CS103. It is supported when the first rear port protocol is DNP3.0.

2.3.1.2 Disturbance Record Extraction

Automatic disturbance record extraction is not supported when the first rear port protocol is Courier, MODBUS or CS103. It is supported when the first rear port protocol is DNP3.0.

2.3.2 Connection to the Second Rear Port

The second rear Courier port connects using the 9-way female D-type connector (SK4) in the middle of the card end plate (between the IRIG-B connector and lower D-type). The connection complies with EIA(RS)-574.

For IEC60870-5-2 over EIA(RS)-232		**For K-bus or IEC60870-5-2 over EIA(RS)-485**	
Pin	Connection	Pin*	Connection
1	No Connection		
2	RxD		
3	TxD		
4	DTR#	4	EIA(RS)-485 - 1 (+ ve)
5	Ground		
6	No Connection		
7	RTS#	7	EIA(RS)-485 - 2 (- ve)
8	CTS#		
9	No Connection		
# - These pins are control lines for use with a modem.		* - All other pins unconnected.	

Notes *Connector pins 4 and 7 are used by both the EIA(RS)-232and EIA(RS)-485 physical layers, but for different purposes. Therefore, the cables should be removed during configuration switches.*
When using the EIA(RS)-485 protocol, an EIA(RS)-485 to EIA(RS)-232 converter is needed to connect the relay to a modem or PC running MiCOM S1 Studio. A Schneider Electric CK222 is recommended.
EIA(RS)-485 is polarity sensitive, with pin 4 positive (+) and pin 7 negative (-).
The K-Bus protocol can be connected to a PC using a KITZ101 or 102.

Table 2 – Pin connections over EIA(RS)-232 and EIS(RS)-485

2.4 EIA(RS)485 Bus

The EIA(RS)-485 two-wire connection provides a half-duplex fully isolated serial connection to the product. The connection is polarized and while the product's connection diagrams show the polarization of the connection terminals, there is no agreed definition of which terminal is which. If the master is unable to communicate with the product and the communication parameters match, make sure the two-wire connection is not reversed.

EIA(RS)-485 provides the capability to connect multiple devices to the same two-wire bus. MODBUS is a master-slave protocol, so one device is the master, and the remaining devices are slaves. It is not possible to connect two masters to the same bus, unless they negotiate bus access.

2.4.1 EIA(RS)485 Bus Termination

The EIA(RS)-485 bus must have 120 Ω (Ohm) ½ Watt terminating resistors fitted at either end across the signal wires, see the *EIA(RS)-485 bus connection arrangements* diagram below. Some devices may be able to provide the bus terminating resistors by different connection or configuration arrangements, in which case separate external components are not needed. However, this product does not provide such a facility, so if it is located at the bus terminus, an external termination resistor is needed.

2.4.2 EIA(RS)485 Bus Connections and Topologies

The EIA(RS)-485 standard requires each device to be directly connected to the physical cable that is the communications bus. Stubs and tees are expressly forbidden, as are star topologies. Loop bus topologies are not part of the EIA(RS)-485 standard and are forbidden by it.

Two-core screened cable is recommended. The specification of the cable depends on the application, although a multi-strand 0.5 mm^2 per core is normally adequate. Total cable length must not exceed 1000 m. The screen must be continuous and connected at one end, normally at the master connection point. It is important to avoid circulating currents, especially when the cable runs between buildings, for both safety and noise reasons.

This product does not provide a signal ground connection. If the bus cable has a signal ground connection, it must be ignored. However, the signal ground must have continuity for the benefit of other devices connected to the bus. For both safety and noise reasons, the signal ground must never be connected to the cable's screen or to the product's chassis.

2.4.3 EIA(RS)485 Bus Biasing

It may also be necessary to bias the signal wires to prevent jabber. Jabber occurs when the signal level has an indeterminate state because the bus is not being actively driven. This can occur when all the slaves are in receive mode and the master is slow to switch from receive mode to transmit mode. This may be because the master purposefully waits in receive mode, or even in a high impedance state, until it has something to transmit. Jabber causes the receiving device(s) to miss the first bits of the first character in the packet, which results in the slave rejecting the message and consequentially not responding. Symptoms of this are poor response times (due to retries), increasing message error counters, erratic communications, and even a complete failure to communicate.

Biasing requires that the signal lines are weakly pulled to a defined voltage level of about 1 V. There should only be one bias point on the bus, which is best situated at the master connection point. The DC source used for the bias must be clean, otherwise noise is injected. Some devices may (optionally) be able to provide the bus bias, in which case external components are not required.

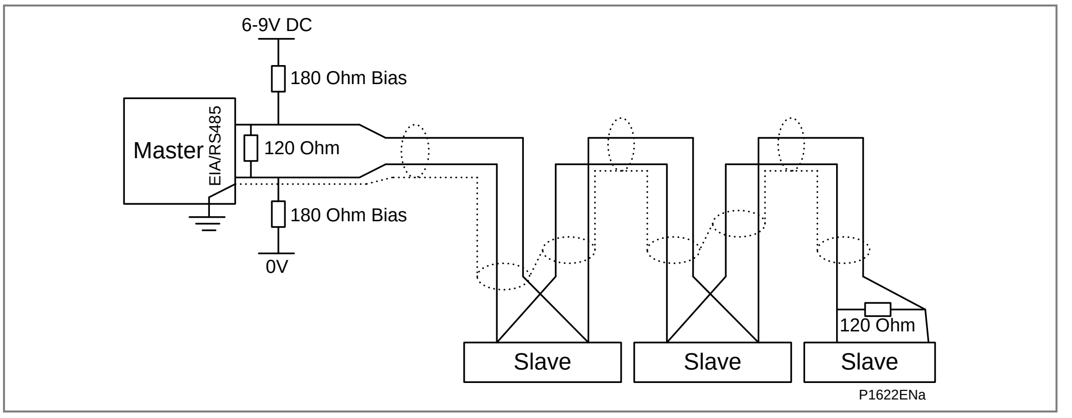


Figure 1 - EIA(RS)485 bus connection arrangements

It is possible to use the product's field voltage output (48 V DC) to bias the bus using values of 2.2 k Ω (½W) as bias resistors instead of the 180 Ω resistors shown in the *EIA(RS)-485 bus connection arrangements* diagram. Note these warnings apply:

Warnings	**It is extremely important that the 120 Ω termination resistors are fitted. Otherwise the bias voltage may be excessive and may damage the devices connected to the bus.** **As the field voltage is much higher than that required, Schneider Electric cannot assume responsibility for any damage that may occur to a device connected to the network as a result of incorrect application of this voltage.** **Ensure the field voltage is not used for other purposes, such as powering logic inputs, because noise may be passed to the communication network.**

2.4.4 Courier Communication

Courier is the communication language developed to allow remote interrogation of its range of protection relays. Courier uses a master and slave. EIA(RS)-232 on the front panel allows only one slave but EIA(RS)-485 on the back panel allows up to 32 daisy-chained slaves. Each slave unit has a database of information and responds with information from its database when requested by the master unit.

The relay is a slave unit that is designed to be used with a Courier master unit such as MiCOM S1 Studio, MiCOM S10, PAS&T or a SCADA system. MiCOM S1 Studio is compatible is specifically designed for setting changes with the relay.

To use the rear port to communicate with a PC-based master station using Courier, a KITZ K-Bus to EIA(RS)-232 protocol converter is needed. This unit (and information on how to use it) is available from Schneider Electric. A typical connection arrangement is shown in the *K-bus remote communication connection arrangements* diagram below. For more detailed information on other possible connection arrangements, refer to the manual for the Courier master station software and the manual for the KITZ protocol converter. Each spur of the K-Bus twisted pair wiring can be up to 1000 m in length and have up to 32 relays connected to it.

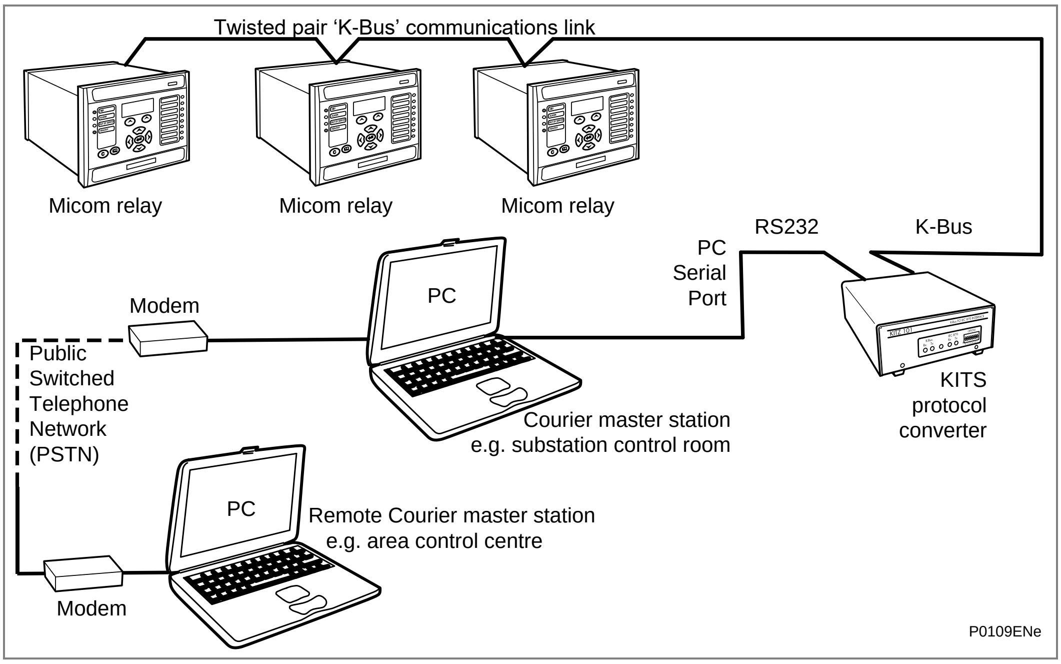


Figure 2 - K-bus remote communication connection arrangements

Once the physical connection is made to the relay, configure the relay's communication settings using the keypad and LCD user interface.

3 CONFIGURING THE COMMUNICATIONS PORTS

3.1 Introduction

Courier works on a master/slave basis where the slave units contain information in the form of a database, and respond with information from the database when it is requested by a master unit.

The relay is a slave unit that is designed to be used with a Courier master unit such as MiCOM S1 Studio, PAS&T or a SCADA system.

3.1.1 Configuring the Front Courier Port

The front EIA(RS)232 9-pin port supports the Courier protocol for one-to-one communication. It is designed for use during installation, commissioning and maintenance and is not suitable for permanent connection. Since this interface is not intended to link the relay to a substation communication system, not all of the features of the Courier interface are supported; the port is not configurable and the following parameters apply:

- Physical presentation: EIA(RS)232 via 9-pin connector
- Frame format: IEC60870-5 FT1.2 = 11-bit (8 Even 1)
- Address: 1
- Baud rate: 19200 bps

Note	*As part of the limited implementation of Courier on the front port, neither automatic extraction of event and disturbance records, nor busy response are supported.)*

3.1.2 Configuring the First Rear Courier Port (RP1)

Once the physical connection is made to the relay, configure the relay's communication settings using the keypad and LCD user interface.

1. In the relay menu, select the **Configuration** column, then check that the **Comms. settings** cell is set to **Visible**.
2. Select the **Communications** column. Only two settings apply to the rear port using Courier, the relay's address and the inactivity timer. Synchronous communication uses a fixed baud rate of 64 kbits/s.
3. Move down the **Communications** column from the column heading to the first cell down. This shows the communication protocol.

```
RP1 Protocol
Courier
```

4. The next cell down the column controls the address of the relay. As up to 32 relays can be connected to one K-Bus spur, each relay must have a unique address so messages from the master control station are accepted by one relay only. Courier uses an integer (from 0 to 254) for the relay address that is set with this cell. Important: no two relays should have the same Courier address. The master station uses the Courier address to communicate with the relay.

```
RP1 Address
1
```

5. The next cell down controls the inactivity timer.

```
RP1 Inactiv timer
10.00 mins.
```

The inactivity timer controls how long the relay waits without receiving any messages on the rear port before it reverts to its default state, including revoking any password access that was enabled. For the rear port this can be set between 1 and 30 minutes.

Note	*Protection and disturbance recorder settings that are modified using an on-line editor such as PAS&T must be confirmed with a write to the 'Save changes' cell of the 'Configuration' column. Off-line editors such as MiCOM S1 Studio do not require this action for the setting changes to take effect.*

The next cell down controls the physical media used for the communication.

```
RP1 Physical link
Copper
```

The default setting is to select the electrical (copper) connection. If the optional fiber optic interface is fitted to the relay, then this setting can be changed to '**Fiber optic**'. This cell is invisible if a second rear communications port or an Ethernet card is fitted, as they are mutually exclusive and occupy the same physical location.

6. If the Physical link selection is copper, the next cell down becomes visible to further define the configuration:

```
RP1 Port Config
KBus
```

The setting choice is between K-Bus and EIA(RS)485. Selecting K-Bus allows connection with K-series devices, but means that a KITZ converter must be used to make a connection. If the EIA(RS)485 selection is made, direct connections can be made to proprietary equipment such as MODEMs. If the EIA(RS)485 selection is made, then two further cells become visible to control the frame format and the communication speed:

7. The frame format is selected in the RP1 Comms mode setting:

```
RP1 Comms Mode
IEC60870 FT1.2
```

The standard default is the IEC 60870-FT1.2. This is an 11-bit framing. Alternatively, a 10-bit framing may be selected for use with MODEMs that do not support 11-bit framing.

8. The final RP1 cell controls the communication speed or baud rate:

```
RP1 Baud Rate
19200 bits/s
```

Courier communications is asynchronous and three baud rate selections are available to allow the relay communication rate to be matched to that of the connected equipment. Three baud rates are supported by the relay, '9600 bits/s', '19200 bits/s' and '38400 bits/s'.

Important	**If you modify protection and disturbance recorder settings using an on-line editor such as PAS&T, you must confirm them. To do this, from the Configuration column select the Save changes cell. Off-line editors such as MiCOM S1 Studio do not need this action for the setting changes to take effect.**

3.1.3 Configuring the MODBUS Communication

Important	**MODBUS is not available for all MiCOM products. MODBUS availability is shown in the *Supported Protocols* table.**

MODBUS is a master/slave communication protocol that can be used for network control. In a similar way to Courier, the master device initiates all actions and the slave devices (the relays) respond to the master by supplying the requested data or by taking the requested action. MODBUS communication uses a twisted pair connection to the rear port and can be used over a distance of 1000 m with up to 32 slave devices.

To use the rear port with MODBUS communication, configure the relay's communication settings using the keypad and LCD user interface.

1. In the relay menu, select the **Configuration** column, then check that the **Comms. settings** cell is set to **Visible**.
2. Select the **Communications** column. Four settings apply to the rear port using MODBUS that are described below.
3. Move down the **Communications** column from the column heading to the first cell down. This shows the communication protocol.

```
RP1 Protocol
MODBUS
```

4. The next cell down controls the MODBUS address of the relay. Up to 32 relays can be connected to one MODBUS spur, and therefore it is necessary for each relay to have a unique address so that messages from the master control station are accepted by one relay only. MODBUS uses an integer number between 1 and 247 for the relay address. It is important that no two relays have the same MODBUS address. The MODBUS address is then used by the master station to communicate with the relay.

```
RP1 MODBUS address
23
```

5. The next cell down controls the inactivity timer.

```
RP1 Inactiv timer
10.00 mins.
```

The inactivity timer controls how long the relay waits without receiving any messages on the rear port before it reverts to its default state, including revoking any password access that was enabled. For the rear port this can be set between 1 and 30 minutes.

6. The next cell down the column controls the baud rate to be used:

```
RP1 Baud rate
9600 bits/s
```

MODBUS communication is asynchronous. Three baud rates are supported by the relay, '9600 bits/s', '19200 bits/s' and '38400 bits/s'. It is important that whatever baud rate is selected on the relay is the same as that set on the MODBUS master station.

7. The next cell controls the parity format used in the data frames:

```
RP1 Parity
None
```

The parity can be set to be one of ‘None’, ‘Odd’ or ‘Even’. It is important that whatever parity format is selected on the relay is the same as that set on the MODBUS master station.

The next cell down controls the physical media used for the communication.

```
RP1 Physical link
Copper
```

The default setting is to select the electrical (copper) connection. If the optional fiber optic interface is fitted to the relay, then this setting can be changed to ‘**Fiber optic**’. This cell is invisible if a second rear communications port or an Ethernet card is fitted, as they are mutually exclusive and occupy the same physical location.

8. The next cell down controls the format of the Date/Time (software 30 or later):

```
MODBUS
IEC time standard
```

The format can be selected as either **Standard** (as for IEC60870-5-4 ‘Binary Time 2a’) which is the default, or to **Reverse** for compatibility with MICOM Px20 and Px30 product ranges. For more information see the *Date and Time Format* section.

3.1.4 Configuring the IEC 60870-5 CS 103 Rear Port, RP1

The IEC specification IEC 60870-5-103: Telecontrol Equipment and Systems, Part 5: Transmission Protocols Section 103 defines the use of standards IEC 60870-5-1 to IEC 60870-5-5 to perform communication with protection equipment. The standard configuration for the IEC 60870-5-103 protocol is to use a twisted pair connection over distances up to 1000 m. As an option for IEC 60870-5-103, the rear port can be specified to use a fiber optic connection for direct connection to a master station. The relay operates as a slave in the system, responding to commands from a master station. The method of communication uses standardized messages which are based on the VDEW communication protocol.

To use the rear port with IEC 60870-5-103 communication, configure the relay’s communication settings using the keypad and LCD user interface.

1. In the relay menu, select the **Configuration** column, then check that the **Comms. settings** cell is set to **Visible**.
2. Select the **Communications** column. Four settings apply to the rear port using IEC 60870-5-103 that are described below.

   Move down the ‘COMMUNICATIONS’ column from the column heading to the first cell to confirm the communication protocol:

   ```
   RP1 Protocol
   IEC60870-5-103
   ```

3. The next cell sets the address of the relay on the IEC 60870-5-103 network:

   ```
   RP1 Address
   162
   ```

   Up to 32 relays can be connected to one IEC 60870-5-103 spur, and therefore it is necessary for each relay to have a unique address so that messages from the master control station are accepted by one relay only. IEC 60870-5-103 uses an integer number between 0 and 254 for the relay address. It is important that no two relays have the same address. The address is then used by the master station to communicate with the relay.

4. The next cell down the column controls the baud rate to be used:

   ```
   RP1 Baud rate
   9600 bits/s
   ```

   IEC 60870-5-103 communication is asynchronous. Two baud rates are supported by the relay, ‘9600 bits/s’ and ‘19200 bits/s’. It is important that whatever baud rate is selected on the relay is the same as that set on the IEC 60870-5-103 master station.

5. The next cell down controls the period between IEC 60870-5-103 measurements:

   ```
   RP1 Meas period
   30.00 s
   ```

   The IEC 60870-5-103 protocol allows the relay to supply measurements at regular intervals. The interval between measurements is controlled by this cell, and can be set between 1 and 60 seconds.

6. An optional fiber optic card is available in the relay to allow optical connection to the IEC 60870-5-103 communication to be made over an optical connection. When fitted, it converts between EIA(RS)485 signals and fiber optic signals and the following cell is visible in the menu column:

```
RP1 Physical link
Copper
```

The default setting is to select the electrical (copper) connection. If the optional fiber optic interface is fitted to the relay, then this setting can be changed to ‘Fiber optic’. This cell is invisible if a second rear communications port or an Ethernet card is fitted, as they are mutually exclusive and occupy the same physical location.

7. The following cell which may be displayed, is not currently used but is available for future expansion.

```
RP1 InactivTimer
```

8. The next cell down can be used for monitor or command blocking:

```
RP1 CS103Blocking
```

There are three settings associated with this cell; these are:

- **Disabled**
  No blocking selected.
- **Monitor Blocking**
  When the monitor blocking DDB Signal is active high, either by energizing an opto input or control input, reading of the status information and disturbance records is not permitted. When in this mode the relay returns a “Termination of general interrogation” message to the master station.
- **Command Blocking**
  When the command blocking DDB signal is active high, either by energizing an opto input or control input, all remote commands are ignored, such as CB Trip/Close or change setting group. When in this mode the relay returns a **negative acknowledgement of command** message to the master station.

3.2 Configuring the Second Rear Communication Port SK4 (where fitted)

For relays with Courier, MODBUS, IEC60870-5-103 or DNP3.0 protocol on the first rear communications port there is the hardware option of a second rear communications port, which runs the Courier language. This can be used over one of three physical links: twisted pair K-Bus (non-polarity sensitive), twisted pair EIA(RS)-485 (connection polarity sensitive) or EIA(RS)-232.

The settings for this port are immediately below those for the first port. See the *Connection Diagrams* chapter.

Once the physical connection is made to the relay, configure the relay's communication settings using the keypad and LCD user interface.

1. In the relay menu, select the **Configuration** column, then check that the **Comms. settings** cell is set to **Visible**.
2. Select the **Communications** column. Only two settings apply to the rear port using Courier, the relay's address and the inactivity timer. Synchronous communication uses a fixed baud rate of 64 kbits/s.
3. Move down the **Communications** column from the column heading to the first cell down. This shows the communication protocol.

```
RP1 Protocol
Courier
```

4. The next cell down the column controls the address of the relay. As up to 32 relays can be connected to one K-Bus spur, each relay must have a unique address so messages from the master control station are accepted by one relay only. Courier uses an integer (from 0 to 254) for the relay address that is set with this cell. Important: no two relays should have the same Courier address. The master station uses the Courier address to communicate with the relay.

```
RP1 Address
1
```

5. The next cell down controls the inactivity timer.

```
RP1 Inactiv timer
10.00 mins.
```

The inactivity timer controls how long the relay waits without receiving any messages on the rear port before it reverts to its default state, including revoking any password access that was enabled. For the rear port this can be set between 1 and 30 minutes.

Note	*Protection and disturbance recorder settings that are modified using an on-line editor such as PAS&T must be confirmed with a write to the 'Save changes' cell of the 'Configuration' column. Off-line editors such as MiCOM S1 Studio do not require this action for the setting changes to take effect.*

The next cell down controls the physical media used for the communication.

```
RP1 Physical link
Copper
```

The default setting is to select the electrical (copper) connection. If the optional fiber optic interface is fitted to the relay, then this setting can be changed to '**Fiber optic**'. This cell is invisible if a second rear communications port or an Ethernet card is fitted, as they are mutually exclusive and occupy the same physical location.

6. If the Physical link selection is copper, the next cell down becomes visible to further define the configuration:

```
RP1 Port Config
KBus
```

The setting choice is between K-Bus and EIA(RS)485. Selecting K-Bus allows connection with K-series devices, but means that a KITZ converter must be used to make a connection. If the EIA(RS)485 selection is made, direct connections can be made to proprietary equipment such as MODEMs. If the EIA(RS)485 selection is made, then two further cells become visible to control the frame format and the communication speed:

7. The frame format is selected in the RP1 Comms mode setting:

```
RP1 Comms Mode
IEC60870 FT1.2
```

The standard default is the IEC 60870-FT1.2. This is an 11-bit framing. Alternatively, a 10-bit framing may be selected for use with MODEMs that do not support 11-bit framing.

8. The final RP1 cell controls the communication speed or baud rate:

```
RP1 Baud Rate
19200 bits/s
```

Courier communications is asynchronous and three baud rate selections are available to allow the relay communication rate to be matched to that of the connected equipment. Three baud rates are supported by the relay, ‘9600 bits/s’, ‘19200 bits/s’ and ‘38400 bits/s’.

Important	**If you modify protection and disturbance recorder settings using an on-line editor such as PAS&T, you must confirm them. To do this, from the Configuration column select the Save changes cell. Off-line editors such as MiCOM S1 Studio do not need this action for the setting changes to take effect.**

3.1 Configuring the Second Rear Courier Port, RP2 (Where Fitted)

For relays having the second rear (Courier) communications port fitted, the settings are located immediately below the ones for the first port described above. The second rear communications port only supports the Courier protocol and the settings are similar to those for Courier RP1. The first cell displays:

1. Move down the settings until the following sub heading is displayed.

```
Rear Port 2 (RP2)
```

2. The next cell defines the protocol, which is fixed at Courier for RP2.

```
RP2 protocol
Courier
```

3. The following cell indicates the status of the hardware.

```
RP2 card status
EIA(RS)232 OK
```

4. The following cell allows for selection of the port configuration.

```
RP2 port config.
EIA(RS)232
```

5. The port can be configured for EIA(RS)232, EIA(RS)485 or K-Bus.
As in the case of the first rear Courier port, if K-Bus is not selected certain other cells to control the communication mode and speed become visible. If either EIA(RS)232 or EIA(RS)485 is selected for the port configuration, the next cell is visible and selects the communication mode.

```
RP2 comms.  Mode
IEC60870 FT1.2
```

6. The standard default is the IEC 60870 FT1.2 for normal operation with 11-bit modems. Alternatively, a 10-bit framing with no parity bit can be selected for special cases.

7. The next cell down sets the communications port address.

```
RP2 address
255
```

Since up to 32 devices can be connected to one K-bus spur, it is necessary for each device to have a unique address so that messages from the master control station are accepted by one device only. Courier uses an integer number between 0 and 254 for the device address that is set with this cell. It is important that no two devices have the same Courier address. The Courier address is then used by the master station to communicate with the device. The default value is 255 and must be changed to a value in the range 0 to 254 before use.

8. The following cell controls the inactivity timer.

```
RP2 InactivTimer
15 mins.
```

9. The inactivity timer controls how long the relay will wait without receiving any messages on the rear port before it reverts to its default state. This includes revoking any password access that was enabled. The inactivity timer can be set between 1 and 30 minutes.

10. If either EIA(RS)232 or EIA(RS)485 is selected for the port configuration, the following cell is visible and selects the communication speed (baud rate):

```
RP2 baud rate
19200
```

Courier communications is asynchronous and three selections are available to allow the relay communication rate to be matched to that of the connected equipment. The three baud rates supported by the relay are: ‘9600 bits/s’, ‘19200 bits/s’ and ‘38400 bits/s’.

3.2 Fiber Optic Converter (option)

An optional fiber optic card is available in this product. This converts the EIA(RS)485 protocols into a fiber optic output. This communication card is available for use on Courier, MODBUS (for products listed in the *Supported Protocols* table), IEC60870-5-103 and DNP3.0 it adds the following setting to the communication column.

This controls the physical media used for the communication:

```
Physical link
Copper
```

The default setting is to select the electrical EIA(RS)485 connection. If the optional fiber optic connectors are fitted to the relay, then this setting can be changed to '**Fiber optic**'. This cell is also invisible if a second rear comms. port, or Ethernet card is fitted, as it is mutually exclusive with the fiber optic connectors, and occupies the same physical location.

Where this is used, connection should be made using either 50/125µm or 62.5/125µm multi-mode optical fibers terminated with BFOC/2.5 (ST) connectors.

3.3 Second Rear Port K-Bus Application

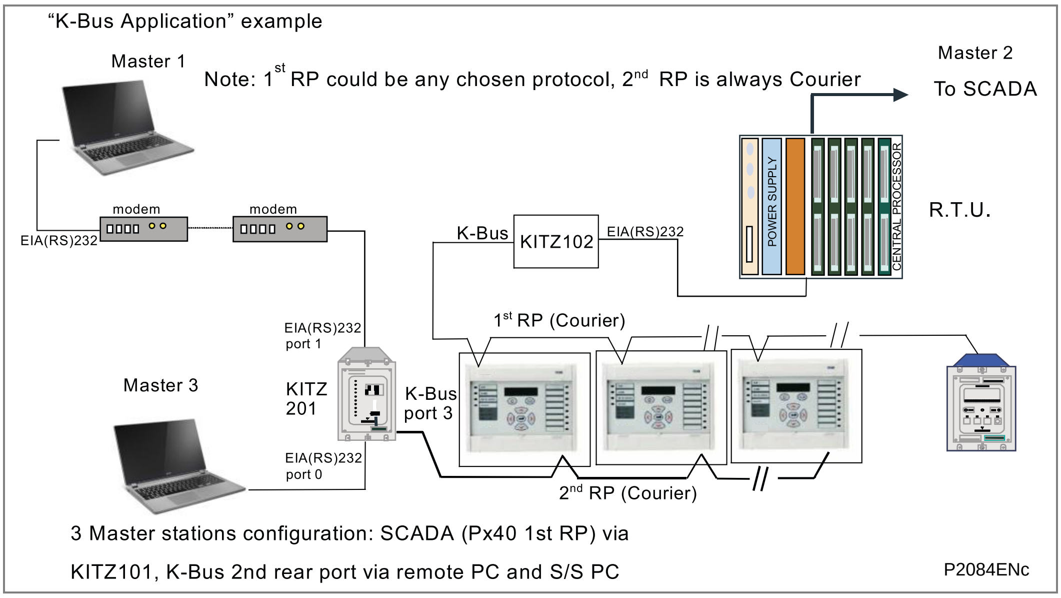


Figure 3 - Second rear port K-Bus application

3.4 Second Rear Port EIA(RS)485 Application

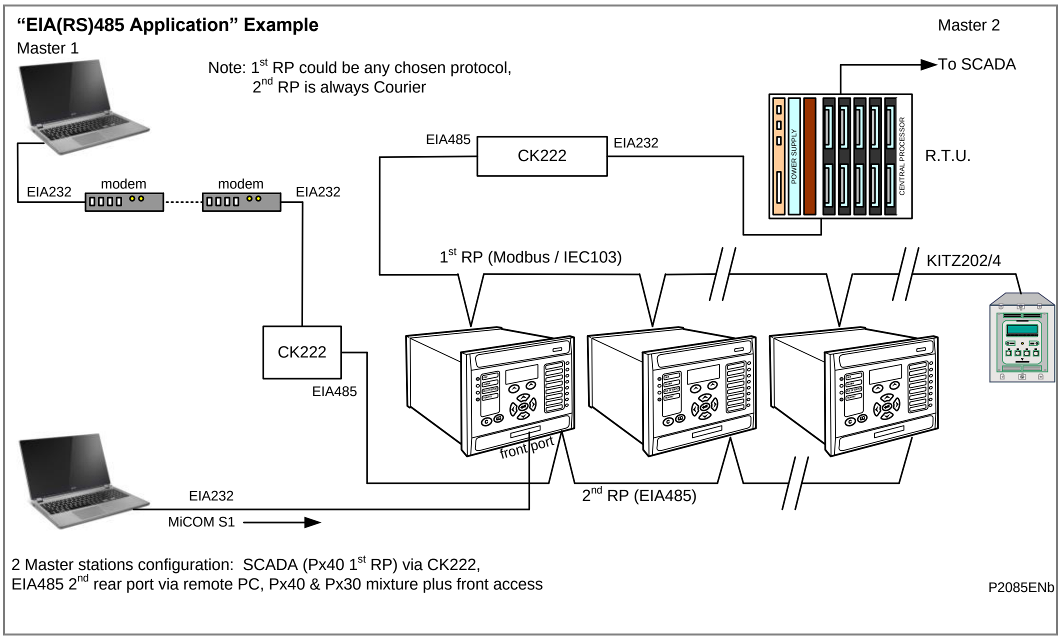


Figure 4 - Second rear port EIA(RS)485 example

3.5 Second Rear Port EIA(RS)232 Application

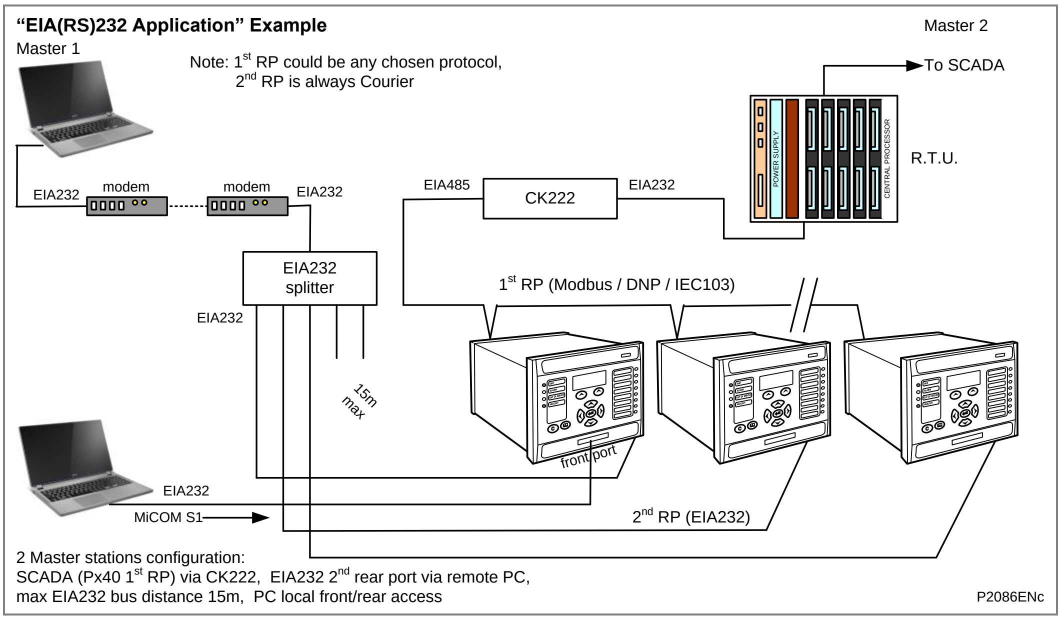


Figure 5 - Second rear port EIA(RS)232 example

3.6 SK5 Port Connection

The lower 9-way D-type connector (SK5) is the InterMiCOM port, which is based on the EIA232 standard.

4 COURIER INTERFACE

4.1 Courier Protocol

Courier is a Schneider Electric communication protocol. The concept of the protocol is that a standard set of commands is used to access a database of settings and data in the relay. This allows a generic master to be able to communicate with different slave devices. The application-specific aspects are contained in the database rather than the commands used to interrogate it, so the master station does not need to be preconfigured.

The same protocol can be used through two physical links K-Bus or EIA(RS)-232.

K-Bus is based on EIA(RS)-485 voltage levels with HDLC FM0 encoded synchronous signaling and its own frame format. The K-Bus twisted pair connection is unpolarized, whereas the EIA(RS)-485 and EIA(RS)-232 interfaces are polarized.

The EIA(RS)-232 interface uses the IEC60870-5 FT1.2 frame format.

The relay supports an IEC60870-5 FT1.2 connection on the front-port. This is intended for temporary local connection and is not suitable for permanent connection. This interface uses a fixed baud rate, 11-bit frame, and a fixed device address.

The rear interface is used to provide a permanent connection for K-Bus and allows multi-drop connection. Although K-Bus is based on EIA(RS)-485 voltage levels, it is a synchronous HDLC protocol using FM0 encoding. It is not possible to use a standard EIA(RS)-232 to EIA(RS)-485 converter to convert IEC60870-5 FT1.2 frames to K-Bus. Also it is not possible to connect K-Bus to an EIA(RS)-485 computer port. A protocol converter, such as the KITZ101, should be used for this purpose.

For a detailed description of the Courier protocol, command-set and link description, see the following documentation:

R6509	K-Bus Interface Guide
R6510	IEC60870 Interface Guide
R6511	Courier Protocol
R6512	Courier User Guide

Alternatively for direct connections, the fiber optic converter card may be used to convert the rear EIA(RS)485 port into a fiber optic (ST) port. See the *Fiber Optic Converter (option)* section for more information.

4.2 Front Courier Port

The front EIA(RS)-232 9 pin port supports the Courier protocol for one-to-one communication. This port complies with EIA(RS)-574; the 9-pin version of EIA(RS)-232, see www.tiaonline.org. It is designed for use during installation and commissioning/maintenance and is not suitable for permanent connection. Since this interface is not used to link the relay to a substation communication system, some of the features of Courier are not implemented. These are as follows:

- Automatic extraction of Event Records:
  - Courier Status byte does not support the Event flag.
  - Send Event/Accept Event commands are not implemented.
- Automatic extraction of Disturbance records:
  - Courier Status byte does not support the Disturbance flag.
- Busy Response Layer:
  - Courier Status byte does not support the Busy flag, the only response to a request is the final data.
- Fixed Address:
  - The address of the front Courier port is always 1; the Change Device address command is not supported.
- Fixed Baud Rate:
  - 19200 bps.
  - Although automatic extraction of event and disturbance records is not supported, it is possible to manually access this data through the front port.

4.3 Supported Command Set

The following Courier commands are supported by the relay:

Protocol Layer:

- Reset Remote Link
- Poll Status
- Poll Buffer*

Low Level Commands:

- Send Event*
- Accept Event*
- Send Block
- Store Block Identifier
- Store Block Footer

Menu Browsing:

- Get Column Headings
- Get Column Text
- Get Column Values
- Get Strings
- Get Text
- Get Value
- Get Column Setting Limits

Setting Changes:

- Enter Setting Mode
- Preload Setting
- Abort Setting
- Execute Setting
- Reset Menu Cell
- Set Value

Control Commands:

- Select Setting Group
- Change Device Address*
- Set Real Time

Note	*Commands marked with an asterisk (*) are not supported through the front Courier port.*

4.4 Courier Database

The Courier database is two-dimensional. Each cell in the database is referenced by a row and column address. Both the column and the row can take a range from 0 to 255. Addresses in the database are specified as hexadecimal values, for example, 0A02 is column 0A (10 decimal) row 02. Associated settings or data are part of the same column. Row zero of the column has a text string to identify the contents of the column and to act as a column heading.

The *Relay Menu Database document* contains the complete database definition for the relay. For each cell location the following information is stated:

- Cell Text
- Cell Data type
- Cell value
- Whether the cell is settable, if so
  - Minimum value
  - Maximum value
  - Step size
- Password Level required to allow setting changes
- String information (for Indexed String or Binary flag cells)

4.5 Setting Changes

(See R6512, Courier User Guide - Chapter 9)
Courier provides two mechanisms for making setting changes, both of these are supported by the relay. Either method can be used for editing any of the settings in the relay database.

There are three categories of settings in the relay database:

- Control and support
- Disturbance recorder
- Protection settings group

Setting changes made to the control and support settings are implemented immediately and stored in non-volatile memory. Changes made to either the Disturbance recorder settings or the Protection Settings Groups are stored in a 'scratchpad' memory and are not immediately implemented by the relay.

To action setting changes stored in the scratchpad the Save **Changes cell** in the **Configuration** column must be written to. This allows the changes to either be confirmed and stored in non-volatile memory, or the setting changes to be aborted.

4.5.1 Setting Transfer Mode

If it is necessary to transfer all of the relay settings to or from the relay, a cell in the **Communication System Data** column can be used. This cell (location BF03) when set to 1 makes all of the relay settings visible. Any setting changes made with the relay set in this mode are stored in scratchpad memory, including control and support settings. When the value of BF03 is set back to 0, any setting changes are verified and stored in non-volatile memory.

4.5.2 Method 1

This uses a combination of three commands to perform a settings change:

Enter Setting Mode	Checks that the cell is settable and returns the limits.
Preload Setting	Places a new value to the cell. This value is echoed to ensure that setting corruption has not taken place. The validity of the setting is not checked by this action.
Execute Setting	Confirms the setting change. If the change is valid, a positive response is returned. If the setting change fails, an error response is returned.
Abort Setting	This command can be used to abandon the setting change.

This is the most secure method. It is ideally suited to on-line editors because the setting limits are taken from the relay before the setting change is made. However, this method can be slow if many settings are being changed because three commands are required for each change.

4.5.3 Method 2

The **Set Value** command can be used to directly change a setting, the response to this command is either a positive confirm or an error code to indicate the nature of a failure. This command can be used to implement a setting more rapidly than the previous method, however the limits are not extracted from the relay. This method is most suitable for off-line setting editors such as MiCOM S1 Studio, or for issuing preconfigured (SCADA) control commands.

4.5.4 Relay Settings

There are three categories of settings in the relay database:

- Control and support
- Disturbance recorder
- Protection settings group

Setting changes made to the control and support settings are implemented immediately and stored in non-volatile memory. Changes made to either the Disturbance recorder settings or the Protection Settings Groups are stored in a ‘scratchpad’ memory and are not immediately implemented by the relay.

To action setting changes stored in the scratchpad the Save **Changes cell** in the **Configuration** column must be written to. This allows the changes to either be confirmed and stored in non-volatile memory, or the setting changes to be aborted.

4.5.5 Setting Transfer Mode

If it is necessary to transfer all of the relay settings to or from the relay, a cell in the **Communication System Data** column can be used. This cell (location BF03) when set to 1 makes all of the relay settings visible. Any setting changes made with the relay set in this mode are stored in scratchpad memory, including control and support settings. When the value of BF03 is set back to 0, any setting changes are verified and stored in non-volatile memory.

4.6 Event Extraction

Events can be extracted either automatically (rear port only) or manually (either Courier port). For automatic extraction all events are extracted in sequential order using the standard Courier event mechanism, this includes fault/maintenance data if appropriate. The manual approach allows the user to select events, faults, or maintenance data at random from the stored records.

4.6.1 Automatic Event Extraction

(See Chapter 7 Courier User Guide, publication R6512).

This method is intended for continuous extraction of event and fault information as it is produced. It is only supported through the rear Courier port.

When new event information is created, the Event bit is set in the Status byte. This indicates to the Master device that event information is available. The oldest, unextracted event can be extracted from the relay using the Send Event command. The relay responds with the event data, which is either a Courier Type 0 or Type 3 event. The Type 3 event is used for fault records and maintenance records.

Once an event has been extracted from the relay, the Accept Event can be used to confirm that the event has been successfully extracted. If all events have been extracted, the event bit is reset. If there are more events still to be extracted, the next event can be accessed using the **Send Event** command as before.

4.6.2 Event Types

Events are created by the relay under these circumstances:

- Change of state of output contact
- Change of state of opto input
- Protection element operation
- Alarm condition
- Setting change
- Password entered/timed-out
- Fault record (Type 3 Courier Event)
- Maintenance record (Type 3 Courier Event)

4.6.3 Event Format

The Send Event command results in these fields being returned by the relay:

- Cell reference
- Time stamp
- Cell text
- Cell value

The *Relay Menu Database* document for the relevant product, contains a table of the events created by the relay and indicates how the contents of the above fields are interpreted. Fault records and Maintenance records return a Courier Type 3 event, which contains the above fields with two additional fields:

- Event extraction column
- Event number

These events contain additional information that is extracted from the relay using the referenced extraction column. Row 01 of the extraction column contains a setting that allows the fault/maintenance record to be selected. This setting should be set to the event number value returned in the record. The extended data can be extracted from the relay by uploading the text and data from the column.

4.6.4 Manual Event Record Extraction

Column 01 of the database can be used for manual viewing of event, fault, and maintenance records. The contents of this column depend on the nature of the record selected. It is possible to select events by event number and to directly select a fault record or maintenance record by number.

Event Record selection (Row 01)

> This cell can be set to a value between 0 to 511 to select from 512 stored events. 0 selects the most recent record and 512 the oldest stored record. For simple event records, (Type 0) cells 0102 to 0105 contain the event details. A single cell is used to represent each of the event fields. If the event selected is a fault or maintenance record (Type 3), the remainder of the column contains the additional information.

Fault Record Selection (Row 05)

> This cell can be used to select a fault record directly, using a value between 0 and 4 to select one of up to five stored fault records. (0 is the most recent fault and 4 is the oldest). The column then contains the details of the fault record selected.

Maintenance Record Selection (Row F0)

> This cell can be used to select a maintenance record using a value between 0 and 4 to select one of up to 10 stored maintenance records. This cell operates in a similar way to the fault record selection.

If this column is used to extract event information from the relay, the number associated with a particular record changes when a new event or fault occurs.

4.7 Disturbance Record Extraction

Select Record Number (Row 01)

> This cell can be used to select the record to be extracted. Record 0 is the oldest unextracted record, already extracted older records are assigned positive values, and negative values are used for more recent records. To help automatic extraction through the rear port, the Disturbance bit of the Status byte is set by the relay whenever there are unextracted disturbance records.

Once a record has been selected, using the above cell, the time and date of the record can be read from cell 02. The disturbance record can be extracted using the block transfer mechanism from cell B00B. The file extracted from the relay is in a compressed format. Use MiCOM S1 Studio to decompress this file and save the disturbance record in the COMTRADE format.

As has been stated, the rear Courier port can be used to extract disturbance records automatically as they occur. This operates using the standard Courier mechanism, see *Chapter 8 of the Courier User Guide*. The front Courier port does not support automatic extraction although disturbance record data can be extracted manually from this port.

4.8 Programmable Scheme Logic (PSL) Settings

The Programmable Scheme Logic (PSL) settings can be uploaded from and downloaded to the relay using the block transfer mechanism defined in the Courier User Guide.

These cells are used to perform the extraction:

- B204 Domain — Used to select either PSL settings (upload or download) or PSL configuration data (upload only)
- B208 Sub-Domain — Used to select the Protection Setting Group to be uploaded or downloaded.
- B20C Version — Used on a download to check the compatibility of the file to be downloaded with the relay.
- B21C Transfer Mode — Used to set up the transfer process.
- B120 Data Transfer Cell — Used to perform upload or download.

The PSL settings can be uploaded and downloaded to and from the relay using this mechanism. If it is necessary to edit the settings, MiCOM S1 Studio must be used because the data is compressed. MiCOM S1 Studio also performs checks on the validity of the settings before they are downloaded to the relay.

5 MODBUS INTERFACE

The MODBUS interface is a master/slave protocol and is defined by: www.modbus.org

MODBUS Serial Protocol Reference Guide: PI-MBUS-300 Rev. E

5.1 Communication Link (Serial Interface)

This interface also uses the rear EIA(RS)485 port (or converted fiber optic port) for communication using ‘**RTU**’ mode communication rather than ‘**ASCII**’ mode as this provides more efficient use of the communication bandwidth. This mode of communication is defined by the MODBUS standard.

5.1.1 Character Framing

The character framing is 1 start bit, 8 data bits, either 1 parity bit and 1 stop bit, or 2 stop bits. This gives 11 bits per character.

5.1.2 Maximum MODBUS Query and Response Frame Size

The maximum query and response frame size is limited to 260 bytes in total. (This includes the frame header and CRC footer, as defined by the MODBUS protocol.).

5.1.3 User Configurable Communications Parameters

The following parameters can be configured for this port using either the front panel interface or the front Courier port:

- Baud rate
- Device address
- Parity
- Inactivity time

5.2 Supported MODBUS Query Functions

The MODBUS protocol provides numerous query functions, of which the product supports the subset in the following table. The product responds with exception code 01 if any other query function is received by it.

Query Function Code	MODBUS Query Name	Application / Interpretation
01	Read Coil Status	Read status of output contacts (0x addresses)
02	Read Input Status	Read status of opto-isolated status inputs (1x addresses)
03	Read Holding Registers	Read setting values (4x addresses)
04	Read Input Registers	Read measurement values (3x addresses)
06	Preset Single Register	Write single setting value (4x addresses)
07	Read Exception Status	Read relay status, same value as register 3x1
08	Diagnostics	Application defined by the MODBUS protocol specification
11	Fetch Communication Event Counter	
12	Fetch Communication Event Log	
16	Preset Multiple Registers (127 max)	Write multiple setting values (4x addresses)

Table 3 - MODBUS query functions supported by the product

5.3 Response Codes

Code	MODBUS response name	Product interpretation
01	Illegal Function Code	The function code transmitted is not supported.
02	Illegal Data Address	The start data address in the request is not an allowable value. If any of the addresses in the range cannot be accessed due to password protection, all changes in the request are discarded and this error response is returned. Note If the start address is correct but the range includes non-implemented addresses, this response is not produced.
03	Illegal Value	A value referenced in the data field transmitted by the master is not in range. Other values transmitted in the same packet are executed if they are in the range.
04	Slave Device Failure	An exception arose during the processing of the received query that is not covered by any of the other exception codes in this table.
05	Acknowledge	Not used.
06	Slave Device Busy	The write command cannot be implemented due to the product’s internal database being locked by another interface. This response is also produced if the product is busy executing a previous request.

Table 4 - MODBUS response code interpretation

5.4 Maximum Query and Response Parameters

The following table shows the maximum amount of data that the product can process for each of the supported query functions (see the Supported MODBUS Query Functions section) and the maximum amount of data that can be sent in a corresponding response frame. The principal constraint is the maximum query and response frame size, as noted in the *Maximum MODBUS Query and Response Frame Size* section. Maximum MODBUS query and response frame size.

Query function code	MODBUS query name	Maximum query data request size	Maximum response data size
01	Read Coil Status	32 coils	32 coils
02	Read Input Status	32 inputs	32 inputs
03	Read Holding Registers	127 registers	127 registers
04	Read Input Registers	127 registers	127 registers
06	Preset Single Register	1 register	1 register
07	Read Exception Status	-	8 coils
08	Diagnostics	-	-
11	Fetch Communication Event Counter	-	-
12	Fetch Communication Event Log	-	70 bytes
16	Preset Multiple Registers	127 registers	127 registers

Table 5 - Maximum query and response parameters for supported queries

5.5 Register Mapping

The MODBUS specification associates a specific register address space to each query that has a data address field. The address spaces are often called memory pages because they are analogous to separate memory devices. A simplistic view of the queries in MODBUS is that a specified location in a specified memory device is being read from or written to. However, the product's implementation of such queries is not as a memory access but as a translation to an internal database query (see Note).

Note	*One consequence of this is that the granularity of the register address space (in the 3x and 4x memory pages) is governed by the size of the data item being requested from the internal database. Since this is often more than the 16 bits of an individual register, not all register addresses are valid. See the Register Data Types section for more details.*

Each MODBUS memory page has a name and an ID. The *MODBUS "memory" pages reference and application* table provides a summary of the memory pages, their Ids, and their application in the product.

It is common practice to prefix a decimal register address with the page ID and generally this is the style used in this document.

Memory page ID	MODBUS memory page name	Product application
0xxxx	Coil Status	Read and write access of the Output Relays.
1xxxx	Input Status	Read only access of the Opto-Isolated Status Inputs.
3xxxx	Input Registers	Read-only data access, such as measurements and records.
4xxxx	Holding Registers	Read and write data access, such as product configurations settings and control commands.
6xxxx	Extended Memory File	Not used or supported.
Note	*xxxx represents the addresses available in the page (0 to 9999).*	

Table 6 - MODBUS "memory" pages reference and application

The MODBUS convention is to document register identifiers with ordinal values (first, second, third…) whereas the actual protocol uses memory-page based register addresses that begin with address zero. Therefore the first register in a memory page is register address zero, the second register is register address 1 and so on. In general, one must be subtracted from a register's identifier to find its equivalent address. The page number notation is not part of the address.

Example:

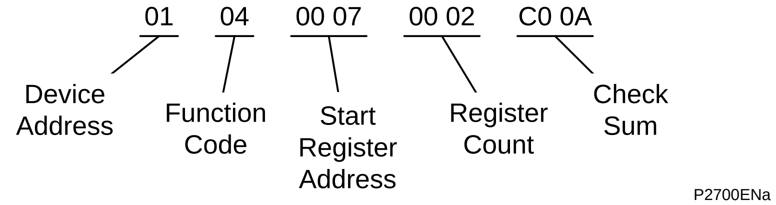
Task:

Obtain the status of the output contacts from the Schneider Electric MiCOM Pxxx device at address 1.

The output contact status is a 32-bit binary string held in input registers 3x8 and 3x9 (see the *Binary Status Information* section).

Select MODBUS function code 4 “Read input registers” and request two registers starting at input register address 7. Note the register address is one less than the required register ordinal.

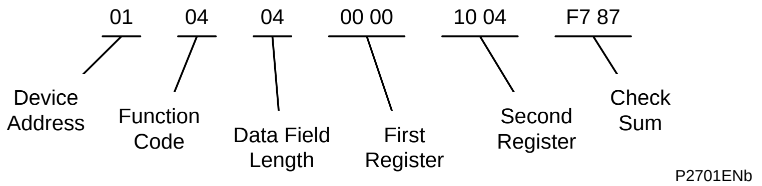
The MODBUS query frame is:



Note that the following frame data is shown in hexadecimal 8-bit bytes.

The frame is transmitted from left to right by the master device. The start register address, register count and check sum are all 16-bit numbers that are transmitted in a high byte - low byte order.

The query may elicit the following response: [4]



The frame was transmitted from left to right by the slave device. The response frame is valid because the eighth bit of the function code field is not set. The data field length is 4 bytes since the query was a read from two 16-bit registers. The data field consists of two pairs of bytes in a high byte - low byte order with the first requested register’s data coming first. Therefore the request for the 32-bit output contact status starting at register 3x8 is 00001004h (1000000000100b), which shows that outputs 3 and 13 are energized and the remaining outputs are de-energized.

5.6 Register Map

For a complete map of the MODBUS addresses supported by the product, see the *Relay Menu Database document*.

The register map tables in this document include an Equivalent Courier Cell column. The cell identifiers relate to the product’s internal Courier database and may be used in cross-reference with the Courier Protocol documentation or the product’s front panel user interface documentation.

The Data Format column specifies the format of the data presented by the associated MODBUS register or registers. The *Register Data Types* section describes the formats used.

The right-hand columns in the tables show whether the register is used in a particular product model. An asterisk indicates that the model uses the register.

5.7 Measurement Values

This table presents all of the product's available measurements: analog values and counters. An asterisk indicates that the model uses the register. Their values are refreshed approximately every second.

Measurement name	Measurement unit	Equivalent courier cell	Start register	End register	Data format	Data size (registers)	P241	P242	P243
IA Magnitude	Amps	0201	3x00200	3x00201	G24	2	*	*	*
IA Phase Angle	Degrees	0202	3x00202		G30	1	*	*	*
IB Magnitude	Amps	0203	3x00203	3x00204	G24	2	*	*	*
IB Phase Angle	Degrees	0204	3x00205		G30	1	*	*	*
IC Magnitude	Amps	0205	3x00206	3x00207	G24	2	*	*	*
IC Phase Angle	Degrees	0206	3x00208		G30	1	*	*	*
IN Derived Mag	Amps	0209	3x00263	3x00264	G24	2	*	*	*
IN Derived Angle	Degrees	020A	3x00265		G30	1	*	*	*
ISEF Magnitude	Amps	020B	3x00209	3x00210	G24	2	*	*	*
ISEF Angle	Degrees	020C	3x00211		G30	1	*	*	*
I1 Magnitude	Amps	020D	3x00212	3x00213	G24	2	*	*	*
I2 Magnitude	Amps	020E	3x00214	3x00215	G24	2	*	*	*
I0 Magnitude	Amps	020F	3x00216	3x00217	G24	2	*	*	*
IA RMS	Amps	0210	3x00218	3x00219	G24	2	*	*	*
IB RMS	Amps	0211	3x00220	3x00221	G24	2	*	*	*
IC RMS	Amps	0212	3x00222	3x00223	G24	2	*	*	*
IN RMS	Amps	0213	3x00224	3x00225	G24	2	*	*	*
VAB Magnitude	Volts	0214	3x00226	3x00227	G24	2	*	*	*
VAB Magnitude	Volts	0214	3x00708	3x00709	G24	2	*	*	*
VAB Phase Angle	Degrees	0215	3x00228		G30	1	*	*	*
VBC Magnitude	Volts	0216	3x00229	3x00230	G24	2	*	*	*
VBC Magnitude	Volts	0216	3x00710	3x00711	G24	2	*	*	*
VBC Phase Angle	Degrees	0217	3x00266		G30	1	*	*	*
VCA Magnitude	Volts	0218	3x00231	3x00232	G24	2	*	*	*
VCA Magnitude	Volts	0218	3x00712	3x00713	G24	2	*	*	*
VCA Phase Angle	Degrees	0219	3x00233		G30	1	*	*	*
VAN Magnitude	Volts	021A	3x00234	3x00235	G24	2	*	*	*
VAN Phase Angle	Degrees	021B	3x00236		G30	1	*	*	*
VBN Magnitude	Volts	021C	3x00237	3x00238	G24	2	*	*	*
VBN Phase Angle	Degrees	021D	3x00239		G30	1	*	*	*
VCN Magnitude	Volts	021E	3x00240	3x00241	G24	2	*	*	*
VCN Phase Angle	Degrees	021F	3x00242		G30	1	*	*	*
VN Magnitude	Volts	0220	3x00243	3x00244	G24	2	*	*	*
VN Angle	Degrees	0221	3x00245		G30	1	*	*	*
Vr Antibacks Mag	Volts	0222	3x00289	3x00290	G24	2	*	*	*
V1 Magnitude	Volts	0224	3x00246	3x00247	G24	2	*	*	*
V2 Magnitude	Volts	0225	3x00248	3x00249	G24	2	*	*	*
VAN RMS	Volts	0227	3x00250	3x00251	G24	2	*	*	*
VBN RMS	Volts	0228	3x00252	3x00253	G24	2	*	*	*
VCN RMS	Volts	0229	3x00254	3x00255	G24	2	*	*	*

Measurement name	Measurement unit	Equivalent courier cell	Start register	End register	Data format	Data size (registers)	P241	P242	P243
VAB RMS	Volts	022A	3x00256	3x00257	G24	2	*	*	*
VBC RMS	Volts	022B	3x00258	3x00259	G24	2	*	*	*
VCA RMS	Volts	022C	3x00260	3x00261	G24	2	*	*	*
Frequency	Hertz	022D	3x00262		G30	1	*	*	*
Frequency	Hertz	022D	3x00721		G30	1	*	*	*
IA-2 Magnitude	Amps	0230	3x00268	3x00269	G24	2			*
IA-2 Phase Angle	Degrees	0231	3x00270		G30	1			*
IB-2 Magnitude	Amps	0232	3x00271	3x00272	G24	2			*
IB-2 Phase Angle	Degrees	0233	3x00273		G30	1			*
IC-2 Magnitude	Amps	0234	3x00274	3x00275	G24	2			*
IC-2 Phase Angle	Degrees	0235	3x00276		G30	1			*
IA Differential	Amps	0236	3x00277	3x00278	G24	2			*
IB Differential	Amps	0237	3x00279	3x00280	G24	2			*
IC Differential	Amps	0238	3x00281	3x00282	G24	2			*
IA Bias	Amps	0239	3x00283	3x00284	G24	2			*
IB Bias	Amps	023A	3x00285	3x00286	G24	2			*
IC Bias	Amps	023B	3x00287	3x00288	G24	2			*
3 Phase Watts	Watts	030A	3x00300	3x00301	G125	2	*	*	*
3 Phase Watts	Watts	030A	3x00714	3x00715	G125	2	*	*	*
3 Phase VArs	VAr	030B	3x00303	3x00304	G125	2	*	*	*
3 Phase VArs	VAr	030B	3x00717	3x00718	G125	2	*	*	*
3 Phase VA	VA	030C	3x00306	3x00307	G125	2	*	*	*
Zero Seq Power	VA	030D	3x00309	3x00310	G125	2		*	*
3Ph Power Factor	-	030E	3x00312		G30	1	*	*	*
3Ph Power Factor	-	030E	3x00720		G30	1	*	*	*
3 Phase WHours Fwd	Wh	0312	3x00313	3x00314	G125	2	*	*	*
3 Phase WHours Rev	Wh	0313	3x00316	3x00317	G125	2	*	*	*
3 Phase VArHours Fwd	VArh	0314	3x00319	3x00320	G125	2	*	*	*
3 Phase VArHours Rev	VArh	0315	3x00322	3x00323	G125	2	*	*	*
3 Phase W Fix Demand	Watts	0317	3x00325	3x00326	G125	2	*	*	*
3 Phase VArs Fix Demand	VAr	0318	3x00328	3x00329	G125	2	*	*	*
3 Phase W Peak Demand	Watts	0320	3x00331	3x00332	G125	2	*	*	*
3 Phase VArs Peak Demand	VAr	0321	3x00334	3x00335	G125	2	*	*	*
Maximum current	Amps	0326	3x00338	3x00339	G24	2	*	*	*
Maximum Voltage	Volts	0327	3x00340	3x00341	G24	2	*	*	*
Load as ratio of full load	Ratio	0401	3x00400		G30	1	*	*	*
Thermal State	Percentage	0402	3x00401		G30	1	*	*	*
Time to thermal overload trip	Seconds	0403	3x00402	3x00403	G24	2	*	*	*
RTD 1 Temperature	Celsius	0405	3x00404		G10	1	*	*	*
RTD 2 Temperature	Celsius	0406	3x00405		G10	1	*	*	*
RTD 3 Temperature	Celsius	0407	3x00406		G10	1	*	*	*

Measurement name	Measurement unit	Equivalent courier cell	Start register	End register	Data format	Data size (registers)	P241	P242	P243
RTD 4 Temperature	Celsius	0408	3x00407		G10	1	*	*	*
RTD 5 Temperature	Celsius	0409	3x00408		G10	1	*	*	*
RTD 6 Temperature	Celsius	041A	3x00409		G10	1	*	*	*
RTD 7 Temperature	Celsius	041B	3x00410		G10	1	*	*	*
RTD 8 Temperature	Celsius	041C	3x00411		G10	1	*	*	*
RTD 9 Temperature	Celsius	041D	3x00412		G10	1	*	*	*
RTD 10 Temperature	Celsius	041E	3x00413		G10	1	*	*	*
Nb of hot starts allowed	-	040F	3x00414		G1	1	*	*	*
Nb of cold starts allowed	-	0410	3x00415		G1	1	*	*	*
Time to next start	Seconds	0411	3x00416	3x00417	G24	2	*	*	*
Last start time	Seconds	0411	3x00416	3x00417	G24	2	*	*	*
Last start current	Amps	0414	3x00420	3x00421	G24	2	*	*	*
Number of motor starts	-	0415	3x00422		G1	1	*	*	*
Number of emergency restarts	-	0417	3x00423		G1	1	*	*	*
Number of reacceleration	-	0419	3x00425		G1	1	*	*	*
Motor running hours	Hours	041B	3x00427		G30	1	*	*	*
RTD Open Cct	-	041D	3x00429		G108	1	*	*	*
RTD Short Cct	-	041E	3x00430		G109	1	*	*	*
RTD Data error	-	041F	3x00431		G110	1	*	*	*
Num RTD hottest measurement	-	0421	3x00432		G1	1	*	*	*
Hottest RTD measurement	Celsius	0422	3x00433		G10	1	*	*	*
Analog Input 1 measurement	-	0424	3x00434	3x00435	G125	2	*	*	*
Analog Input 2 measurement	-	0425	3x00436	3x00437	G125	2	*	*	*
Analog Input 3 measurement	-	0426	3x00438	3x00439	G125	2	*	*	*
Analog Input 4 measurement	-	0427	3x00440	3x00441	G125	2	*	*	*
Nb of control trips	-	0501	3x00500		G1	1	*	*	*
Nb of Trip Ith>	-	0502	3x00501		G1	1	*	*	*
Nb of Trip Icc>1	-	0503	3x00502		G1	1	*	*	*
Nb of Trip Icc>2	-	0504	3x00531		G1	1	*	*	*
Nb of Trip ISEF>1	-	0505	3x00503		G1	1	*	*	*
Nb of Trip ISEF>2	-	0506	3x00504		G1	1	*	*	*
Nb of Trip IEFD>1	-	0507	3x00532		G1	1	*	*	*
Nb of Trip IEFD>1	-	0508	3x00533		G1	1	*	*	*
Nb of Trip I2>1	-	0509	3x00505		G1	1	*	*	*
Nb of Trip I2>2	-	050A	3x00506		G1	1	*	*	*
Nb of Trip P0>	-	050B	3x00507		G1	1	*	*	*
Nb of Trip V<1	-	050C	3x00508		G1	1	*	*	*
Nb of Trip V<2	-	050D	3x00509		G1	1	*	*	*
Nb of Trip F<1	-	050E	3x00510		G1	1	*	*	*

Measurement name	Measurement unit	Equivalent courier cell	Start register	End register	Data format	Data size (registers)	P241	P242	P243
Nb of Trip F<2	-	050F	3x00511		G1	1	*	*	*
Nb of Trip P<1	-	0510	3x00512		G1	1	*	*	*
Nb of Trip P<2	-	0511	3x00534		G1	1	*	*	*
Nb of Trip Cos PHI < Lead	-	0512	3x00513		G1	1	*	*	*
Nb of Trip Cos PHI < Lag	-	0513	3x00536		G1	1	*	*	*
Nb of Trip Ret P>	-	0514	3x00535		G1	1	*	*	*
Nb of Trip V>1	-	0515	3x00514		G1	1	*	*	*
Nb of Trip V>2	-	0516	3x00515		G1	1	*	*	*
Nb of Trip VN>1	-	0517	3x00516		G1	1	*	*	*
Nb of Trip VN>2	-	0518	3x00517		G1	1	*	*	*
Nb of Prolonged start	-	0519	3x00518		G1	1	*	*	*
Nb of Locked rotor-strt	-	051A	3x00519		G1	1	*	*	*
Nb of Locked rotor-run	-	051B	3x00520		G1	1	*	*	*
Nb of Trip RTD 1	-	051C	3x00521		G1	1	*	*	*
Nb of Trip RTD 2	-	051D	3x00522		G1	1	*	*	*
Nb of Trip RTD 3	-	051E	3x00523		G1	1	*	*	*
Nb of Trip RTD 4	-	051F	3x00524		G1	1	*	*	*
Nb of Trip RTD 5	-	0520	3x00525		G1	1	*	*	*
Nb of Trip RTD 6	-	0521	3x00526		G1	1	*	*	*
Nb of Trip RTD 7	-	0522	3x00527		G1	1	*	*	*
Nb of Trip RTD 8	-	0523	3x00528		G1	1	*	*	*
Nb of Trip RTD 9	-	0524	3x00529		G1	1	*	*	*
Nb of Trip RTD 10	-	0525	3x00530		G1	1	*	*	*
Nb of Trip Diff	-	0526	3x00537		G1	1			*
Nb of Trip Clio1	-	0527	3x00538		G1	1	*	*	*
Nb of Trip Clio2	-	0528	3x00539		G1	1	*	*	*
Nb of Trip Clio3	-	0529	3x00540		G1	1	*	*	*
Nb of Trip Clio4	-	052A	3x00541		G1	1	*	*	*
Nb FFail1 Trip	-	052B	3x00542		G1	1	*	*	*
Nb FFail2 Trip	-	052C	3x00543		G1	1	*	*	*
Nb Trip Icc>3	-	052D	3x00502		G1	1	*	*	*
Nb Trip Icc>4	-	052E	3x00531		G1	1	*	*	*
CB Operations	-	0601	3x00600		G1	1	*	*	*
Total IA Broken	Amps	0602	3x00601	3x00602	G24	2	*	*	*
Total IB Broken	Amps	0603	3x00603	3x00604	G24	2	*	*	*
Total IC Broken	Amps	0604	3x00605	3x00606	G24	2	*	*	*
CB Operate Time	Seconds	0605	3x00607		G25	1	*	*	*

Table 7 - Measurement data available in the P240 product range

5.8 Binary Status Information

Binary status information is available for the product’s optically-isolated status inputs (optos), relay contact outputs, alarm flags, control inputs, internal Digital Data Bus (DDB), and the front panel 25-pin test port (see Note).

Note	*The test port allows the product to be configured to map up to eight of its DDB signals (see the Relay Menu Database document) to eight output pins. The usual application is to control test equipment. However, since the test port output status is available on the MODBUS interface, it could be used to efficiently collect up to eight DDB signals.*

The product’s internal DDB consists of 2048 binary-status flags. The allocation of the points in the DDB are largely product and version specific. See the *Relay Menu Database document*, for a definition of the product’s DDB.

The relay-contact status information is available from the 0x “Coil Status” MODBUS page and from the 3x “Input Register” MODBUS page.

The current state of the optically isolated status inputs is available from the 1x “Input Status” MODBUS page and from the 3x “Input Register” MODBUS page. The principal 3x registers are part of the DDB status register area (725 & 726). For legacy reasons, a single register at 3x00007 provides the status of the first 16 inputs.

The 0x “Coil Status” and 1x “Input Status” pages allow individual or blocks of binary status flags to be read. The resultant data is left aligned and transmitted in a big-endian (high-order to low-order) format in the response frame. Relay contact 1 is mapped to coil 1, contact 2 to coil 2 and so on. Similarly, opto input 1 is mapped to input 1, opto input 2 to input 2 and so on.

Name	Equivalent courier cell	Start register	End register	Data format	Data size (registers)	P241	P242	P243
Product Status	-	3x00001		G26	1	*	*	*
Opto I/P Status	0020	3x00007		G8	1	*	*	*
Relay O/P Status	0021	3x00008	3x00009	G9	2	*	*	*
Alarm Status 1	0050	3x00011	3x00012	G96	2	*	*	*
Alarm Status 2	0051	3x00013	3x00014	G111	2	*	*	*
Alarm Status 3	0052	3x00015	3x00016	G303	2	*	*	*
Ctrl I/P Status	1201	4x00950	4x00951	G202	2	*	*	*
Test Port Status	0F03	311022	311022	G124	1	*	*	*
DDB 31 - 0	0F20	311023	311024	G27	2	*	*	*
DDB 63 - 32	0F21	311025	311026	G27	2	*	*	*
DDB 95 - 64	0F22	311027	311028	G27	2	*	*	*
DDB 127 - 96	0F23	311029	311030	G27	2	*	*	*
DDB 159 - 128	0F24	311031	311032	G27	2	*	*	*
DDB 191 - 160	0F25	311033	311034	G27	2	*	*	*
DDB 223 - 192	0F26	311035	311036	G27	2	*	*	*
DDB 255 - 224	0F27	311037	311038	G27	2	*	*	*
DDB 287 - 256	0F28	311039	311040	G27	2	*	*	*
DDB 319 - 288	0F29	311041	311042	G27	2	*	*	*
DDB 351 - 320	0F2A	311043	311044	G27	2	*	*	*
DDB 383 - 352	0F2B	311045	311046	G27	2	*	*	*
DDB 415 - 384	0F2C	311047	311048	G27	2	*	*	*
DDB 447 - 416	0F2D	311049	311050	G27	2	*	*	*
DDB 479 - 448	0F2E	311051	311052	G27	2	*	*	*
DDB 511 - 480	0F2F	311053	311054	G27	2	*	*	*

Name	Equivalent courier cell	Start register	End register	Data format	Data size (registers)	P241	P242	P243
DDB 543 - 512	0F30	311055	311056	G27	2	*	*	*
DDB 575 - 544	0F31	311057	311058	G27	2	*	*	*
DDB 607 - 576	0F32	311059	311060	G27	2	*	*	*
DDB 639 - 608	0F33	311061	311062	G27	2	*	*	*
DDB 671 - 640	0F34	311063	311064	G27	2	*	*	*
DDB 703 - 672	0F35	311065	311066	G27	2	*	*	*
DDB 735 - 704	0F36	311067	311068	G27	2	*	*	*
DDB 767 - 736	0F37	311069	311070	G27	2	*	*	*
DDB 799 - 768	0F38	311071	311072	G27	2	*	*	*
DDB 831 - 800	0F39	311073	311074	G27	2	*	*	*
DDB 863 - 832	0F3A	311075	311076	G27	2	*	*	*
DDB 895 - 864	0F3B	311077	311078	G27	2	*	*	*
DDB 927 - 896	0F3C	311079	311080	G27	2	*	*	*
DDB 959 - 928	0F3D	311081	311082	G27	2	*	*	*
DDB 991 - 960	0F3E	311083	311084	G27	2	*	*	*
DDB 1023 - 992	0F3F	311085	311086	G27	2	*	*	*
DDB element 1055 - 1024	0F40	311087	311088	G27	2	*	*	*
DDB element 1087 - 1056	0F41	311089	311090	G27	2	*	*	*
DDB element 1119 - 1088	0F42	311091	311092	G27	2	*	*	*
DDB element 1151 - 1120	0F43	311093	311094	G27	2	*	*	*
DDB element 1183 - 1152	0F44	311095	311096	G27	2	*	*	*
DDB element 1215 - 1184	0F45	311097	311098	G27	2	*	*	*
DDB element 1247 - 1216	0F46	311099	311100	G27	2	*	*	*
DDB element 1279 - 1248	0F47	311101	311102	G27	2	*	*	*
DDB element 1311 - 1280	0F48	311103	311104	G27	2	*	*	*
DDB element 1343 - 1312	0F49	311105	311106	G27	2	*	*	*
DDB element 1375 - 1344	0F4A	311107	311108	G27	2	*	*	*
DDB element 1407 - 1376	0F4B	311109	311110	G27	2	*	*	*
DDB element 1439 - 1408	0F4C	311111	311112	G27	2	*	*	*
DDB element 1471 - 1440	0F4D	311113	311114	G27	2	*	*	*
DDB element 1503 - 1472	0F4E	311115	311116	G27	2	*	*	*
DDB element 1535 - 1504	0F4F	311117	311118	G27	2	*	*	*
DDB element 1567 - 1536	0F50	311119	311120	G27	2	*	*	*
DDB element 1599 - 1568	0F51	311121	311122	G27	2	*	*	*
DDB element 1631 - 1600	0F52	311123	311124	G27	2	*	*	*
DDB element 1663 - 1632	0F53	311125	311126	G27	2	*	*	*
DDB element 1695 - 1664	0F54	311127	311128	G27	2	*	*	*
DDB element 1727 - 1696	0F55	311129	311130	G27	2	*	*	*
DDB element 1759 - 1728	0F56	311131	311132	G27	2	*	*	*
DDB element 1791 - 1760	0F57	311133	311134	G27	2	*	*	*
DDB element 1823 - 1792	0F58	311135	311136	G27	2	*	*	*
DDB element 1855 - 1824	0F59	311137	311138	G27	2	*	*	*
DDB element 1887 - 1856	0F5A	311139	311140	G27	2	*	*	*

Name	Equivalent courier cell	Start register	End register	Data format	Data size (registers)	P241	P242	P243
DDB element 1919 - 1888	0F5B	311141	311142	G27	2	*	*	*
DDB element 1951 - 1920	0F5C	311143	311144	G27	2	*	*	*
DDB element 1983 - 1952	0F5D	311145	311146	G27	2	*	*	*
DDB element 2015 - 1984	0F5E	311147	311148	G27	2	*	*	*
DDB element 2047 - 2016	0F5F	311149	311150	G27	2	*	*	*

Table 8 - Binary status information available in the P240 product range

5.9 Measurement and Binary Status 3x Register Sets

The data available from the 3x input registers is arranged into register sets. A register set is a fixed collection of values in a contiguous block of register addresses. The advantage of this is that multiple values may be read with a single MODBUS query, function code 4 “Read Input Registers”, up to the maximum data limits of the query, see the *Maximum Query and Response Parameters* section.

The definition of a register-set is specified by the selection of a start and end address, which can span multiple contiguous values in the 3x Register, see the *Relay Menu Database document*. The only rule is that a register set must not result in an attempt to read only part of a multi-register data type, see the *Register Data Types* section. A register set can span unused register locations, in which case a value of zero is returned for each such register location.

Some examples of useful register sets are:

- For P24x:
  - 3x200 to 3x288 provides a selection of measurements
  - 311023 to 311150 provide the DDB status
  - 3x404 to 3x413 provide the ten RTD measurement values

There are many other possibilities depending on your application and an appraisal of the 3x Register Map in the *Relay Menu Database document.* The capabilities of the MODBUS master device, performance targets, and communications latencies may also influence the degree to which multiple values are read as register sets, as opposed to individually.

5.10 Controls

The *Control (commands) available in the product range* table shows MODBUS 4x “Holding Registers” that allow the external system to control aspects of the product’s behavior, configuration, records, or items of plant connected to the product such as circuit breakers.

The **Command or setting** column indicates whether the control is a self-resetting “Command” or a state based “Setting”.

“Command” controls automatically return to their default value when the control action has been completed. This may cause problems with masters that try to verify write requests by reading back the value that was written.

“Setting” controls maintain the written value, assuming that it was accepted. For example, the **Active Settings** register reports the current active group on reads. The Active Setting Group register also accepts writes with a valid setting group number to change the active group to the one specified. This assumes that the setting group selection by optically isolated status inputs has not been enabled and that the specified group is enabled.

Entries without a defined setting range, as for the **min.**, **max.** and **step** columns, are binary-string values whose pattern is defined by its stated data type.

5.11 Event Extraction

The product can store up to 512 event records in battery backed-up memory. An event record consists of a time stamp, a record type, and a set of information fields. The record type and the information fields record the event that occurred at the time captured by the time stamp.

The product has several classes of event record:

- Alarm events
- Opto-isolated status input events
- Relay contact output events
- Protection/DDB operation events
- Fault data capture events
- General events

The *Relay Menu Database document* specifies the available events. The product provides an “event filtering” feature that may be used to prevent specific events from being logged. The event filter is configured in the **Record Control** section of the product’s menu database in the MiCOM S1 Studio configuration tool.

The product supports two methods of event extraction providing either automatic or manual extraction of the stored event, fault, and maintenance records.

The product stores event, fault, and maintenance records in three separate queues. As entries are added to the fault and maintenance queues, a corresponding event is added to the event queue. Each queue is of different length and each queue may be individually cleared – see the *Event Record Delection* section. It is therefore possible to have a fault event or a maintenance event entry in the event queue with no corresponding entry in the associated queue because it has been overwritten or deleted.

The manual extraction procedure (see the *Manual Extraction Procedure section*) allows each of these three queues to be read independently.

The automatic extraction procedure (sss the *Automatic Extraction Procedure section*) reads records from the event queue. If the event record is a fault or a maintenance record, the record’s extended data is read also, if it is available from their queues.

Note	*Version 31 of the product introduced a new set of 3x registers for the presentation of the event and fault record data. These registers are used throughout the text of the following sub-sections. For legacy compatibility, the original registers are still provided. These are described as previous MODBUS addresses in the Relay Menu Database document. They should not be used for new installations. See the* ***Legacy Event Record Support*** *section for additional information.*

5.11.1 Manual Extraction Procedure

There are three registers available to manually select stored records, there are also three read only registers allowing the number of stored records to be determined.

- 40100 - Select Event, 0 to 249
- 40101 - Select Fault, 0 to 4
- 40102 - Select Maintenance Record, 0 to 4

For each of the above registers a value of 0 represents the most recent stored record.

The following registers can be read to indicate the numbers of the various types of record stored.

- 30100 - Number of stored records
- 30101 - Number of stored fault records
- 30102 - Number of stored maintenance records

Each fault or maintenance record logged causes an event record to be created by the relay. If this event record is selected the additional registers allowing the fault or maintenance record details will also become populated.

5.11.2 Automatic Extraction Procedure

Automatic event-record extraction allows records to be extracted as they occur. Event records are extracted in sequential order, including any fault or maintenance data that may be associated with an event.

The MODBUS master can determine whether the product has any events stored that have not yet been extracted. This is done by reading the product's status register 3x00001 (G26 data type). If the event bit of this register is set, the product contains event records that have not yet been extracted.

To select the next event for sequential extraction, the master station writes a value of one to the record selection register 4x00400 (G18 data type). The event data, plus any fault or maintenance data, can be read from the registers specified in the *Record Data* section. Once the data has been read, the event record is marked. This is done by writing a value of 2 to register 4x00400. The G18 data type consists of bit fields. Therefore it is also possible to both mark the current record as read and automatically select the next unread record. This is done by writing a value of 3 to the register.

When the last (most recent) record is accepted, the event flag in the status register (3x00001) resets. If the last record is accepted by writing a value of 3 to the record selection register (4x00400), a dummy record appears in the event-record registers with an "Event Type" value of 255. Selecting another record when none are available gives a MODBUS exception code 3, "Invalid value" (see the *MODBUS Response Code Interpretation* section).

One possible event record extraction procedure is shown in the following *Automatic event extraction procedure* diagram.

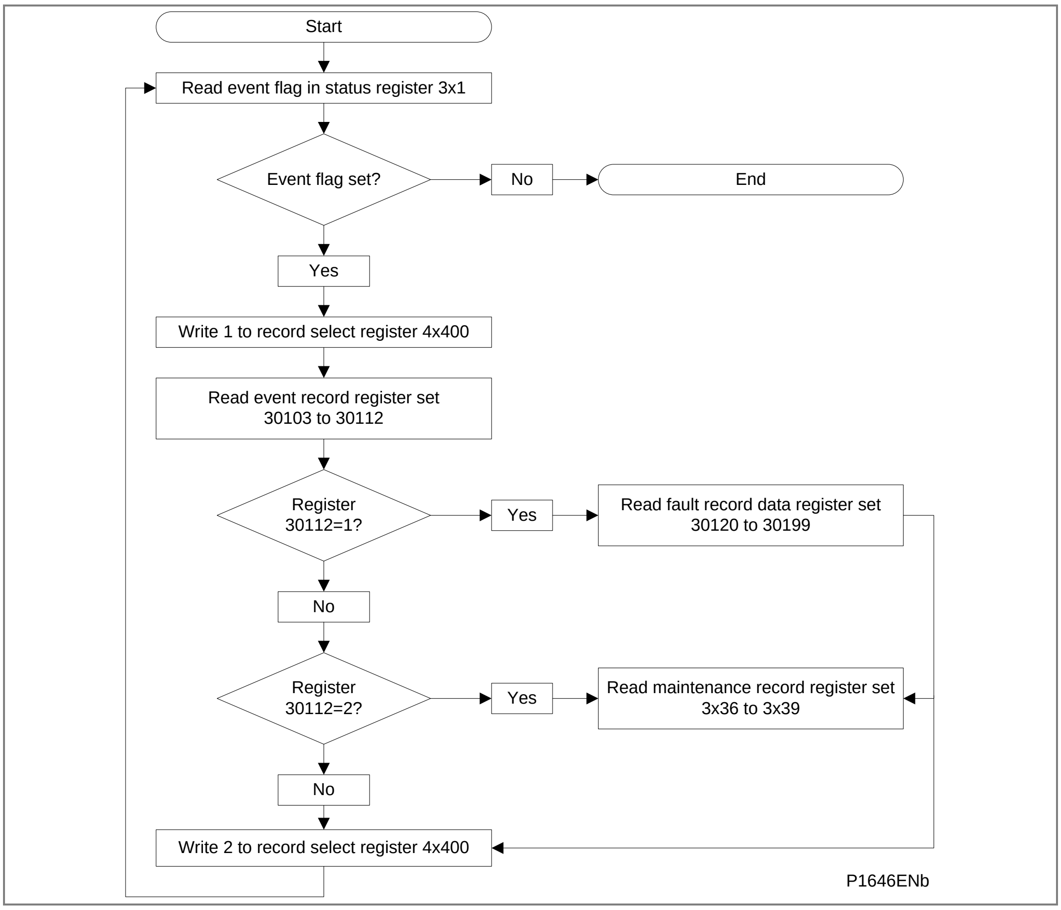


Figure 6 - Automatic event extraction procedure

5.11.3 Record Data

The location and format of the registers used to access the record data is the same whether they have been selected using manual or automatic extraction mechanisms, see the *Manual Extraction Procedure* and *Automatic Extraction Procedure* sections.

Description	Register	Length (registers)	Comments
Time Stamp	30103	4	See G12 data type the Relay Menu Database, P24x/EN MD.
Event Type	30107	1	Indicates the type of the event record. See G13 data type in the Relay Menu Database, *P24x/EN MD* (additionally, a value of 255 indicates that the end of the event log has been reached).
Event Value	30108	2	Contains the associated status register value, as a string of binary flags, for relay-contact, opto-input, alarm, and protection events. Otherwise, it will have a value of zero. When a status value is supplied, the value represents the recorded value of the event types associated register pair, as indicated by the Event Origin value (see Note 1).

Description	Register	Length (registers)	Comments
Event Origin	30110	1	The Event Original value indicates the MODBUS Register pair where the change occurred (see Note 2). Possible values are: 30011 Alarm Status 1 event 30013 Alarm Status 2 event 30015 Alarm Status 3 event 30723 Relay contact event (2 registers: DDB 0-31 status) 30727 Status input event (2 registers: DDB 64-95 status) 40537 to 40548 Protection events (Indicates the 32-bit DDB status word that was the origin of the event) For General events, Fault events, and Maintenance events a value of zero will be returned.
Event Index	30111	1	The Event Index value is used to distinguish between events with the same Event Type and Event Origin. The registers value depends on the type of the event: For protection events, the value is the ID of the DDB that caused the event. For alarm events, the value is the ID of the alarm that caused the event. In both cases, the value includes the direction of the state transition in the most significant bit. This direction bit is 1 for a 0-1 (low to high) change, and 0 for a 1-0 (high to low) change. For all other types of events, it will have a value of zero.
Additional Data Present	30112	1	Indicates whether the record has additional data. 0 Indicates that there is no additional data. 1 Indicates that fault record data can be read from 3x10020 to 3x10999 (see Note 3). In order to obtain fault record data, event record must be extracted. 2 Indicates that maintenance record data can be read from registers 3x36 to 3x39.

Note 1 *The protection-event status information is the value of the DDB status word that contains the protection DDB that caused the event*

Note 2 *Subtracting 3000 from the Event Origin value results in the MODBUS 3x memory-page register ID, subtracting one from this results in the MODBUS register address - see section* ***Error! Reference source not found.****. The resultant register address can be used in a function code 4 MODBUS query.*

Note 3 *The exact number of fault record registers depends on the individual product - see Relay Menu Database, P24x/EN MD.*

Table 9 - Event record extraction registers

If a fault record or maintenance record is directly selected using the manual mechanism, the data can be read from the fault or maintenance data register ranges specified in the *Maintenance record types* table. The event record data in registers 3x10003 to 3x10012 is not valid.

See the *Relay Menu Database document* for the record values for each event.

The general procedure for decoding an event record is to use the value of the **Event Type** field combined with the value of the **Event Index** field to uniquely identify the event. The exceptions to this are event types 4, 5, 7, 8, & 9.

Event types 4 **Relay Contact Output Events** and 5 **Opto-Isolated Status Input Events** only provide the value of the input or output status register (as indicated by the Event Origin value) when the event occurred. If event transition information for each input or output is required, it must be deduced by comparing the event value with the previous event value (for identically-typed events records).

Event type 7 **General Event** events are solely identified by their **Event Value**.

Event types 8 **Fault Record** and 9 **Maintenance Record** require additional registers to be read when the associated additional data is available (see Note). The Fault record registers in the range 30120 to 30199 (the exact number of registers depends on the individual product) are documented in the 3x register-map in the *Relay Menu Database document*. The two additional 32-bit maintenance record register-pairs consist of a maintenance record type (register pair 3x36/7) and a type-specific error code (register pair 3x38/9). The *Maintenance record types* table lists the different types of maintenance record available from the product.

Note	*As noted at the beginning of the Event Extraction section, it should not be assumed that the additional data is available for fault and maintenance record events.*

Maintenance record	Front panel text	Record type 3x00036
Power on test errors (non-fatal)		
Watchdog 1 failure (fast)	Fast W'Dog Error	0
Battery fail	Battery Failure	1
Battery-backed RAM failure	BBRAM Failure	2
Field voltage failure	Field Volt Fail	3
Ribbon bus check failure	Bus Reset Error	4
Watchdog 2 failure (slow)	Slow W'Dog Error	5
Continuous self-test errors		
SRAM bus failure	SRAM Failure Bus	6
SRAM cell failure	SRAM Failure Blk.	7
Flash EPROM checksum failure	FLASH Failure	8
Program code verify failure	Code Verify Fail	9
Battery-backed RAM failure	BBRAM Failure	10
Battery fail	Battery Failure	11
Field Voltage failure	Field Volt Fail	12
EEPROM failure	EEPROM Failure	13
Fatal software exception	Software Failure	14
Incorrect hardware configuration	H/W Verify Fail	15
Software exception (typically non-fatal)	Non Standard	16
Analog module failure	Ana. Sample Fail	17
Ethernet card error	NIC Soft Error	18

Table 10 - Maintenance record types

5.11.4 Event Record Deletion

It is possible to independently delete (“clear”) the stored event, fault, and maintenance record queues. This is done by writing a value of 1, 2, or 3 to register 4x401 (G6 data type), respectively.

Register 4x401 also provides an option to reset the product’s front panel indications, which has the same effect as pressing the front panel “Clear” key when viewing alarm indications using the front panel user interface. This is done by writing a value of 4 to register 4x401.

See also the *Disturbance Record Deletion* section for details about deleting disturbance records.

5.11.5 Legacy Event Record Support

The obsolete fault record data between registers 3x113 and 3x199, and 3x490 and 3x499, now exists between registers 30120 and 30199. In comparison with the obsolete fault record data, the data between registers 30120 and 30199 is ordered slightly differently and it contains new data values. These new values since version 31 of the product are not available in the obsolete fault-record register sets.

The maintenance-record registers 3x36 to 3x39 remain unaffected by this evolution.

Description	Obsolete register	Length (registers)	Corresponds to register
Number of stored event records	3x00100	1	3x10100
Number of stored fault records	3x00101	1	3x10101
Number of stored maintenance records	3x00102	1	3x10102
Time Stamp	3x00103	4	3x10103
Event Type	3x00107	1	3x10107
Event Value	3x00108	2	3x10108
Event Origin	3x00110	1	3x10110
Event Index	3x00111	1	3x10111
Additional Data Present	3x00112	1	3x10112

Table 11 - Event record 3x registers

5.12 Disturbance Record Extraction

The product provides facilities for both manual and automatic extraction of disturbance records. The two methods differ only in the mechanism for selecting a disturbance record; the method for extracting the data and the format of the data are identical.

Records extracted are presented in IEEE COMTRADE format. This involves extracting two files: an ASCII text configuration file, and a binary data file.

Each file is extracted by repeatedly reading a data-page until all of the file’s data has been transferred. The data-page is made up of 127 registers; providing a maximum of 254 bytes for each register block request.

5.12.1 Interface Registers

The following set of registers is presented to the master station to support the extraction of uncompressed disturbance records:

Register	Name	Description
3x00001	Status register	Provides the status of the product as bit flags: b0 Out of service b1 Minor self test failure b2 Event b3 Time synchronization b4 Disturbance b5 Fault b6 Trip b7 Alarm b8 to b15 Unused A '1' in bit "b4" indicates the presence of one or more disturbance records.
3x00800	Number of stored disturbances	Indicates the total number of disturbance records currently stored in the product, both extracted and unextracted.
3x00801	Unique identifier of the oldest disturbance record	Indicates the unique identifier value for the oldest disturbance record stored in the product. This is an integer value used in conjunction with the 'Number of stored disturbances' value to calculate a value for manually selecting records.
4x00250	Manual disturbance record selection register	This register is used to manually select disturbance records. The values written to this cell are an offset of the unique identifier value for the oldest record. The offset value, which ranges from 0 to the No of stored disturbances - 1, is added to the identifier of the oldest record to generate the identifier of the required record.
4x00400	Record selection command register	This register is used during the extraction process and has a number of commands. These are: b0 Select next event b1 Accept event b2 Select next disturbance record b3 Accept disturbance record b4 Select next page of disturbance data b5 Select data file
3x00930 to 3x00933	Record time stamp	These registers return the timestamp of the disturbance record.
3x00802	Number of registers in data page	This register informs the master station of the number of registers in the data page that are populated.
3x00803 to 3x00929	Data page registers	These 127 registers are used to transfer data from the product to the master station.
3x00934	Disturbance record status register	The disturbance record status register is used during the extraction process to indicate to the master station when data is ready for extraction. See next table.
4x00251	Data file format selection	This is used to select the required data file format. This is reserved for future use.

Table 12 - Disturbance record extraction registers

The Disturbance Record status register will report one of the following values:

State		Description
Idle		This will be the state reported when no record is selected; such as after power on or after a record has been marked as extracted.
Busy		The product is currently processing data.
Page ready		The data page has been populated and the master can now safely read the data.
Configuration complete		All of the configuration data has been read without error.
Record complete	4	All of the disturbance data has been extracted.
Disturbance overwritten	5	An error occurred during the extraction process where the disturbance being extracted was overwritten by a new record.
No unextracted disturbances	6	An attempt was made by the master station to automatically select the next oldest unextracted disturbance when all records have been extracted.
Not a valid disturbance	7	An attempt was made by the master station to manually select a record that did not exist in the product.
Command out of sequence	8	The master station issued a command to the product that was not expected during the extraction process.

Table 13 - Disturbance record status register (3x934) values

5.12.2 Extraction Procedure

The following procedure must be used to extract disturbance records from the product. The procedure is split into four sections:

1. Selection of a disturbance, either manually or automatically.
2. Extraction of the configuration file.
3. Extraction of the data file.
4. Accepting the extracted record (automatic extraction only).

5.12.2.1 Manual Extraction Procedure

The procedure used to extract a disturbance manually is shown in the following *Manual selection of a disturbance record* diagram. The manual method of extraction does not allow for the acceptance of disturbance records.

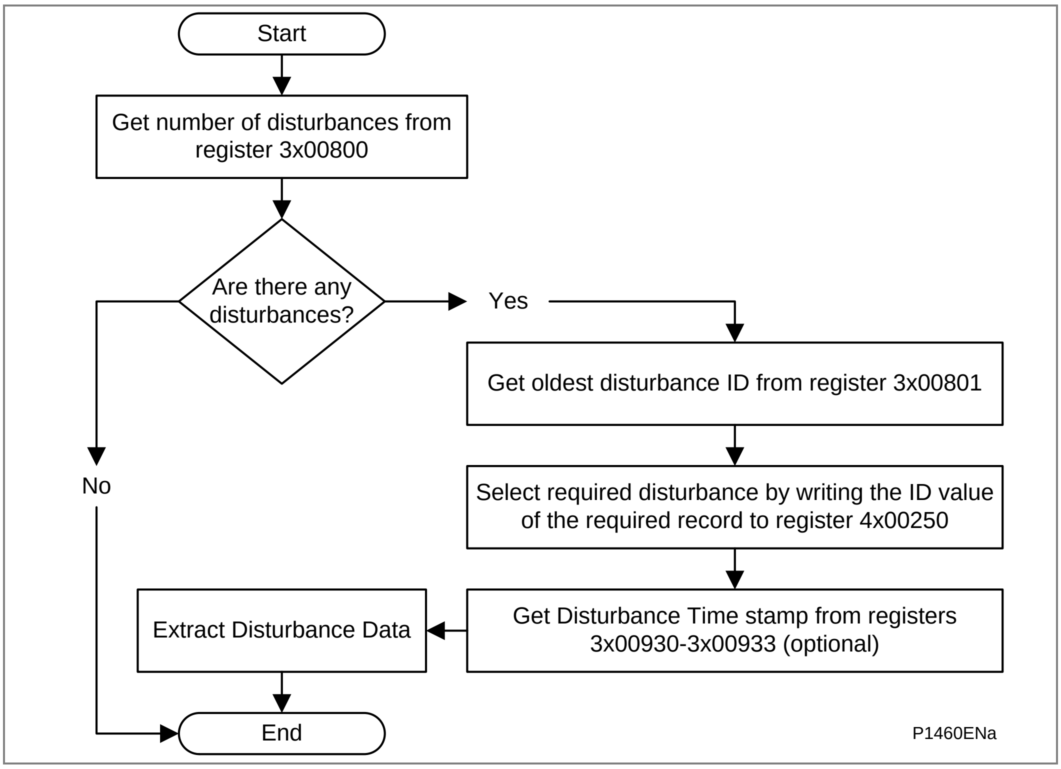


Figure 7 - Manual selection of a disturbance record

5.12.2.2 Automatic Extraction Procedure - Option 1

There are two methods that can be used for automatically extracting disturbances.

- Option 1 is simpler and is better at extracting single disturbance records, i.e. when the disturbance recorder is polled regularly.
- Option 2, however, is more complex to implement but is more efficient at extracting large quantities of disturbance records. This may be useful when the disturbance recorder is polled only occasionally and hence may have many stored records.

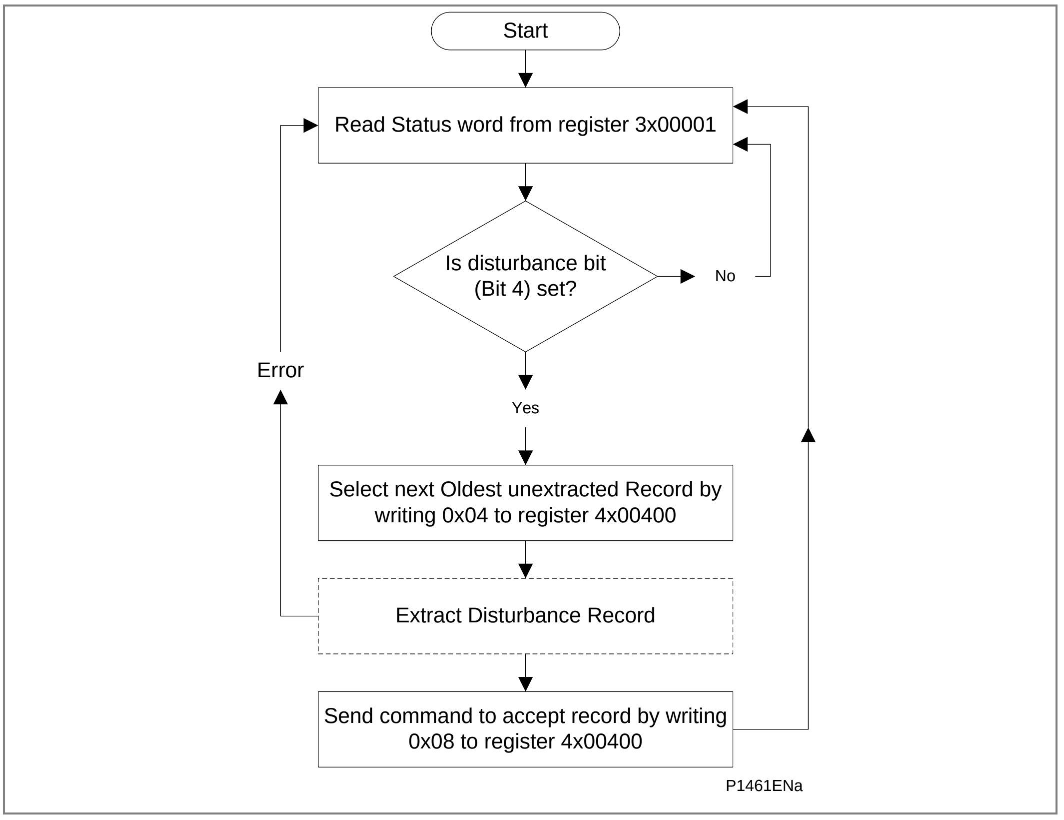


Figure 8 - Automatic selection of a disturbance - option 1

5.12.2.3 Automatic Extraction Procedure - Option 2

The second method that can be used for automatic extraction is shown in the *Automatic selection of a disturbance - option 2* diagram. This also shows the acceptance of the disturbance record once the extraction is complete.

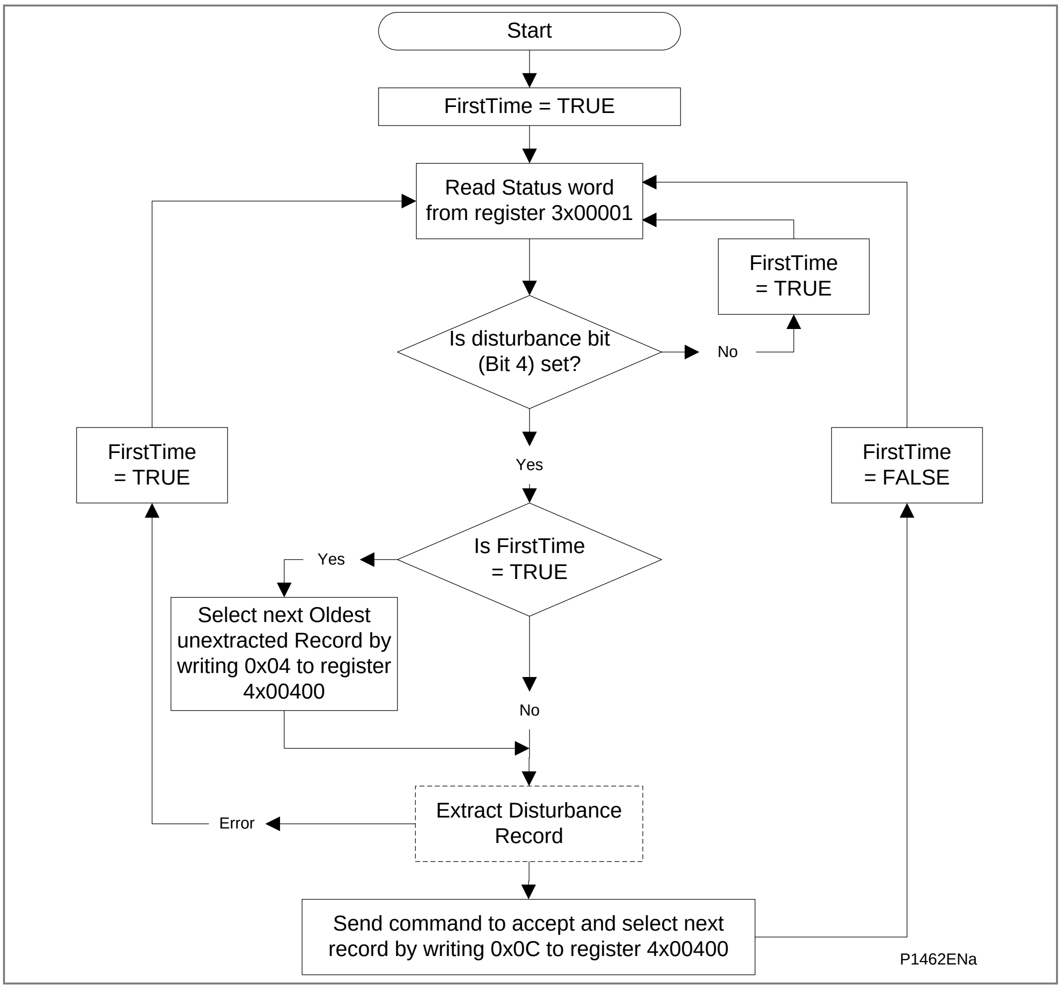


Figure 9 - Automatic selection of a disturbance - option 2

5.12.2.4 Extracting the Disturbance Data

Extraction of a selected disturbance record is a two-stage process. This involves first reading the configuration file, then the data file. The *Extracting the COMTRADE configuration file* diagram shows how the configuration file is read and *the Extracting the COMTRADE binary data file* diagram shows how the data file is extracted.

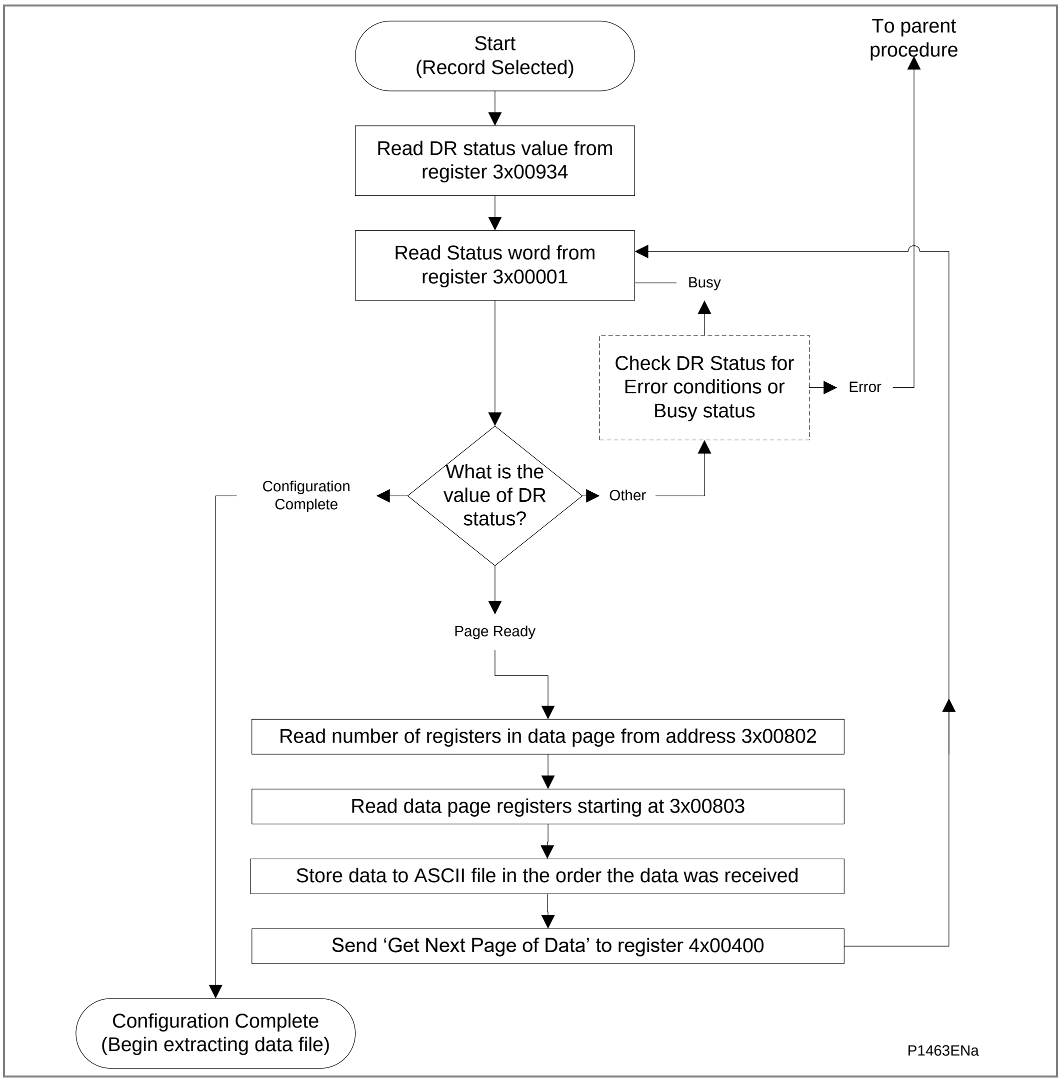


Figure 10 - Extracting the COMTRADE configuration file

Figure 11 shows how the data file is extracted:

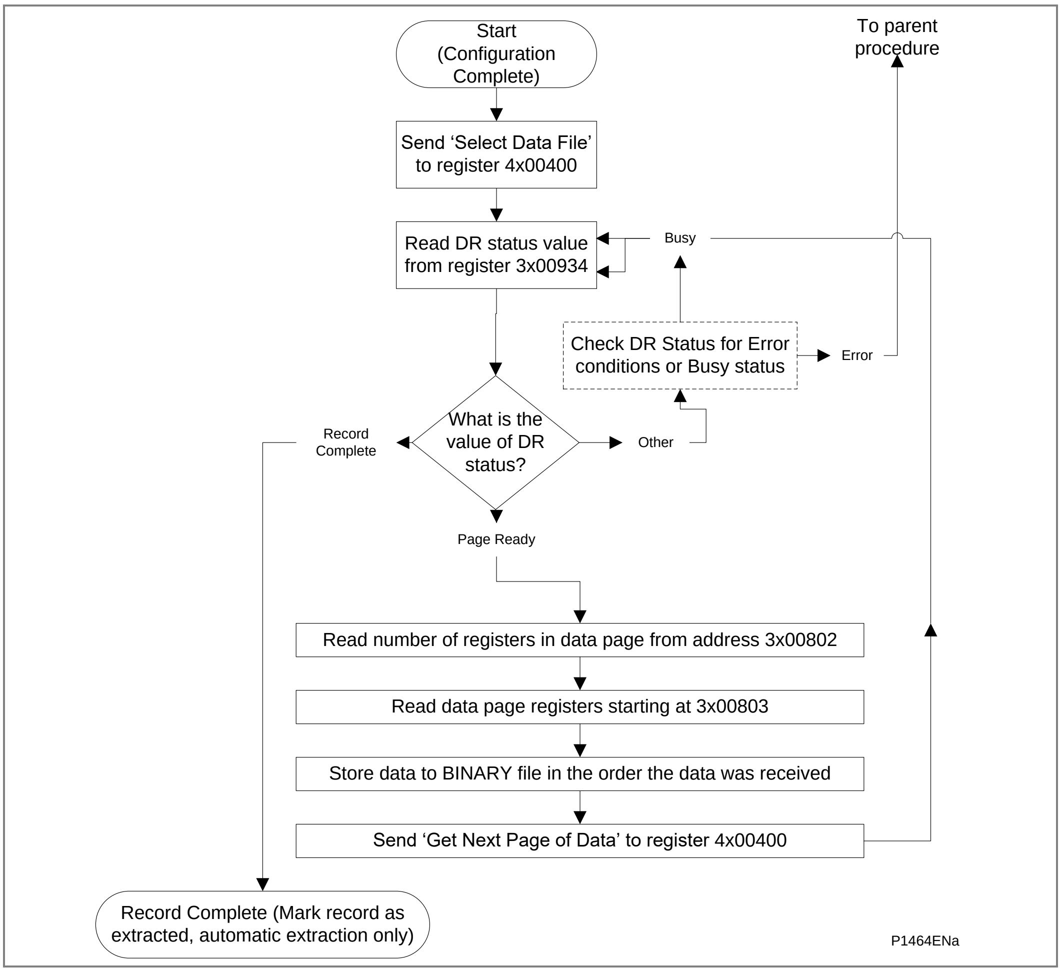


Figure 11 - Extracting the COMTRADE binary data file

During the extraction of a COMTRADE file, an error may occur that is reported in the disturbance record status register, 3x934. This can be caused by the product overwriting the record that is being extracted. It can also be caused by the master issuing a command that is not in the bounds of the extraction procedure.

5.12.3 Storage of Extracted Data

The extracted data needs to be written to two separate files. The first is the configuration file, which is in ASCII text format, and the second is the data file, which is in a binary format.

5.12.3.1 Storing the Configuration File

As the configuration data is extracted from the product, it should be stored to an ASCII text file with a '.cfg' file extension. Each register in the page is a G1 format 16-bit unsigned integer that is transmitted in big-endian byte order. The master must write the configuration file page-data to the file in ascending register order with each register's high order byte written before its low order byte, until all the pages have been processed.

5.12.3.2 Storing the Binary Data File

As the binary data is extracted from the product, it should be stored to a binary file with the same name as the configuration file, but with a '.dat' file extension instead of the '.cfg' extension. Each register in the page is a G1-format 16-bit unsigned integer that is transmitted in big-endian byte order. The master must write the page data to a file in ascending register order with each register's high order byte written before its low order byte until all the pages have been processed.

5.12.4 Disturbance Record Deletion

All of the disturbance records stored in the product can be deleted ("cleared") by writing 5 to the record control register 4x401 (G6 data type). See the *Event Record Deletion* section for details on event record deletion.

5.13 Setting Changes

The relay settings can be split into two categories:

- Control and support settings
- Disturbance record settings and protection setting groups

Changes to settings in the control and support area are executed immediately. Changes to the protection setting groups or the disturbance recorder settings are stored in a temporary 'scratchpad' area and must be confirmed before they are implemented. All the product settings are 4xxxx page registers; see the *Relay Menu Database document*. The following points should be noted when changing settings:

- Settings implemented using multiple registers must be written to using a multi-register write operation. The product does not support write access to sub-parts of multi-register data types.
- The first address for a multi-register write must be a valid address. If there are unmapped addresses in the range that is written to, the data associated with these addresses are discarded.
- If a write operation is performed with values that are out of range, an "illegal data" response code is produced. Valid setting values in the same write operation are executed.
- If a write operation is performed attempting to change registers that require a higher level of password access than is currently enabled, all setting changes in the write operation are discarded.

5.13.1 Password Protection

The product's settings can be subject to Password protection. The level of password protection required to change a setting is indicated in the 4x register-map table in the *Relay Menu Database document*. Level 2 is the highest level of password access, level 0 indicates that no password is required.

The following registers are available to control password protection:

Models without Cyber Security

40001 & 40002 Password entry

40022 Default password level

40023 & 40024 Setting to change password level 1

40025 & 40026 Setting to change password level 2

30010 Can be read to indicate current access level

5.13.2 Control and Support Settings

Control and support settings are committed immediately when a value is written to such a register. The MODBUS registers in this category are:

- 4x00000-4x00599
- 4x00700-4x00999
- 4x02049 to 4x02052
- 4x10000-4x10999

5.13.2.1 Time Synchronization

The value of the product's real time clock can be set by writing the desired time (see the *Date and Time Format (Data Type G12)* section) to registers 4x02049 through 4x02052. These registers are standard to Schneider Electric MiCOM products, which makes it easier to broadcast a time synchronization packet, being a block write to the time setting registers sent to slave address zero.

When the product's time has been set using these registers, the Time Synchronized flag in the MODBUS Status Register (3x1: type G26) is set. The product automatically clears this flag if more than five minutes has elapsed since these registers were last written to.

A "Time synchronization" event is logged if the new time value is more than two seconds different to the current value.

5.13.3 Disturbance Recorder Configuration Settings

Disturbance recorder configuration-settings are written to a scratchpad memory area. A confirmation procedure is required to commit the contents of the scratchpad to the disturbance recorder's set-up, which ensures that the recorders configuration is consistent at all times. The contents of the scratchpad memory can be discarded with the abort procedure. The scratchpad confirmation and abort procedures are described in the *Scratchpad Management* section.

The disturbance recorder configuration registers are in the range:

- 4x00600-4x00699

5.13.4 Protection Settings

Protection configuration-settings are written to a scratchpad memory area. A confirmation procedure is required to commit the contents of the scratchpad to the product's protection functions, which ensures that their configuration is consistent at all times. The contents of the scratchpad memory can be discarded with the abort procedure. The scratchpad confirmation and abort procedures are described in the *Scratchpad Management* section.

The product supports four groups of protection settings. One protection-group is active and the other three are either dormant or disabled. The active protection-group can be selected by writing to register 4x00404. An illegal data response is returned if an attempt is made to set the active group to one that has been disabled.

The MODBUS registers for each of the four groups are repeated in the following ranges:

- Group 1 4x01000-4x02999, (see note) 4x11000-4x12999
- Group 2 4x03000-4x04999, 4x13000-4x14999
- Group 3 4x05000-4x06999, 4x15000-4x16999
- Group 4 4x07000-4x08999, 4x17000-4x18999

Note	*Registers 4x02049 to 4x02052 are not part of protection setting group #1 so they do not repeat in any of the other protection setting groups. These registers are for time synchronization purposes and are standard for most Schneider Electric products. See the Time Synchronization section.*

5.13.5 Scratchpad Management

Register 4x00405 can be used to either confirm or abort the setting changes in the scratchpad area. In addition to the basic editing of the protection setting groups, these functions are provided:

- Default values can be restored to a setting group or to all of the product settings by writing to register 4x00402.
- It is possible to copy the contents of one setting group to another by writing the source group to register 4x00406 and the target group to 4x00407.
- The setting changes performed by either of these two operations are made to the scratchpad area. These changes must be confirmed by writing to register 4x00405.

5.14 Register Data Types

The product maps one or more MODBUS registers to data-typed information contained in an internal database. These data-types are referred to as G-Types since they have a 'G' prefixed identifier. The *Relay Menu Database document* gives a complete definition of the all of the G-Types used in the product.

Generally the data types are transmitted in high byte to low byte order, also known as "Big Endian format". This may require the MODBUS master to reorder the received bytes into a format that complies with its byte order and register order (for multi-register G-Types) conventions. Most MODBUS masters provide byte-swap and register-swap device (or data point) configuration to cope with the wide range of implementations.

The product's data types cannot be broken into smaller parts. Therefore multi-register data types cannot be read from or written to on an individual register basis. All of the registers for a multi-register data-typed item must be read from or written to with a single block read or write command. The following subsections provide some additional notes for a few of the more complex G-Types.

5.15 Numeric Setting (Data Types G2 & G35)

Numeric settings are integer representations of real (non-integer) values. The register value is the number of setting increments (or steps) that the real value is away from the real minimum value. This is expressed by this formula:

$S_{real} = S_{min.} + (S_{inc.} \times S_{numeric})$

Where:

S_{real} Setting real value

$S_{min.}$ Setting real minimum value

$S_{inc.}$ Setting real increment (step) value

$S_{numeric}$ Setting numeric (register) value

For example, a setting with a real value setting range of 0.01 to 10 in steps of 0.01 would have the following numeric setting values:

Real value (S_{real})	Numeric value ($S_{numeric}$)
0.01	0
0.02	1
1.00	99

Table 14 – Real and numeric values

The G2 numeric data type uses 1 register as an unsigned 16-bit integer, whereas the G35 numeric data type uses 2 registers as an unsigned 32-bit integer. The G2 data type therefore provides a maximum setting range of $2^{16} \times S_{inc}$. Similarly the G35 data type provides a maximum setting range of $2^{32} \times S_{inc}$.

5.16 Date and Time Format (Data Type G12)

The date-time data type G12 allows real date and time information to be conveyed down to a resolution of 1 ms. The data-type is used for record time-stamps and for time synchronization (see the *Time Synchronization* section).

The structure of the data type is shown in the following table and complies with the IEC60870-5-4 Binary Time 2a format.

Byte	Bit Position							
	7	6	5	4	3	2	1	0
1	m^7	m^6	m^5	m^4	m^3	m^2	m^1	m^0
2	m^{15}	m^{14}	m^{13}	m^{12}	m^{11}	m^{10}	m^9	m^8
3	IV	R	I^5	I^4	I^3	I^2	I^1	I^0
4	SU	R	R	H^4	H^3	H^2	H^1	H^0
5	W^2	W^1	W^0	D^4	D^3	D^2	D^1	D^0
6	R	R	R	R	M^3	M^2	M^1	M^0
7	R	Y^6	Y^5	Y^4	Y^3	Y^2	Y^1	Y^0

Where:

m	=	0…59,999ms	Y	=	0…99 Years (year of century)
I	=	0…59 minutes	R	=	Reserved bit = 0
H	=	0…23 Hours	SU	=	Summertime: 0=standard time, 1=summer time
W	=	1…7 Day of week; Monday to Sunday, 0 for not calculated	IV	=	Invalid value: 0=valid, 1=invalid
D	=	1…31 Day of Month			
M	=	1…12 Month of year; January to December	range	=	0ms…99 years

Table 15 - G12 date & time data type structure

The seven bytes of the structure are packed into four 16-bit registers. Two packing formats are provided: standard and reverse. The prevailing format is selected by the G238 setting in the **Date and Time** menu column or by register 4x306 (Modbus IEC Time).

The standard packing format is the default and complies with the IEC60870-5-4 requirement that byte 1 is transmitted first. This is followed by byte 2 through to byte 7, followed by a null (zero) byte to make eight bytes in total. Since register data is usually transmitted in big-endian format (high-order byte followed by low-order byte), byte 1 is in the high-order byte position followed by byte 2 in the low-order position for the first register. The last register contains just byte 7 in the high-order position and the low-order byte has a value of zero.

The reverse packing format is the exact byte transmission order reverse of the standard format. The null (zero) byte is sent as the high-order byte of the first register and byte 7 as the register's low-order byte. The second register's high-order byte contains byte 6 and byte 5 in its low order byte.

Both packing formats are fully documented in the *Relay Menu Database document* for the G12 type.

The principal application of the reverse format is for date-time packet format consistency when a mixture of MiCOM Px20, Px30, and Px40 series products are being used. This is especially true when there is a requirement for broadcast time synchronization with a mixture of such MiCOM products.

The data type provides only the value for the year of the century. The century must be deduced. The century could be imposed as 20 for applications not dealing with dates stored in this format from the previous (20th) century. Alternatively, the century can be calculated as the one that produces the nearest time value to the current date. For example: 30-12-99 is 30-12-1999 when received in 1999 & 2000, but is 30-12-2099 when received in 2050. This technique allows 2-digit years to be accurately converted to 4 digits in a ±50 year window around the current datum.

The invalid bit has two applications:

- It can indicate that the date-time information is considered inaccurate, but is the best information available.
- Date-time information is not available.

The summertime bit is used to indicate that summertime (day light saving) is being used and, more importantly, to resolve the alias and time discontinuity which occurs when summertime starts and ends. This is important for the correct time correlation of time stamped records.

Note	*The value of the summertime bit does not affect the time displayed by the product.*

The day of the week field is optional and if not calculated is set to zero.

This data type (and therefore the product) does not cater for time zones so the end user must determine the time zone used by the product. UTC (universal co-ordinated time) is commonly used and avoids the complications of daylight saving timestamps.

5.17 Power and Energy Measurement Data Formats (G29 & G125)

The power and energy measurements are available in two data formats, G29 integer format and G125 IEEE754 floating point format. The G125 format is preferred over the older G29 format.

5.17.1 Data Type G29

Data type G29 consists of three registers. The first register is the per-unit power or energy measurement and is of type G28, which is a signed 16-bit quantity. The second and third registers contain a multiplier to convert the per-unit value to a real value.

The multiplier is of type G27, which is an unsigned 32-bit quantity. Therefore the overall value conveyed by the G29 data type must be calculated as G29 = G28 × G27.

The product calculates the G28 per unit power or energy value as

G28 = ((measured secondary quantity) / (CT secondary) × (110 V / (VT secondary)).

Since data type G28 is a signed 16-bit integer, its dynamic range is constrained to ±32768. This limitation should be borne in mind for the energy measurements, as the G29 value saturates a long time before the equivalent G125.

The associated G27 multiplier is calculated as

G27 = (CT primary) × (VT primary / 110 V)
when primary value measurements are selected,
and as
G27 = (CT secondary) × (VT secondary / 110 V)
when secondary value measurements are selected.

Due to the required truncations from floating point values to integer values in the calculations of the G29 component parts and its limited dynamic range, the use of the G29 values is only recommended when the MODBUS master cannot deal with the G125 IEEE754 floating point equivalents.

Note	*The G29 values must be read in whole multiples of three registers. It is not possible to read the G28 and G27 parts with separate read commands.*

Example:

For A-Phase Power (Watts) (registers 3x00300 - 3x00302) for a 110 V nominal,
In = 1 A, VT ratio = 110 V:110 V and CT ratio = 1 A : 1 A.

Applying A-phase 1A @ 63.51V

A-phase Watts = ((63.51 V × 1 A) / In=1 A) × (110/Vn=110 V) = 63.51 Watts

The G28 part of the value is the truncated per unit quantity, which is equal to 64 (40h).

The multiplier is derived from the VT and CT ratios set in the product, with the equation ((CT Primary) × (VT Primary) / 110 V)). Therefore the G27 part of the value equals 1 and the overall value of the G29 register set is 64×1 = 64 W.

The registers would contain:

3x00300 - 0040h
3x00301 - 0000h
3x00302 - 0001h

Using the previous example with a VT ratio = 110,000 V:110 V and CT ratio = 10,000 A : 1 A the G27 multiplier would be 10,000 A × 110,000 V / 110 = 10,000,000. The overall value of the G29 register set is 64 × 10,000,000 = 640 MW. (Note that there is an actual error of 49 MW in this calculation due to loss of resolution).

The registers would contain:

3x00300 - 0040h
3x00301 - 0098h
3x00302 - 9680h

5.17.2 Data Type G125

Data type G125 is a short float IEEE754 floating point format, which occupies 32 bits in two consecutive registers. The most significant 16 bits of the format are in the first (low order) register and the least significant 16 bits in the second register.

The value of the G125 measurement is as accurate as the product's ability to resolve the measurement after it has applied the secondary or primary scaling factors as required. It does not suffer from the truncation errors or dynamic range limitations associated with the G29 data format.

6 IEC 60870-5-103 INTERFACE

The IEC60870-5-103 interface is a master/slave interface with the relay as the slave device. The relay conforms to compatibility level 2; compatibility level 3 is not supported.

These IEC60870-5-103 facilities are supported by this interface:

- Initialization (Reset)
- Time Synchronization
- Event Record Extraction
- General Interrogation
- Cyclic Measurements
- General Commands
- Disturbance Record Extraction
- Private Codes

6.1 Physical Connection and Link Layer

Two connection options are available for IEC60870-5-103, either the rear EIA(RS)-485 port or an optional rear fiber optic port. If the fiber optic port is fitted, the active port can be selected using the front panel menu or the front Courier port. However the selection is only effective following the next relay power up.

For either of the two connection modes, both the relay address and baud rate can be selected using the front panel menu or the front Courier port. Following a change to either of these two settings a reset command is required to re-establish communications, see the description of the reset command in the *Initialization* section.

6.2 Initialization

Whenever the relay has been powered up, or if the communication parameters have been changed, a reset command is required to initialize the communications. The relay responds to either of the two reset commands (Reset CU or Reset FCB). However, the Reset CU clears any unsent messages in the relay’s transmit buffer.

The relay responds to the reset command with an identification message ASDU 5. The Cause Of Transmission (COT) of this response is either Reset CU or Reset FCB depending on the nature of the reset command. For information on the content of ASDU 5 see *section IEC60870-5-103 in the Relay Menu Database document*.

In addition to the ASDU 5 identification message, if the relay has been powered up it also produces a power-up event.

6.3 Time Synchronization

The relay time and date can be set using the time synchronization feature of the IEC60870-5-103 protocol. The relay corrects for the transmission delay as specified in IEC60870-5-103. If the time synchronization message is sent as a send / confirm message, the relay responds with a confirm. Whether the time-synchronization message is sent as a send / confirm or a broadcast (send / no reply) message, a time synchronization Class 1 event is generated.

If the relay clock is synchronised using the IRIG-B input, it is not possible to set the relay time using the IEC60870-5-103 interface. If the time is set using the interface, the relay creates an event using the current date and time from the internal clock, which is synchronised to IRIG-B.

6.4 Spontaneous Events

Events are categorized using the following information:

- Function Type
- Information Number

The IEC60870-5-103 profile in the *Relay Menu Database document*, contains a complete listing of all events produced by the relay.

6.5 General Interrogation (GI)

The General Interrogation (GI) request can be used to read the status of the relay, the function numbers, and information numbers that are returned during the GI cycle. See the IEC60870-5-103 profile in the *Relay Menu Database document*.

6.6 Cyclic Measurements

The relay produces measured values using ASDU 9 cyclically. This can be read from the relay using a Class 2 poll (note ADSU 3 is not used). The rate at which the relay produces new measured values can be controlled using the Measurement Period setting. This setting can be edited from the front panel menu or the front Courier port and is active immediately following a change.

The measurands transmitted by the relay are sent as a proportion of 2.4 times the rated value of the analog value.

6.7 Commands

A list of the supported commands is contained in the *Relay Menu Database document*. The relay responds to other commands with an ASDU 1, with a Cause of Transmission (COT) indicating ‘negative acknowledgement’.

6.8 Test Mode

Using either the front panel menu or the front Courier port, it is possible to disable the relay output contacts to allow secondary injection testing to be performed. This is interpreted as ‘test mode’ by the IEC60870-5-103 standard. An event is produced to indicate both entry to and exit from test mode. Spontaneous events and cyclic measured data transmitted while the relay is in test mode has a COT of ‘test mode’.

6.9 Disturbance Records

The disturbance records are stored in uncompressed format and can be extracted using the standard mechanisms described in IEC60870-5-103.

Note	*IEC60870-5-103 only supports up to 8 records.*

6.10 Blocking of Monitor Direction

The relay supports a facility to block messages in the Monitor direction and in the Command direction. Messages can be blocked in the Monitor and Command directions using the menu commands, Communications - CS103 Blocking -
Disabled / Monitor Blocking / Command Blocking or DDB signals Monitor Blocked and Command Blocked.

6.11 Setting Changes through IEC103 Protocol

The IEC 870-5-103 Standard suggests using the generic services for read/write operations on the proprietary data of different manufacture protection equipments, the directory structure specified by the standard for accessing the generic data is the same as the Px40 setting structure. With the generic services selected in the Platform Software full access to the relay's database is possible over the first rear communications port using the IEC608070-5-103 protocol with Level 3 compatibility.

Each cell in the database has an attribute that defines whether it is included in the list of cells that are subject to a General Interrogation of Generic data.

The following Group 1,2,3 and 4 settings will be included in the GGI:

- Overcurrent, Neg Seq O/C, Broken Conductor, Earth Fault 1 and 2,
- SEF/REF Prot'n, Residual O/V NVD, Thermal Overload, NEG Sequence O/V,
- Cold Load Pickup, Selective Logic, Admit Protection, Power Protection,
- Volt Protection, Freq Protection, CB FAIL & I<, Supervision,
- Fault Locator, System Checks, Autoreclose, ADV.Frequency.

7 IEC 61850 ETHERNET INTERFACE

7.1 Introduction

IEC 61850 is the international standard for Ethernet-based communication in substations. It enables integration of all protection, control, measurement and monitoring functions in a substation, and provides the means for interlocking and inter-tripping. It combines the convenience of Ethernet with the security which is essential in substations today.

The MiCOM protection relays can integrate with the PACiS substation control systems, to complete Schneider Electric's offer of a full IEC 61850 solution for the substation. The majority of MiCOM Px3x and Px4x relay types can be supplied with Ethernet, in addition to traditional serial protocols. Relays which have already been delivered with UCA2.0 on Ethernet can be easily upgraded to IEC 61850.

7.2 What is IEC 61850?

IEC 61850 is a 14-part international standard, which defines a communication architecture for substations. It is more than just a protocol and provides:

- Standardized models for IEDs and other equipment in the substation
- Standardized communication services (the methods used to access and exchange data)
- Standardized formats for configuration files
- Peer-to-peer (for example, relay to relay) communication

The standard includes mapping of data onto Ethernet. Using Ethernet in the substation offers many advantages, most significantly including:

- High-speed data rates (currently 100 Mbits/s, rather than tens of kbits/s or less used by most serial protocols)
- Multiple masters (called “clients”)
- Ethernet is an open standard in every-day use

Schneider Electric has been involved in the Working Groups which formed the standard, building on experience gained with UCA2.0, the predecessor of IEC 61850.

7.2.1 Interoperability

A major benefit of IEC 61850 is interoperability. IEC 61850 standardizes the data model of substation IEDs which simplifies integration of different vendors’ products. Data is accessed in the same way in all IEDs, regardless of the vendor, even though the protection algorithms of different vendors’ relays may be different.

IEC 61850-compliant devices are not interchangeable, you cannot replace one device with another (although they are interoperable). However, the terminology is predefined and anyone with knowledge of IEC 61850 can quickly integrate a new device without mapping all of the new data. IEC 61850 improves substation communications and interoperability at a lower cost to the end user.

7.2.2 Data Model

To ease understanding, the data model of any IEC 61850 IED can be viewed as a hierarchy of information. The categories and naming of this information is standardized in the IEC 61850 specification.

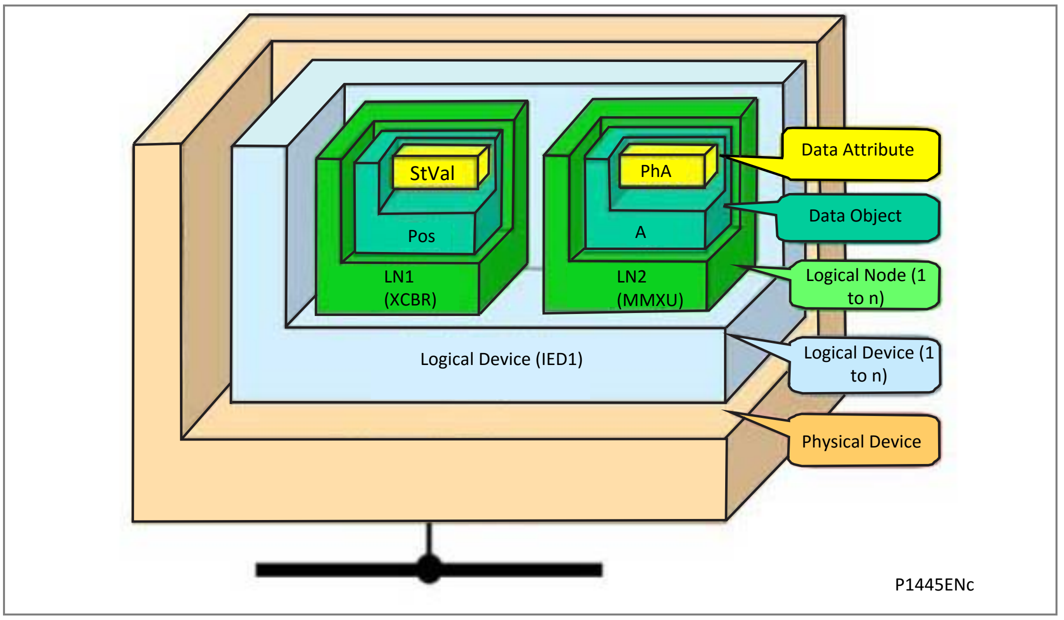


Figure 12 - Data model layers in IEC 61850

The levels of this hierarchy can be described as follows:

- Physical Device — Identifies the actual IED in a system. Typically the device's name or IP address can be used (for example **Feeder_1** or **10.0.0.2**).
- Logical Device — Identifies groups of related Logical Nodes inthe Physical Device. For the MiCOM relays, five Logical Devices exist: **Control, Measurements, Protection, Records, System**.
- Wrapper/Logical Node Instance — Identifies the major functional areas in the IEC 61850 data model. Either 3 or 6 characters are used as a prefix to define the functional group (wrapper) while the actual functionality is identified by a 4 character Logical Node name, suffixed by an instance number. For example, XCBR1 (circuit breaker), MMXU1 (measurements), FrqPTOF2 (overfrequency protection, stage 2).
- Data Object — This next layer is used to identify the type of data presented. For example, **Pos** (position) of Logical Node type **XCBR**.
- Data Attribute — This is the actual data (such as measurement value, status, and description). For example, **stVal** (status value) indicates the actual position of the circuit breaker for Data Object type **Pos** of Logical Node type **XCBR**.

7.3 IEC 61850 in MiCOM Relays

IEC 61850 is implemented in MiCOM relays by use of a separate Ethernet card. This card manages the majority of the IEC 61850 implementation and data transfer to avoid any impact on the performance of the protection.

To communicate with an IEC 61850 IED on Ethernet, it is necessary only to know its IP address. This can then be configured into either:

- An IEC 61850 **client** (or **master**), for example a PACiS computer (MiCOM C264) or HMI, or
- An **MMS browser**, with which the full data model can be retrieved from the IED, without any prior knowledge

7.3.1 Capability

The IEC 61850 interface provides these capabilities:

- Read access to measurements

  All measurands are presented using the measurement Logical Nodes, in the **Measurements** Logical Device. Reported measurement values are refreshed by the relay once per second, in line with the relay user interface.

  The following fault data have been mapped in LN RFLO1 of LD Records of IEC61850 data model for the latest fault record:

  - Fault voltages, Fault currents and Fault location
  - Operating time of relay and Operating time of breaker
  - Fault time, Fault date, etc…
- Support for time synchronization over an Ethernet link

  Time synchronization is supported using SNTP (Simple Network Time Protocol). This protocol is used to synchronize the internal real time clock of the relays.
- GOOSE peer-to-peer communication
  GOOSE communications of statuses are included as part of the IEC 61850 implementation. See *Peer-to-Peer (GSE) Communications* for more details.
- Disturbance record extraction
  Disturbance records can be extracted from MiCOM relays by file transfer, as ASCII format COMTRADE files.
- Controls
  The following control services are available:
  - Direct Control
  - Direct Control with enhanced security
  - Select Before Operate (SBO) with enhanced security
  - Controls are applied to open and close circuit breakers using XCBR.Pos and DDB signals ‘Control Trip’ and ‘Control Close’.
  - System/LLN0. LLN0.LEDRs are used to reset any trip LED indications.
- Reports
  Reports only include data objects that have changed and not the complete dataset. The exceptions to this are a General Interrogation request and integrity reports.
- Buffered Reports
  Eight Buffered Report Control Blocks, (BRCB), are provided in SYSTEM/LLN0 in Logical Device ‘System’.
  Buffered reports are configurable to use any configurable dataset located in the same Logical device as the BRCB (SYSTEM/LLN0).
- Unbuffered Reports
  Sixteen Unbuffered Report Control Blocks (URCB) are provided in SYSTEM/LLN0 in Logical Device ‘System’.
  Unbuffered reports are configurable to use any configurable dataset located in the same Logical device as the URCB (SYSTEM/LLN0).

- Configurable Data Sets
  It is possible to create and configure datasets in any Logical Node using the IED Configurator. The maximum number of datasets will be specified in an IED's ICD file. An IED is capable of handling 100 datasets.
- Published GOOSE message
  Eight GOCBs are provided in SYSTEM/LLN0.
- Uniqueness of control
  The Uniqueness of control mechanism is implemented to be consistent with the PACiS mechanism. This requires the relay to subscribe to the OrdRun signal from all devices in the system and be able to publish such a signal in a GOOSE message.
- Select Active Setting Group
  Functional protection groups can be enabled or disabled using private mod/beh attributes in the Protection/LLN0.OcpMod object. Setting groups are selectable using the Setting Group Control Block class, (SGCB). The Active Setting Group can be selected using the System/LLN0.SP.SGCB.ActSG data attribute in Logical Device 'System'.
- Quality for GOOSE
  It is possible to process the quality attributes of any Data Object in an incoming GOOSE message. Devices that do not support IEC61850 quality flags send quality attributes as all zeros. The supported quality attributes for outgoing GOOSE messages are described in the Protocol Implementation eXtra Information for Testing (PIXIT) document.
- Address List
  An Address List document (to be titled ADL) is produced for each IED which shows the mapping between the IEC61850 data model and the internal data model of the IED. It includes a mapping in the reverse direction, which may be more useful. This document is separate from the PICS/MICS document.
- Originator of Control
  Originator of control mechanism is implemented for operate response message and in the data model on the ST of the related control object, consistent with the PACiS mechanism.

The multiplier will always be included in the Unit definition and will be configurable in SCL, but not settable at runtime. It will apply to the magnitude, rangeC.min & rangeC.max attributes. rangeC.min & rangeC.max will not be settable at runtime to be more consistent with Px30 and to reduce configuration problems regarding deadbands.

Setting changes, such as changes to protection settings, are done using MiCOM S1 Studio. These changes can also be done using the relay's front port serial connection or the relay's Ethernet link, and is known as "tunneling".

7.3.2 IEC 61850 Configuration

One of the main objectives of IEC 61850 is to allow IEDs to be directly configured from a configuration file generated at system configuration time. At the system configuration level, the capabilities of the IED are determined from an IED capability description file (ICD), which is provided with the product. Using a collection of these ICD files from different products, the entire protection of a substation can be designed, configured and tested (using simulation tools) before the product is even installed into the substation.

To help this process, the MiCOM S1 Studio Support Software provides an IEC61850 IED Configurator tool. Select **Tools > IEC61850 IED Configurator**. This tool allows the preconfigured IEC 61850 configuration file (SCD or CID) to be imported and transferred to the IED. The configuration files for MiCOM relays can also be created manually, based on their original IED Capability Description (ICD) file.

Other features include the extraction of configuration data for viewing and editing, and a sophisticated error-checking sequence. The error checking ensures the configuration data is valid for sending to the IED and ensures the IED functions correctly in the substation.

To help the user, some configuration data is available in the **IED CONFIGURATOR** column of the relay user interface, allowing read-only access to basic configuration data.

7.3.2.1 Configuration Banks

To promote version management and minimize down-time during system upgrades and maintenance, the MiCOM relays have incorporated a mechanism consisting of multiple configuration banks. These configuration banks are categorized as:

- Active Configuration Bank
- Inactive Configuration Bank

Any new configuration sent to the relay is automatically stored in the inactive configuration bank, therefore not immediately affecting the current configuration. Both active and inactive configuration banks can be extracted at any time.

When the upgrade or maintenance stage is complete, the IED Configurator tool can be used to transmit a command to a single IED. This command authorizes the activation of the new configuration contained in the inactive configuration bank, by switching the active and inactive configuration banks. This technique ensures that the system down-time is minimized to the start-up time of the new configuration. The capability to switch the configuration banks is also available using the **IED CONFIGURATOR** column.

For version management, data is available in the **IED CONFIGURATOR** column in the relay user interface, displaying the SCL Name and Revision attributes of both configuration banks.

7.3.2.2 Network Connectivity

Note	*This section presumes a prior knowledge of IP addressing and related topics. Further details on this topic may be found on the Internet (search for IP Configuration) and in numerous relevant books.*

Configuration of the relay IP parameters (IP Address, Subnet Mask, Gateway) and SNTP time synchronization parameters (SNTP Server 1, SNTP Server 2) is performed by the IED Configurator tool. If these parameters are not available using an SCL file, they must be configured manually.

If the assigned IP address is duplicated elsewhere on the same network, the remote communications do not operate in a fixed way. However, the relay checks for a conflict at power up and every time the IP configuration is changed. An alarm is raised if an IP conflict is detected.

Use the **Gateway** setting to configure the relay to accept data from networks other than the local network.

7.4 Data Model of MiCOM Relays

The data model naming adopted in the Px30 and Px40 relays has been standardized for consistency. The Logical Nodes are allocated to one of the five Logical Devices, as appropriate, and the wrapper names used to instantiate Logical Nodes are consistent between Px30 and Px40 relays.

The data model is described in the Model Implementation Conformance Statement (MICS) document, which is available separately. The MICS document provides lists of Logical Device definitions, Logical Node definitions, Common Data Class and Attribute definitions, Enumeration definitions, and MMS data type conversions. It generally follows the format used in Parts 7-3 and 7-4 of the IEC 61850 standard.

7.5 Communication Services of MiCOM Relays

The IEC 61850 communication services which are implemented in the Px30 and Px40 relays are described in the Protocol Implementation Conformance Statement (PICS) document, which is available separately. The PICS document provides the Abstract Communication Service Interface (ACSI) conformance statements as defined in Annex A of Part 7-2 of the IEC 61850 standard.

7.6 Peer-to-Peer (GSE) Communications

The implementation of IEC 61850 Generic Object Oriented Substation Event (GOOSE) sets the way for cheaper and faster inter-relay communications. The generic substation event model provides fast and reliable system-wide distribution of input and output data values. The generic substation event model is based on autonomous decentralization This provides an efficient method of allowing simultaneous delivery of the same generic substation event information to more than one physical device, by using multicast services.

The use of multicast messaging means that IEC 61850 GOOSE uses a publisher-subscriber system to transfer information around the network*. When a device detects a change in one of its monitored status points, it publishes (sends) a new message. Any device that is interested in the information subscribes (listens) to the data message.

*Note**	*Multicast messages cannot be routed across networks without specialized equipment.*

Each new message is retransmitted at user-configurable intervals until the maximum interval is reached, to overcome possible corruption due to interference and collisions. In practice, the parameters which control the message transmission cannot be calculated. Time must be allocated to the testing of GOOSE schemes before or during commissioning; in just the same way a hardwired scheme must be tested.

7.6.1 Scope

A maximum of 64 virtual inputs are available in the PSL which can be mapped directly to a published dataset in a GOOSE message (only 1 fixed dataset is supported). All published GOOSE signals are BOOLEAN values.

Each GOOSE signal contained in a subscribed GOOSE message can be mapped to any of the 64 virtual inputs in the PSL. The virtual inputs allow the mapping to internal logic functions for protection control, directly to output contacts or LEDs for monitoring.

The MiCOM relay can subscribe to all GOOSE messages but only the following data types can be decoded and mapped to a virtual input:

- BOOLEAN
- BSTR2
- INT16
- INT32
- INT8
- UINT16
- UINT32
- UINT8

The MiCOM relay on Ed2 mode can also subscribe analogue GOOSE messages with Float32 data type. The received analogue values can not apply to any application function, these values will be stored only on the IEC 61850 data model.

7.6.2 Simulation GOOSE Configuration

From MiCOM S1 Studio select Tools > IEC 61850 IED Configurator (Ed.2). Make sure the configuration is correct as this ensures efficient GOOSE scheme operation.

The relay can be set to publish/subscribe simulation/test GOOSE; it is important that this setting is returned to publish/receive normal GOOSE messages after testing to permit normal operation of the application and GOOSE messaging.

The relay provides a single setting to receive Simulated GOOSE, however it manages each subscribed GOOSE signal independently when the setting is set to simulated GOOSE. Each subscription (virtual input) will continue to respond to GOOSE messages without the simulation flag set; however once the relay receives a GOOSE for a subscription with the simulation flag set, it will respond to this and ignore messages without the simulation flag set. Other subscriptions (virtual inputs) which have not received a GOOSE message with the simulation flag will continue to operate as before. When the setting is reset back to normal GOOSE messaging the relay will ignore all GOOSE messages with the simulation flag set and act on GOOSE messages without the simulation flag.

WARNING **If you set the GOOSE in Simulation Mode, you MUST set it back to normal GOOSE after testing.**
IT IS POTENTIALLY EXTREMELY UNSAFE TO ATTEMPT TO USE ANY RELAY WHICH IS STILL IN GOOSE SIMULATION MODE.

7.6.3 High Performance GOOSE

In addition, the Px40 device is designed to provide maximum performance through an optimized publishing mechanism. This optimized mechanism is enabled so that the published GOOSE message is mapped using only the data attributes rather than mapping a complete data object. If data objects are mapped, the GOOSE messaging will operate correctly; but without the benefit of the optimized mechanism.

A pre-configured dataset named as "HighPerformGOOSE" is available in Ed.2 ICD template, which include all data attributes of all virtual outputs. We recommend using this dataset to get the benefit of better GOOSE performance. The optimized mechanism also applies to Ed.1 but without such a pre-configured dataset.

7.7 Ethernet Functionality

Settings relating to a failed Ethernet link are available in the ‘COMMUNICATIONS’ column of the relay user interface.

7.7.1 Ethernet Disconnection

IEC 61850 ‘Associations’ are unique and made to the relay between the client (master) and server (IEC 61850 device). If the Ethernet is disconnected, such associations are lost and must be re-established by the client. The TCP_KEEPALIVE function is implemented in the relay to monitor each association and terminate any which are no longer active.

7.7.2 Redundant Ethernet Communication Ports

For information regarding the Redundant Ethernet communication ports, refer to the stand alone document *Px4x/EN REB/B11*.

7.7.3 Loss of Power

If the relay's power is removed, the relay allows the client to re-establish associations without a negative impact on the relay’s operation. As the relay acts as a server in this process, the client must request the association. Uncommitted settings are cancelled when power is lost. Reports requested by connected clients are reset and must be re-enabled by the client when the client next creates the new association to the relay.

INSTALLATION

CHAPTER 16

Date (month/year):	11/2016			
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.			
Hardware suffix:	P141/P142/P143	J/L	P44y (P443/P446)	K/M
	P145	J/M	P547	K
	P241	J	P54x (P543/P544/P545/P546)	K/M
	P242/P243	K	P642	J/L
	P342	J	P643	K/M
	P343/P344/P345	K	P645	K/M
	P391	A	P74x (P741/P742/P743)	J/K
	P445	J/L	P746	K/M
	P44x (P441/P442/P444)	J/K	P841	K/M
	P44x (P442/P444)	M	P849	K/M
Software version:	P14x (P141/P142/P143/P145)	43/44/46/ B0/B1/B2	P44y (P443/P446) P547	55/H4 57
	P24x (P241/P242/P243):	57	P54x (P543/P544/P545/P546)	45/55/H4
	P342/P343/P344/P345/P391	36	P64x (P642/P643/P645)	04/A0/B1/B2
	P445	35/36/J4	P74x (P741/P742/P743)	51/A0/B1
	P44x (P441/P442/P444)	C7.x/D4.x/ D5.x/D6.x/	P746	A0/B1/B2/B3/ C1/C2/C3
	P44x (P442/P444)	E0/E1	P841 P849	45/55/G4/H4 A0/B1
Connection diagrams:	P14x (P141, P142, P143 & P145): 10P141xx (xx = 01 to 02) 10P142xx (xx = 01 to 05) 10P143xx (xx = 01 to 11) 10P145xx (xx = 01 to 11) P24x (P241, P242 & P243): 10P241xx (xx = 01 to 02) 10P242xx (xx = 01) 10P243xx (xx = 01) P34x (P342, P343, P344, P345 & P391): 10P342xx (xx = 01 to 17) 10P343xx (xx = 01 to 19) 10P344xx (xx = 01 to 12) 10P345xx (xx = 01 to 07) 10P391xx (xx = 01 to 02) P445: 10P445xx (xx = 01 to 04) P44x (P441, P442 & P444): 10P44101 (SH 1 & 2) 10P44201 (SH 1 & 2) 10P44202 (SH 1) 10P44203 (SH 1 & 2) 10P44401 (SH 1) 10P44402 (SH 1) 10P44403 (SH 1 & 2) 10P44404 (SH 1) 10P44405 (SH 1) 10P44407 (SH 1 & 2) P44y (P443 & P446): 10P44303 (SH 01 and 03) 10P44304 (SH 01 and 03) 10P44305 (SH 01 and 03) 10P44306 (SH 01 and 03) 10P44600 10P44601 (SH 1 to 2) 10P44602 (SH 1 to 2) 10P44603 (SH 1 to 2)		P54x (P543, P544, P545 & P546): 10P54302 (SH 1 to 2) 10P54303 (SH 1 to 2) 10P54400 10P54404 (SH 1 to 2) 10P54405 (SH 1 to 2) 10P54502 (SH 1 to 2) 10P54503 (SH 1 to 2) 10P54600 10P54604 (SH 1 to 2) 10P54605 (SH 1 to 2) 10P54606 (SH 1 to 2) P547: 10P54702xx (xx = 01 to 02) 10P54703xx (xx = 01 to 02) 10P54704xx (xx = 01 to 02) 10P54705xx (xx = 01 to 02) P64x (P642, P643 & P645): 10P642xx (xx = 1 to 10) 10P643xx (xx = 1 to 6) 10P645xx (xx = 1 to 9) P74x (P741, P742 & P743): 10P740xx (xx = 01 to 07) P746: 10P746xx (xx = 00 to 21) P841: 10P84100 10P84101 (SH 1 to 2) 10P84102 (SH 1 to 2) 10P84103 (SH 1 to 2) 10P84104 (SH 1 to 2) 10P84105 (SH 1 to 2) P849: 10P849xx (xx = 01 to 06)	

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FIGURES

1 INTRODUCTION TO MICOM RANGE

About MiCOM Range

MiCOM is a comprehensive solution capable of meeting all electricity supply requirements. It comprises a range of components, systems and services from Schneider Electric.

Central to the MiCOM concept is flexibility. MiCOM provides the ability to define an application solution and, through extensive communication capabilities, integrate it with your power supply control system.

The components within MiCOM are:

- P range protection relays
- C range control products
- M range measurement products for accurate metering and monitoring
- S range versatile PC support and substation control packages

MiCOM products include extensive facilities for recording information on the state and behaviour of the power system using disturbance and fault records. They can also provide measurements of the system at regular intervals to a control centre enabling remote monitoring and control to take place.

For up-to-date information, please see:

www.schneider-electric.com

MiCOM Px4x Products

The MiCOM Px4x series of protection devices provide a wide range of protection and control functions and meet the requirements of a wide market segment.

Different parts of the Px4x range provide different functions. These include:

- **P14x** **Feeder Management** relay suitable for MV and HV systems
- **P24x** **Motors** and rotating machine management relay for use on a wide range of synchronous and induction machines
- **P34x** **Generator Protection** for small to sophisticated generator systems and interconnection protection
- **P445** Full scheme **Distance Protection** relays for MV, HV and EHV systems
- **P44x** Full scheme **Distance Protection** relays for MV, HV and EHV systems
- **P44y** Full scheme **Distance Protection** relays for MV, HV and EHV systems
- **P54x** **Line Differential** protection relays for HV/EHV systems with multiple communication options and phase comparison protection for use with PLC
- **P547** **Line Differential** protection relays for HV/EHV systems with multiple communication options and phase comparison protection for use with PLC
- **P64x** **Transformer Protection Relays**
- **P74x** **Numerical Busbar Protection** for use on MV, HV and EHV busbars
- **P746** **Numerical Busbar Protection** for use on MV, HV and EHV busbars
- **P84x** **Breaker Failure** protection relays

Note	*During 2011, the International Electrotechnical Commission classified the voltages into different levels (IEC 60038). The IEC defined LV, MV, HV and EHV as follows: LV is up to 1000V. MV is from 1000V up to 35 kV. HV is from 110 kV or 230 kV. EHV is above 230 KV.* *There is still ambiguity about where each band starts and ends. A voltage level defined as LV in one country or sector, may be described as MV in a different country or sector. Accordingly, LV, MV, HV and EHV suggests a possible range, rather than a fixed band. Please refer to your local Schneider Electric office for more guidance.*

2 RECEIPT, HANDLING, STORAGE AND UNPACKING RELAYS

2.1 Receipt of Relays

Protective relays, although generally of robust construction, require careful treatment prior to installation on site.

Upon receipt, relays should be examined immediately to ensure no external damage has been sustained in transit. If damage has been sustained, a claim should be made to the transport contractor and Schneider Electric should be promptly notified.

Relays that are supplied unmounted and not intended for immediate installation should be returned to their protective polythene bags and delivery carton. See the *Storage* section for more information about the storage of relays.

2.2 Handling of Electronic Equipment

Warning	**Before carrying out any work on the equipment, you should be familiar with the contents of the Safety Information chapter/Safety Guide SFTY/5L M/L11 or later issue, the Technical Data chapter and the ratings on the equipment rating label.**

A person's normal movements can easily generate electrostatic potentials of several thousand volts. Discharge of these voltages into semiconductor devices when handling electronic circuits can cause serious damage which, although not always immediately apparent, will reduce the reliability of the circuit. This is particularly important to consider where the circuits use Complementary Metal Oxide Semiconductors (CMOS), as is the case with these relays.

The electronic circuits inside the relay are protected from electrostatic discharge when housed in the case. Do not expose them to risk by removing the front panel or Printed Circuit Boards (PCBs) unnecessarily.

Each PCB incorporates the highest practicable protection for its semiconductor devices. However, if it becomes necessary to remove a PCB, the following precautions should be taken to preserve the high reliability and long life for which the relay has been designed and manufactured.

- Before removing a PCB, ensure that you are at the same electrostatic potential as the equipment by touching the case.
- Handle analogue input modules by the front panel, frame or edges of the circuit boards. PCBs should only be handled by their edges. Avoid touching the electronic components, printed circuit tracks or connectors.
- Do not pass the module to another person without first ensuring you are both at the same electrostatic potential. Shaking hands achieves equipotential.
- Place the module on an anti-static surface, or on a conducting surface which is at the same potential as yourself.
- If it is necessary to store or transport printed circuit boards removed from the case, place them individually in electrically conducting anti-static bags.

In the unlikely event that you are making measurements on the internal electronic circuitry of a relay in service, it is preferable that you are earthed to the case with a conductive wrist strap. Wrist straps should have a resistance to ground between 500kΩ to 10MΩ. If a wrist strap is not available you should maintain regular contact with the case to prevent a build-up of electrostatic potential. Instrumentation which may be used for making measurements should also be earthed to the case whenever possible.

More information on safe working procedures for all electronic equipment can be found in IEC 61340-5-1. It is strongly recommended that detailed investigations on electronic circuitry or modification work should be carried out in a special handling area such as described in the aforementioned Standard document.

2.3 Storage

If relays are not to be installed immediately upon receipt, they should be stored in a place free from dust and moisture in their original cartons. Where de-humidifier bags have been included in the packing they should be retained. The action of the de-humidifier crystals will be impaired if the bag is exposed to ambient conditions and may be restored by gently heating the bag for about an hour prior to replacing it in the carton.

To prevent battery drain during transportation and storage a battery isolation strip is fitted during manufacture. With the lower access cover open, presence of the battery isolation strip can be checked by a red tab protruding from the positive side.

Care should be taken on subsequent unpacking that any dust which has collected on the carton does not fall inside. In locations of high humidity the carton and packing may become impregnated with moisture and the de-humidifier crystals will lose their efficiency.

Prior to installation, relays should be stored at a temperature of between -40°C to +70°C (-13°F to +158°F).

2.4 Unpacking

Care must be taken when unpacking and installing the relays so that none of the parts are damaged and additional components are not accidentally left in the packing or lost. Make sure that any user’s CDROM or technical documentation is NOT discarded, and accompanies the relay to its destination substation.

Note	*With the lower access cover open, the red tab of the battery isolation strip will be seen protruding from the positive side of the battery compartment. Do not remove this strip because it prevents battery drain during transportation and storage and will be removed as part of the commissioning tests.*

Relays must only be handled by skilled persons.

The site should be well lit to facilitate inspection, clean, dry and reasonably free from dust and excessive vibration. This particularly applies to installations which are being carried out at the same time as construction work.

3 RELAY MOUNTING

MiCOM relays are dispatched either individually or as part of a panel/rack assembly. Individual relays are normally supplied with an outline diagram showing the dimensions for panel cut-outs and hole centres. This information can also be found in the product publication.

Secondary front covers can also be supplied as an option item to prevent unauthorised changing of settings and alarm status. They are available in sizes 40TE and 60TE. The 60TE cover also fits the 80TE case size of the relay.

The old GN0037/GN0038 part numbers are now obsolete.

They have been replaced by the GN0242/GN0243 versions as shown below.

Product	Size	Part No (obsolete)	Replacement Part No
P40	**40TE** **60TE / 80TE**	**GN0037 001** **GN0038 001**	**GN0242 001** **GN0243 001**
P14x	40TE 60TE / 80TE	GN0037 001 GN0038 001	GN0242 001 GN0243 001
P24xxxxxxxxxxxA P24xxxxxxxxxxxC	40TE 60TE / 80TE	GN0037 001 GN0038 001	GN0242 001 GN0243 001
P24xxxxxxxxxxxJ P24xxxxxxxxxxxK	40TE 60TE / 80TE		GN0242 001 GN0243 001
P34xxxxxxxxxxxA P34xxxxxxxxxxxC	40TE 60TE / 80TE	GN0037 001 GN0038 001	GN0242 001 GN0243 001
P34xxxxxxxxxxxJ P34xxxxxxxxxxxK	40TE 60TE / 80TE		GN0242 001 GN0243 001
P44x	40TE 60TE / 80TE	GN0037 001 GN0038 001	GN0242 001 GN0243 001
P44y	60TE / 80TE	GN0038 001	GN0243 001
P445	40TE 60TE / 80TE	GN0037 001 GN0038 001	GN0242 001 GN0243 001
P54x	60TE / 80TE	GN0038 001	GN0243 001
P547	60TE / 80TE	GN0038 001	GN0243 001
P64xxxxxxxxxxxA/B/C	40TE 60TE / 80TE	GN0037 001 GN0038 001	GN0242 001 GN0243 001
P64xxxxxxxxxxxJ/K	40TE 60TE / 80TE		GN0242 001 GN0243 001
P74x P74x	40TE 60TE	GN0037 001 GN0038 001	GN0242 001 GN0243 001
P746	80TE	GN0038 001	GN0243 001
P841	60TE / 80TE	GN0038 001	GN0243 001
P849	80TE	GN0038 001	GN0243 001

Note *Part Numbers suitable for rack-mounting have an "N" as the 10^{th} digit.*
Part Numbers suitable for panel-mounting have an "M" as the 10^{th} digit.
Size 40TE may be GN0242 001 and 60TE/80TE as GN0243 001.

Table 1 - Products, sizes and part numbers

The design of the relay is such that the fixing holes in the mounting flanges are only accessible when the access covers are open and hidden from sight when the covers are closed.

If a MiCOM P991 or Easergy test block is to be included with the relays, we recommend you position the test block on the right-hand side of the associated relays (when viewed from the front). This minimises the wiring between the relay and test block, and allows the correct test block to be easily identified during commissioning and maintenance tests.

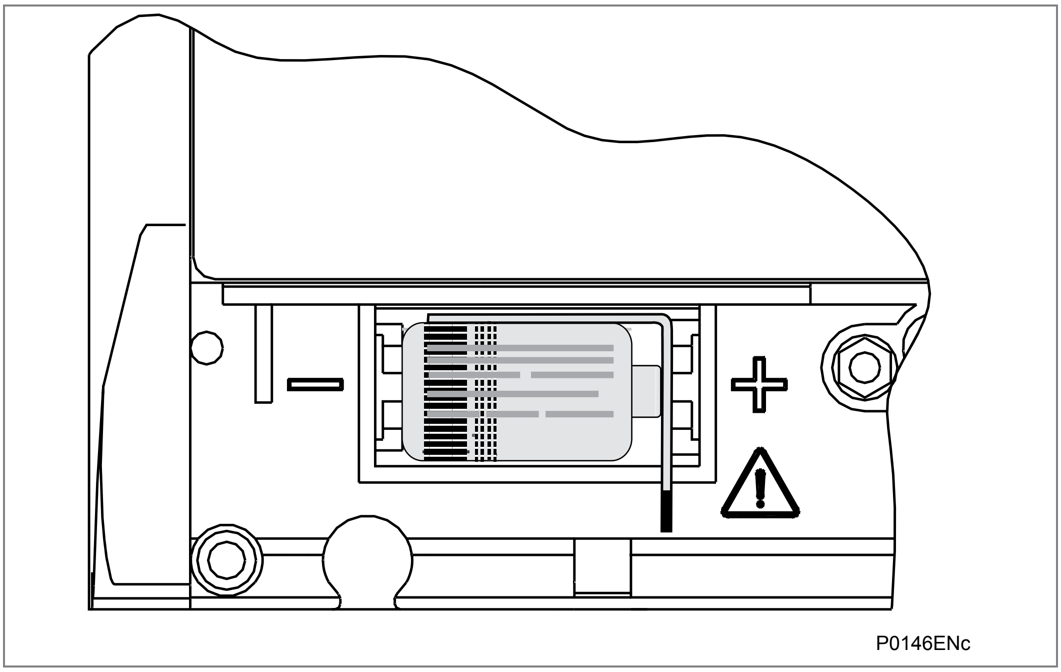

Figure 1 - Location of battery isolation strip

If you need to test correct relay operation during the installation, the battery isolation strip can be removed but should be replaced if commissioning of the scheme is not imminent. This will prevent unnecessary battery drain during transportation to site and installation. The red tab of the isolation strip can be seen protruding from the positive side of the battery compartment when the lower access cover is open. To remove the isolation strip, pull the red tab whilst lightly pressing the battery to prevent it falling out of the compartment. When replacing the battery isolation strip, ensure that the strip is refitted as shown in the *Location of battery isolation strip* diagram, i.e. with the strip behind the battery with the red tab protruding.

3.1 Rack Mounting

Virtually all MiCOM relays can be rack mounted using single tier rack frames (part number FX0021 101), see the ***Rack mounting of relays*** diagram below. These frames have dimensions in accordance with IEC 60297 and are supplied pre-assembled ready to use. On a standard 483 mm rack this enables combinations of case widths up to a total equivalent of size 80TE to be mounted side-by-side.

The two horizontal rails of the rack frame have holes drilled at approximately 26 mm intervals and the relays are attached via their mounting flanges using M4 Taptite self-tapping screws with captive 3 mm thick washers (also known as a SEMS unit). These fastenings are available in packs of 5 (part number ZA0005 104).

Warning **Risk of damage to the front cover moulding. Do not use conventional self-tapping screws, including those supplied for mounting other relays because they have slightly larger heads.**

Once the tier is complete, the frames are fastened into the racks using mounting angles at each end of the tier.

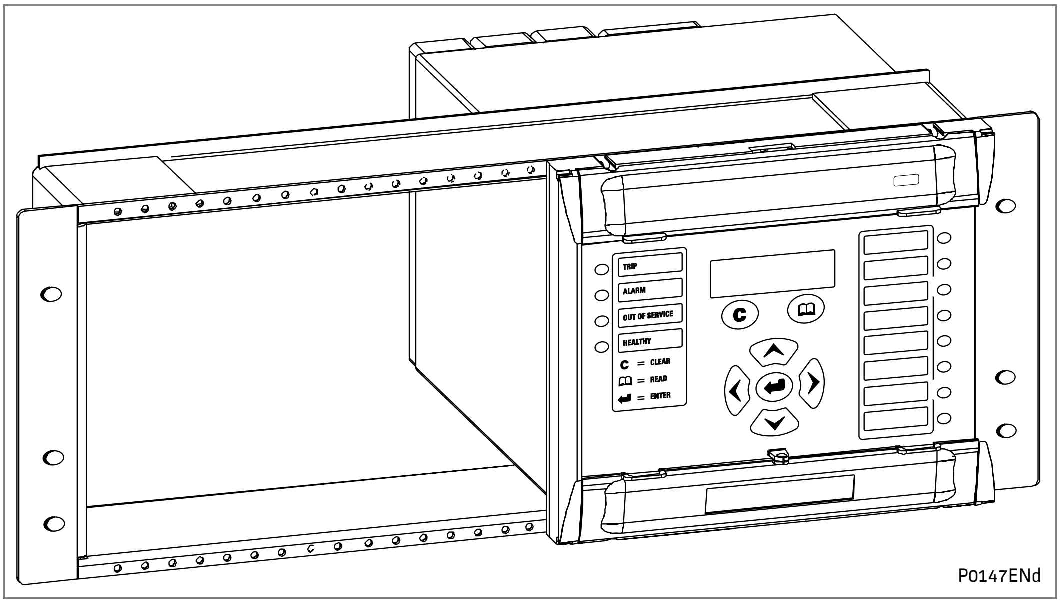

Figure 2 - Rack mounting of relays

Relays can be mechanically grouped into single tier (4U) or multi-tier arrangements by the rack frame. This enables schemes using MiCOM products to be pre-wired together prior to mounting.
Use blanking plates if there are empty spaces. The spaces may be for future installation of relays or because the total size is less than 80TE on any tier. Blanking plates can also be used to mount ancillary components. The following ***Blanking plates*** table shows the sizes that can be ordered.

Note	*Blanking plates are only available in grey.*

Case size summation	Blanking plate part number
10TE	GJ2028 102
20TE	GJ2028 104
30TE	GJ2028 106
40TE	GJ2028 108

Table 2 - Blanking plates

3.2 Panel Mounting

The relays can be flush mounted into panels using M4 SEMS Taptite self-tapping screws with captive 3 mm thick washers (also known as a SEMS unit). These fastenings are available in packs of 5 (part number ZA0005 104).

Warning **Risk of damage to the front cover moulding. Do not use conventional self-tapping screws, including those supplied for mounting other relays because they have slightly larger heads.**

Alternatively tapped holes can be used if the panel has a minimum thickness of 2.5 mm. If several relays are mounted in a single cut-out in the panel, mechanically group them together horizontally or vertically to form rigid assemblies prior to mounting in the panel.

Note *Fastening MiCOM relays with pop rivets is not advised because this does not allow easy removal if repair is necessary.*

Rack-mounting panel-mounted versions: it is possible to rack-mount some relay versions which have been designed to be panel-mounted. The relay is mounted on a single-tier rack frame, which occupies the full width of the rack. To make sure a panel-mounted relay assembly complies with BS EN60529 IP52, fit a metallic sealing strip between adjoining relays (Part No GN2044 001) and a sealing ring from the following ***IP52 sealing rings*** table around the complete assembly.

Width	Single tier	Double tier
40TE	GJ9018 008	GJ9018 024
45TE	GJ9018 009	GJ9018 025
50TE	GJ9018 010	GJ9018 026
55TE	GJ9018 011	GJ9018 027
60TE	GJ9018 012	GJ9018 028
65TE	GJ9018 013	GJ9018 029
70TE	GJ9018 014	GJ9018 030
75TE	GJ9018 015	GJ9018 031
80TE	GJ9018 016	GJ9018 032

Table 3 - IP52 sealing rings

4 RELAY WIRING

This section serves as a guide to selecting the appropriate cable and connector type for each terminal on the MiCOM relay.

Warning	**Before carrying out any work on the equipment, you should be familiar with the contents of the Safety Information chapter/Safety Guide SFTY/5L M/L11 or later issue, the Technical Data chapter and the ratings on the equipment rating label.**

4.1 Medium and Heavy Duty Terminal Block Connections

Key:

Heavy duty terminal block: CT and VT circuits, terminals with "C","D","E" or "F" prefix (depending on the relay)

Medium duty: All other terminal blocks (grey color)

Loose relays are supplied with sufficient M4 screws for making connections to the rear mounted terminal blocks using ring terminals, with a recommended maximum of two ring terminals per relay terminal.

If required, Schneider Electric can supply M4 90° crimp ring terminals in three different sizes depending on wire size (see the *M4 90° crimp ring terminals* table). Each type is available in bags of 100.

Part number	Wire size	Insulation colour
ZB9124 901	0.25 – 1.65mm^2 (22 – 16AWG)	Red
ZB9124 900	1.04 – 2.63mm^2 (16 – 14AWG)	Blue
ZB9124 904	2.53 – 6.64mm^2 (12 – 10AWG)	Uninsulated*

Note — ** To maintain the terminal block insulation requirements for safety, fit an insulating sleeve over the ring terminal after crimping.*

Table 4 - M4 90° crimp ring terminals

The following minimum wire sizes are recommended:

- Current Transformers 2.5mm^2
- Auxiliary Supply Vx 1.5mm^2
- RS485 Port See separate section
- Rotor winding to P391 1.0mm^2
- Other circuits 1.0mm^2

Due to the limitations of the ring terminal, the maximum wire size that can be used for any of the medium or heavy duty terminals is 6.0mm^2 using ring terminals that are not pre-insulated. Where it required to only use pre-insulated ring terminals, the maximum wire size that can be used is reduced to 2.63mm^2 per ring terminal. If a larger wire size is required, two wires should be used in parallel, each terminated in a separate ring terminal at the relay.

The wire used for all connections to the medium and heavy duty terminal blocks, except the RS485 port, should have a minimum voltage rating of 300Vrms.

It is recommended that the auxiliary supply wiring should be protected by a 16A maximum High Rupture Capacity (HRC) fuse of type NIT or TIA. For safety reasons, current transformer circuits must never be fused. Other circuits should be appropriately fused to protect the wire used.

Note — *The high-break contacts optional fitted to P44y (P443/P446) and P54x relays are polarity sensitive. External wiring must respect the polarity requirements which are shown on the external connection diagram to ensure correct operation.*

Each opto input has selectable filtering. This allows use of a pre-set filter of ½ cycle which renders the input immune to induced noise on the wiring: although this method is secure it can be slow, particularly for intertripping. This can be improved by switching off the ½ cycle filter in which case one of the following methods to reduce ac noise should be considered. The first method is to use double pole switching on the input, the second is to use screened twisted cable on the input circuit. The recognition time of the opto inputs without the filtering is <2 ms and with the filtering is <12 ms.

4.2 EIA(RS)485 Port

Connections to the first rear EIA(RS)485 port use ring terminals. 2-core screened cable is recommended with a maximum total length of 1000m or 200nF total cable capacitance. A typical cable specification would be:

Each core:	16/0.2mm copper conductors. PVC insulated
Nominal conductor area:	0.5mm^2 per core
Screen:	Overall braid, PVC sheathed

See the SCADA Communications chapter for details of setting up an EIA(RS)485 bus.

4.3 Current Loop Input Output (CLIO) Connections (if applicable)

Where current loop inputs and outputs are available on a MiCOM relay, the connections are made using screw clamp connectors, as per the RTD inputs, on the rear of the relay which can accept wire sizes between 0.1 mm^2 and 1.5 mm^2. It is recommended that connections between the relay and the current loop inputs and outputs are made using a screened cable. The wire should have a minimum voltage rating of 300 Vrms.

4.4 IRIG-B Connections (if applicable)

The IRIG-B input and BNC connector have a characteristic impedance of 50Ω. It is recommended that connections between the IRIG-B equipment and the relay are made using coaxial cable of type RG59LSF with a halogen free, fire retardant sheath.

4.5 EIA(RS)232 Port

Short term connections to the RS232 port, located behind the bottom access cover, can be made using a screened multi-core communication cable up to 15m long, or a total capacitance of 2500pF. The cable should be terminated at the relay end with a 9-way, metal shelled, D-type male plug. The Getting Started chapter of this manual details the pin allocations.

4.6 Optical Fiber Connectors (when applicable)

Warning **LASER LIGHT RAYS: Where fibre optic communication devices are fitted, never look into the end of a fiber optic due to the risk of causing serious damage to the eye. Optical power meters should be used to determine the operation or signal level of the device. Non-observance of this rule could possibly result in personal injury.**

If electrical to optical converters are used, they must have management of character idle state capability (for when the fibre optic cable interface is "Light off").
Specific care should be taken with the bend radius of the fibres, and the use of optical shunts is not recommended as these can degrade the transmission path over time.
The relay uses 1310nm multi mode 100BaseFx and BFOC 2.5 - (ST/LC according to the MiCOM model) connectors (one Tx – optical emitter, one Rx – optical receiver).

4.7 Ethernet Port for IEC 61850 and/or DNP3.0 (where applicable)

4.7.1 Fiber Optic (FO) Port

The relays can have 100 Mbps Ethernet port. Fibre Optic (FO) connection is recommended for use in permanent connections in a substation environment. The 100 Mbit port uses a type LC connector (according to the MiCOM model), compatible with fiber multimode 50/125 µm or 62.5/125 µm to 1310 nm.

Note	*The new LC fiber optical connector can be used with the Px40 Enhanced Ethernet Board.*

4.7.2 RJ-45 Metallic Port

Due to possibility of noise and interference on this part, it is recommended that this connection type be used for short-term connections and over short distance. Ideally, where the relays and switches are located in the same cubicle.

The connector for the Ethernet port is a shielded RJ-45. The following ***Signals on the Ethernet connector*** table shows the signals and pins on the connector.

Pin	Signal name	Signal definition
1	TXP	Transmit (positive)
2	TXN	Transmit (negative)
3	RXP	Receive (positive)
4	-	Not used
5	-	Not used
6	RXN	Receive (negative)
7	-	Not used
8	-	Not used

Table 5 - Signals on the Ethernet connector

4.8 RTD Connections (if applicable)

Where RTD inputs are available on a MiCOM relay, the connections are made using screw clamp connectors on the rear of the relay that can accept wire sizes between 0.1 mm^2 and 1.5 mm^2. The connections between the relay and the RTDs must be made using a screened 3-core cable with a total resistance less than 10 Ω. The cable should have a minimum voltage rating of 300 Vrms.

A 3-core cable should be used even for 2-wire RTD applications, as it allows for the cable’s resistance to be removed from the overall resistance measurement. In such cases the third wire is connected to the second wire at the point the cable is joined to the RTD.

The screen of each cable must only be earthed at one end, preferably at the relay end and must be continuous. Multiple earthing of the screen can cause circulating current to flow along the screen, which induces noise and is unsafe.

It is recommended to minimize noise pick-up in the RTD cables by keeping them close to earthed metal casings and avoiding areas of high electromagnetic and radio interference. The RTD cables should not be run adjacent to or in the same conduit as other high voltage or current cables.

A typical cable specification would be:

Each core: 7/0.2 mm copper conductors heat resistant PVC insulated

Nominal conductor area: 0.22 mm^2 per core

Screen: Nickel-plated copper wire braid heat resistant PVC sheathed

The extract below may be useful in defining cable recommendations for the RTDs:

Noise pick-up by cables can be categorized in to three types:

- Resistive
- Capacitive
- Inductive

Resistive coupling	requires there to be an electrical connection to the noise source. So assuming that the wire and cable insulation is sound and that the junctions are clean then this can be dismissed.
Capacitive coupling	requires there to be sufficient capacitance for the impedance path to the noise source to be small enough to allow for significant coupling. This is a function of the dielectric strength between the signal cable on the noise source and the potential (i.e. power) of the noise source.
Inductive coupling	occurs when the signal cable is adjacent to a cable/wire carrying the noise or it is exposed to a radiated EMF.

Standard screened cable is normally used to protect against capacitively coupled noise, but in order for it to be effective the screen must only be bonded to the system ground at one point, otherwise a current could flow and the noise would be coupled in to the signal wires of the cable. There are different types of screening available, but basically there are two types: aluminum foil wrap and tin-copper braid.

Foil screens are good for low to medium frequencies and braid is good for high frequencies. High-fidelity screen cables provide both types.

Protection against magnetic inductive coupling requires very careful cable routing and magnetic shielding. The latter can be achieved with steel-armored cable and the use of steel cable trays. It is important that the armor of the cable is grounded at both ends so that the EMF of the induced current cancels the field of the noise source and hence shields the cables conductors from it. (However, the design of the system ground must be considered and care taken to not bridge two isolated ground systems since this could be hazardous and defeat the objectives of the original ground design). The cable should be laid in the cable trays as close as possible to the metal of the tray and under no circumstance should any power cable be in or near to the tray. (Power cables should only cross the signal cables at 90 degrees and never be adjacent to them).

Both the capacitive and inductive screens must be contiguous from the RTD probes to the relay terminals.

The best types of cable are those provided by the RTD manufactures. These tend to be three conductors (a so-called "triad") which are screened with foil. Such triad cables are available in armored forms as well as multi-triad armored forms.

4.9 Download/Monitor Port

Short term connections to the download/monitor port, located behind the bottom access cover, can be made using a screened 25-core communication cable up to 4m long. The cable should be terminated at the relay end with a 25-way, metal shelled, D-type male plug.

The Getting Started and Commissioning chapters this manual details the pin allocations.

4.10 Second EIA(RS)232/485 Port

Relays with Courier, MODBUS, IEC 60870-5-103 or DNP3 protocol on the first rear communications port have the option of a second rear port, running Courier protocol. The second rear communications port can be used over one of three physical links:

- twisted pair K-Bus (non-polarity sensitive),
- twisted pair EIA(RS)485 (connection polarity sensitive) or
- EIA(RS)232. This EIA(RS)232 port is actually compliant to EIA(RS)574; the 9-pin version of EIA(RS)232, see www.tiaonline.org.

4.10.1 Connection to the Second Rear Port

The second rear Courier port connects via a 9-way female D-type connector (SK4) in the middle of the card end plate (in between IRIG-B connector and lower D-type). The connection is compliant to EIA(RS)574.

4.10.1.1 For IEC 60870-5-2 over EIA(RS)232/574

Pin	Connection
1	No Connection
2	RxD
3	TxD
4	DTR#
5	Ground
6	No Connection
7	RTS #
8	CTS #
9	No Connection
# - These pins are control lines for use with a modem.	

Table 6 - Pin connections for IEC 60870-5-2 over EIA(RS)232/574

Connections to the second rear port configured for EIA(RS)232 operation can be made using a screened multi-core communication cable up to 15 m long, or a total capacitance of 2500 pF. The cable should be terminated at the relay end with a 9-way, metal shelled, D-type male plug. The table above details the pin allocations.

4.10.1.2 For K-bus or IEC 60870-5-2 over EIA(RS)485

Pin*	Connection
4	EIA(RS)485 - 1 (+ ve)
7	EIA(RS)485 - 2 (- ve)
* - All other pins unconnected.	

> *Note* *Connector pins 4 and 7 are used by both the EIA(RS)232/574 and EIA(RS)485 physical layers, but for different purposes. Therefore, the cables should be removed during configuration switches.*
> *For the EIA(RS)485 protocol an EIA(RS)485 to EIA(RS)232/574 converter will be required to connect a modem or PC running MiCOM S1 Studio, to the relay. A Schneider Electric CK222 is recommended.*
> *EIA(RS)485 is polarity sensitive, with pin 4 positive (+) and pin 7 negative (-).*
> *The K-Bus protocol can be connected to a PC via a KITZ101 or 102.*
> *It is recommended that a 2-core screened cable be used. To avoid exceeding the second communications port flash clearances it is recommended that the length of cable between the port and the communications equipment should be less than 300 m. This length can be increased to 1000 m or 200nF total cable capacitance if the communications cable is not laid in close proximity to high current carrying conductors. The cable screen should be earthed at one end only.*

Table 7 - Pin connections for K-bus or IEC 60870-5-2 over EIA(RS)485

A typical cable specification would be:

Each core:	16/0.2mm copper conductors. PVC insulated
Nominal conductor area:	0.5mm^2 per core
Screen:	Overall braid, PVC sheathed

4.11 Earth Connection (Protective Conductor)

Every relay must be connected to the local earth bar using the M4 earth studs in the bottom left hand corner of the relay case. The minimum recommended wire size is 2.5mm^2 and should have a ring terminal at the relay end.
Due to the limitations of the ring terminal, the maximum wire size that can be used for any of the medium or heavy duty terminals is 6.0mm^2 per wire. If a greater cross-sectional area is required, two parallel connected wires, each terminated in a separate ring terminal at the relay, or a metal earth bar could be used.

Note	*To prevent any possibility of electrolytic action between brass or copper earth conductors and the rear panel of the relay, precautions should be taken to isolate them from one another. This could be achieved in a number of ways, including placing a nickel-plated or insulating washer between the conductor and the relay case, or using tinned ring terminals.*

Warning	**Before carrying out any work on the equipment, you should be familiar with the contents of the Safety Information chapter/Safety Guide SFTY/5L M/L11 or later issue, the Technical Data chapter and the ratings on the equipment rating label.**

4.12 P391 Rotor Earth Fault Unit (REFU) Mounting

Under rotor earth fault conditions, DC currents of up to 29mA can appear in the earth circuit. Accordingly, the P391 must be permanently connected to the local earth via the protective conductor terminal provided.
This section serves as a guide to selecting the appropriate cable and connector type for each terminal on the P391 unit.

Caution	**You must be familiar with all safety statements listed in the Commissioning chapter and the Safety Information section SFTY/4LM/G11 (or later issue) before undertaking any work on the P391.**

Caution	**Under no circumstances should the high voltage DC rotor winding supply be connected via Easergy or P99x test blocks. Both Easergy and P990 test blocks are not rated for continuous working voltages greater than 300 Vrms. These test blocks are not designed to withstand the inductive EMF voltages which will be experienced on disconnection or de-energization of the DC rotor winding supply.**

4.12.1 Medium Duty Terminal Block Connections

Information about the medium duty terminal block connections is described in the ***Medium and Heavy Duty Terminal Block Connections*** section.

Caution **Wiring between the DC rotor winding and the P391 must be suitably rated to withstand at least twice the rotor winding supply voltage to earth. This is to ensure that the wiring insulation can withstand the inductive Electro Motive Force (EMF) voltage which will be experienced on disconnection or de-energization of the DC rotor winding supply.**

Due to the limitations of the ring terminal, the maximum wire size that can be used for any of the medium terminals is 6.0 mm^2 using ring terminals that are not pre-insulated (protective conductor terminal (PCT) only). All P391 terminals, except PCT shall be pre-insulated ring terminals, the maximum wire size that can be used is reduced to 2.63 mm^2 per ring terminal.

Wiring between the DC rotor winding and the P391 shall be suitably rated to withstand at least twice the rotor winding supply voltage to earth. The wire used for other P391 connections to the medium duty terminal blocks should have a minimum voltage rating of 300 Vrms.

The dielectric withstand of P391 injection resistor connections (A16, B16, A8, B8) to earth is 5.8 kV rms, 1 minute.

It is recommended that the auxiliary supply wiring should be protected by a High Rupture Capacity (HRC) fuse of type NIT or TIA, rated between 2 A and 16 A. Other circuits should be appropriately fused to protect the wire used.

5 CASE DIMENSIONS

The MiCOM range of products are available in a series of different case sizes.
The case sizes available for each product are shown here:

Range	Case Size		
	40TE	**60TE**	**80TE**
P14x	P141, P142	P143, P145	P143
P24x	P241	P242	P243
P34x	P341, P342	P341, P342, P343	P343, P344, P345
P441	P441		
P44x		P442	P444
P44y			P443, P446
P445	P445	P445	
P541	P541		
P542		P542	
P54x		P543, P544	P545, P546
P547			P547
P64x	P642	P643, P645	P645
P74x	P742	P743	P741
P746			P746
P841		P841	P841
P849			P849

Table 8 - Products and case sizes

5.1 40TE Case Dimensions

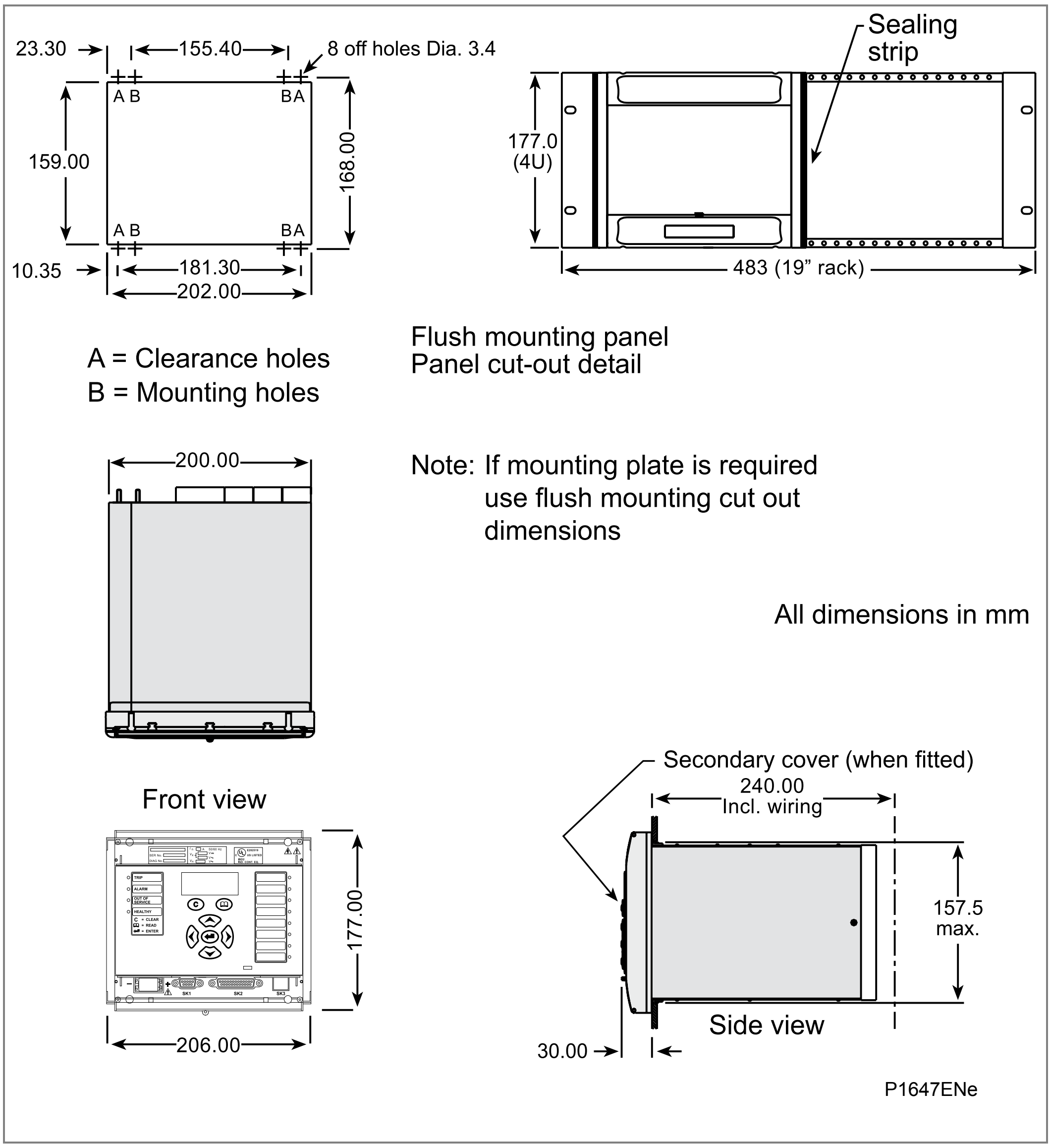

Figure 3 - 40TE Case Dimensions

5.2 60TE Case Dimensions

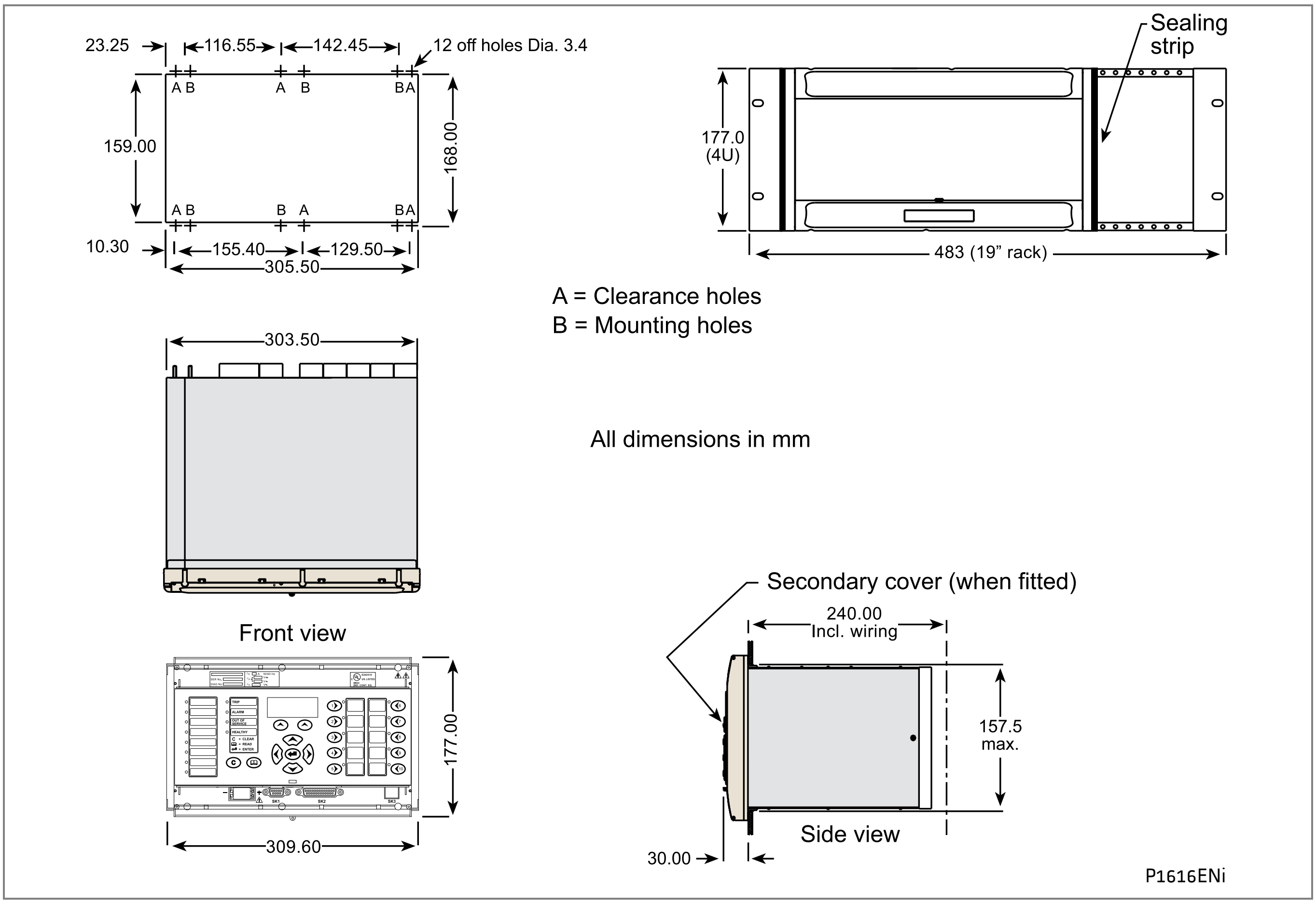

Figure 4 - 60TE Case Dimensions

5.3 80TE Case Dimensions

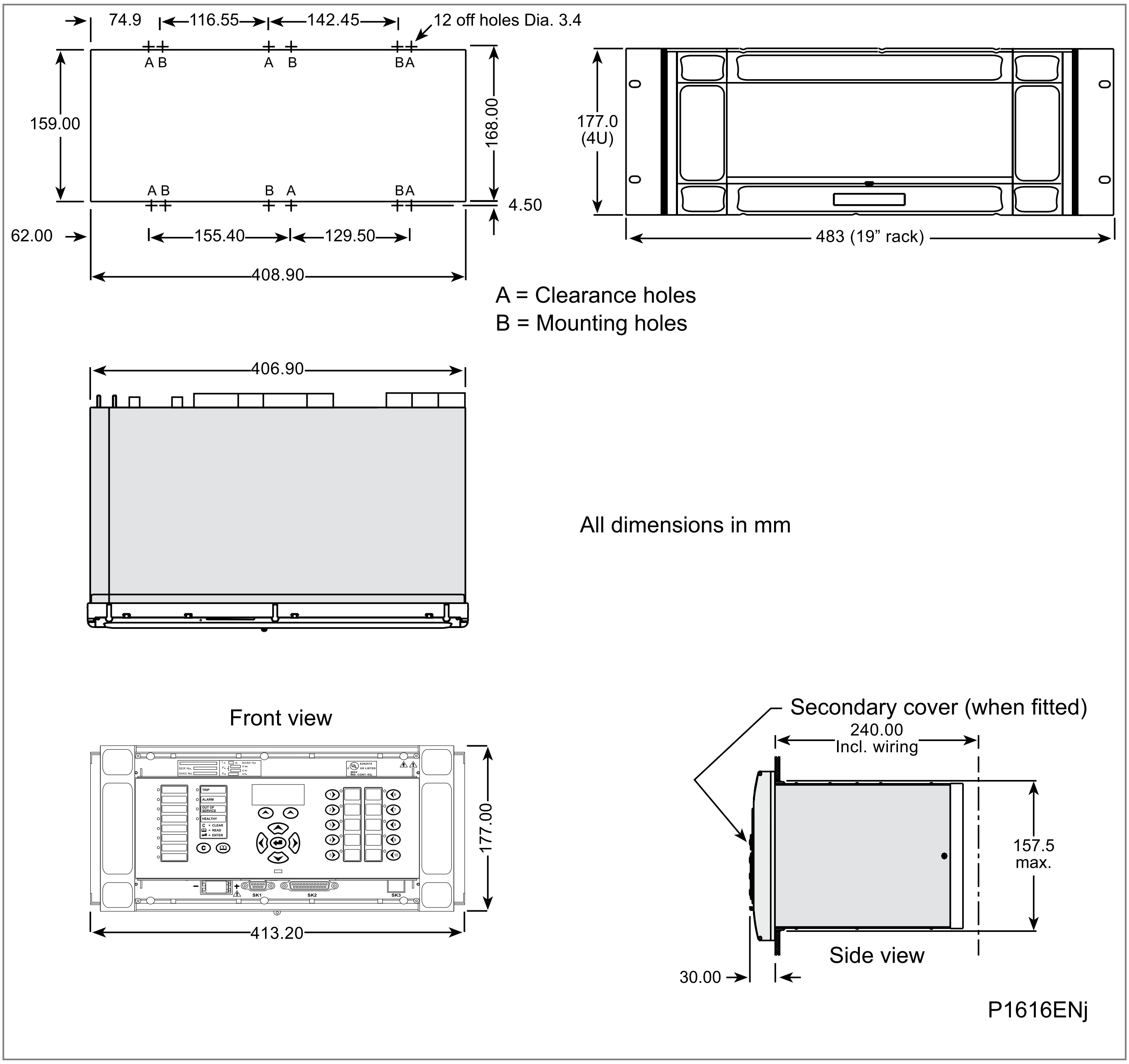

Figure 5 - 80TE Case Dimensions

CONNECTION DIAGRAMS

CHAPTER 17

Date:	05/2017
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.
Hardware suffix:	L (P241) & M (P242 & P243)
Software version:	D1
Connection diagrams:	10P241xx (xx = 01 to 02) 10P242xx (xx = 01) 10P243xx (xx = 01)

CONTENTS

FIGURES

1 ANALOGUE INPUTS

The MiCOM P241/P242 relay has 3-phase current inputs, one earth current input and 3-phase voltage inputs.

The P243 has 6-phase current inputs, one earth current input and 3-phase voltage inputs.

1.1 CTs Inputs for the Phase and Earth Currents

The phase and earth current inputs can be set independently to 1 A or 5 A. The choice of the CTs ratio is done in the menu 'CT and VT ratios' of the MiCOM P24x relay.

The following illustrations show different configurations of CTs and VTs : only the 5 A current inputs are indicated.

Important	**Connections of the earth and phase cts must be done in accordance with the ct ratio selected in the "ct and vt ratios" menu.** **Each time a change is made, the relay must be reset and then restarted (power supply must be cut off and then restored).**

1.1.1 Three CTs and Core Balance CT Configuration

This configuration is a classical configuration, P241 example:

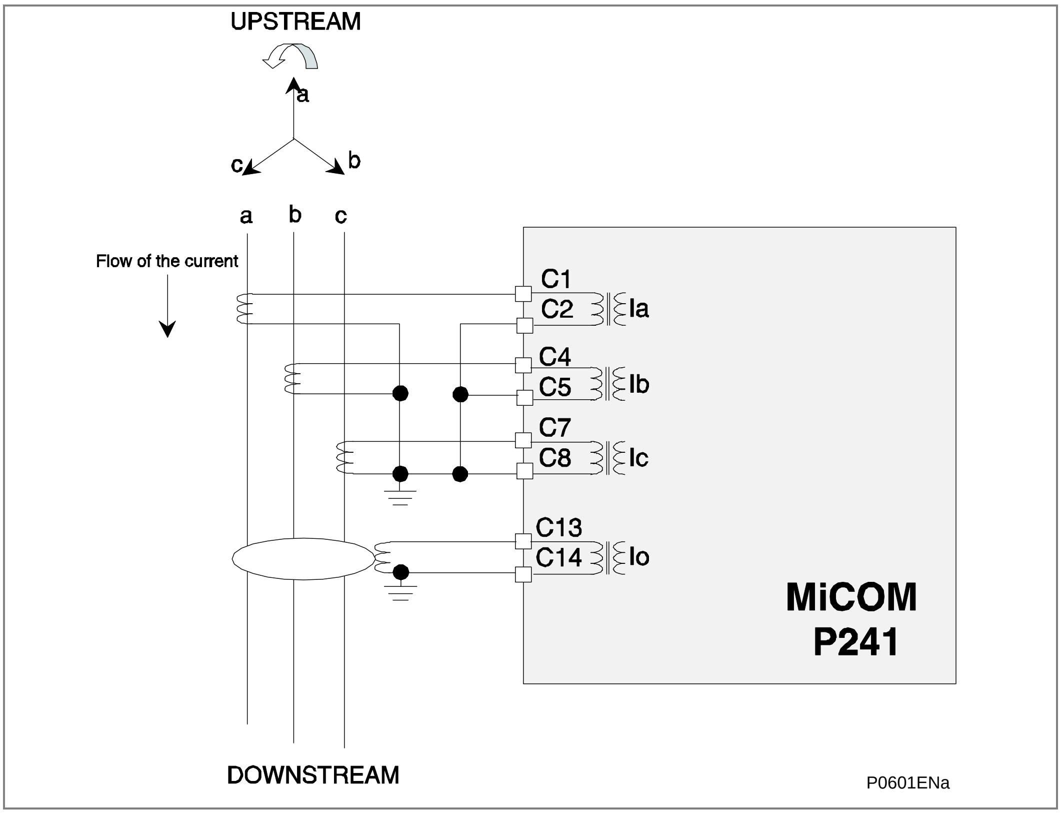

Figure 1 - Three CT and core balance CT configuration

1.1.2 Three CTs Configuration

Due to this configuration, the earth current input is the arithmetic sum of the 3 phase currents. This configuration is mainly used when a core balanced CT is not available.
P241 example :

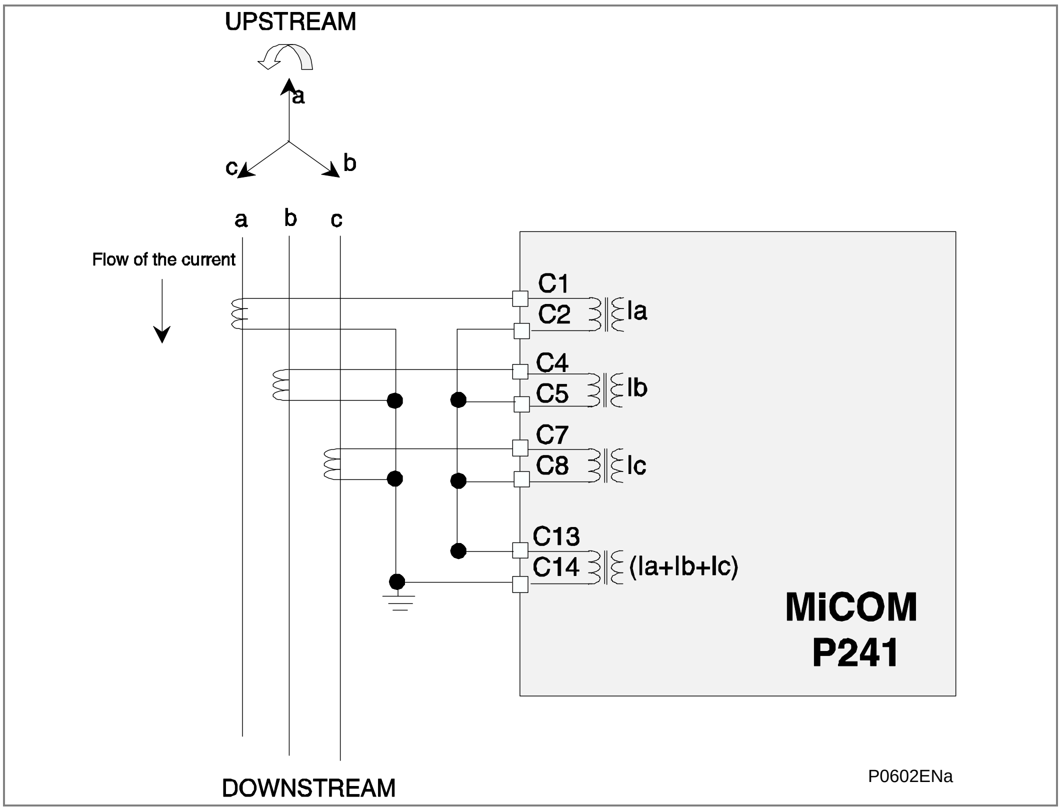

Figure 2 - Three CT configuration

It is possible to realize the summation of the 3 phase currents internally. The protection function is called **Derived E/F** and must be selected in the **CONFIGURATION** menu.

1.1.3 Two CTs and Core Balance CT Configuration

The proper configuration for the use of 2 CTs to detect phase current is shown below, P241 example:

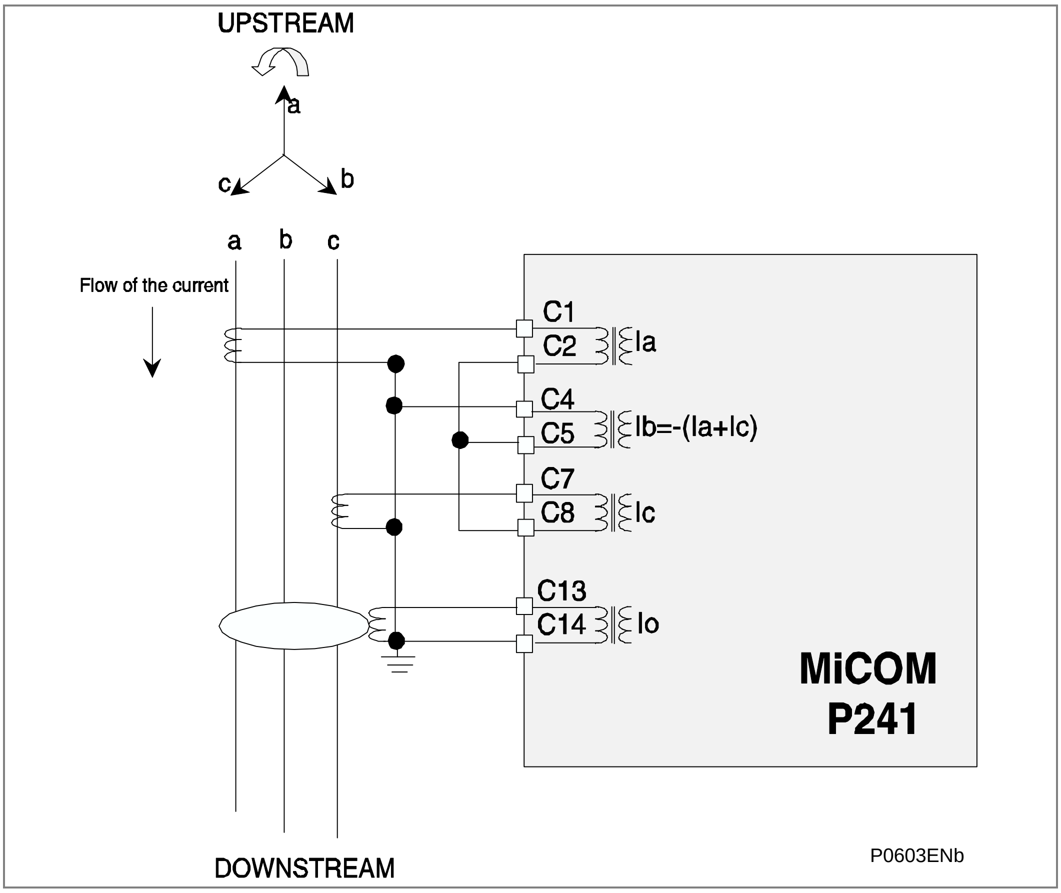

Figure 3 - Two CTs and core balance CT configuration

Note	*Since Ib = Ia + Ic the negative sequence currents calculated during earth faults are incorrect affecting thermal overload and negative sequence overcurrent protection. This usually has little effect since the earth fault element will normally be set to trip instantaneously.*

1.2 VT Inputs

Three configurations can be used for the phase voltage inputs : the choice of the configuration is realized in the **CT AND VT RATIOS** – **VT connecting mode** menu of the MiCOM P24x relay.

1.2.1 Three Phase VTs Configuration

P241 example :

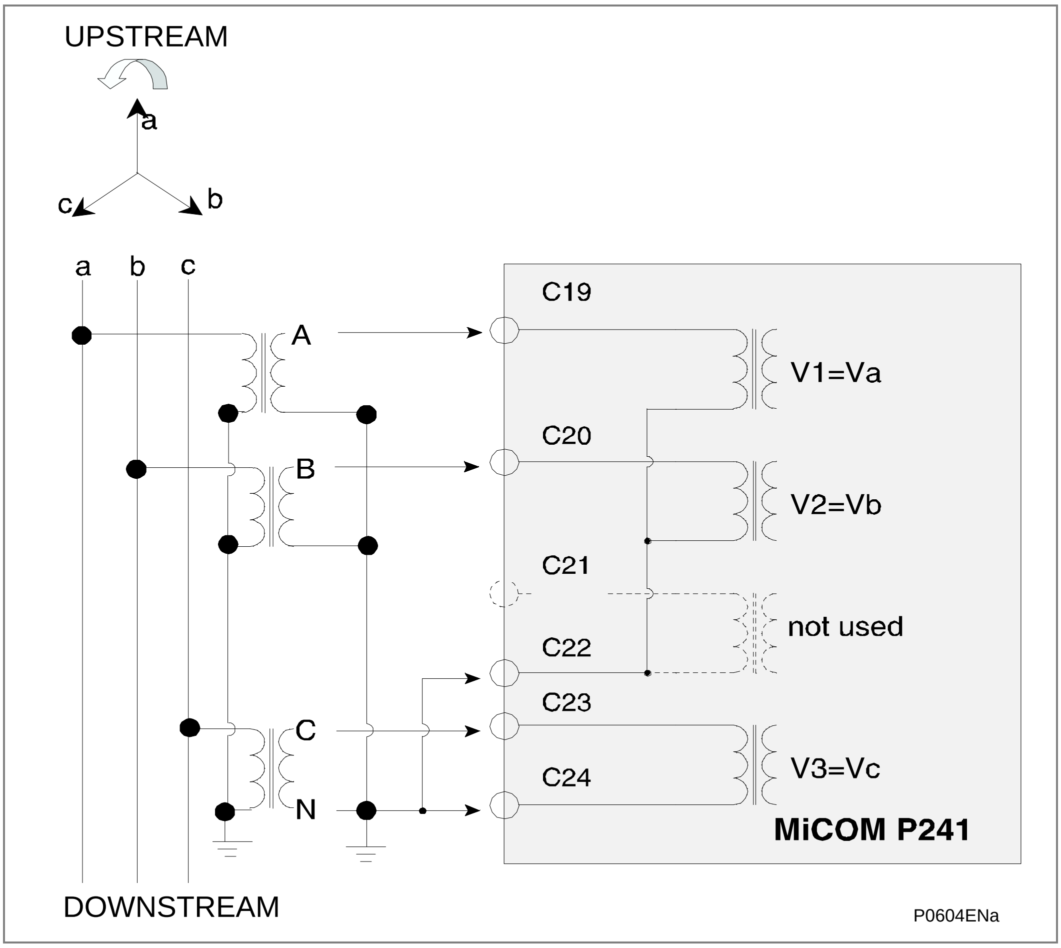

Figure 4 - Three phase VTs configuration

1.2.2 Two Phase VTs and Residual VT Configuration

P241 example:

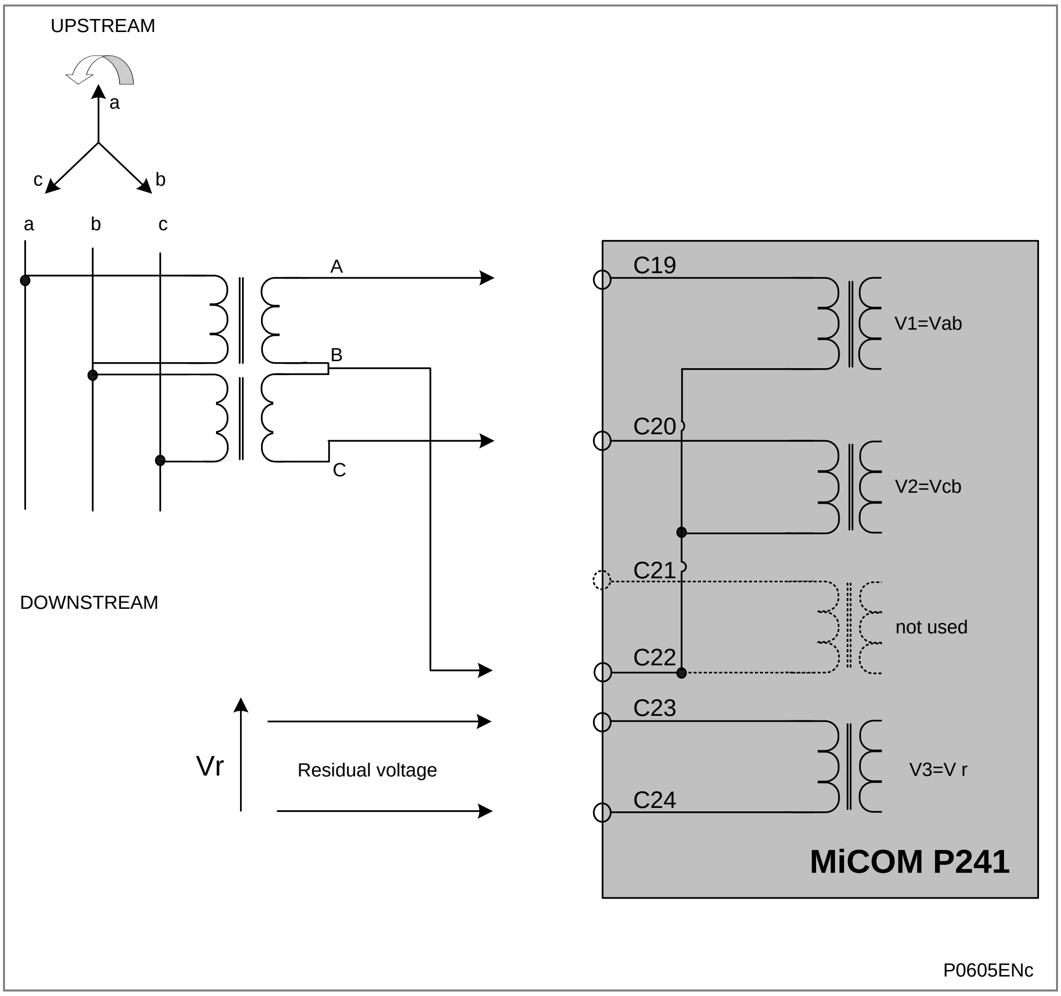

Figure 5 - Two phase VTs and residual VT configuration

1.2.3 Two Phase VTs and Anti-Backspin (Vremanent Phase-Phase) VT Configuration

P241 example:

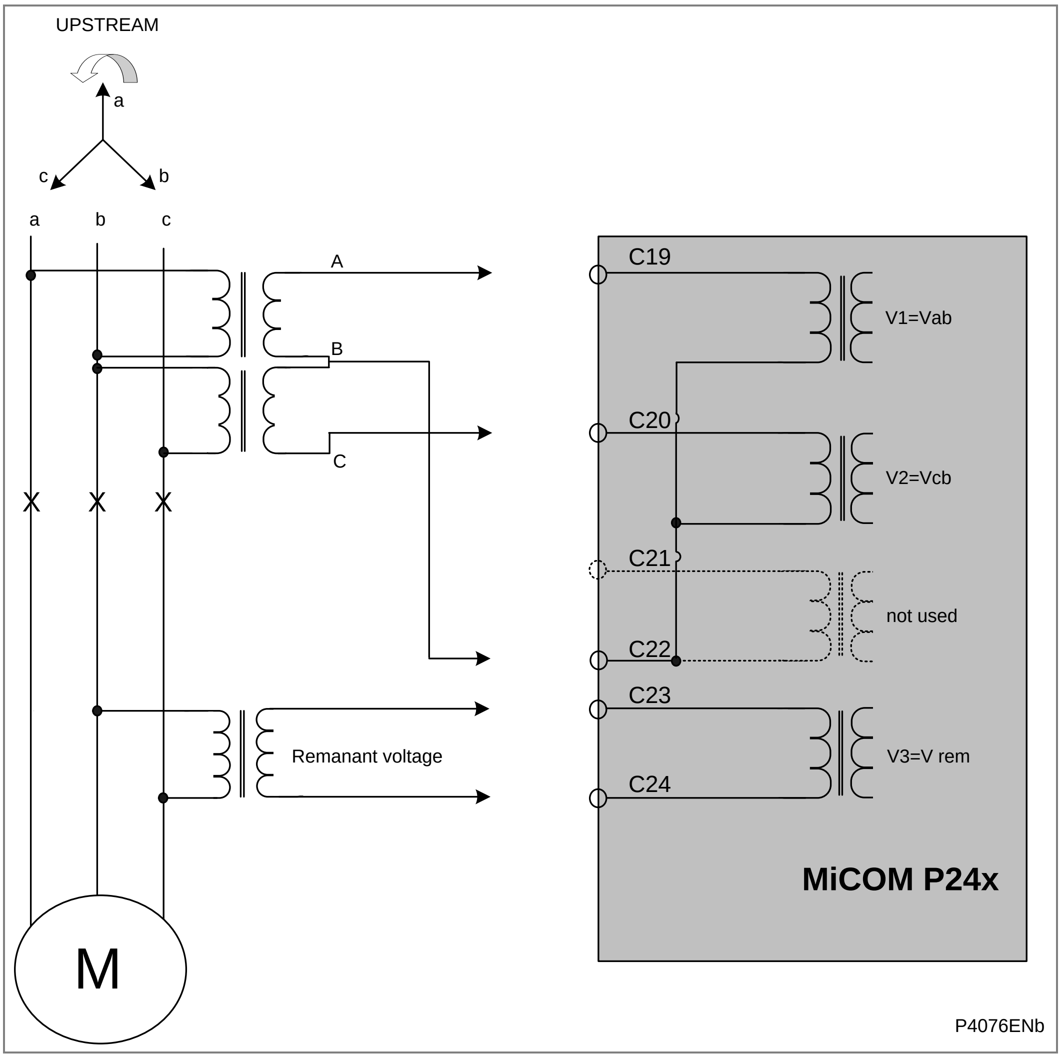

Figure 6 - Two phase VTs and Anti-Backspin (remanent phase-phase) VT configuration

Note	*In order to measure the motor generated voltage when under backspin condition (back emf), the VT used for remanant voltage measurement should be connected upstream the motor and downstream the motor CB.*

2 P24X EXTERNAL CONNECTION DIAGRAMS

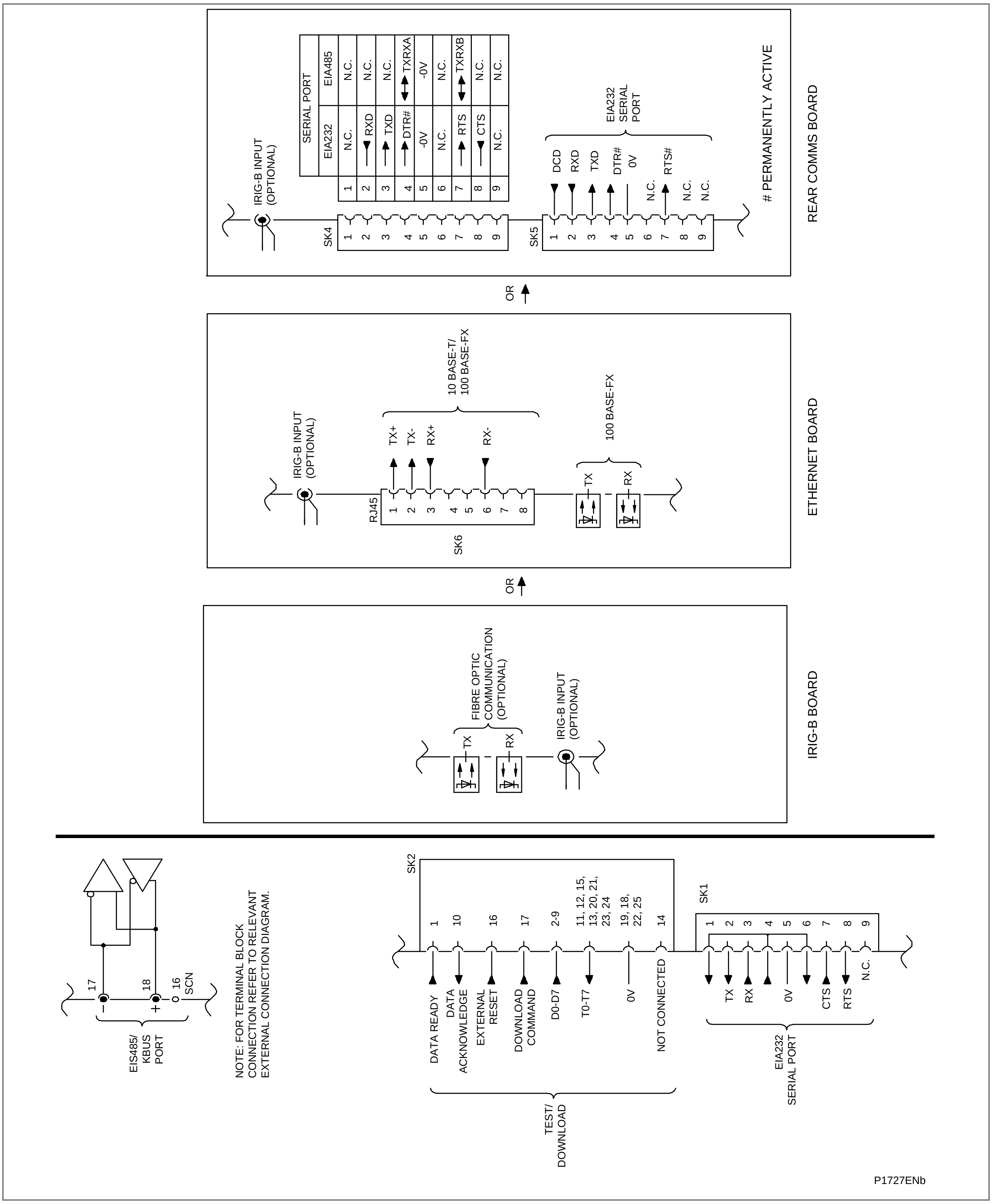

Figure 7 - Comms. options MiCOM Px40 platform

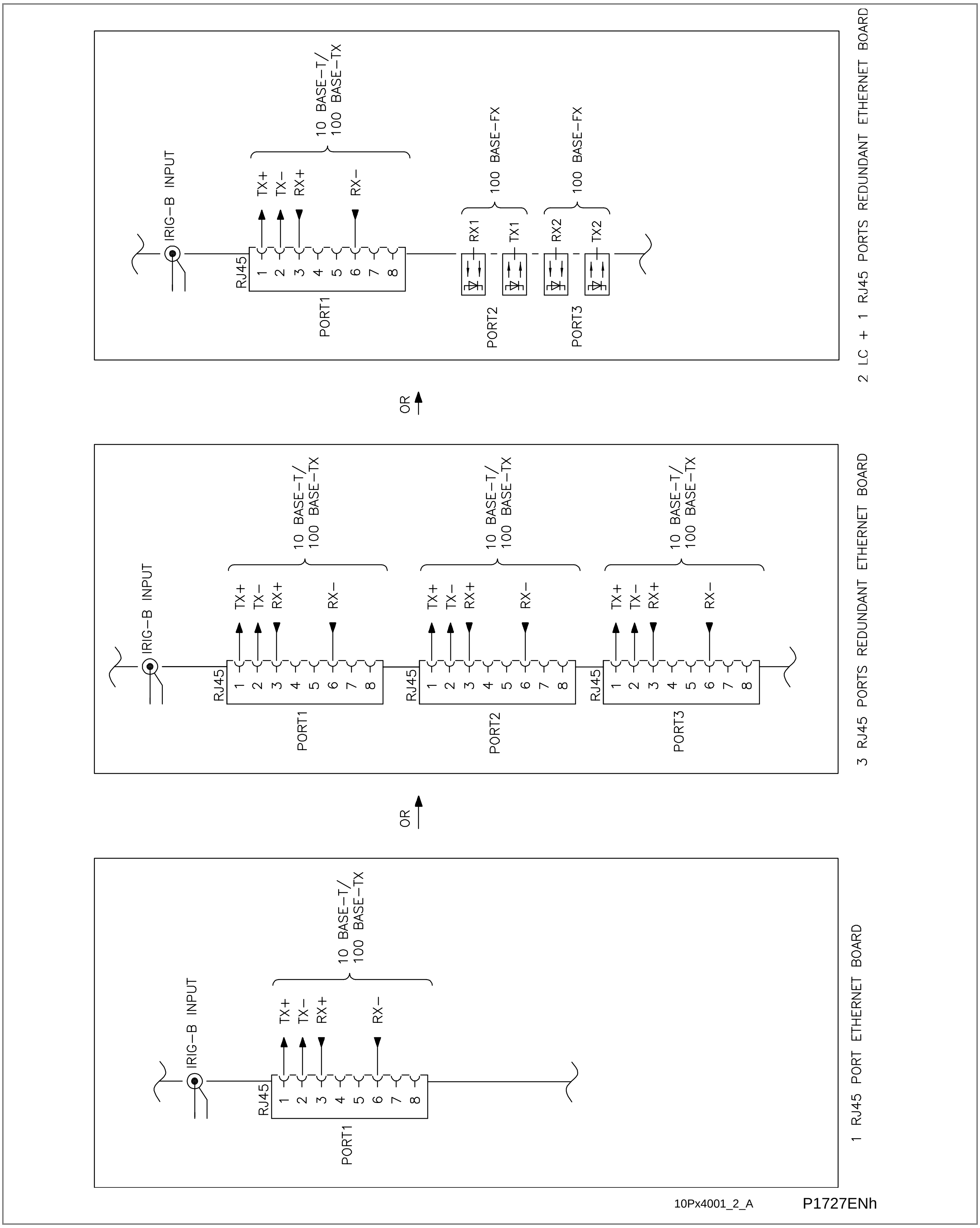

Figure 8 - External Communications Options MiCOM Px40 platform

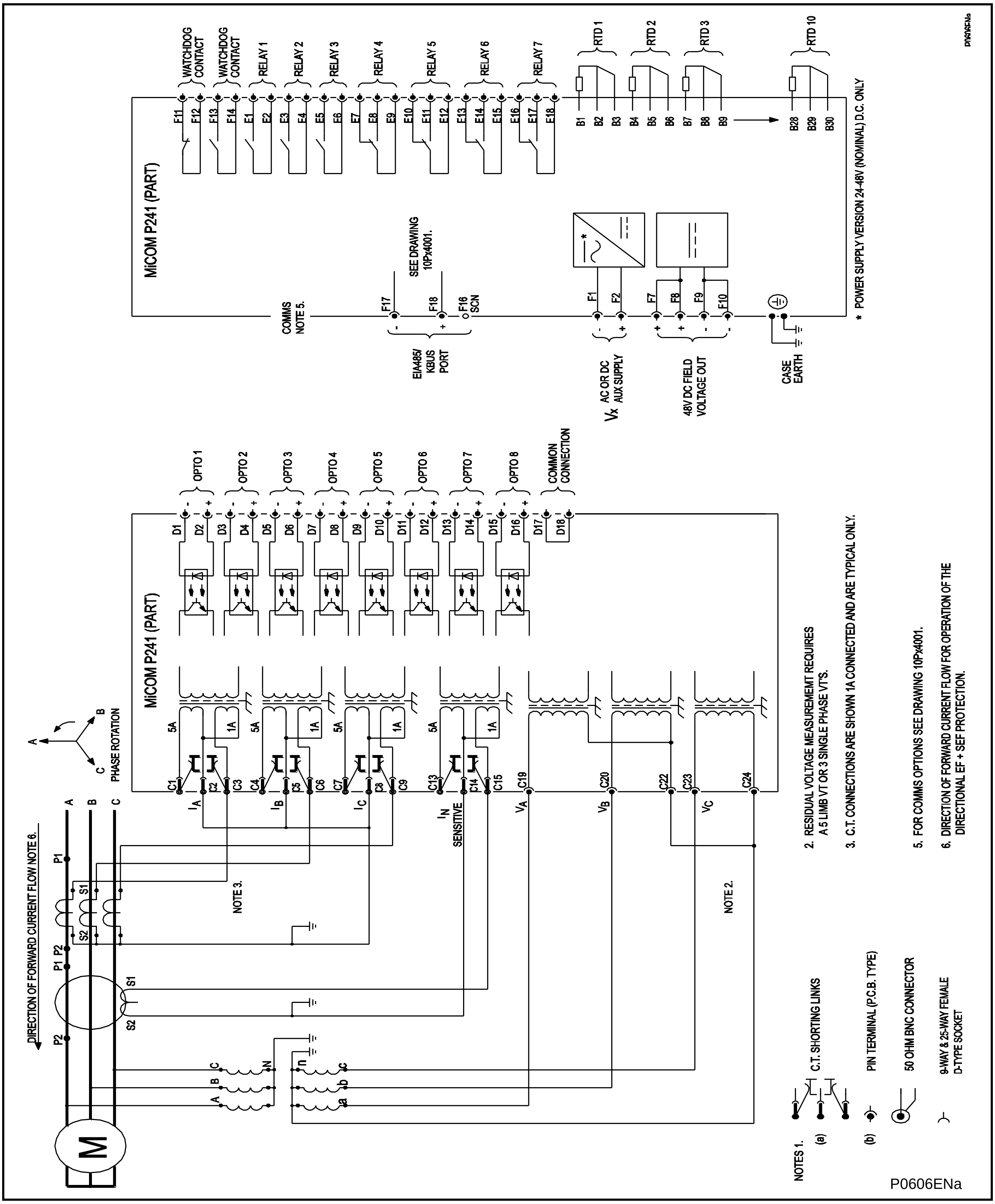

Figure 9 - P241 external connections - 3VTs connection + RTD option

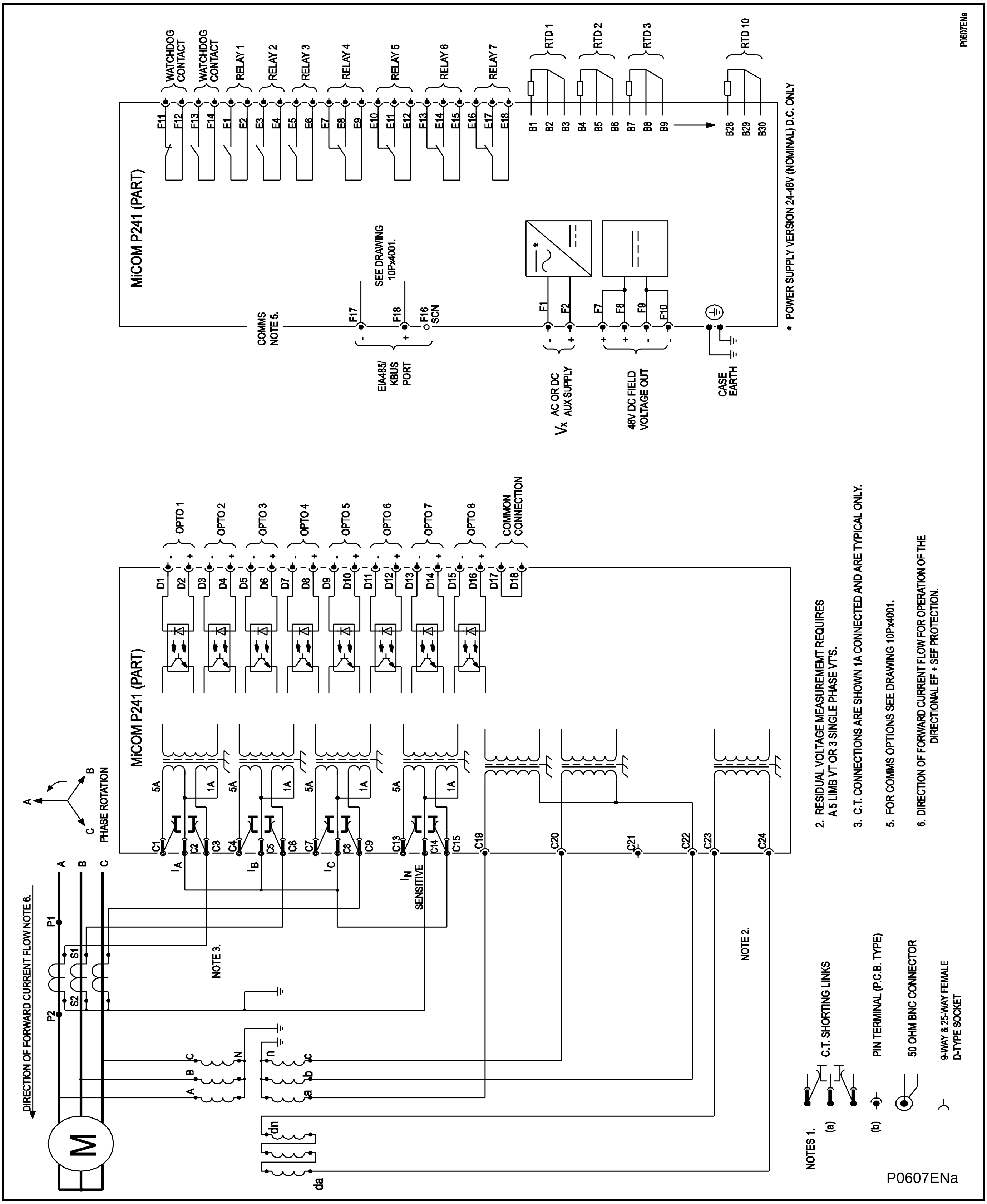

Figure 10 - P241 external connections - 2VTs and residual connection + RTD option

Figure 11 - P241 external connections – RTD option

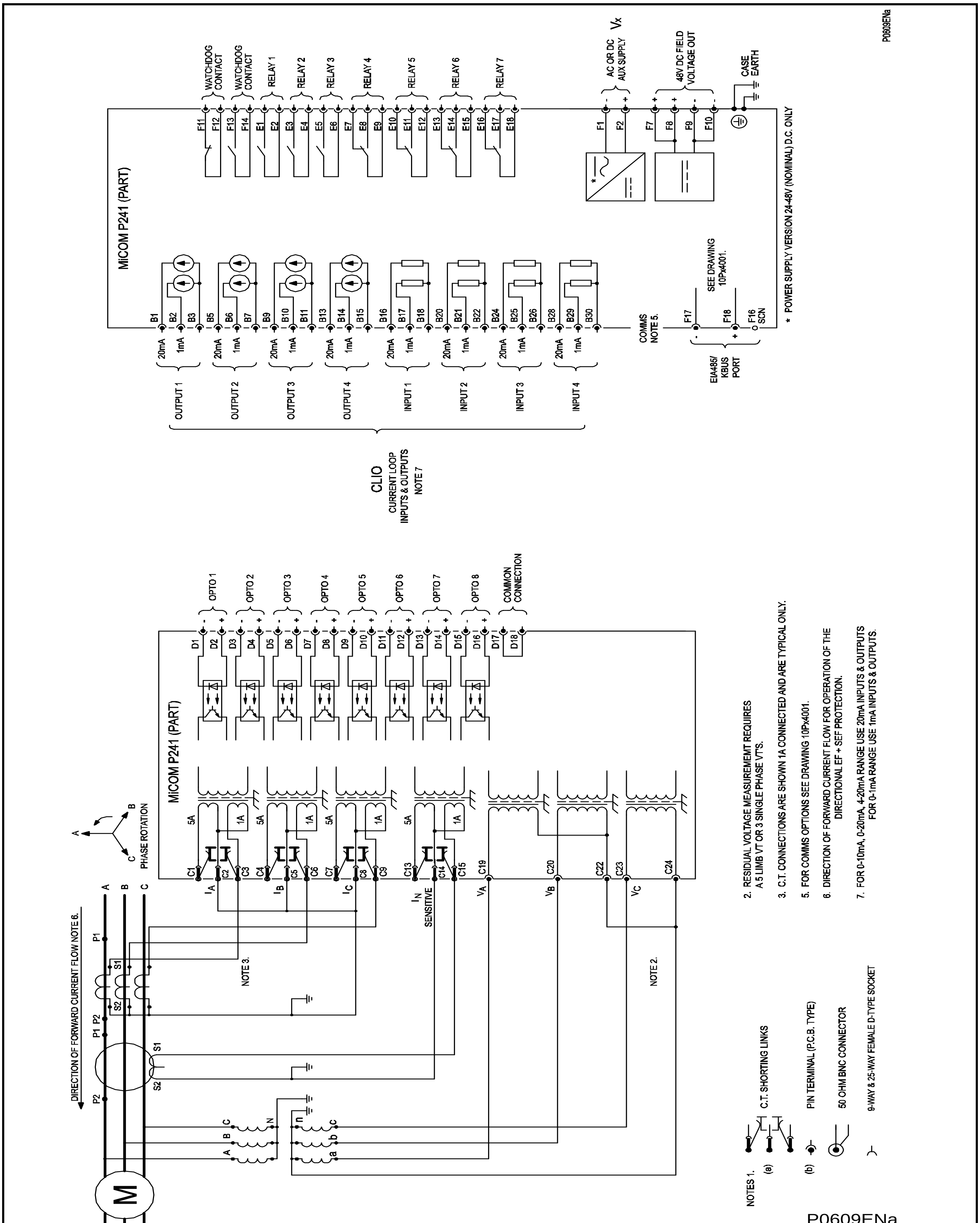

Figure 12 - P241 external connections – 3VTs connection + CLIO option

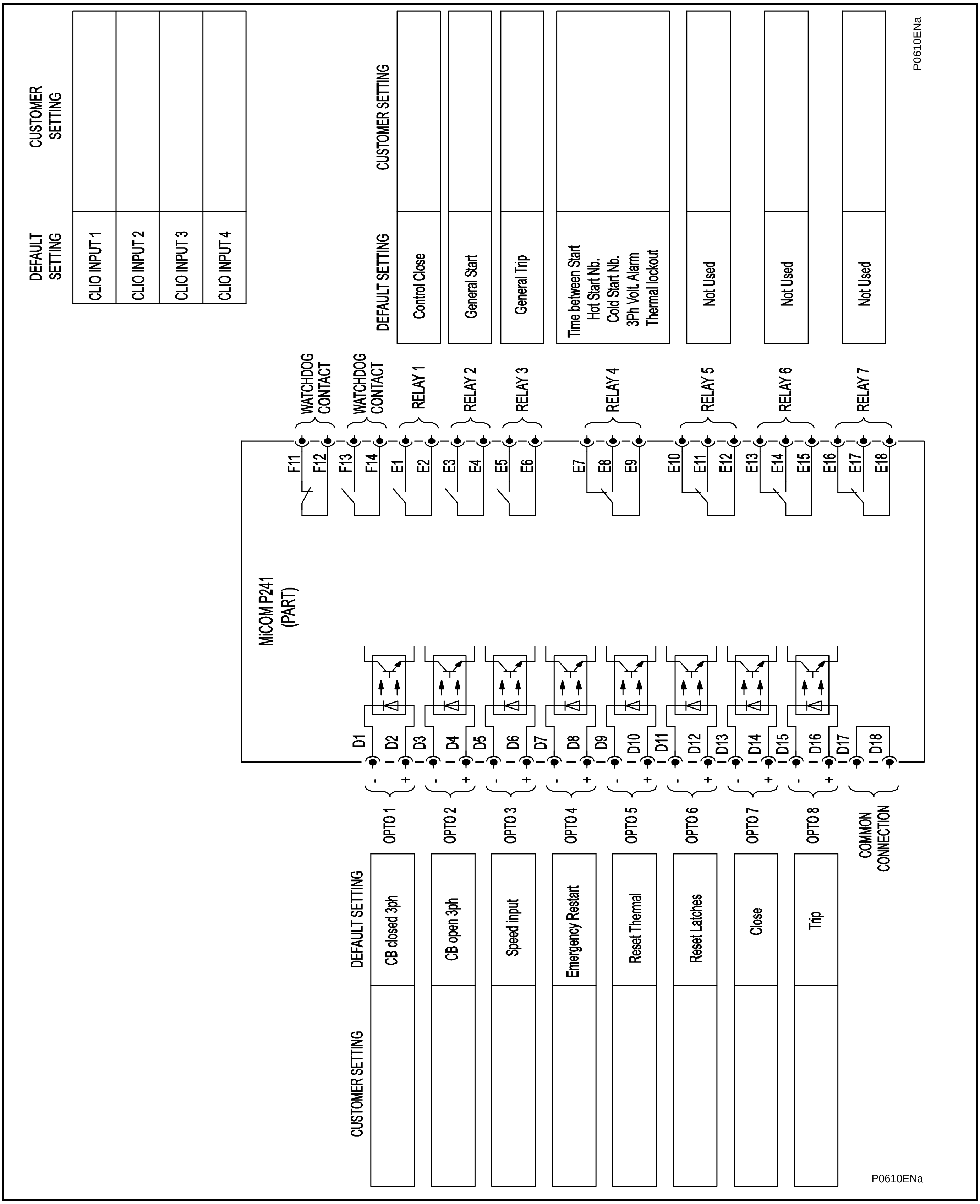

Figure 13 - P241 external connections – CLIO option

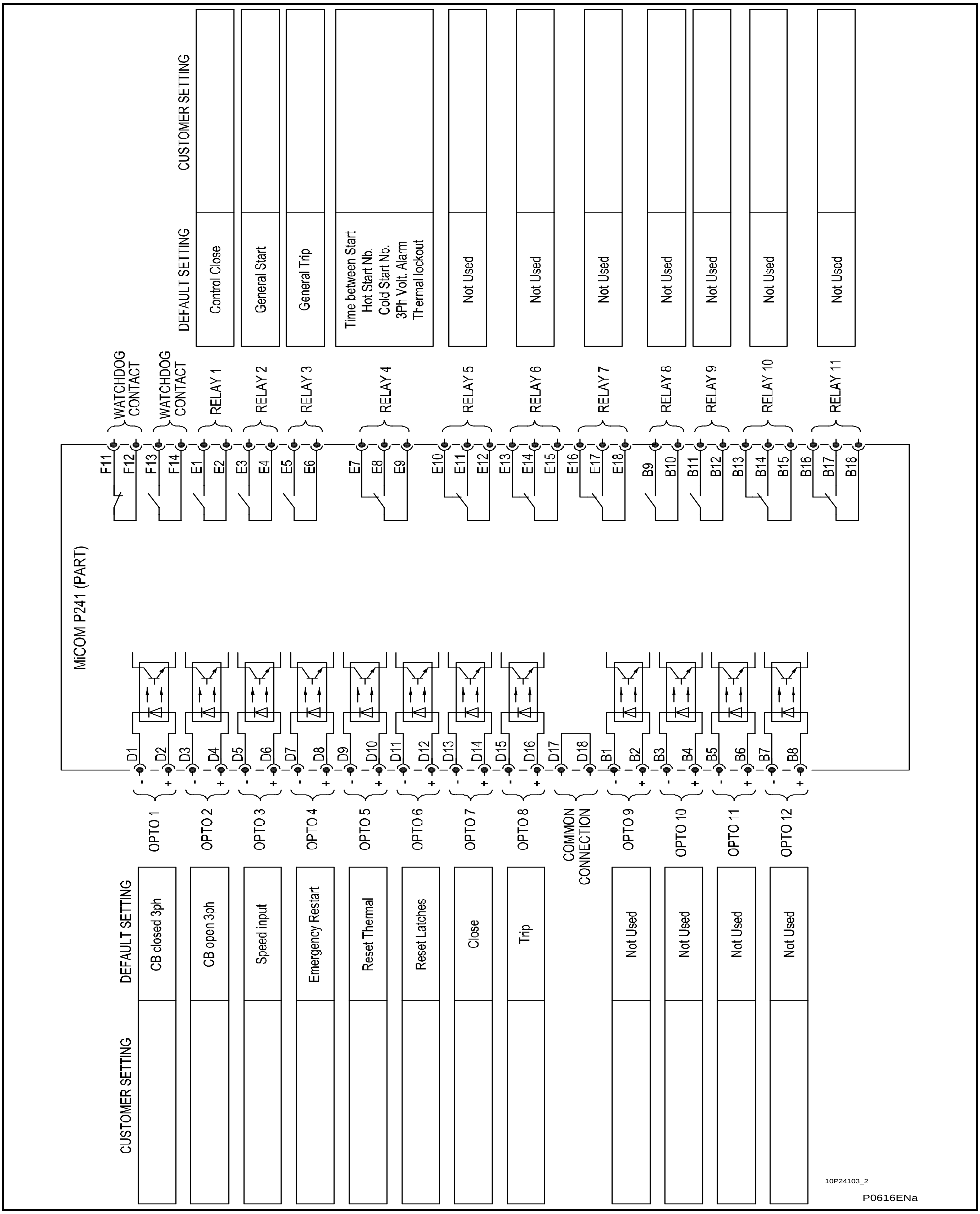

Figure 14 - P241 external connections (40TE) - 12 Inputs + 11 Outputs board

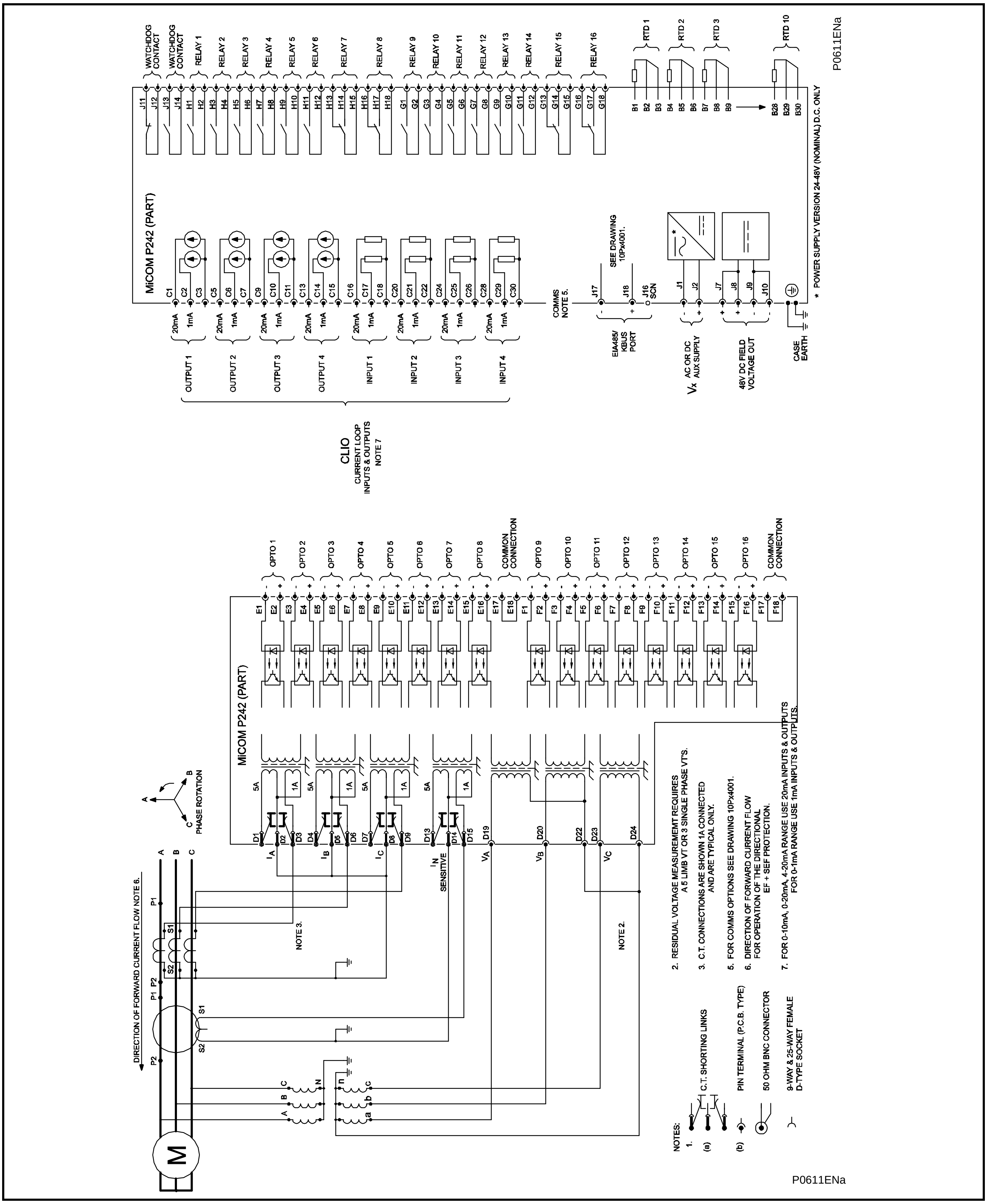

Figure 15 - P242 external connections– 3VTs connection + RTD + CLIO options

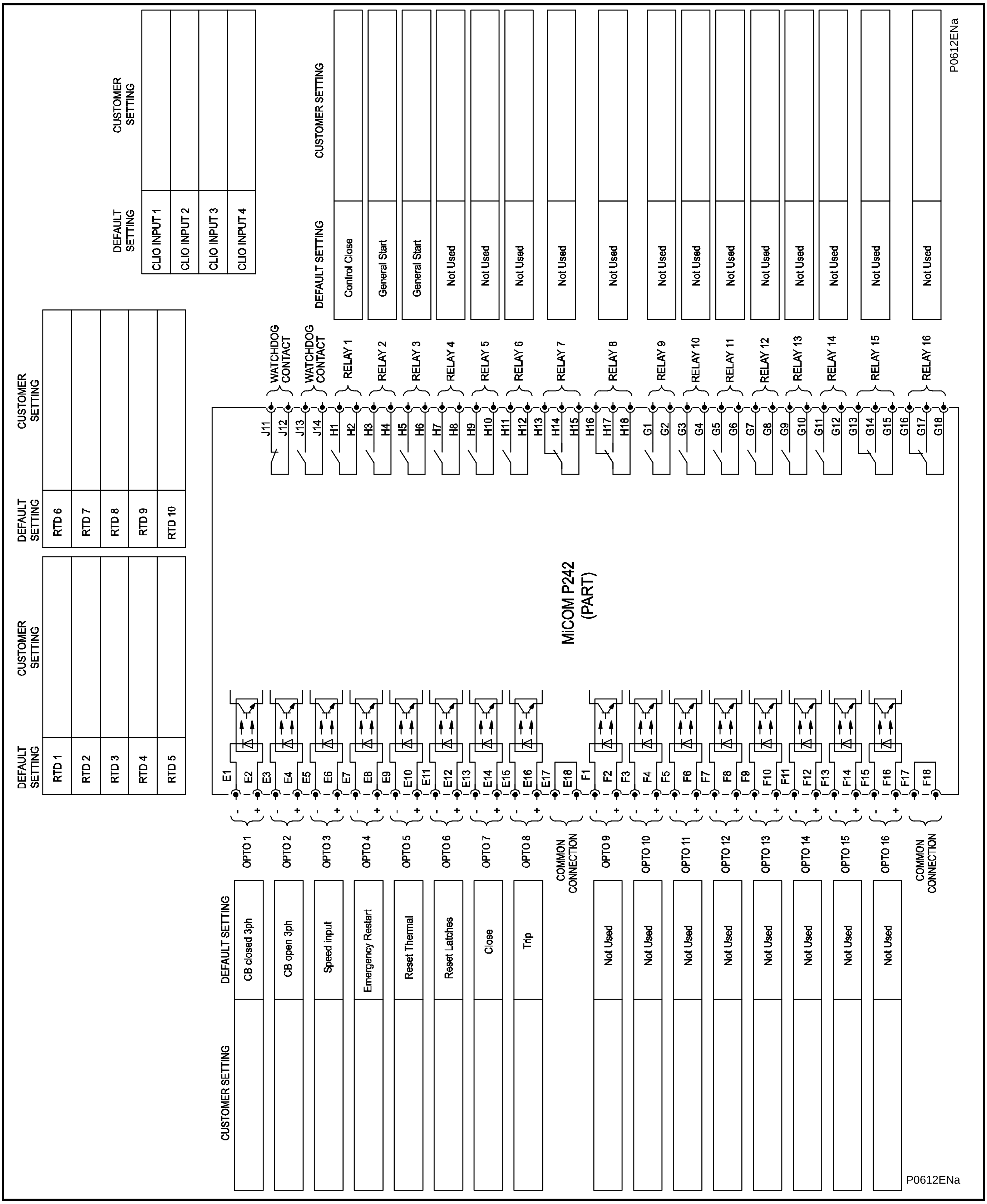

Figure 16 - P242 external connections– 3VTs connection + RTD + CLIO options

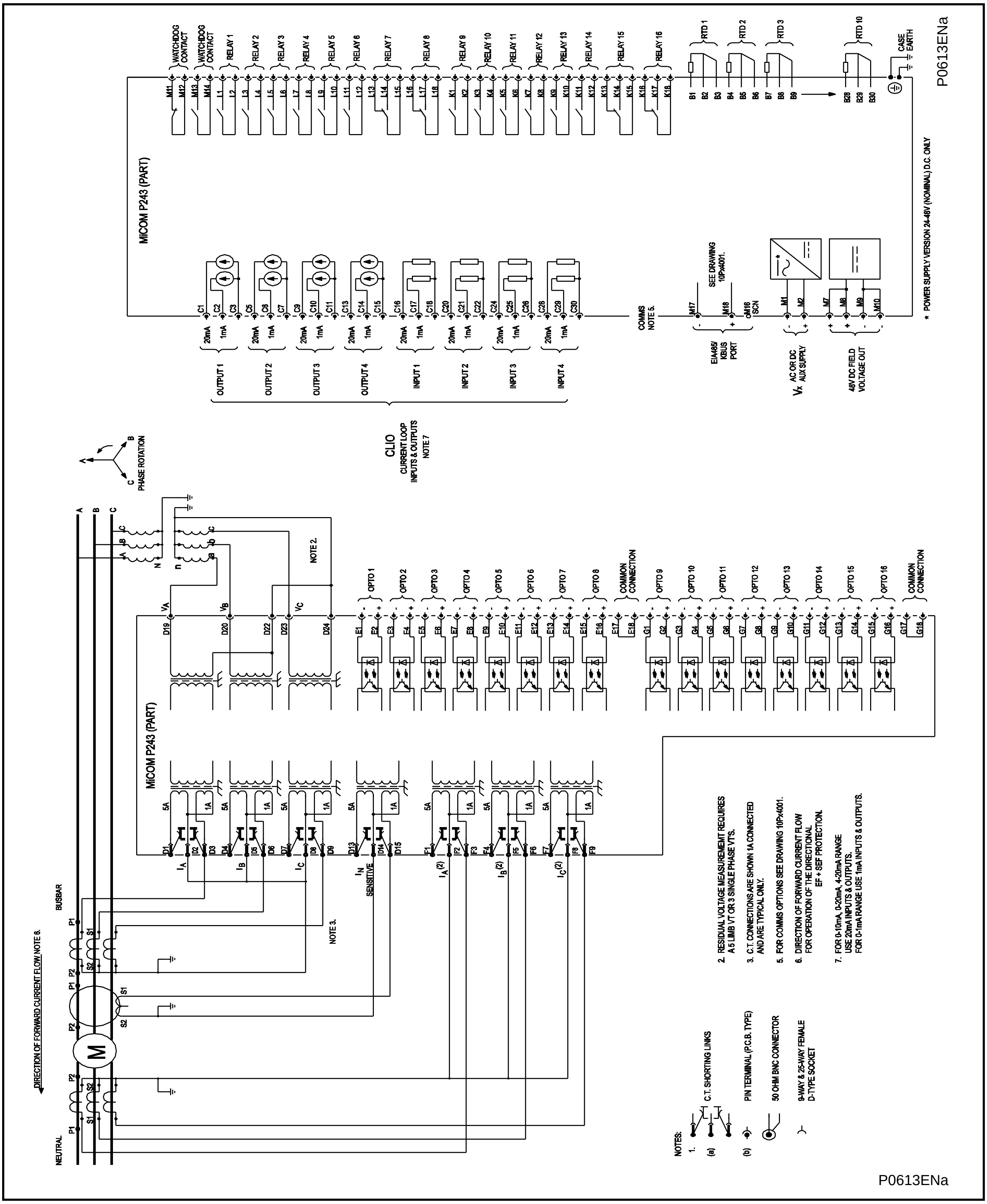

Figure 17 - P243 external connections– 3VTs connection + RTD + CLIO options – biased differential [87M]

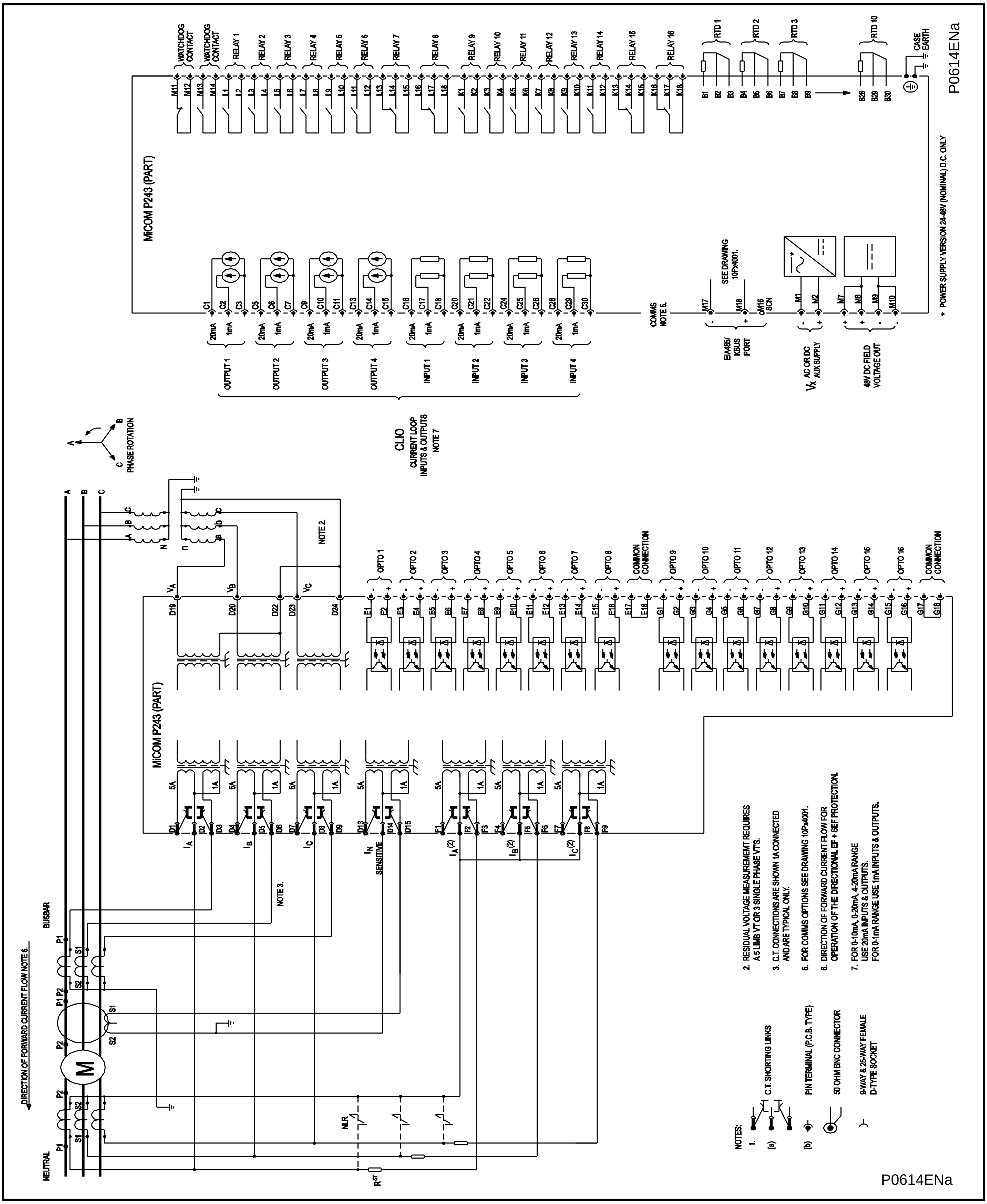

Figure 18 - P243 external connections – 3VTs connection + RTD + CLIO – high impedance differential [87M]

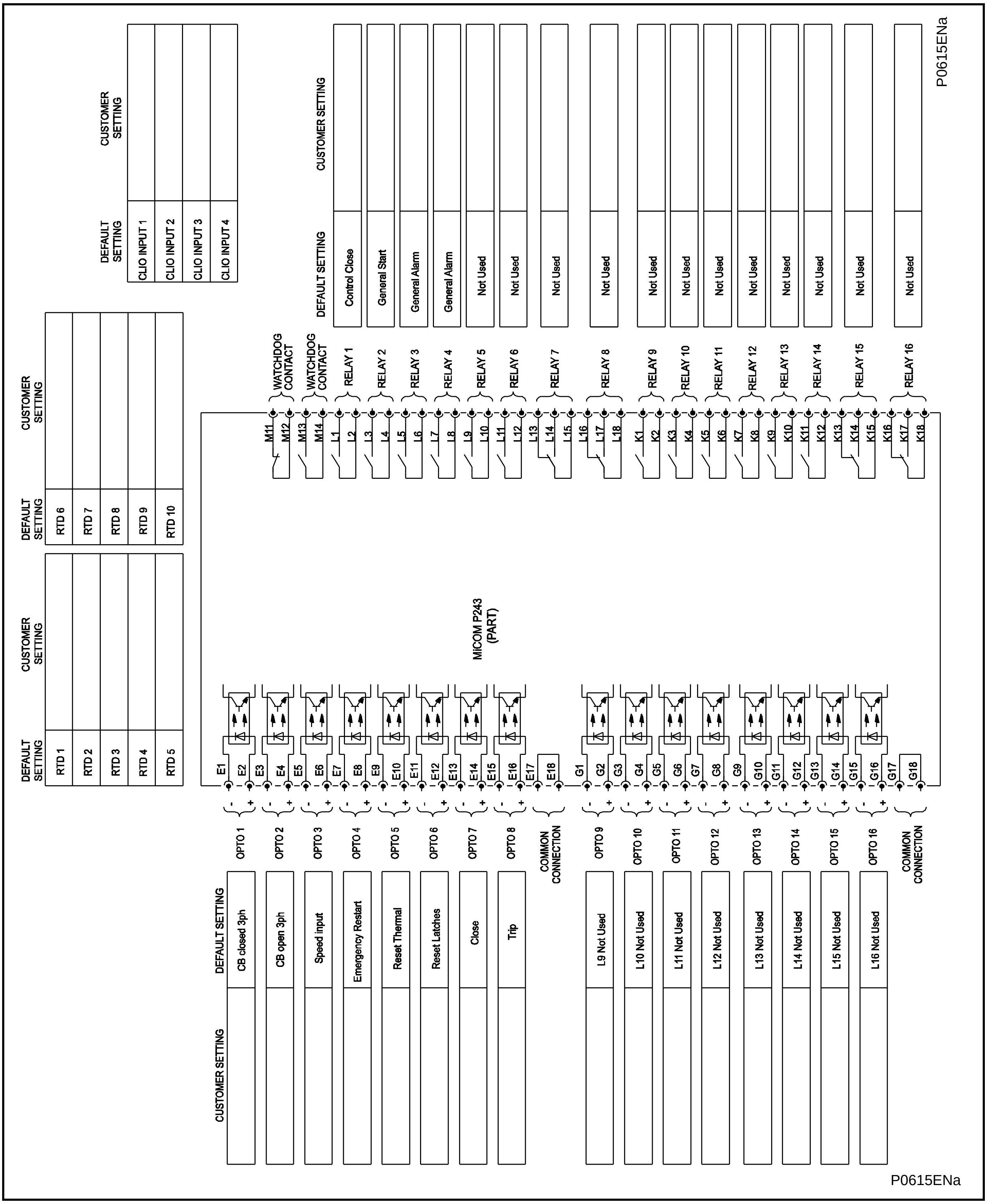

Figure 19 - P243 external connections – 3VTs connection + RTD + CLIO options

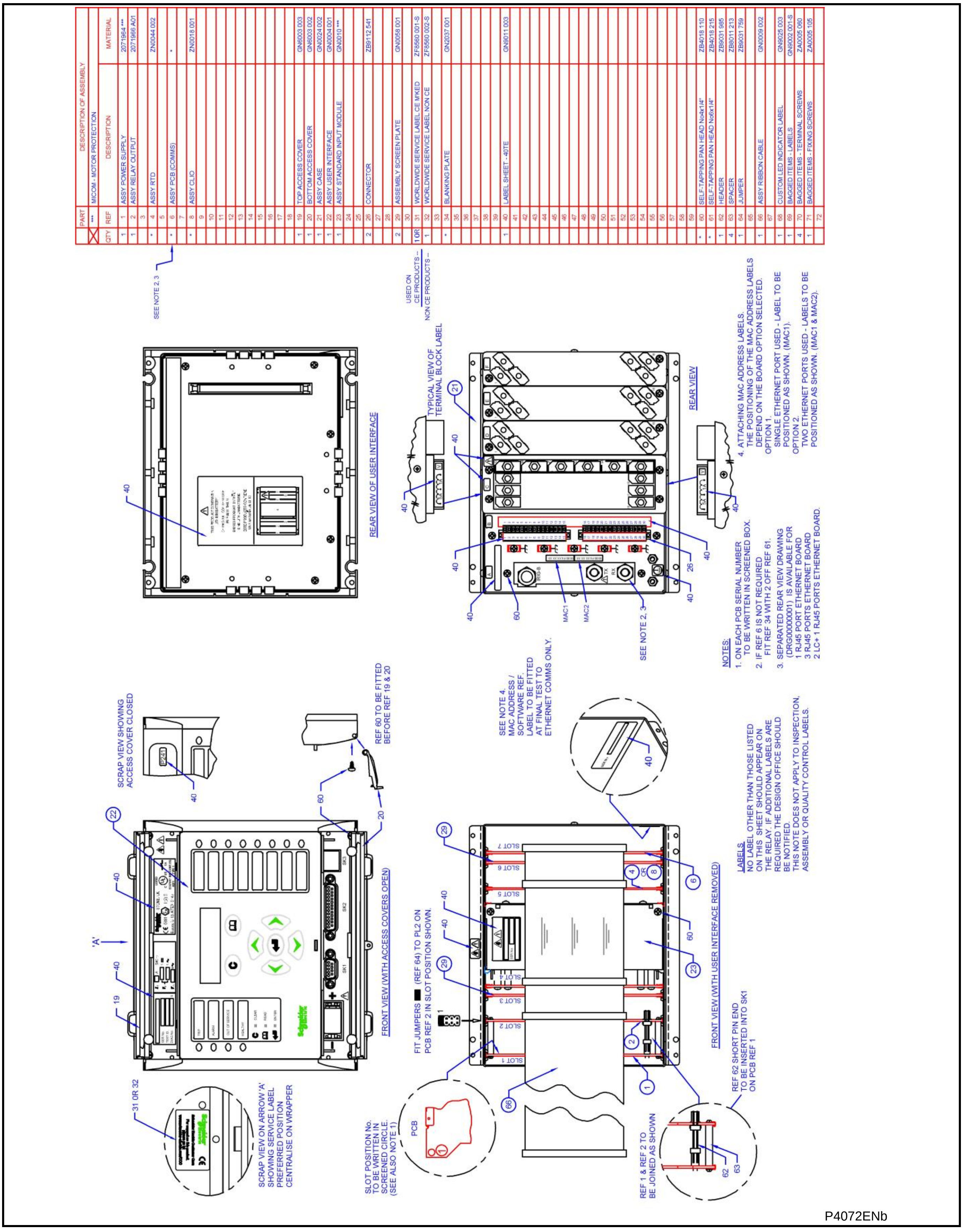

Figure 20 - Assembly P241 motor protection relay (40TE) (8 I/P & 7 O/P with optional RTD & CLIO)

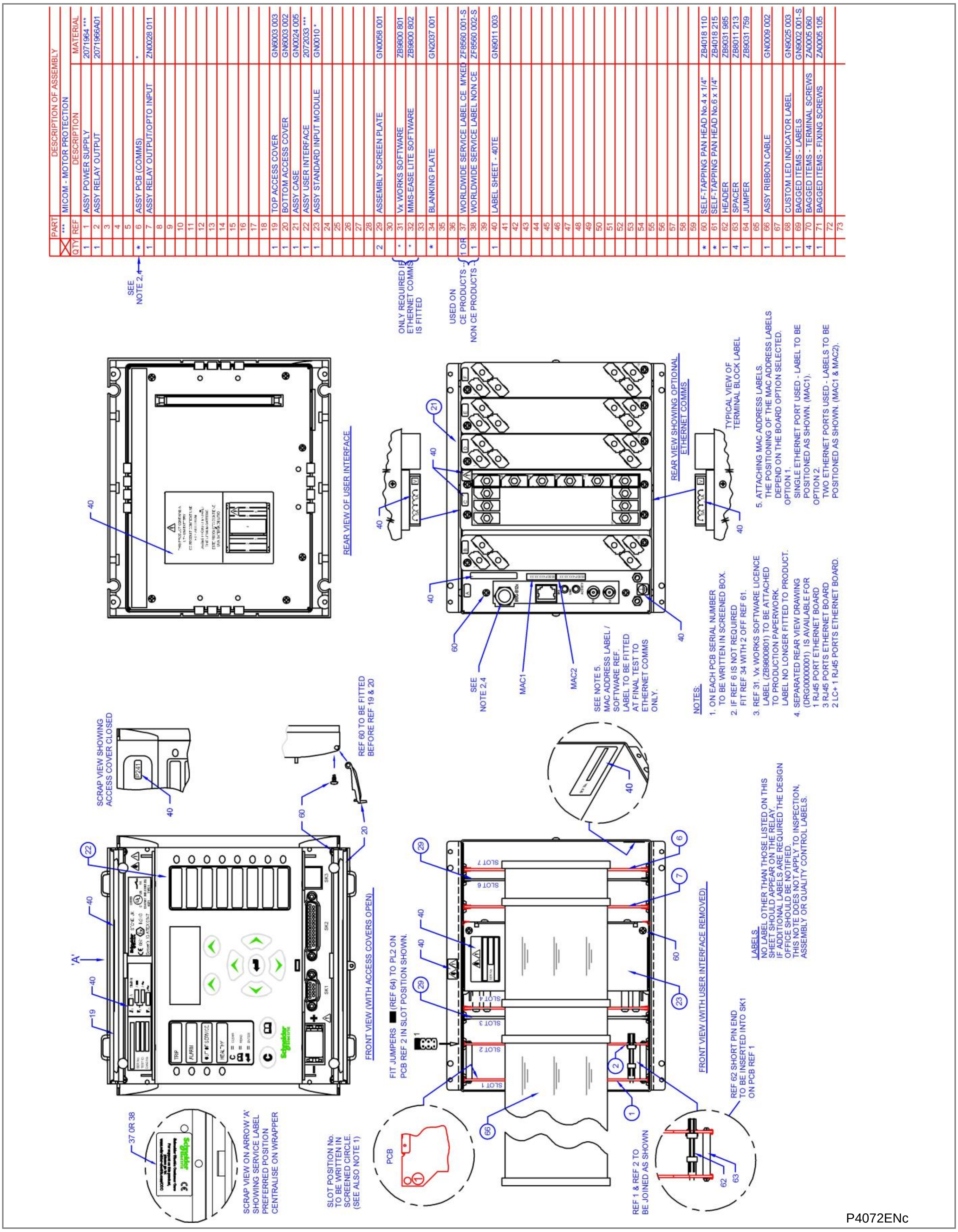

Figure 21 - Assembly drawing for P241 with optional 12 I/P and 11 O/P

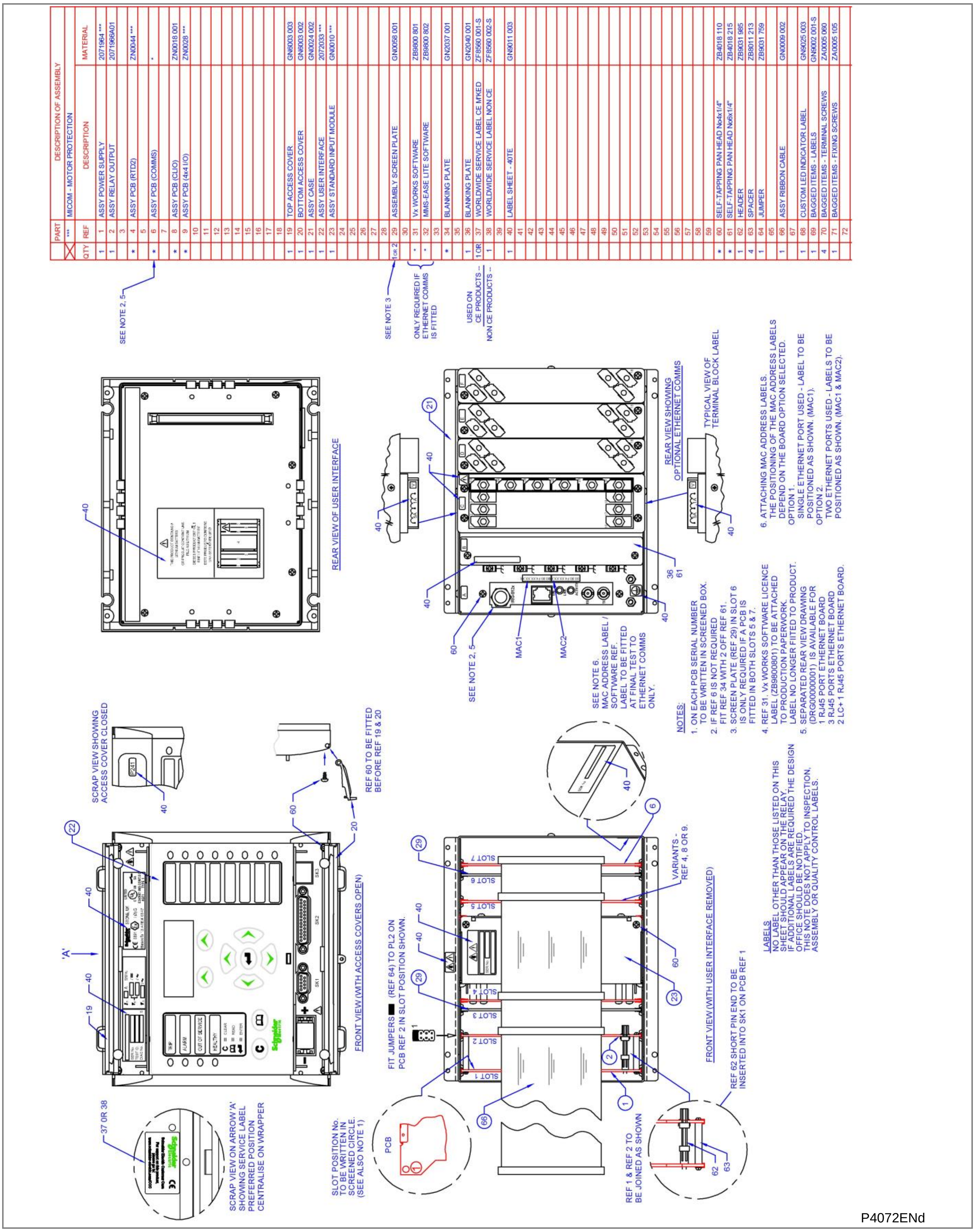

Figure 22 - Assembly drawing for P241 with optional IEC 61850 (40 TE)

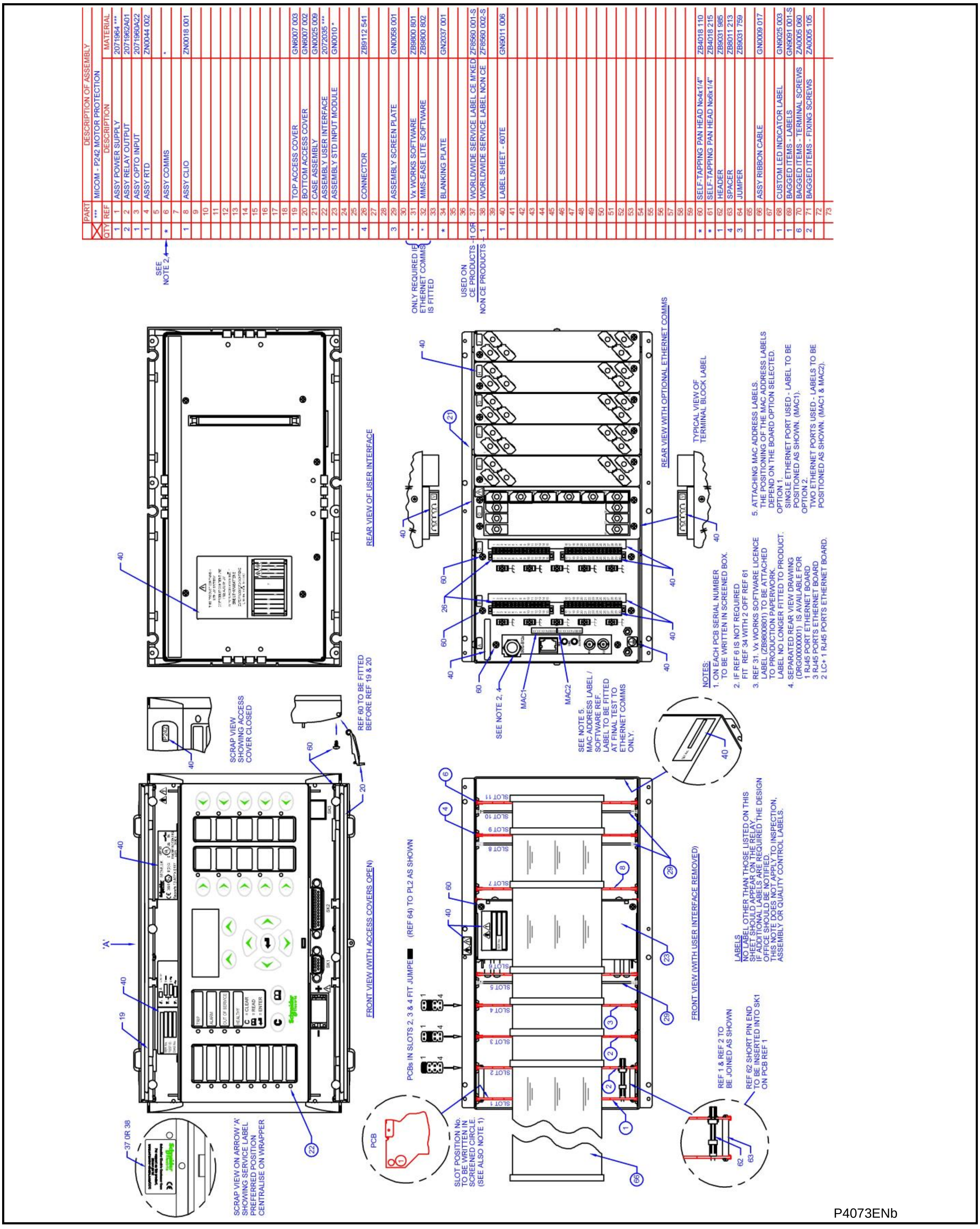

Figure 23 - Assembly P242 motor protection relay (60TE) (16 I/P & 16 O/P with optional RTD & CLIO)

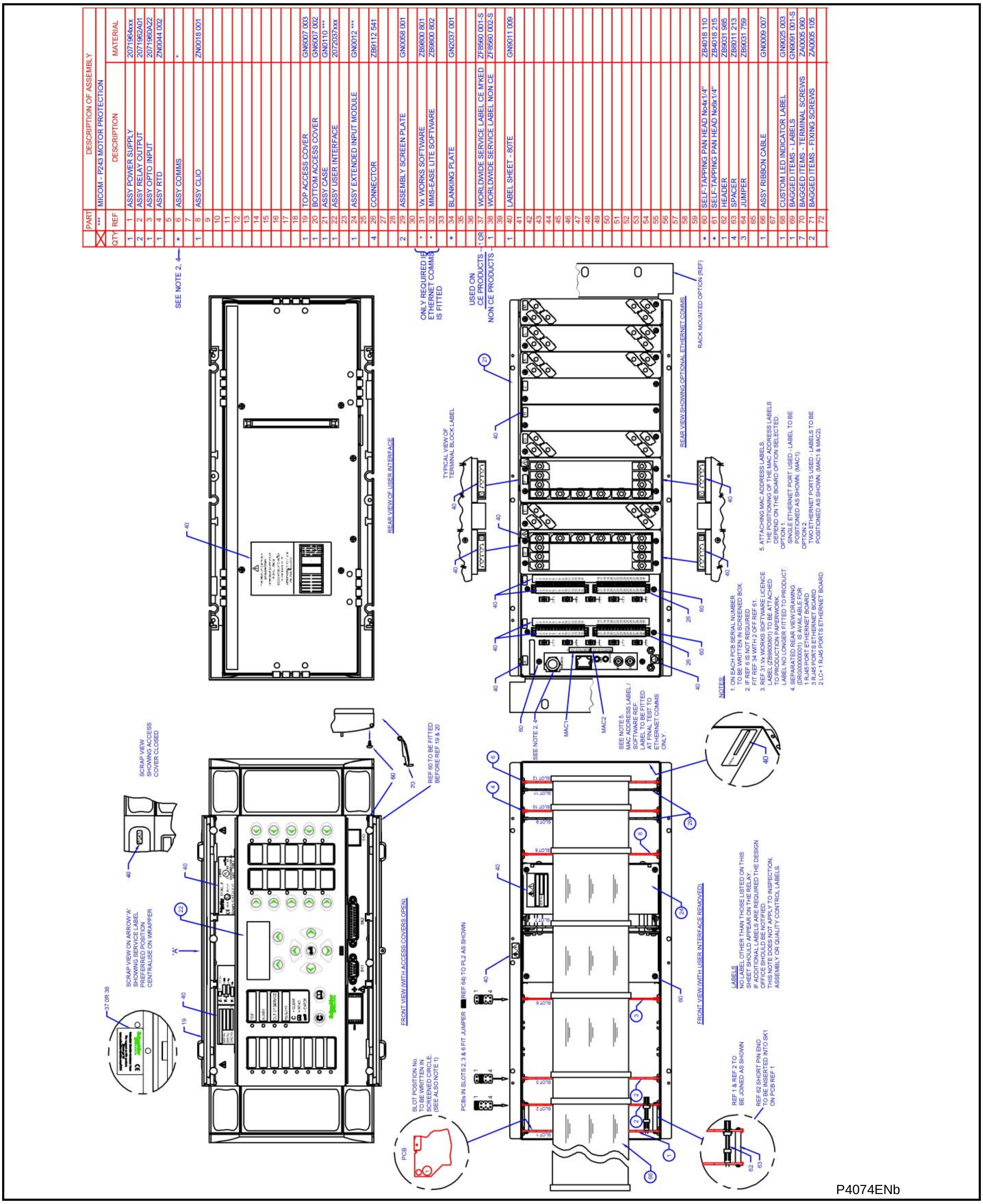

Figure 24 - Assembly P243 motor protection relay (80TE) (16 I/P & 16 O/P with optional RTD & CLIO

CYBER SECURITY

CHAPTER 18

Date (month/year):	01/2017			
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.			
Hardware Suffix:	P141/P142/P143 P145 P445 P44x (P442/P444) P44y (P443/P446)	L M L M M	P54x (P543/P544/P545/P546) P642 P643/P645 P746 P841A (one circuit breaker) P841B (two circuit breakers) P849	M L M M M M M
Software Version:	P14x (P141/P142/P143/P145) P445 P44x (P442/P444) P44y (P443/P446)	B2 J4/J6 E1 H4	P54x (P543/P544/P545/P546) P64x (P642/P643/P645) P746 P841A (one circuit breaker) P841B (two circuit breakers) P849	H4 B2 B3/C3 G4 H4 B1
Connection Diagrams:	P14x (P141, P142, P143 & P145): 10P141xx (xx = 01 to 02) 10P142xx (xx = 01 to 05) 10P143xx (xx = 01 to 11) 10P145xx (xx = 01 to 11) P445: 10P445xx (xx = 01 to 04) P44x (P442 & P444): 10P44101 (SH 1 & 2) 10P44201 (SH 1 & 2) 10P44202 (SH 1) 10P44203 (SH 1 & 2) 10P44401 (SH 1) 10P44402 (SH 1) 10P44403 (SH 1 & 2) 10P44404 (SH 1) 10P44405 (SH 1) 10P44407 (SH 1 & 2) P44y (P443 & P446): 10P44303 (SH 01 and 03) 10P44304 (SH 01 and 03) 10P44305 (SH 01 and 03) 10P44306 (SH 01 and 03) 10P44600 10P44601 (SH 1 to 2) 10P44602 (SH 1 to 2) 10P44603 (SH 1 to 2)		P54x (P543, P544, P545 & P546): 10P54302 (SH 1 to 2) 10P54303 (SH 1 to 2) 10P54400 10P54404 (SH 1 to 2) 10P54405 (SH 1 to 2) 10P54502 (SH 1 to 2) 10P54503 (SH 1 to 2) 10P54600 10P54604 (SH 1 to 2) 10P54605 (SH 1 to 2) 10P54606 (SH 1 to 2) P64x (P642, P643 & P645): 10P642xx (xx = 1 to 10) 10P643xx (xx = 1 to 6) 10P645xx (xx = 1 to 9) P746: 10P746xx (xx = 00 to 21) P841: 10P84100 10P84101 (SH 1 to 2) 10P84102 (SH 1 to 2) 10P84103 (SH 1 to 2) 10P84104 (SH 1 to 2) 10P84105 (SH 1 to 2) P849: 10P849xx (xx = 01 to 06)	
	Note *This chapter covers the combinations of Products, Software Versions and Hardware Suffixes identified here. If you are using earlier software or hardware, please refer to the Schneider Electric Customer Care Centre (www.schneider-electric.com/ccc) for details of which version of this chapter to refer to.*			

CONTENTS

TABLES

FIGURES

1 OVERVIEW

1.1 Definition

Cyber security is a domain that addresses attacks on or by computer systems and through computer networks that can result in accidental or intentional disruptions. Cyber security addresses not only deliberate attacks, such as from disgruntled employees, industrial espionage, and terrorists, but also inadvertent compromises of the information infrastructure due to user errors, equipment failures, and natural disasters.

1.2 Introduction to Cyber Security

The objective of cyber security is to provide increased levels of protection for information and physical assets from theft, corruption, misuse, or accidents while maintaining access for their intended users.

To achieve this objective the owner of the grid must take into account Cyber Security at every level of his organization by the management of an ongoing process that encompasses procedures, policies, technical (software, and hardware asset) and regulatory constraints.

The following diagram outlines some of the associated topics.

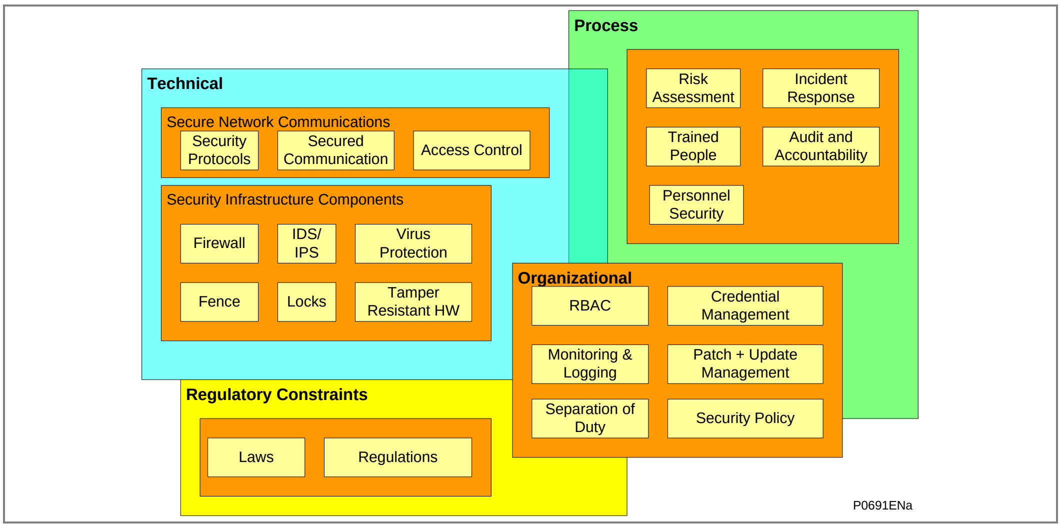

Figure 1 – Associated topics

The asset owner needs to run a continuous improvement process as outlined here:

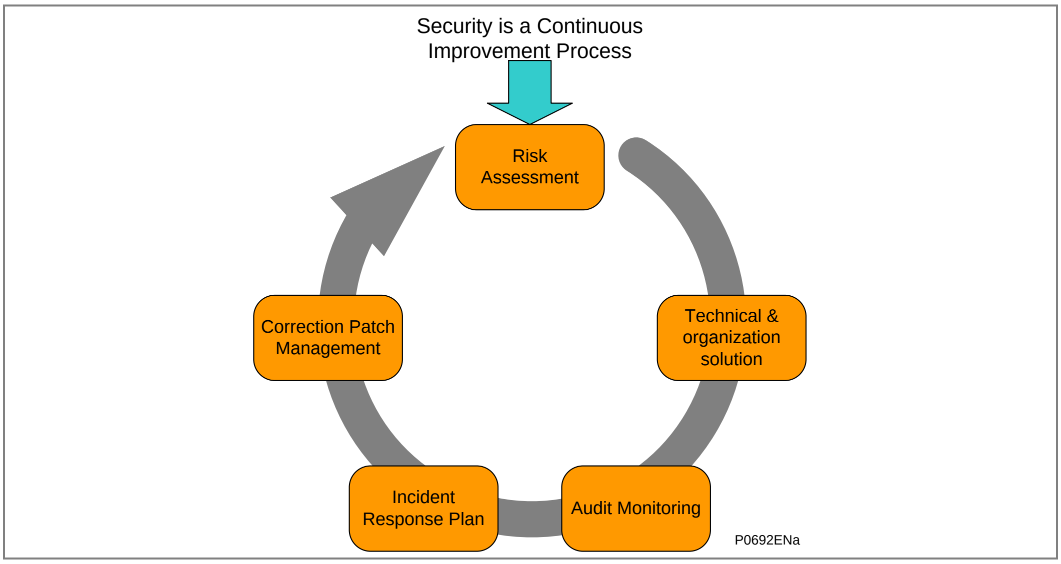

Figure 2 – Continuous improvement process

No single solution can provide adequate protection against all cyber attacks on the control network. Schneider Electric recommends employing a “defense in depth” approach using multiple security techniques to help mitigate risk.

A secured system is to offer:

- Detective controls: Monitor and record specific types of events: Security logs, Intrusion, detection systems, Video Surveillance etc.
- Preventive controls: Help blocking or controlling specific event : Antivirus, White listing, Firewall etc.
- Recovery controls: Help achieve Business continuity and Disaster recovery planning objectives in case of an incident: Backup and Restore solution.

As protective relay vendor, Schneider Electric helps the grid owner to achieve by providing technical features inside the IED, described in the next chapters.

Important	**This product contains a cyber-security function, which manages the encryption of the data exchanged through some of the communication channels. The aim is to protect the data (configuration and process data) from any corruption, malice, attack. Subsequently, this product might be subject to control from customs authorities. It might be necessary to request special authorization from these customs authorities before any export/import operation. For any technical question relating to the characteristics of this encryption please contact your Customer Care Centre - www.schneider-electric.com/ccc.**

1.3 Roles, Rights and relationship between IEC62351 and MiCOM Px4x

1.3.1 Role Based Access Control (RBAC)

The Role Based Access Control (RBAC) is a method to restrict resource access to authorized users. RBAC is an alternative to traditional Mandatory Access Control (MAC) and Discretionary Access Control (DAC).

A key feature of RBAC model is that all access is through roles. A role is essentially a collection of permissions, and all users receive permissions only through the roles to which they are assigned, or through roles they inherit through the role hierarchy.

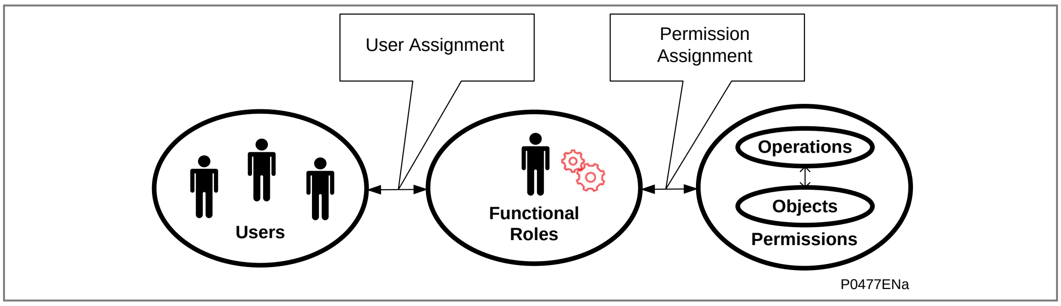

Figure 3 - RBAC Role structure

Roles are created for various job activities. The ***Permissions***, to perform certain operations, are assigned to specific roles. ***Users*** are assigned particular roles, and through those role assignments acquire the computer permissions to perform particular computer-system functions. Since ***users*** are not assigned permissions directly, but only acquire them through their role (or roles), management of individual user rights becomes a matter of simply assigning appropriate roles to the user's account; this simplifies common operations, such as adding a user, or changing user's account.

RBAC defines four different concepts:

RBAC Standard Definition	Description
Object	An ***object*** can represent information containers (e.g. files, directories in an operating system, tables and views in a database management system) or device resources, such as IEDs.
Subject	A ***subject*** is a user of the system. Note that a subject can be a person, or an automated agent / device.
Right	A ***right*** is the ability to access an object in order to perform certain operations (e.g. setting a data or reading a file)
Role	A ***role*** defines a certain authority level in the system. Rights are assigned to roles.

Table 1 – RBAC object, subject, rights and roles definitions

RBAC defines three primary rules:

RBAC Rule	Description
Role assignment	A subject can exercise a permission only if the subject has selected or been assigned a role.
Role authorization	A subject's active role must be authorized for the subject. With rule 1 above, this rule ensures that users can take on only roles for which they are authorized.
Permission authorization	A subject can exercise permission only if the permission is authorized for the subject's active role. With rules 1 and 2, this rule ensures that users can exercise only permissions for which they are authorized.

Table 2 – RBAC permission and authorization rules

1.3.2 User Roles

Different named roles are associated with different access rights. Roles and Rights are setup in a pre-defined arrangement, according to the IEC62351 standard, but customized to the MiCOM Px4x equipment.

When the user tries to access an IED, they need to login using their own username and their own password. The username/password combination is then checked against the records stored on the IED. If they are allowed to login, a message appears which shows them what Role they have been assigned to. It is the role that defines their access to the relevant parts of the system.

The default user roles for MiCOM Px4x are shown here:

Role	Description
VIEWER	Can View what objects are present within a Logical-Device by presenting the type ID of those objects.
OPERATOR	An Operator can view what objects and values are present within a Logical-Device by presenting the type ID of those objects as well as perform control actions.
ENGINEER	An Engineer can view what objects and values are present within a Logical-Device by presenting the type ID of those objects. Moreover, an engineer has full access to Datasets and Files and can configure the server locally or remotely.
SECADM	Security Administrator can change subject-to-role assignments (outside the device) and role-to-right assignment (inside the device) and security policy setting; change security setting such as certificates for subject authentication and access token verification.
SECAUD	Security Auditor can view audit logs

Table 3 – Default user roles summary for MiCOM Px4x

Each authorized user must be placed into at least ONE of these roles that most suits their job description. It is possible to assign a user into a different role; and/or to change the rights associated with a particular role. This means that the administrator can change the access rights for one role; and this will affect ALL the users who are assigned to that role.

It is possible for MiCOM Px4x to create the customized user roles.

1.3.3 Rights

In a similar way in which a set of pre-defined Roles have been created, a pre-defined set of Rights have been created.

These Rights give different permissions to look at what devices may be present, what those devices may contain, manage data within those devices (directly or by using files) and configure rights for other people.

A list of the pre-defined Rights for IEC 62351-8 is given here:

Right	Description
VIEW	Allows the subject/role to discover what objects are present within a Logical-Device by presenting the type ID of those objects. If this right is not granted to a subject/role, the Logical-Device for which the View right has not been granted shall not appear
READ	Allows the subject/role to obtain all or some of the values in addition to the type and ID of objects that are present within a Logical-Device;
DATASET	Allows the subject/role to have full management rights for both permanent and non-permanent Datasets;
REPORTING	Allows a subject/role to use buffered reporting as well as un-buffered reporting;
FILEREAD	Allows the subject/role to have read rights for file objects;
FILEWRITE	Allows the subject/role to have write rights for file objects. This right includes the FILEREAD right
CONTROL	Allows a subject to perform control operations;
CONFIG	Allows a subject to locally or remotely configure certain aspects of the server;
SETTINGGROUP	Allows a subject to remotely configure Settings Groups;
FILEMNGT	Allows the role to transfer files to the Logical-Device, as well as delete existing files on the Logical-Device;
SECURITY	Allows a subject/role to perform security functions at both a Server/Service Access Point and Logical-Device basis. To add Information about the concept of Rights.

Table 4 – Pre-defined rights for IEC 62351-8

The specific Rights for MiCOM Px4x are listed below. These are dependent on the IED data type. Please refer to each product MD file (Menu Database) for the IED data type.

Rights	Authorized Actions to IED	IED_DESC	IED_DATA	DISPLAY	IED_CONFIG	PROT_CONFIG	IEC_COMMAND	AUDIT	IED_FN_KEY	IED_CLEAR
Read Only (SAT default_access_right)	Read	x	x	x	x		x			
	Write	x								
IED Configuration (SAT configuration_right)	Read/write/upload/download				x					
HMI Display Settings (SAT display_action_right)	Read/write/select			x						
Protection Configuration (SAT protection_configuration_right)	Read/write					x				
IED Commands (SAT control_right)	Read/write/clear/reset/select						x			
Reading of Records & Events (SAT audit_read_right)	Read/select/upload							x		
Extraction of Records and Events (SAT audit_write_right)	Send/accept							x		
IED Function Key (SAT fn_key_access_right)	Write								x	
IED Records Clear (SAT clear_right)	Read/write/clear									x

Table 5 – Specific rights for MiCOM Px4x

1.3.4 Roles and their Access Rights

A complete list of the Roles and their access Rights is shown in this table:

Rights \ Roles		VIEWER	OPERATOR	ENGINEER	SECADM	SECAUD
Pre-defined Rights for IEC 62351	VIEW	X	X	X	X	X
	READ		X	X	X	X
	DATASET			X		
	REPORTING	X	X	X		X
	FILEREAD					X
	FILEWRITE			X	X	
	FILEMNGT			X	X	
	CONTROL		X		X	
	CONFIG			X	X	
	SETTINGGROUP				X	
	LOGS				X	X
	SECURITY				X	
Specific Rights for MiCOM Px4x	Read Only	X	X	X		X
	IED Configuration			X		
	HMI Display Settings		X	X		
	Protection Configuration			X		
	IED Commands		X	X		
	Reading of Records and Events	X	X	X		X
	Extraction of Records and Events		X	X		X
	IED Function Key		X	X		
	IED Clear			X		

Table 6 – Pre-defined roles (and rights) for IEC 62351-8 and MiCOM Px4x

Important	**The reason why these are described as Default, is that it is possible to change the definitions of Roles and Rights, using the full version of the SAT software. Depending on the work done by the system administrator, it is possible that your own situation may vary from these initial recommendations.**

1.4 Security Administration Tool (SAT) Software

Important	**This can only be used with Px4x relays with cyber security CSL1 features.**

Important	**For Dual Ethernet cards the SAT functionality is available from communication interface 1. The connection to the SAT would be available from interface 2 only when interface 1 is disconnected from the network.**

The Security Administration Tool (SAT) is the security configuration tool of MiCOM Px4x equipment. It allows the security administrator to define the security policy to the IEDs.

The Security Administrator manages RBAC and security policies data. Security Administrator defines needs to protect devices in accordance with user privileges. Thus, the system security can be configured easily and precisely.

The SAT is used by the Security Administrator to manage the system's security database and deploys security configurations to IED(s).

The SAT allows to Manage User Accounts, Roles, Permission, Elements to Secure (ETS) and Security Server parameters without connection with devices. Information is store on the MS SQL database. This is the Offline mode. SAT allows devices management connected on network. This is the online mode.

The Role Based Access Control (RBAC) is a method to restrict resource access to authorized users. Please refer to this documentation on section "*System RBAC Management*" for more details.

The following table contains the main user main functions of the SAT:

Category	User Function	Note
Offline General Administration	User Accounts Management	User Account Functions: * Creation * Edition * Suppress * Viewing * Sorting * Filtering
	Server Configuration	
	Users Accounts & Roles association Management	Associate a role to the user account
Offline Advanced Administration	Roles Management	Roles Functions: * Creation * Edition * Suppress * Viewing * Sorting
	Element To Secure (ETS) Management	Define ETS which are in fact the PACiS assets present in the project (C264, PACiS Gateway, ECOSUI, IED and SAM). Add, Suppress and Sort permissions associated with the ETS.
	Global Security Management	The Global Security allows scope(s) and associate or disassociate role(s) management for each user account. The security administrator manages the current scope by the Roles: * View Roles List, User Account List and associations User-Roles or Role-Users * Associate / dissociate role(s) for each User Account * Add / Suppress User account(s) for each Role
	Permission access	Define parameters: * Password validity * Inactivity period * Automatic logout period * Maximum attempts of login and lockout period
Communication	Refresh IED list	
	Display IED Logs	
	Display SAM Logs	
	Push RBAC and Security Policies	Send Security Configuration to all Devices integrating Security features.

Table 7 – Main SAT user functions

The details of how to use the SAT are provided in the SAT documentation:

SAT (Security Administration Tool) Documentation - User Guide

This is available from the Schneider Electric website: www.schneider-electric.com.

2 MICOM PX4X CYBER SECURITY IMPLEMENTATION

Schneider Electric MiCOM Px4x IEDs have always been and will continue to be equipped with state-of-the-art security measures. Due to the ever-evolving communication technology and new threats to security, this requirement is not static. Hardware and software security measures are continuously being developed and implemented to mitigate the associated threats and risks.

Considered some users may not want to use the cyber security, Schneider Electric offers MiCOM Px4x relays with CSL0 and CSL1 as below:

CSL0: Simple password management, No SAT required.

CSL1: Advanced cyber security, SAT required.

This depends on the model number, as CSL1 is depend on the Ethernet communication. Hence if the IED if supports only legacy protocol this will be CLS0 default as. The digit position number 9 (protocol options) in the Cortec / model number is used to distinguish it.

Protocol Option Number	Protocol options	Cyber Security options
1	K-Bus/Courier	CSL0
2	Modbus	CSL0
3	IEC 60870 -5 - 103	CSL0
4	DNP3.0	CSL0
6	IEC 61850 Edition 1 / 2 and Courier via rear K-Bus/RS485	CSL0
7	IEC 61850 Edition 1 / 2 and CS103 via rear port RS485	CSL0
B	IEC 61850 Edition 1 / 2 and DNP3oE and DNP Serial	CSL0
G	IEC 61850 Edition 1 / 2 and Courier via rear K-Bus/RS485	CSL1
H	IEC 61850 Edition 1 / 2 and CS103 via rear port RS485	CSL1
L	IEC 61850 Edition 1 / 2 and DNP3oE and DNP3 serial	CSL1

Table 8 – MiCOM Px4x protocol options for cyber security options

2.1 MiCOM Px4x with CSL1 - Advanced Cyber Security

For MiCOM Px4x IEDs which support CSL1, this means the IED supports advanced user account right management. Moreover, the IED supports security logs/events and secure administration capability.
If you want to use cyber security, you need to order the IED that supports CSL1. In this case, the Security Administration Tool (SAT) is required for RBAC configuration.
At the IED level, these cyber security features have been implemented:

- Passwords management (via the SAT)
- RBAC Management (via the SAT)
- User Locking
- Inactivity Timer
- RBAC recovery
- Port Disablement (via S1 Studio or the front panel)
- Simple Network Management Protocol (SNMP)
- Security Logs

2.1.1 Password Management (via the SAT)

For the IED if CSL1 supported, there are two types of password possible for the IED access: alphanumeric password or Arrow Key password.

The alphanumeric password is only settable via the SAT:

- Passwords may be any length between 1 and 32 characters long
- Passwords may contain any ASCII character in the range ASCII code 33 (21 Hex) to ASCII code 122 (7A Hex) inclusive
- Passwords may or may not be NERC/IEEE 1686 compliant
- The alphanumeric password will used for courier client access

For more details about NERC/IEEE 1686 password compliant, please check the standard.

The Arrow Key password is only settable via the SAT:

- The Arrow Key password is a combination of the four arrow keys on the front panel
- The Arrow Key password may be any length between 1 and 8 of arrow keys long
- The Arrow Key password can only used in the front panel
- The user also can disable the Arrow Key password by not setting it

Important	**If the Arrow Key password is not configured, the alphanumeric password will be used for the front panel access. In this case, alphanumeric passwords longer than 16 characters are not allowed.** **MiCOM S1 Studio and the front panel are not allowed to change the password.**

2.1.2 RBAC Management (via the SAT)

By default, the IED includes a factory RBAC which has three users, and for each user, the Rights depend on the user Role. Please refer to the *Roles and their Access Rights* section for more details.

Username	Role	Default password
SecurityAdmin	SECADM	AAAAAAAA
EngineerLevel	ENGINEER	AAAA
OperatorLevel	OPERATOR	AAAA

Table 9 – Factory RBAC

A Local Default Access function also available for the default RBAC, with the VIEWER role, which allows everyone login the IED in the front panel with VIEWER role. For more details about the Local Default Access function, please refer to the *Local Default Access* section.

For more information about how the SAT management the RBAC and cyber security policies, please see the *Security Administration Tool (SAT)* section.

2.1.3 User Locking

The user is locked out temporarily, after a defined number of failed password entry attempts.

Important	**If a user is locked out, the block is applied to that named user and to the all IED interfaces. The blocking of one user, does not apply blocks to others.** **If the user entry is blocked, recover the RBAC or push a new RBAC will not reset the blocked user entry, but IED reboot will reset the blocking time and attempts count, so the user entry will be unblocked.**

An invalid password entry will display a 'Login Failed PW Incorrect' message for 2s. It also reduces the Attempts Remaining Counter (Attempts Remain) by 1 and it remains at this level until the interface inactivity timer expires (CSL0 models) or until the Password Attempts Timer configured in SAT expires (CSL1 models) or another password entry is made. If Attempts Remain equals 1 then a '1 Attempt Left' warning will also be issued for 2s. When Attempts Remain equals 0 then a 'USER LOCKED OUT' warning is displayed for 2s and access for that user is blocked. If the Blocking Timer expires, or the correct password is entered before Attempts Remain reaches zero, then the Attempts Remain is reset to the Attempts Limit.

Once the user entry is blocked, the Blocking Timer is initiated. If the locked out user is selected whilst the Attempts Remain is zero a 'USER LOCKED OUT' error message is displayed.

2.1.4 Inactivity Timer

The MiCOM device runs an inactivity timer, which means that it records the last time an action was taken by a user who was logged in.

If the user does not perform an action within a pre-defined interval, the user will be logged off. This is to reduce the risk that a device can accidentally be left open to access by unauthorized people.

The inactivity timer is separate for each interface.

The inactivity timer is configurable by using the SAT.

Important	**In case of a connection through an Ethernet interface, the actual inactive time depends on the setting value of both "Minimum inactivity period" & "[0E A7] ETH Tunl Timeout", the smaller value of both timers will be applied.**

Refer to the Table 12 for more details about the settings.

2.1.5 RBAC Recovery

RBAC recovery is the means by which the device can be reset to the factory RBAC settings if required. To obtain the recovery password, the customer must go to www.schneider-electric.com/ccc to raise a recovery password request and supply the IED *Security Code*.

Caution	**The "recovery" password gives you access to the Factory RBAC Configuration. This action deletes all existing users (and their passwords), and restores to Factory RBAC Configuration. Recover the RBAC does not affect relay proper settings and does not provoke reboot of the relay - the protection functions of the relay are always maintained.**

2.1.5.1 Generate Security Code

The security code is a 16-character ASCII string. It is a read-only parameter. The IED generates its own random security code. This is when a new code is generated:

- On power up
- On expiry of validity timer (see below)
- When the recovery password is entered

As soon as the security code is ***first*** displayed on the LCD display, a validity timer is started. This validity timer is set to 120 hours and is not configurable. The validity timer is not reset if you request a subsequent code within the 120 hour period.

To prevent accidental reading of the IED security code the cell will initially display a warning message on the front panel of the IED:

```
PRESS ENTER TO
READ SEC. CODE
```

The security code will be displayed on confirmation, whereupon the validity timer will be started. Note that the security code can only be read from the front panel.

Important	**The recover password will be invalid once the new Security Code is generated, so please make sure the IED is always powered on before you get the reover password, and make sure you input the recover password within 120 hours.**

2.1.5.2 Entry of the Recovery Password

The "recovery" password is intended for recovery only. It is not a replacement password that can be used continually. It can only be used once – for password recovery.

Entry of the recovery password is done at the local front panel and it causes the IED to reset the RBAC back to default.

On this action, the following message is displayed on the front panel of the IED:

```
RBAC reset done
Press any key
```

2.1.6 Port Disabling (Equipment Hardening)

The availability of unused ports could provide a security risk. Hence, unused ports can be disabled (also known as equipment hardening) – either via the front panel or by MiCOM S1 Studio. An Engineer role is needed to perform this action.

These physical ports and logical ports can be enabled/disabled:

Port types	Menu text	Col	Row	Default Setting	Available Value
Physical Ports	Front port	25	05	Enable	Enable/Disable
	Rear Port 1	25	06	Enable	Enable/Disable
	Rear Port 2	25	07	Enable	Enable/Disable
	Ethernet Port 1	25	08	Enable	Enable/Disable
	Ethernet Port 1/2	25	09	Enable	Enable/Disable
	Ethernet Port 2/3	25	0A	Enable	Enable/Disable
	Ethernet Port 3	25	0B	Enable	Enable/Disable
Logical Ports	Courier Tunnel	25	0C	Enable	Enable/Disable
	IEC61850	25	0D	Enable	Enable/Disable
	DNP3oE	25	0E	Enable	Enable/Disable

Table 10 - Port hardening settings

Note	*The port disabling setting cells are not provided in the settings file. In addition, it is not possible to disable simultaneously more than one physical port or Logical port.* *New redundant Ethernet boards have three physical ports but total two interfaces. The actual disabled physical port is depended on the redundant communication mode (PRP, HSR or Dual IP). Refer to the Dual Redundant Ethernet Board (Upgrade) (DREB) chapter (Px4x/EN EB) for more details.*

When the Ethernet board related physical ports or logical ports are disabled or enabled, the Ethernet card will reboot. The status of the ports will be available after reboot of the Ethernet board.

For more details about how to disable/enable the unused ports, please see sections:

- How to Disable a Physical Port
- How to Disable a Logical Port

2.1.7 Simple Network Management Protocol (SNMP)

Simple Network Management Protocol (SNMP) allows security monitoring of events and alarms. Standard third-party SNMP client software can be used to access the log of these events and alarms. Access to the SNMP MIB is given on a read-only basis. For further details of gaining access to the MIB, please contact Schneider Electric.

2.1.8 Security Logs

The Security Logs needs to store logs from each item of equipment. These logs are generated by the system, and cannot be edited by the user. A variety of different items are recorded, including: bad/faulty access attempts, login attempts, authentication errors, changes to roles, users and access control lists, network backup and configuration changes, communication failures and so on.

Security logs emissions depend on the security standards that are configurable by the SAT.

The security logs will push to a Syslog server if the Syslog server IP address and Syslog server IP port are configured and connected.

SAT also can be used to explore the security logs but MiCOM S1 studio is not supported.

The settings for the security log standards and Syslog server IP address and ports are listed in the *Configurable cyber security settings* table. For more detail about the security log configuration, please refer to the SAT documentation.

Note	*The Security logs time stamp may be time shifted by several milliseconds compared with local event log.* *The security logs will not be generated if the Ethernet card is starting up.* *If the Syslog server is unavailable, the new logs will be stored and overwriting the oldest logs.*

This table lists the security logs categories available for each standard.

Log ID	Additional field	Explanation	Level	Standards					
				BDEW	E3	NERC CIP	IEEE 1686	IEC 62351	CS Phase 1
CONNECTION_SUCCESS	The additional field will contain the issuer of the connection: LOCAL or NETWORK	Successful connection	INFO	x	x	x	x		x
CONNECTION_FAILURE		Failed connection (wrong credentials)	WARNING	x	x	x	x		x
CONNECTION_FAILURE_ AND_BLOCK		Failed connection (wrong credentials) triggering the blocking of the account on the IED	DANGER	x	x	x	x		x
CONNECTION_FAILURE_ ALREADY_BLOCKED		Failed connection because of a blocked userID on this IED	DANGER	x	x	x	x		x
DISCONNECTION		Disconnection triggered by the peer /user	INFO	x	x	x	x		x
DISCONNECTION_TIMEOUT		Disconnection triggered by a timeout	INFO	x	x	x	x		x
CONTROL_OPERATION	Type & Data associated to the control	Trace and control / override of real data from a peer	INFO				x		
CONFIGURATION_ DOWNLOAD	Version	Download of the configuration file from the device - Files include PSL, Courier setting, DNP setting, MCL/CID and user curves (crv)	INFO				x		
CONFIGURATION_UPLOAD	Version	Upload of a new configuration file into the device - Files include PSL, Courier setting, DNP setting, MCL and user curves (crv)	INFO				x		
RBAC_UPDATE	Version	Update of the RBAC cache in the IED	INFO				x		x
SEC_LOGS_RETRIEVAL	Version	Retrieval of the security logs of the IED	INFO				x		
TIME_CHANGE	New & Old time	Modification of the time of the IED	INFO				x		
REBOOT_ORDER	None	Reboot order sent to the IED / IED start up	DANGER				x		x
PORT_MANAGEMENT	Port, action (enable / disable)	Any comms port enabled / disabled	INFO						x
AUTHORIZATION_REQ	Action, object	Any authorization request sent to the CS brick	INFO			x		x	x

Table 11 – Security logs recorded

2.1.9 Common Cyber Security Settings

The System Administrator can customize the cyber security settings at the SAT. The following table shows the common cyber security settings. Parts of settings also are visible on the IED with specific Courier cells but not editable in IED or MiCOM S1 Studio. These are shown in the right hand columns of this table:

Setting in SAT	Default Setting	Available Value	Menu in IED	Col	Row
Minimum inactivity period	15	1 to 99 Minutes	-	-	-
If the user does not perform any action within this interval, the user will be logged off.					
Allow user locking	Yes	Yes/No	-	-	-
Option allows user account locking					
Maximum login attempts	5	1 to 99	Attempts Limit	25	02
The maximum failed password entry attempts, the user will lock once the attempts reached.					
Password attempts timer	3	1 to 30 Minutes	Attempts timer	25	03
The time for reset the attempts count to 0. The user got to maximum login attempts.					
Automatic user account unlocking	Yes	Yes/No	-	-	-
Enable/disable the attempts times aromatic reset function.					
Locking period duration	240	1 to 86400 Seconds	Blocking timer	25	04
The Locking period duration (seconds)					
Password Complexity	None	None / IEEE1686/ NERC	-	-	-
Set the password compliant standard.					
Log and monitoring standard	BDEW	BDEW / E3 /NERC-CIP / IEE1686 / IEC62351/ CS_PH1	-	-	-
Setup security log emission standard					
Syslog server IP address	0.0.0.0		-	-	-
Syslog server IP address					
Syslog server IP port	601	1 to 65535	-	-	-
Syslog server IP port					
SNMP client IP address	0.0.0.0		-	-	-
SNMP client IP address					

Table 12 – Configurable cyber security settings

These settings show some common information about cyber security, which are not configurable whether by SAT, or MiCOM S1 Studio or the front panel.

Menu in IED	Col	Row	Description
User Banner	25	01	Show user banner information: ACCESS ONLY FOR AUTHORITY USERS
Attempts remain	25	11	Show the remains attempt times for user login.
Blk time remain	25	12	Show the remains time for blocked user to unlock
User Name	25	21~2F	Configured user name (in SAT)
Security Code	25	FE	The security code used to recovery the password.
RBAC Password	25	FF	Enter 16 characters recover password to recovery password

Table 13 – Un-configurable cyber security settings

2.1.10 Local Default Access

Local Default Access function can be disabled/enabled in the SAT.
The intention for Local Default Access function is to allow the user easy to access the IED from the front panel and without any authorization required. This means if the Local Default Access function is enabled, everyone will be authorized to access the front panel with associated Rights.

By default, the Local Default Access has the VIEWER role, it is also possible to associate the other Roles to the Local Default Access, which is configurable in the SAT.
Local Default Access function is only available in the front panel.
The Local Default Access login/logout process is invisible for the user.

2.2 MiCOM Px4x with CSL0- Simple Password Management

For MiCOM Px4x IED with CSL0, as the Security Administration Tool (SAT) is not supported, all the cyber security features which need SAT support will not be available.

This section describes the different implementations by comparing with CLS1.

The cyber security features that are not mentioned in this section will default to be the same as CSL1.

2.2.1 Password Management

For MiCOM Px4x IED with CSL0, SAT is not supported for the configuration, so only the alphanumeric password can be used.

- The alphanumeric password is settable via MiCOM S1 Studio and the Front panel
- Passwords may be any length between 1 and 16 characters long
- Passwords may contain any ASCII character in the range ASCII code 33 (21 Hex) to ASCII code 122 (7A Hex) inclusive
- No password compliance is required
- The alphanumeric password will used for Courier access and the front panel access

Arrow key password is not available for IED with CLS0.

2.2.2 Fixed Factory RBAC

For MiCOM Px4x IED with CSL0, the user list and its role/right will be fixed as factory RBAC and not configurable. Refer to the *Factory RBAC* table for more details.

2.2.3 Security Logs/SNMP Services

The security logs/SNMP services are not available for MiCOM Px4x IED with CSL0.

2.2.4 Cyber Security Settings

For MiCOM Px4x IED with CSL0, all cyber security settings are fixed as default setting and un-configurable. Refer to the *Configurable cyber security settings* table for the default settings.

2.2.5 Disable/Blank Password

For MiCOM Px4x IED with CSL0, it is possible to remove the user password. In MiCOM S1 Studio, this is achieved by click the BOX “Disable the password”. In the IED, this is achieved by setting the password as blank.

Once the password is disabled/blank, the user can login to the IED directly and there is no need to enter the password.

3 HOW TO USE CYBER SECURITY FEATURES

These sections shows the most common tasks associated with Cyber Security features.

For many of these tasks, the steps you take are the same as you have performed previously; with the main changes being in the steps you use to login and/or logout.

3.1 How to Login

3.1.1 Local Default Access

If the Local Default Access is enabled, the user may login to the front panel with associated roles.

See Table 14 for the applied cases.

3.1.2 Auto Login

Auto login means the user will login the IED automatically and no need to select the user name and enter the password. In this case, the user will be authorized with relevant rights. The auto login will be applied in these cases:

<table>
<tr><th>CS Version</th><th>Interface</th><th>RBAC/PW Cases</th><th>Login Process</th></tr>
<tr><td rowspan="3">CSL1</td><td rowspan="2">Front panel</td><td>Factory RBAC</td><td>Auto login with EngineerLevel</td></tr>
<tr><td>Customized RBAC</td><td>Local Default Access Enabled: Login with Local Default Access
Local Default Access Disabled: Login with Prompt User List</td></tr>
<tr><td>Courier Interface</td><td>All cases</td><td>Login with Prompt User List</td></tr>
<tr><td rowspan="4">CSL0</td><td rowspan="2">Front panel</td><td>Factory RBAC</td><td>Auto login with EngineerLevel</td></tr>
<tr><td>Password changed</td><td>EngineerLevel password is “AAAA” or is disabled/blank: Auto login with EngineerLevel
OperatorLevel password is “AAAA” or is disabled/blank: Auto login with OperatorLevel
EngineerLevel and OperatorLevel password changed: Auto login with ViewerLevel Access</td></tr>
<tr><td rowspan="2">Courier Interface</td><td>Factory RBAC</td><td>Auto login with EngineerLevel</td></tr>
<tr><td>Password changed</td><td>EngineerLevel password is “AAAA” or is disabled/blank: Auto login with EngineerLevel
OperatorLevel password is “AAAA” or is disabled/blank: Auto login with OperatorLevel
EngineerLevel and OperatorLevel password changed: Login with Prompt User List</td></tr>
</table>

Table 14 – Auto Login process

For more details about the Factory RBAC, please refer to Table 9.

3.1.3 Login with Prompt User List

This login process will happen if:

- The Auto login process is not applied.
- Or high authorization is required for the current operation.

In this case, the IED will prompt the user list, and the user needs to select proper user name and enter the password to login.

3.2 How to Logout

3.2.1 How to Logout at the IED

For security consideration, it would be better to “logout' the IED once the configuration done. You can do this by going up to the default display. When you are at the default display and you press the ‘Cancel’ button, you may be prompted to log out with the following display:

```
ENTER TO LOGOUT
CLEAR TO CANCEL
```

You will be asked this question if you are logged in.

If you confirm, the following message is displayed for 2 seconds:

```
LOGGED OUT
User Name
```

If you decide not to log out (i.e. you cancel), the following message is displayed for 2 seconds.

```
LOGOUT CANCELLED
User Name
```

Note	*The MiCOM IED runs a timer, which logs the user out after a period of inactivity. For more details, refer to the Inactivity Timer section.*

3.2.2 How to Logout at MiCOM S1 Studio

- Right-click on the device name and select Log Off.
- In the Log Off confirmation dialog click Yes.

3.3 How to Disable a Physical Port

Using MiCOM S1 Studio or the front panel it is possible to disable unused physical ports. This can not be done by the SAT. By default, an Engineer-role is needed to perform this action.

To prevent accidental disabling of a port, a warning message is displayed according to whichever port is required to be disabled. For example if rear port 1 is to be disabled, the following message appears:

```
REAR PORT 1 TO BE
DISABLED.CONFIRM
```

There are between two and four ports eligible for disablement:

- Front port
- Rear port 1
- Rear port 2 (available in the specific models)
- Ethernet port (available in the specific models)

Important	**It is not possible to disable a port from which the disabling port command originates.**

3.4 How to Disable a Logical Port

Using MiCOM S1 Studio or the front panel it is possible to disable unused logical ports. This can't be done by the SAT. An Engineer-role is needed to perform this action.

Caution	**Disabling the Ethernet port will disable all Ethernet based communications.**

If it is not desirable to disable the Ethernet port, it is possible to disable selected protocols on the Ethernet card and leave others functioning.

These protocols can be disabled:

- IEC61850 (available in the specific models)
- Courier Tunnelling (available in the specific models)
- IEC61850 + DNPoE (available in the specific models)

3.5 How to Secure a Function Key (When Available)

In cyber security implementation, this function has been linked to the front panel authorization.

- When the function key pressed, if there is no user login in the front panel or the logged- in user is not authorized, a prompt message will be raised in the front panel to ask the user to login. Once the user is logged-in, they need to press the function key again to execute the command.
- If the user is already logged in and the authorization is OK, the command will be executed immediately.
- By default, the OPERATOR or ENGINEER Roles are able to operate the function keys.
- The function key will be executed immediately if the auto login process is applied and the user is authorized.
- If unauthorized users press the Function Key during the setting change, they need to commit the changes first then login with authorized user to operate the function key.

4 GLOSSARY FOR CYBER SECURITY

Term	Meaning
CIP Standards	Critical Infrastructure Protection standards. NERC CIP standards have been given the force of law by the Federal Energy Regulatory Commission (FERC)
DCS	Distributed Control System
HMI	Human Machine Interface
IED	Intelligent Electronic Device. It is a power industry term to describe microprocessor-based controllers of power system equipments (e.g. Circuit breaker, transformer, etc)
LOGS	All the operations related to the security (connection, configuration…) are automatically caught in events that are logged in order to provide a good visibility of the previous actions to the security administrators.
MIB	Management Information Base
NERC	North American Electric Reliability Corporation
RBAC	Role Based Access Control. Authentication and authorization mechanism based on roles granted to a user. Roles are made of rights, themselves being actions that can be applied on objects. Each user's action is authorized or not based on his roles
Roles	A role is a logical representation of a person activity. This activity authorizes or forbids operations within the tool suite thanks to permissions that are associated to the role. A role needs to be attached to a user account to have a real purpose.
SAM	Security Administration Module. Device in charge of security management on an IP-over-Ethernet network.
SAT	Security Administration Tool TSF based application used to define and create security configuration
Secured IED	Devices embedding security mechanisms defined in the security architecture document
Security Administrator	A user of the system granted to manage its security
SNMP	Simple Network Management Protocol (SNMP) is an "Internet-standard protocol for managing devices on IP networks
TAT	Transfer Administration Tool
Unsecured IED	Relay/IEDs with no security mechanisms.

Table 15 – Glossary for cyber security

DUAL REDUNDANT ETHERNET BOARD (DREB)

CHAPTER 19

Date (month/year):	01/2017			
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.			
Hardware Suffix:	P141/P142/P143	L	P54x (P543/P544/P545/P546)	M
	P145	M	P642	L
	P241	L	P643/P645	M
	P242/P243	M	P741/P743	M
	P342	L	P742	L
	P343/P344/P345	M	P746	M
	P445	L	P841A (one circuit breaker)	M
	P44x (P442/P444)	M	P841B (two circuit breakers)	M
	P44y (P443/P446)	M	P849	M
Software Version:	P14x (P141/P142/P143/P145)	B0/B2	P54x (P543/P544/P545/P546)	H4
	P24x (P241/P242/P243)	D0	P64x (P642/P643/P645)	B1/B2
	P341	B1/E1	P746	B1/B2/B3 C1/C2/C3
	P34x (P342/P343/P344/P345)	B0/B1	P74x (P741/P742/P743)	B0
	P445	B0/B1/E0/E1/J4/J6	P841A	G4
	P44x (P442/P444)	E0/E1	P841B	H4
	P44y (P443/P446)	H4	P849	B0/B1
Connection Diagrams:	P14x (P141, P142, P143 & P145): 10P141xx (xx = 01 to 02) 10P142xx (xx = 01 to 05) 10P143xx (xx = 01 to 11) 10P145xx (xx = 01 to 11) P24x (P241, P242 & P243): 10P241xx (xx = 01 to 02) 10P242xx (xx = 01) 10P243xx (xx = 01) P34x (P342, P343, P344, P345 & P391): 10P342xx (xx = 01 to 17) 10P343xx (xx = 01 to 19) 10P344xx (xx = 01 to 12) 10P345xx (xx = 01 to 07) 10P391xx (xx = 01 to 02) P44x (P442 & P444): 10P44101 (SH 1 & 2) 10P44201 (SH 1 & 2) 10P44202 (SH 1) 10P44203 (SH 1 & 2) 10P44401 (SH 1) 10P44402 (SH 1) 10P44403 (SH 1 & 2) 10P44404 (SH 1) 10P44405 (SH 1) 10P44407 (SH 1 & 2) P44y (P443 & P446): 10P44303 (SH 01 and 03) 10P44304 (SH 01 and 03) 10P44305 (SH 01 and 03) 10P44306 (SH 01 and 03) 10P44600 10P44601 (SH 1 to 2) 10P44602 (SH 1 to 2) 10P44603 (SH 1 to 2) P445: 10P445xx (xx = 01 to 04)		P54x (P543, P544, P545 & P546): 10P54302 (SH 1 to 2) 10P54303 (SH 1 to 2) 10P54400 10P54404 (SH 1 to 2) 10P54405 (SH 1 to 2) 10P54502 (SH 1 to 2) 10P54503 (SH 1 to 2) 10P54600 10P54604 (SH 1 to 2) 10P54605 (SH 1 to 2) 10P54606 (SH 1 to 2) P547: 10P54702xx (xx = 01 to 02) 10P54703xx (xx = 01 to 02) 10P54704xx (xx = 01 to 02) 10P54705xx (xx = 01 to 02) P64x (P642, P643 & P645): 10P642xx (xx = 1 to 10) 10P643xx (xx = 1 to 6) 10P645xx (xx = 1 to 9) P74x (P741, P742 & P743): 10P740xx (xx = 01 to 07) P746: 10P746xx (xx = 00 to 21) P841: 10P84100 10P84101 (SH 1 to 2) 10P84102 (SH 1 to 2) 10P84103 (SH 1 to 2) 10P84104 (SH 1 to 2) 10P84105 (SH 1 to 2) P849: 10P849xx (xx = 01 to 06)	

CONTENTS

FIGURES

TABLES

Notes:

1 INTRODUCTION

The redundant Ethernet board assures redundancy at IED level. It is fitted into the following MiCOM IEDs from Schneider Electric.

- P141, P142, P143, P145
- P241, P242, P243
- P341, P342, P343, P344, P345
- P442, P443, P444, P445, P446
- P543, P544, P545, P546, P547
- P642, P643, P645
- P741, P743, P746
- P841, P849

1.1 Standard Safety Statements

For safety information please see the Safety Information chapter of the relevant Px4x Technical Manual.

2 HARDWARE DESCRIPTION

IEC 61850 work over Ethernet. Three boards are available:

- 1RJ45 Port Ethernet Board
- 3RJ45 Ports Redundant Ethernet Board
- 2LC+1RJ45 Ports Redundant Ethernet Board.

All are required for communications but 3RJ45 Ports and 2LC+1RJ45 Ports Redundant Ethernet Board allow an alternative path to be always available, providing bumpless redundancy.

Industrial network failure can be disastrous. Redundancy provides increased security and reliability, but also devices can be added to or removed from the network without network downtime.

The following list shows Schneider Electric's implementation of Ethernet redundancy, which has two variants with embedded IEC 61850 over Ethernet, plus PRP and HSR redundancy protocols.

- Parallel Redundancy Protocol (PRP)/High-availability Seamless Redundancy (HSR) with 1310 nm multi mode 100BaseFx fiber optic Ethernet ports (LC connector) and modulated/un- modulated IRIG-B input. Part number 2072069A01.

Note	*The board offers compatibility with any PRP/HSR device.*

- Parallel Redundancy Protocol (PRP)/High-availability Seamless Redundancy (HSR) with 100BaseTx Ethernet ports (RJ45) and modulated/un- modulated IRIG-B input. Part number 2072071A01.

Note	*The board offers compatibility with any PRP/HSR device.*

The redundant Ethernet board is fitted into Slot A of the IED, which is the optional communications slot. Each Ethernet board has three MAC addresses for two groups, one group (PORT 1) including one host MAC address, the other group (PORT 2 & 3) used for redundant application, including one host MAC address and one redundant agency device MAC address. Two host MAC addresses of the IED are printed on the rear panel of the IED.

In additional above for HSR/PRP redundant protocols, the redundant Ethernet board also can be operate on Dual IP mode. In this case, each Ethernet board has two host MAC addresses.

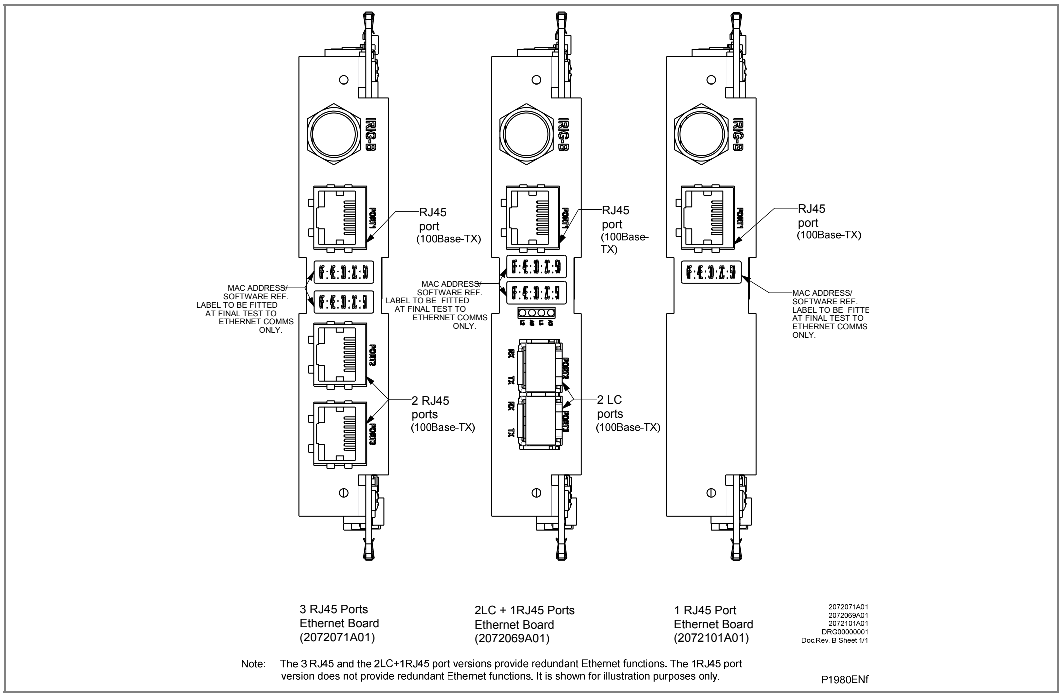

Figure 1 - Ethernet board connectors (3 RJ45 or 2 LC + RJ45 or 1 RJ45)

2.1 IRIG-B Connector

This is available as a modulated/un-modulated input.
See section 6.1.

2.2 LEDs

LED	Function	On	Off	Flashing
Green	Link	Link ok	Link broken	
Yellow	Activity			Traffic activity

Table 1 - LED functionality

2.3 Optical Fiber Connectors

Use 1310 nm multi mode 100BaseFx and LC connectors.
See Figure 1 and section 6.1.

Connector	PRP	HSR
2	R_X	R_X
2	T_X	T_X
3	R_X	R_X
3	T_X	T_X

Table 2 - Optical fiber connector functionality

3 REDUNDANCY PROTOCOLS

There are two redundancy protocols available:

- PRP (Parallel Redundancy Protocol)
- HSR (High-availability Seamless Redundancy)

3.1 Parallel Redundancy Protocol (PRP)

When the upper protocol layers send a data packet, the PRP interface creates a “twin packet” from this. The PRP interface then transmits redundant data packet of the twin pair to each participating LAN simultaneously. As they are transmitted via different LANs, the data packets may have different run times.
The receiving PRP interface forwards the first packet of a pair towards the upper protocol layers and discards the second packet. When viewed from the application, a PRP interface functions like a standard Ethernet interface.
The PRP interface or a Redundancy Box (RedBox) injects a Redundancy Control Trailer (RCT) into each packet. The RCT is a 48-bit identification field and is responsible for the identification of duplicates. This field contains, LAN identification (LAN A or B), information about the length of the payload, and a 16-bit sequence number. The PRP interface increments the sequence number for each packet sent. Using the unique attributes included in each packet, such as Physical MAC source address and sequence number, the receiving RedBox or Double Attached Node (DAN) interface identifies and discards duplicates.
Depending on the packet size, with PRP it attains a throughput of 93 to 99% of the available bandwidth.

3.1.1 PRP Network Structure

PRP uses two independent LANs. The topology of each of these LANs is arbitrary, and ring, star, bus and meshed topologies are possible.
The main advantage of PRP is loss-free data transmission with an active (transit) LAN. When the terminal device receives no packets from one of the LANs, the second (transit) LAN maintains the connection. As long as 1 (transit) LAN is available, repairs and maintenance on the other (transit) LAN have no impact on the data packet transmission.
The elementary devices of a PRP network are known as RedBox (Redundancy Box) and DANP (Double Attached Node implementing PRP).
Both devices have one connection each to the (transit) LANs.
The devices in the (transit) LAN are conventional switches that do not require any PRP support. The devices transmit PRP data packets transparently, without evaluating the RCT information.
Terminal devices that are connected directly to a device in the (transit) LAN are known as SAN (Single Attached Node). If there is an interruption, these terminal devices cannot be reached via the redundant line. To use the uninterruptible redundancy of the PRP network, you integrate your device into the PRP network via a RedBox.

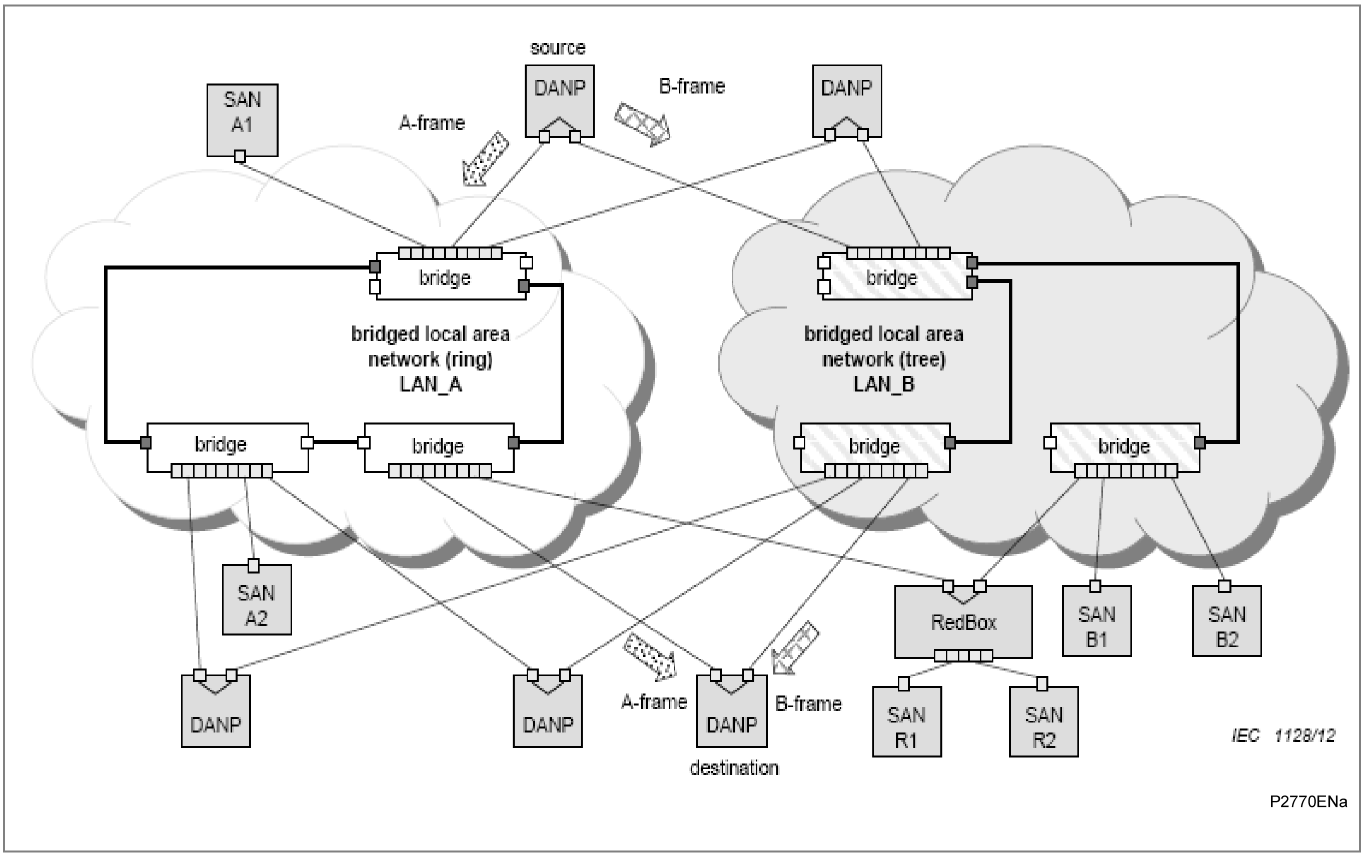

Figure 2 - PRP example of general redundant network

3.1.2 Example Configuration

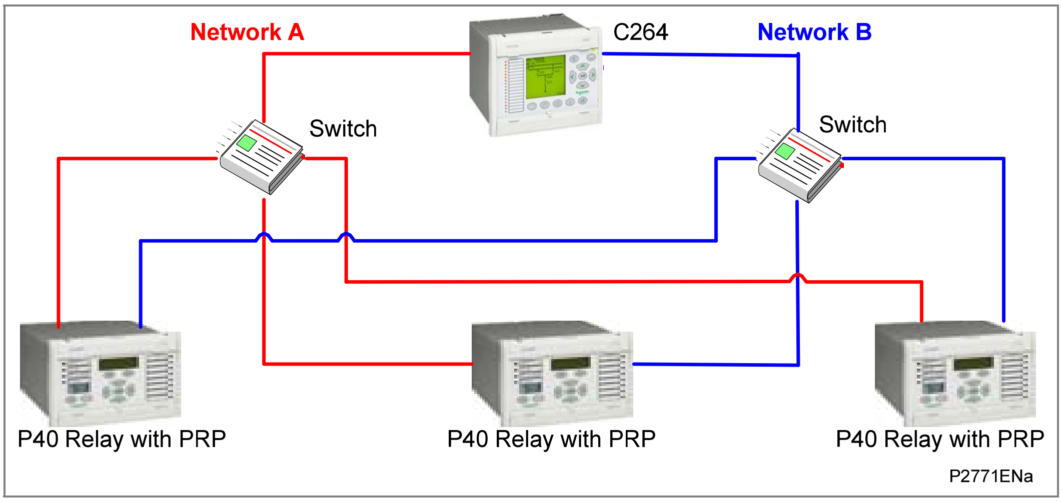

Figure 3 - PRP Relay Configuration

3.2 High-availability Seamless Redundancy (HSR)

High-availability Seamless Redundancy (HSR) can only be used in a ring topology, This section describes the application of the PRP principles (IEC 62439-3- Clause 4) to implement a High-availability Seamless Redundancy (HSR), retaining the PRP property of zero recovery time, applicable to rings. With respect to PRP, HSR allows you to greatly reduce the network infrastructure. With respect to rings based on IEEE 802.1D (RSTP), IEC 62439-2 (MRP), IEC 62439-6 (DRP) or IEC 62439-7 (RRP), the available network bandwidth for network traffic is somewhat reduced depending on the type of traffic. Nodes within the ring are restricted to be HSR-capable bridging nodes, thus avoiding the use of dedicated bridges. Singly Attached Nodes (SANs) such as laptops or printers cannot be attached directly to the ring, but need attachment through a RedBox (redundancy box).

3.2.1 HSR Network Structure

As in PRP, a node has two ports operated in parallel; it is a DANH (Doubly Attached Node with HSR protocol).
A simple HSR network consists of doubly-attached bridging nodes, each having two ring ports, interconnected by full-duplex links, as shown in these examples for a ring topology:

- Figure 4 (multicast)
- Figure 5 (unicast)

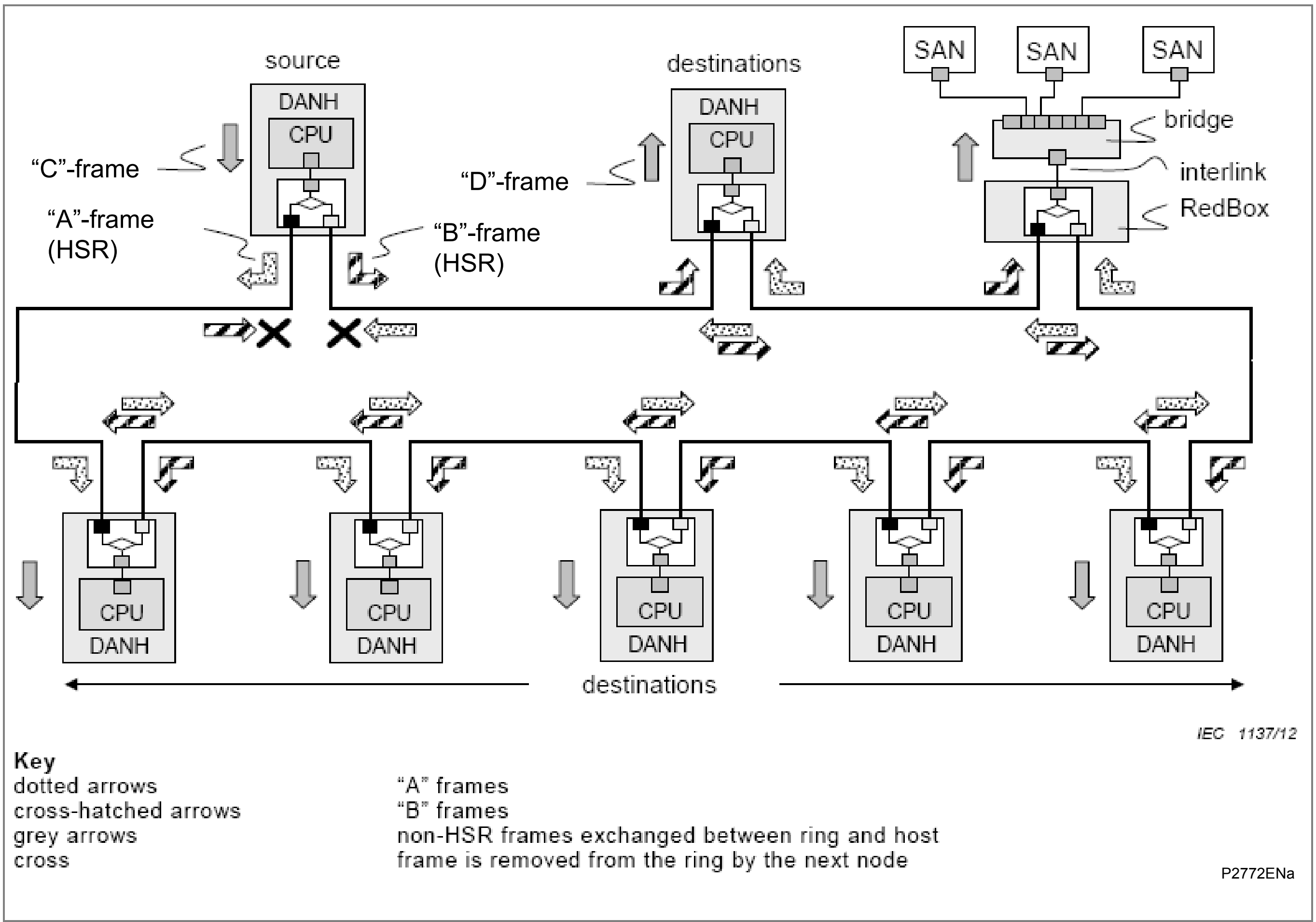

Figure 4 - HSR example of ring configuration for multicast traffic

A source DANH sends a frame passed from its upper layers ("C" frame), prefixes it by an HSR tag to identify frame duplicates and sends the frame over each port ("A"-frame and "B"-frame). A destination DANH receives, in the fault-free state, two identical frames from each port within a certain interval, removes the HSR tag of the first frame before passing it to its upper layers ("D"-frame) and discards any duplicate.
The nodes support the IEEE 802.1D bridge functionality and forward frames from one port to the other, except if they already sent the same frame in that same direction.
In particular, the node will not forward a frame that it injected into the ring.

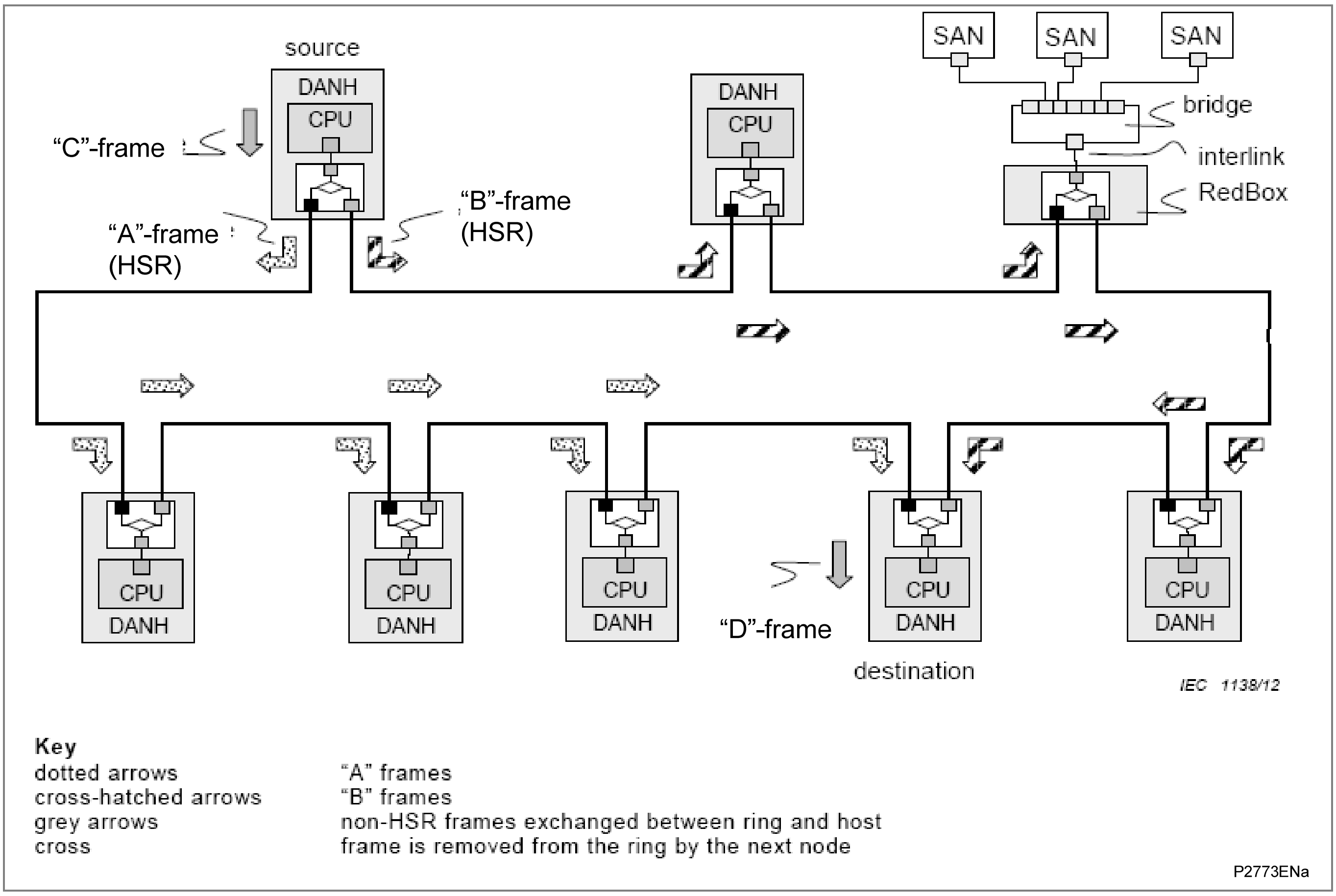

Figure 5 - HSR example of ring configuration for unicast traffic

A destination node of a unicast frame does not forward a frame for which it is the only destination, except for testing.
Frames circulating in the ring carry the HSR tag inserted by the source, which contains a sequence number. The doublet {source MAC address, sequence number} uniquely identifies copies of the same frame.
Singly Attached Nodes (SANs), for instance maintenance laptops or printers cannot be inserted directly into the ring since they have only one port and cannot interpret the HSR tag in the frames. SANs communicate with ring devices through a RedBox (redundancy box) that acts as a proxy for the SANs attached to it, as shown in the diagram.
Connecting non-HSR nodes to ring ports, breaking the ring, is allowed to enable configuration. Non-HSR traffic within the closed ring is supported in an optional mode.

3.2.2 Example Configuration

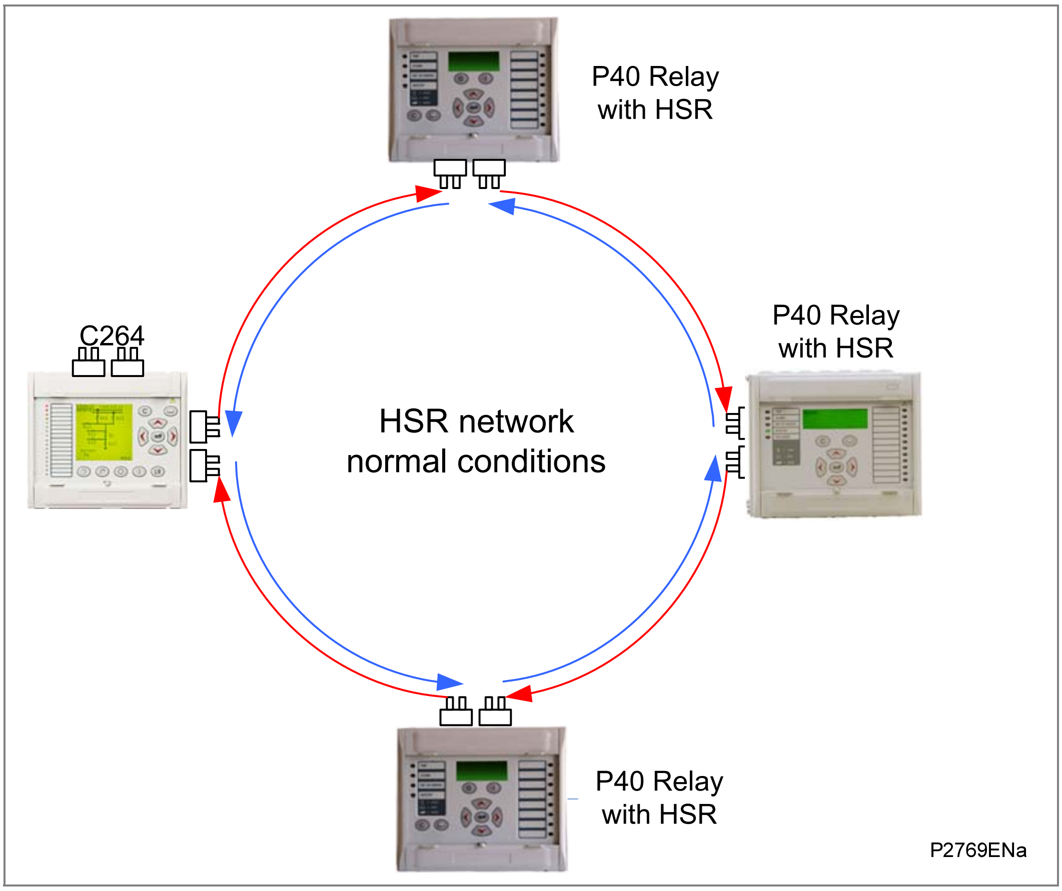

Figure 6 - HSR Relay Configuration

3.3 Generic Functions for all Redundant Ethernet Boards

The following apply to the redundant Ethernet protocols (PRP and HSR).

3.3.1 Priority Tagging

802.1p priority is enabled on all ports.

3.3.2 Simple Network Management Protocol (SNMP)

Simple Network Management Protocol (SNMP) is the network protocol developed to manage devices in an IP network. SNMP relies on a Management Information Base (MIB) that contains information about parameters to supervise. The MIB format is a tree structure, with each node in the tree identified by a numerical Object IDentifier (OID). Each OID identifies a variable that can be read or set using SNMP with the appropriate software. The information in the MIBs is standardized.

3.3.2.1 Redundant Ethernet Board MIB Structure

The IEC 62439-3 MIB provides the following objects available at the OID = .1.0.62439:

SNMP OID	Parameter name	Description
1	iso	
1	std	
1.0.62439	iec62439	
1.0.62439.2	prp	
1.0.62439.2.0	linkRedundancyEntityNotifications	
1.0.62439.2.1	linkRedundancyEntityObjects	
1.0.62439.2.1.0	lreConfiguration	
1.0.62439.2.1.0.0	lreConfigurationGeneralGroup	
1.0.62439.2.1.0.0.1	lreManufacturerName	Specifies the name of the LRE device manufacturer
1.0.62439.2.1.0.0.2	lreInterfaceCount	Total number of LREs present in this system
1.0.62439.2.1.0.1	lreConfigurationInterfaceGroup	
1.0.62439.2.1.0.1.0	lreConfigurationInterfaces	
1.0.62439.2.1.0.1.0.1	lreInterfaceConfigTable	List of PRP/HSR LREs. Each entry corresponds to one PRP/HSR Link Redundancy Entity (LRE), each representing a pair of LAN ports A and B. Basic devices supporting PRP/HSR may have only one LRE and thus one entry in the table, while more complex devices may have several entries for multiple LREs
1.0.62439.2.1.0.1.0.1.1	lreInterfaceConfigEntry	Each entry contains management information
1.0.62439.2.1.0.1.0.1.1.1	lreInterfaceConfigIndex	A unique value for each LRE
1.0.62439.2.1.0.1.0.1.1.2	lreRowStatus	Indicates the status of the LRE table entry
1.0.62439.2.1.0.1.0.1.1.3	lreNodeType	Specifies the operation mode of the LRE: PRP mode 1 (1) HSR mode (2). Note: PRP mode 0 is considered deprecated and is not supported by this revision of the MIB
1.0.62439.2.1.0.1.0.1.1.4	lreNodeName	Specifies this LRE's node name
1.0.62439.2.1.0.1.0.1.1.5	lreVersionName	Specifies the version of this LRE's software
1.0.62439.2.1.0.1.0.1.1.6	lreMacAddress	Specifies the MAC address to be used by this LRE. MAC addresses are identical for all ports of a single LRE
1.0.62439.2.1.0.1.0.1.1.7	lrePortAdminStateA	Specifies whether the port A shall be active or not Active through administrative action (Default: active)
1.0.62439.2.1.0.1.0.1.1.8	lrePortAdminStateB	Specifies whether the port B shall be active or not Active through administrative action (Default: active)
1.0.62439.2.1.0.1.0.1.1.9	lreLinkStatusA	Shows the actual link status of the LRE's port A
1.0.62439.2.1.0.1.0.1.1.10	lreLinkStatusB	Shows the actual link status of the LRE's port B

SNMP OID	Parameter name	Description
1.0.62439.2.1.0.1.0.1.1.11	lreDuplicateDiscard	Specifies whether a duplicate discard algorithm is used at reception (Default: discard)
1.0.62439.2.1.0.1.0.1.1.12	lreTransparentReception	If removeRCT is configured, the RCT is removed when forwarding to the upper layers, only applicable for PRP LRE (Default: removeRCT)
1.0.62439.2.1.0.1.0.1.1.13	lreHsrLREMode	This enumeration is only applicable if the LRE is an HSR bridging node or RedBox. It shows the mode of the HSR LRE: (1) Default mode: The HSR LRE is in mode h and bridges tagged HSR traffic (2) Optional mode: The HSR LRE is in mode n and bridging between its HSR ports is disabled. Traffic is HSR tagged (3) Optional mode: The HSR LRE is in mode t and bridges non-tagged HSR traffic between its HSR ports (4) Optional mode: The HSR LRE is in mode u and behaves like in mode h, except it does not remove unicast messages (5) Optional mode: The HSR LRE is configured in mixed mode. HSR frames are handled according to mode h. Non-HSR frames are handled according to 802.1D bridging rules
1.0.62439.2.1.0.1.0.1.1.14	lreSwitchingEndNode	This enumeration shows which feature is enabled in this particular LRE: (1): an unspecified non-bridging node, e.g. SRP. (2): an unspecified bridging node, e.g. RSTP. (3): a PRP node/RedBox. (4): an HSR RedBox with regular Ethernet traffic on its interlink. (5): an HSR switching node. (6): an HSR RedBox with HSR tagged traffic on its interlink. (7): an HSR RedBox with PRP traffic for LAN A on its interlink. (8): an HSR RedBox with PRP traffic for LAN B on its interlink.
1.0.62439.2.1.0.1.0.1.1.15	lreRedBoxIdentity	Applicable to RedBox HSR-PRP A and RedBox HSR-PRP B. One ID is used by one pair of RedBoxes (one configured to A and one configured to B) coupling an HSR ring to a PRP network. The integer value states the value of the path field a RedBox inserts into each frame it receives from its interlink and injects into the HSR ring. When interpreted as binary values, the LSB denotes the configuration of the RedBox (A or B), and the following 3 bits denote the identifier of a RedBox pair.
1.0.62439.2.1.0.1.0.1.1.16	lreEvaluateSupervision	True if the LRE evaluates received supervision frames. False if it drops the supervision frames without evaluating. Note: LREs are required to send supervision frames, but reception is optional. Default value is dependent on implementation.
1.0.62439.2.1.0.1.0.1.1.17	lreNodesTableClear	Specifies that the Node Table is to be cleared
1.0.62439.2.1.0.1.0.1.1.18	lreProxyNodeTableClear	Specifies that the Proxy Node Table is to be cleared
1.0.62439.2.1.1	lreStatistics	
1.0.62439.2.1.1.1	lreStatisticsInterfaceGroup	
1.0.62439.2.1.1.1.0	lreStatisticsInterfaces	
1.0.62439.2.1.1.1.0.1	lreInterfaceStatsTable	List of PRP/HSR LREs. Each entry corresponds to one PRP/HSR Link Redundancy Entity (LRE), each representing a pair of LAN ports A and B and a port C towards the application/interlink. Basic devices supporting PRP/HSR may have only one LRE and thus one entry in the table, while more complex devices may have several entries for multiple LREs.
1.0.62439.2.1.1.1.0.1.1	lreInterfaceStatsEntry	An entry containing management information applicable to a particular LRE
1.0.62439.2.1.1.1.0.1.1.1	lreInterfaceStatsIndex	A unique value for each LRE
1.0.62439.2.1.1.1.0.1.1.2	lreCntTxA	Number of frames sent over port A that are HSR tagged or fitted with a PRP Redundancy Control Trailer. Only frames that are HSR tagged or do have a PRP RCT are counted. Initial value = 0.
1.0.62439.2.1.1.1.0.1.1.3	lreCntTxB	Number of frames sent over port B that are HSR tagged or fitted with a PRP Redundancy Control Trailer. Only frames that are HSR tagged or do have a PRP RCT are counted. Initial value = 0.

SNMP OID	Parameter name	Description
1.0.62439.2.1.1.1.0.1.1.4	lreCntTxC	Number of frames sent towards the application interface of the DANP or DANH or over the interlink of the RedBox. All frames (with our without PRP RCT or HSR tag) are counted. Initial value = 0
1.0.62439.2.1.1.1.0.1.1.5	lreCntErrWrongLanA	Number of frames with the wrong LAN identifier received on LRE port A. Initial value = 0. Only applicable to PRP ports.
1.0.62439.2.1.1.1.0.1.1.6	lreCntErrWrongLanB	Number of frames with the wrong LAN identifier received on LRE port B. Initial value = 0. Only applicable to PRP ports
1.0.62439.2.1.1.1.0.1.1.7	lreCntErrWrongLanC	Number of frames with the wrong LAN identifier received on the interlink of a RedBox. Only applicable to HSR RedBoxes in HSR-PRP configuration (hsrredboxprpa and hsrredboxprpb).
1.0.62439.2.1.1.1.0.1.1.8	lreCntRxA	Number of frames received on a LRE port A. Only frames that are HSR tagged or fitted with a PRP Redundancy Control Trailer are counted. Initial value = 0.
1.0.62439.2.1.1.1.0.1.1.9	lreCntRxB	Number of frames received on a LRE port B. Only frames that are HSR tagged or fitted with a PRP Redundancy Control Trailer are counted. Initial value = 0
1.0.62439.2.1.1.1.0.1.1.10	lreCntRxC	Number of frames received from the application interface of a DANP or DANH or the number of number of frames received on the interlink of a RedBox. All frames (with our without PRP RCT or HSR tag) are counted. Initial value = 0.
1.0.62439.2.1.1.1.0.1.1.11	lreCntErrorsA	Number of frames with errors received on this LRE port A. Initial value = 0
1.0.62439.2.1.1.1.0.1.1.12	lreCntErrorsB	Number of frames with errors received on this LRE port B. Initial value = 0
1.0.62439.2.1.1.1.0.1.1.13	lreCntErrorsC	Number of frames with errors received on the application interface of a DANP or DANH or on the interlink of a RedBox. Initial value = 0.
1.0.62439.2.1.1.1.0.1.1.14	lreCntNodes	Number of nodes in the Nodes Table
1.0.62439.2.1.1.1.0.1.1.15	lreCntProxyNodes	Number of nodes in the Proxy Node Table. Only applicable to RedBox. Initial value = 0.
1.0.62439.2.1.1.1.0.1.1.16	lreCntUniqueRxA	Number of entries in the duplicate detection mechanism on port A for which no duplicate was received. Initial value = 0
1.0.62439.2.1.1.1.0.1.1.17	lreCntUniqueRxB	Number of entries in the duplicate detection mechanism on port B for which no duplicate was received. Initial value = 0
1.0.62439.2.1.1.1.0.1.1.18	lreCntUniqueRxC	Number of entries in the duplicate detection mechanism on the application interface of the DAN or the interlink of the RedBox for which no duplicate was received. Initial value = 0
1.0.62439.2.1.1.1.0.1.1.19	lreCntDuplicateRxA	Number of entries in the duplicate detection mechanism on port A for which one single duplicate was received. Initial value = 0.
1.0.62439.2.1.1.1.0.1.1.20	lreCntDuplicateRxB	Number of entries in the duplicate detection mechanism on port B for which one single duplicate was received. Initial value = 0.
1.0.62439.2.1.1.1.0.1.1.21	lreCntDuplicateRxC	Number of entries in the duplicate detection mechanism on the application interface of the DAN or the interlink of the RedBox for which one single duplicate was received. Initial value = 0.
1.0.62439.2.1.1.1.0.1.1.22	lreCntMultiRxA	Number of entries in the duplicate detection mechanism on port A for which more than one duplicate was received. Initial value = 0.
1.0.62439.2.1.1.1.0.1.1.23	lreCntMultiRxB	Number of entries in the duplicate detection mechanism on port B for which more than one duplicate was received. Initial value = 0
1.0.62439.2.1.1.1.0.1.1.24	lreCntMultiRxC	Number of entries in the duplicate detection mechanism on the application interface of the DAN or the interlink of the RedBox for which more than one duplicate was received. Initial value = 0
1.0.62439.2.1.1.1.0.1.1.25	lreCntOwnRxA	Number of HSR tagged frames received on Port A that originated from this device. Frames originate from this device if the source MAC matches the MAC of the LRE, or if the source MAC appears in the proxy node table (if implemented). Applicable only to HSR. Initial value = 0.
1.0.62439.2.1.1.1.0.1.1.26	lreCntOwnRxB	Number of HSR tagged frames received on Port B that originated from this device. Frames originate from this device if the source MAC matches the MAC of the LRE, or if the source MAC appears in the proxy node table (if implemented). Applicable only to HSR. Initial value = 0.

SNMP OID	Parameter name	Description
1.0.62439.2.1.1.1.0.2	lreNodesTable	The node table (if it exists on that node) contains information about all remote LRE, which advertised themselves through supervision frames
1.0.62439.2.1.1.1.0.2.1	lreNodesEntry	Each entry in the node table (if it exists) contains information about a particular remote LRE registered in the node table, which advertised itself through supervision frames.
1.0.62439.2.1.1.1.0.2.1.1	lreNodesIndex	Unique value for each node in the LRE's node table
1.0.62439.2.1.1.1.0.2.1.2	lreNodesMacAddress	Each MAC address corresponds to a single Dual Attached Node
1.0.62439.2.1.1.1.0.2.1.3	lreTimeLastSeenA	Time in TimeTicks (1/100s) since the last frame from this remote LRE was received over LAN A. Initialized with a value of 0 upon node registration in the node table
1.0.62439.2.1.1.1.0.2.1.4	lreTimeLastSeenB	Time in TimeTicks (1/100s) since the last frame from this remote LRE was received over LAN B. Initialized with a value of 0 upon node registration in the node table.
1.0.62439.2.1.1.1.0.2.1.5	lreRemNodeType	DAN type, as indicated in the received supervision frame
1.0.62439.2.1.1.1.0.3	lreProxyNodeTable	The proxy node table (if implemented) contains information about all nodes, for which the LRE acts as a connection to the HSR/PRP network.
1.0.62439.2.1.1.1.0.3.1	lreProxyNodeEntry	Each entry in the proxy node table contains information about a particular node for which the LRE acts as a connection to the HSR/PRP network.
1.0.62439.2.1.1.1.0.3.1.1	lreProxyNodeIndex	A unique value for each node in the LRE's proxy node table.
1.0.62439.2.1.1.1.0.3.1.2	lreProxyNodeMacAddress	Each entry contains information about a particular node for which the LRE acts as a proxy for the HSR/PRP network.
1.0.62439.2.2	linkRedundancyEntityConformance	

Table 3 - Redundant Ethernet board MIB Structure

*Port number: 1 to 6 for the RJ45, port 7 management, port 8 ring

Various SNMP client software tools can be used with the MiCOM Px4x, C264 and Hx8x range. Schneider Electric recommends using an SNMP MIB browser which can perform the basic SNMP operations such as GET, GETNEXT, and RESPONSE.

Redundant agency device configuration will be required to access SNMP, refer to section 4.4 for more details.

3.3.3 Simple Network Time Protocol (SNTP)

Simple Network Time Protocol (SNTP) is supported by both the IED and the redundant Ethernet switch. SNTP is used to synchronize the clocks of computer systems over packet-switched, variable-latency data networks. A jitter buffer is used to reduce the effects of variable latency introduced by queuing in packet switched networks, ensuring a continuous data stream over the network.

The IED receives the synchronization from the SNTP server. This is done using the IP address of the SNTP server entered into the IED from the IED Configurator software.

3.3.4 Dual Ethernet Communication (Dual IPs)

3.3.4.1 Dual IP Introduction

Dual IP means the IED provides two independent IEC 61850 interfaces, and both these interfaces support MMS and Goose message.

The IED which supports Dual IP can provide the customer with more flexible network connections: two fully segregated Station BUS networks, or one Station Bus and one Process Bus (for Goose message transmission).

Dual IP is not mutually exclusive with PRP/HSR - Dual IP is automatically supported even if the IED is operate under HSR/PRP mode.

3.3.4.2 Dual IP in MiCOM

Dual IP is only supported for devices with the new Ethernet board assembly. This is shown by the model number, where the 7th digit is either hardware option Q or R. These boards have three Ethernet ports, as shown in Figure 1.

A setting is provided in the HMI to switch the operation mode between PRP/HSR/Dual IP.

Operation mode	Port 1	Port 2	Port3
PRP	Interface 1	Interface 2 (PRP)	Interface 2 (PRP)
HSR	Interface 1	Interface 2 (HSR)	Interface 2 (HSR)
Dual IP	* Interface 1 on Port 1 or Port 2		Interface 2

** Note In Dual IP mode, interface 1 can be available on port 1 or port 2. If both of port 1 and port 2 are connected, only port 1 will work.*

Table 4 - Ethernet ports operation mode

For each interface, the fully IEC 61850 functions (GOOSE and MMS services) are supported independently.

For outgoing GOOSE messages, you need to configure whether a message is to be transmitted across one or both Ethernet connections. You also need to configure the destination parameters such as multicast MAC address, AppID, VLAN, etc.

Two communication parameters also need to be configured for each interface (IP address, MAC address, subnet mask). For the CID which is exported from SCD file, the second interface communication parameters are not configured. This needs to be done by manually editing in the IED configurator (this being invisible by the SCD file). This process needs to be completed before the exported CID file is downloaded to the IED. (this being invisible by the SCD file).

3.3.4.3 **Typical User Cases**

Below for Interface 1 and Interface 2, from a functional point of view it is same. The customer has flexibility to define the functionality according their requirements.

- Both for Station Bus to have duplicated network for DCS.
- One for Station Bus and one for process bus (Goose message)

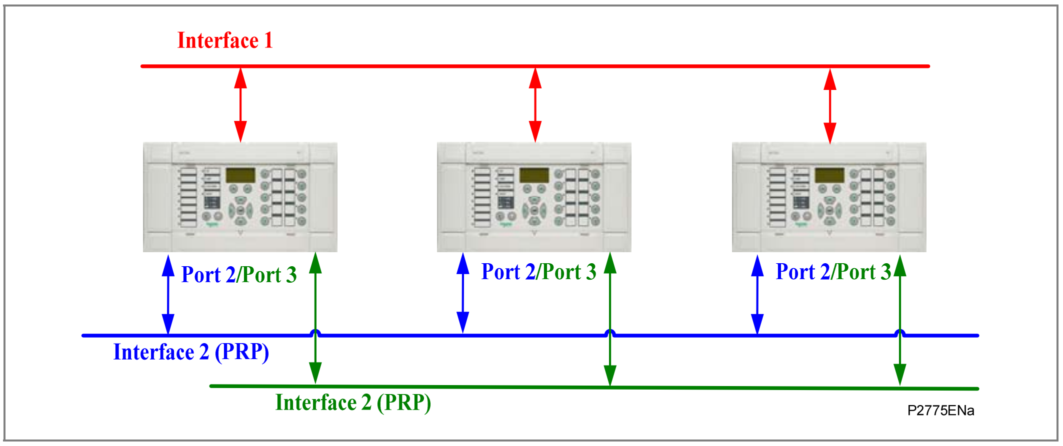

Figure 7 - PRP + Dual IP (Ethernet Mode PRP)

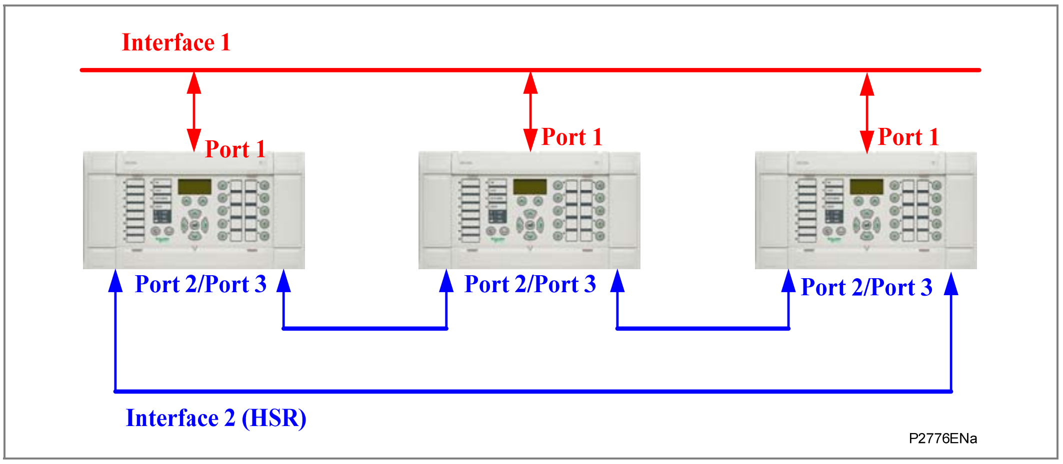

Figure 8 - HSR + Dual IP (Ethernet Mode HSR)

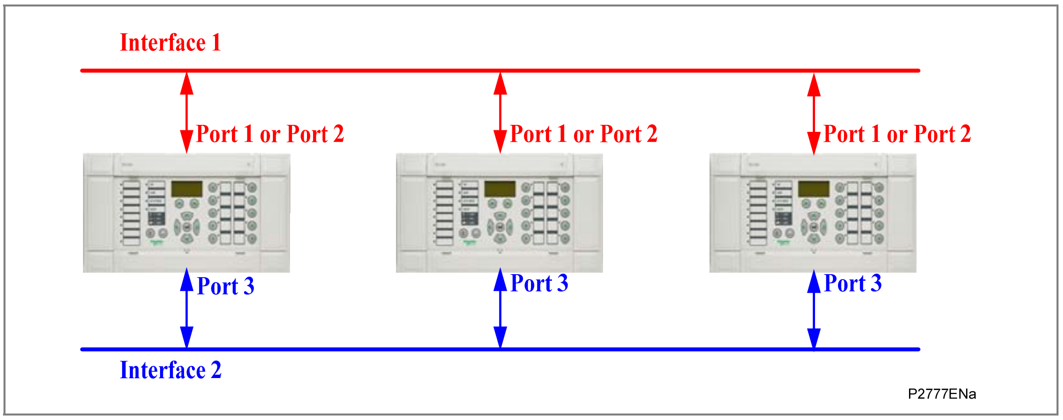

Figure 9 - Dual IP (Ethernet Mode Dual IP)

4 CONFIGURATION

The new redundant Ethernet board supports three communication operation modes. These can be achieved by change the setting in HMI. It is not necessary to flash the firmware.

Also for the two interfaces, the communication parameters need to be configured. These include the IP address, MAC address, and subnet mask, etc.

For redundant protocols, the communication parameters for redundant agency device also need to be configured.

4.1 Configuring Ethernet Communication Mode

Menu Text	Cell Add.	Default Setting	Available Setting
ETH COMM Mode	0016	Dual IP	Dual IP, PRP, HSR
This setting can only be change using the HMI, and the setting change will cause the Ethernet board reboot. Restore default setting does not apply to this setting.			

Table 5 - Ethernet communication mode setting

4.2 Configuring the IED Communication Parameters

The communication parameter for each interface is configured using the IED Configurator software in MiCOM S1 Studio. **Customers can configure these parameters according to their needs, but the IP address for these two interfaces should not be in the same subnet.**

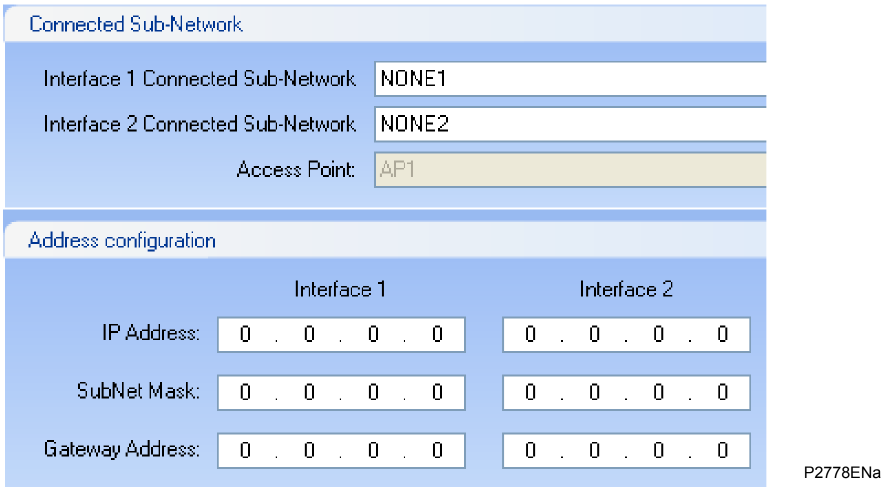

Figure 10 - Communication Parameters for two Interfaces

To use the device configuration with Courier Tunneling, for each interface, a default IP address has been applied. The default IP address for the first three bytes is fixed for each interface as below,

Interface	First three Bytes for IP address
Interface 1	169.254.0.xxx
Interface 2	169.254.1.yyy
Note *xxx = Mod(The last byte MAC1 address, 128) + 1* *yyy = Mod(The last byte MAC2 address, 128) + 1*	

Table 6 - First three bytes for default IP address

The default IP address can be found in the ***IED CONFIGURATOR*** column. Also, you can also calculate it according the MAC address label which is mounted on the rear panel of the Ethernet card.

4.3 Configuring GOOSE Publish Parameters

For outgoing GOOSE messages, you need to configure whether a message is to be transmitted over one or both Ethernet connections. You also need to configure the destination parameters including multicast MAC address, AppID, VLAN, etc.

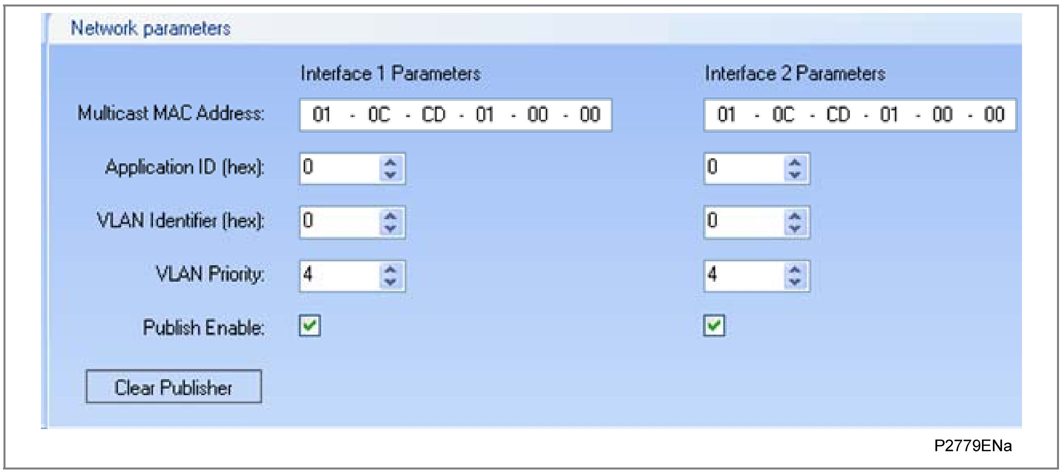

Figure 11 - Goose Publish Parameters for two Interfaces

4.4 Redundant Agency Device Configuration

The redundant agency device configuration is used by the SNMP server and only available for the device which works on PRP/HSR mode. The SNMP server can only be connected with Interface 2 (HSR/PRP port).

The following settings need to be configured in setting files:

- IP address
- Subnet Mask
- Gateway.

The MAC address is set when the device is manufactured. Also, the default IP is applied and linked to the MAC address. This default IP address can be seen in the HMI, in the Communication settings section.

The default IP address is 169.254.2.zzz.

zzz = Mod (The last byte MAC3 address, 128) + 1

5 COMMISSIONING

5.1 PRP Star Connection

The following diagram shows the Px4x IEDs with the PRP variant of Redundant Ethernet boards connected in a STAR topology. The STAR topology can have one or more high-end PRP-enabled Ethernet switches to interface with another network. The Ethernet switch is an HSR-enabled switch with a higher number of ports, which should be configured as the root bridge.

The number of IEDs that can be connected in the STAR can be up to 128.

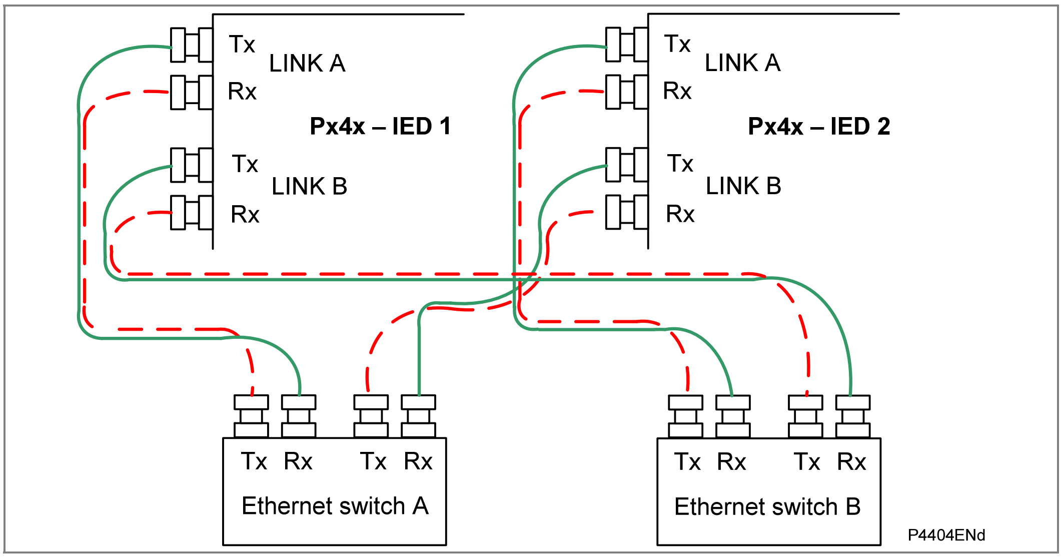

Figure 12 - PRP star connection

5.2 HSR Ring Connection

The following diagram shows the Px4x IEDs (Px4x - IED 1 to IED N) with the HSR variant of redundant Ethernet boards connected in a ring topology. The ring topology can have one or more high-end HSR-enabled Ethernet switches to interface with another network or a control center. The Ethernet switch is an HSR enabled switch with a higher number of ports.

The Ethernet switch, which is connected to the controlling PC, should be configured as the root bridge.

The number of IEDs that can be connected in the ring can be up to 128.

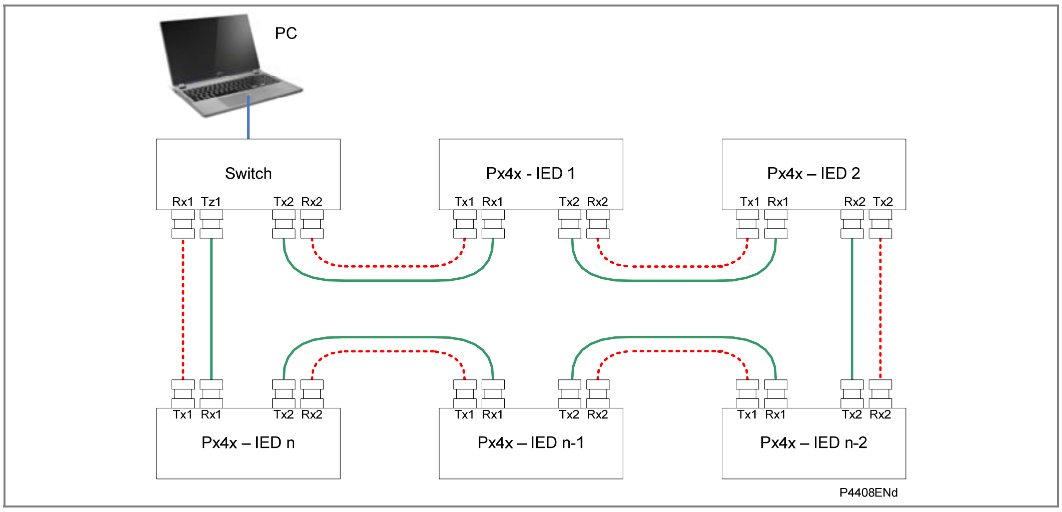

Figure 13 - HSR ring topology

The number of IEDs that can be connected in the ring can be up to 128.

6 TECHNICAL DATA

The technical data applies to a Redundant Ethernet board fitted into these MiCOM products.

- P141, P142, P143, P145
- P241, P242, P243
- P341, P342, P343, P344, P345
- P442, P443, P444, P445, P446
- P543, P544, P545, P546, P547
- P642, P643, P645
- P741, P743, P746
- P841, P849

6.1 Board Hardware

6.1.1 100 Base TX Communications Interface (in accordance with IEEE802.3 and IEC 61850)

Cable type	Screened Twisted Pair (STP)
Connector type	RJ45
Maximum distance	100m
Full Duplex	100 Mbps

Table 7 - 100 Base TX interface

6.1.2 100 Base FX Communications Interface (in accordance with IEEE802.3 and IEC 61850)

Optical fiber cable	Multi-mode 50/125 µm or 62.5/125 µm
Center wavelength	1310 nm
Connector type	LC
Maximum distance	2 km
Full Duplex	100 Mbps

Table 8 - 100 Base FX interface

6.1.3 Transmitter Optical Characteristics

(TA = -40° C to 85° C)

Parameter	Sym	Min.	Typ.	Max.	Unit
Output Optical Power 62.5/125 µm, NA = 0.275 Fiber	PO	-20	-17.0	-14	dBm avg.
Output Optical Power 50/125 µm, NA = 0.20 Fiber	PO	-23.5	-20.0	-14	dBm avg.
Optical Extinction Ratio				10	dB
Output Optical Power at Logic “0” State	PO (“0”)			-45	dBm avg.

Table 9 - Tx optical characteristics

6.1.4 Receiver Optical Characteristics

(TA = -40° C to 85° C)

Parameter	Sym	Min.	Typ.	Max.	Unit
Input Optical Power	PIN	-31		-14	dBm avg.

Table 10 - Rx optical characteristics

6.1.5 IRIG-B and Real-Time Clock

6.1.5.1 Performance

Year 2000:	Compliant
Real time accuracy:	< ±2 seconds / day
External clock synchronization:	Conforms to IRIG standard 200-98, format B

6.1.5.2 Features

Real time 24 hour clock settable in hours, minutes and seconds
Calendar settable from January 1994 to December 2092
Clock and calendar maintained via battery after loss of auxiliary supply
Internal clock synchronization using IRIG-B Interface for IRIG-B signal is BNC

6.1.5.3 Self-adapted Rear IRIG-B interface (Modulated or Unmodulated)

BNC plug
Isolation to SELV level
50 ohm coaxial cable

6.2 Type Tests

6.2.1 Insulation

Per EN / IEC 60255-27:
Insulation resistance > 100 MΩ at 500 Vdc
(Using only electronic/brushless insulation tester).

6.2.2 Creepage Distances and Clearances

Per EN / IEC 60255-27:
Pollution degree 3, Overvoltage category III,

6.2.3 High Voltage (Dielectric) Withstand

(EIA RS-232 ports excepted and normally-open contacts of output relays excepted).

(i) As for EN / IEC 60255-27:

2 kV rms AC, 1 minute:
Between all independent circuits.
Between independent circuits and case earth (ground).
1 kV rms AC for 1 minute, across open watchdog contacts.
1 kV rms AC for 1 minute, across open contacts of changeover output relays.
1 kV rms AC for 1 minute for all D-type EIA(RS)-232 or EIA(RS)-485 ports between the communications port terminals and protective (earth) conductor terminal.
1 kV rms AC for 1 minute between RJ45 ports and the case earth (ground).

(ii) As for ANSI/IEEE C37.90:

1.5 kV rms AC for 1 minute, across open contacts of normally open output relays.
1 kV rms AC for 1 minute, across open watchdog contacts.
1 kV rms AC for 1 minute, across open contacts of changeover output relays.

6.2.4 Impulse Voltage Withstand Test

As for EN / IEC 60255-27:

(i) Front time: 1.2 μs, Time to half-value: 50 μs,
Peak value: 5 kV, 0.5 J
Between all independent circuits.
Between independent circuits and case earth ground.

(ii) Front time: 1.2 μs, Time to half-value: 50 μs,
Peak value: 1.5kV, 0.5 J
Between RJ45 ports and the case earth (ground).
EIA(RS)-232 & EIA(RS)-485 ports and normally open contacts of output relays excepted.

6.3 ElectroMagnetic Compatibility (EMC)

6.3.1 1 MHz Burst High Frequency Disturbance Test

As for EN / IEC 60255-22-1, Class III,

Common-mode test voltage:	2.5 kV,
Differential test voltage:	1.0 kV,
Test duration:	2 s,
Source impedance:	200 Ω

(EIA(RS)-232 ports excepted).

6.3.2 100 kHz and 1MHz Damped Oscillatory Test

EN / IEC 61000-4-18:	Level 3
Common mode test voltage:	2.5 kV
Differential mode test voltage:	1 kV

6.3.3 Immunity to Electrostatic Discharge

As for EN / IEC 60255-22-2, EN / IEC 61000-4-2:

15kV discharge in air to user interface, display, communication ports and exposed metalwork.
6kV contact discharge to the screws on the front of the front communication ports.
8kV point contact discharge to any part of the front of the product.

6.3.4 Electrical Fast Transient or Burst Requirements

As for EN / IEC 60255-22-4, Class B:

±4.0 kV, 5kHz and 100kHz applied to all inputs / outputs excluding communication ports
±2.0 kV, 5kHz and 100kHz applied to all communication ports

As for EN / IEC 61000-4-4, severity level 4:

±2.0 kV, 5kHz and 100kHz applied to all inputs / outputs and communication ports excluding power supply and earth.
±4.0 kV, 5kHz and 100kHz applied to all power supply and earth port

Rise time of one pulse:	5 ns
Impulse duration (50% value):	50 ns
Burst duration:	15 ms or 0.75ms
Burst cycle:	300 ms
Source impedance:	50 Ω

6.3.5 Surge Withstand Capability

As for IEEE/ANSI C37.90.1:
4 kV fast transient and 2.5 kV oscillatory
applied directly across each output contact, optically isolated input, and power supply circuit.

6.3.6 Surge Immunity Test

As for EN / IEC 61000-4-5, EN / IEC 60255-26:
Time to half-value: 1.2 to 50 μs,
Amplitude: 4 kV between all groups and case earth (ground),
Amplitude: 2 kV between terminals of each group.
Amplitude: 1kV for LAN ports

6.3.7 Conducted/Radiated Immunity

For RTDs used for tripping applications the conducted and radiated immunity performance is guaranteed only when using totally shielded RTD cables (twisted leads).

6.3.8 Immunity to Radiated Electromagnetic Energy

Per EN / IEC 61000-4-3 and EN / IEC 60255-22-3, Class 3
Test field strength, frequency band 80 to 1000 MHz and
1.4 GHz to 2.7GHz: 10 V/m,
Test using AM: 1 kHz / 80%, Spot tests at 80, 160, 450, 900, 1850, 2150 MHz
Per IEEE/ANSI C37.90.2:
80MHz to 1000MHz, zero and 100% square wave modulated.
Field strength of 35V/m.

6.3.9 Radiated Immunity from Digital Communications

As for EN / IEC61000-4-3, Level 4:
Test field strength, frequency band 800 to 960 MHz,
and 1.4 to 2.0 GHz: 30 V/m, Test using AM: 1 kHz/80%.

6.3.10 Radiated Immunity from Digital Radio Telephones

As for EN / IEC 61000-4-3: 10 V/m, 900 MHz and 1.89 GHz.

6.3.11 Immunity to Conducted Disturbances Induced by Radio Frequency Fields

As for EN / IEC 61000-4-6, Level 3, Disturbing test voltage: 10 V.

6.3.12 Power Frequency Magnetic Field Immunity

As for EN / IEC 61000-4-8, Level 5,
100 A/m applied continuously, 1000 A/m applied for 3 s.
As for EN / IEC 61000-4-9, Level 5,
1000 A/m applied in all planes.
As for EN / IEC 61000-4-10, Level 5,
100 A/m applied in all planes at 100 kHz and 1 MHz with a burst duration of 2 s.

6.3.13 Conducted Emissions

As for CISPR 22 Class A:
Power supply:
0.15 - 0.5 MHz, 79 dBμV (quasi peak) 66 dBμV (average)
0.5 - 30 MHz, 73 dBμV (quasi peak) 60 dBμV (average)
Permanently connected communications ports:
0.15 - 0.5MHz, 97dBμV (quasi peak) 84dBμV (average)
0.5 - 30MHz, 87dBμV (quasi peak) 74dBμV (average)

6.3.14 Radiated Emissions

As for CISPR 22 Class A:
30 to 230 MHz, 40 dBμV/m at 10m measurement distance
230 to 1 GHz, 47 dBμV/m at 10 m measurement distance.
1 – 3GHz, 76dBμV/m (peak), 56dBμV/m (average) at 3m measurement distance.
3 – 5GHz, 80dBμV/m (peak), 60dBμV/m (average) at 3m measurement distance.

6.4 Environmental Conditions

6.4.1 Ambient Temperature Range

Per EN 60068-2-1 & EN / IEC 60068-2-2

Operating temperature range:	-25°C to +55°C (or -13°F to +131°F)
Storage and transit:	-25°C to +70°C (or -13°F to +158°F)

6.4.2 Ambient Humidity Range

Per EN /IEC 60068-2-78:

56 days at 93% relative humidity and +40 °C

Per EN / IEC 60068-2-14

5 cycles, -25°C to +55 °C
1°C / min rate of change

Per EN / IEC 60068-2-30

Damp heat cyclic, six (12 + 12) hour cycles, +25 to +55°C

6.4.3 Corrosive Environments

Per EN / IEC 60068-2-60, Part 2, Test Ke, Method (class) 3
Industrial corrosive environment/poor environmental control, mixed gas flow test.
21 days at 75% relative humidity and +30°C
Exposure to elevated concentrations of H_2S, (100 ppb), NO_2, (200 ppb) & Cl_2 (20 ppb).
Per EN / IEC 60068-2-52 Salt mist (7 days)
Per EN / IEC 60068-2-43 for H_2S (21 days), 15 ppm
Per EN / IEC 60068-2-42 for SO_2 (21 days), 25 ppm

6.5 EU Directives

6.5.1 EMC Compliance

As for 2004/108/EC:

Compliance to the European Commission Directive on EMC is demonstrated using a Technical File. Product Specific Standards were used to establish conformity:
EN 60255-26

6.5.2 Product Safety

Per 2006/95/EC:

Compliance to the European Commission Low Voltage Directive (LVD) is demonstrated using a Technical File. A product-specific standard was used to establish conformity.

CE EN 60255-27

6.5.3 R&TTE Compliance

Radio and Telecommunications Terminal Equipment (R&TTE) directive 99/5/EC.

Compliance demonstrated by compliance to both the EMC directive and the Low voltage directive, down to zero volts.

Applicable to rear communications ports.
Compliance demonstrated by Notified Body certificates of compliance.

6.5.4 Other Approvals

For ATEX Potentially Explosive Atmospheres directive 94/9/EC compliance, consult Schneider Electric.
For other approvals such as UL / CUL / CSA, consult Schneider Electric.

6.6 Mechanical Robustness

6.6.1 Vibration Test

Per EN / IEC 60255-21-1	Response Class 2 Endurance Class 2

6.6.2 Shock and Bump

Per EN / IEC 60255-21-2	Shock response Class 2 Shock withstand Class 1 Bump Class 1

6.6.3 Seismic Test

Per EN / IEC 60255-21-3:	Class 2

7 CORTEC

This is a generic Cortec to cover all IEDs using the **Redundant Ethernet** boards.
It does not necessarily include all the possible options for all products in the MiCOM Px4x range. Likewise, it is possible that options shown in this list, may not be available for all products

Variants	Order Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
MiCOM Protection		P														
Application/Platform:																
Feeder Management:			1	4	*											
Motor Protection:			2	4	*											
Generator Protection Relay:			3	4	*											
Distance Protection Relay:			4	4	*											
Current Differential:			5	4	*											
Transformer:			6	4	*											
Busbar:			7	4	*											
Breaker Fail:			8	4	*											
Vx Aux Rating:																
24 - 32 Vdc						9										
48 - 110 Vdc						2										
110 - 250 Vdc (100 - 240 Vac)						3										
In/Vn Rating (model dependent):																
Product Dependent							*									
Hardware Options (model dependent):																
Standard - no options								1								
IRIG-B only (modulated)								2								
Fibre optic converter only								3								
IRIG-B (modulated) & fibre optic converter								4								
Ethernet with 100Mits/s fibre-optic port								6								
Second Rear Comms Port (Courier EIA232/EIA485/k-bus)								7								
Second Rear Comms Port + IRIG-B (modulated) (Courier EIA232/EIA485/k-bus)								8								
InterMiCOM + Courier Rear Port								E								
InterMiCOM + Courier Rear Port + IRIG-B modulated								F								
Redundant Ethernet (100Mbit/s) PRP or HSR and Dual IP, 2 LC ports + 1 RJ45 port + Modulated/Unmodulated IRIG-B								Q								
Redundant Ethernet (100Mbit/s) PRP or HSR and Dual IP, 3 RJ45 ports + Modulated/Unmodulated IRIG-B								R								
Ethernet (100Mbit/s), 1 RJ45 port + Modulated/Unmodulated IRIG-B								S								
Product Specific Options (model dependent):																
Product Dependent									*							
Protocol Options:																
K-Bus/Courier										1						
Modbus										2						
IEC60870-5-103 (VDEW)										3						
DNP3.0										4						
IEC 61850 over Ethernet and Courier via rear K-Bus/RS485 OR IEC 61850 Edition 1 and Edition 2 and Courier via rear K-Bus/RS485										6						
IEC 61850 over ethernet with CS103 rear port RS485 protocol OR IEC 61850 Edition 1 and Edition 2 and CS103 via rear port RS485										7						
IEC 61850 Edition 1 / 2 and DNPoE and DNP3 Serial with simple password management - (CSL0)										B						
IEC 61850 Edition 1 / 2 and Courier via rear K-Bus/RS485 with advanced Cyber Security - CSL1 - Security Administration Tool (SAT) required										G						
IEC 61850 Edition 1 / 2 and CS103 via rear port RS485 with advanced Cyber Security - CSL1 - Security Administration Tool (SAT) required										H						
IEC 61850 Edition 1 / 2 and DNPoE and DNP3 Serial with advanced Cyber Security - CSL1 - Security Administration Tool (SAT) required										L						
Mounting Options:																
Flush Panel Mounting											M					

Rack Mounting (80TE only)	N
Language Options:	
English, French, German, Spanish	0
English, French, German, Russian	5
Chinese, English or French via HMI, with English or French only via Communications port	C
Software Version:	
	* *
Customisation:	
Default	8
Customer Specific	9
Design Suffix:	
Phase 3 CPU	L
Extended Phase 3 CPU	M

PRP NOTES

CHAPTER 20

Date (month/year):	12/2016			
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.			
Hardware Suffix:	P141/P142/P143 P145 P241 P242/P243 P342 P343/P344/P345 P445 P44x (P442/P444) P44y (P443/P446)	L M L M L M L M M	P54x (P543/P544/P545/P546) P642 P643/P645 P741/P743 P742 P746 P841A (one circuit breaker) P841B (two circuit breakers) P849	M L M M L M M M M
Software Version:	P14x (P141/P142/P143/P145) P24x (P241/P242/P243) P341 P34x (P342/P343/P344/P345) P445 P44x (P442/P444) P44y (P443/P446)	B0/B2 D0 B1/E1 B0/B1 J4/B0/B1/E0/E1 E0/E1 H4	P54x (P543/P544/P545/P546) P64x (P642/P643/P645) P746 P74x (P741/P742/P743) P841A P841B P849	H4 B1/B2 B1/B2/B3 C1/C2/C3 B0 G4 H4 B0/B1
Connection Diagrams:	P14x (P141, P142, P143 & P145): 10P141xx (xx = 01 to 02) 10P142xx (xx = 01 to 05) 10P143xx (xx = 01 to 11) 10P145xx (xx = 01 to 11) P24x (P241, P242 & P243): 10P241xx (xx = 01 to 02) 10P242xx (xx = 01) 10P243xx (xx = 01) P34x (P342, P343, P344, P345 & P391): 10P342xx (xx = 01 to 17) 10P343xx (xx = 01 to 19) 10P344xx (xx = 01 to 12) 10P345xx (xx = 01 to 07) 10P391xx (xx = 01 to 02) P445: 10P445xx (xx = 01 to 04) P44x(P442 & P444): 10P44101 (SH 1 & 2) 10P44201 (SH 1 & 2) 10P44202 (SH 1) 10P44203 (SH 1 & 2) 10P44401 (SH 1) 10P44402 (SH 1) 10P44403 (SH 1 & 2) 10P44404 (SH 1) 10P44405 (SH 1) 10P44407 (SH 1 & 2) P44y (P443 & P446): 10P44303 (SH 01 and 03) 10P44304 (SH 01 and 03) 10P44305 (SH 01 and 03) 10P44306 (SH 01 and 03) 10P44600 10P44601 (SH 1 to 2) 10P44602 (SH 1 to 2) 10P44603 (SH 1 to 2)		P54x (P543, P544, P545 & P546): 10P54302 (SH 1 to 2) 10P54303 (SH 1 to 2) 10P54400 10P54404 (SH 1 to 2) 10P54405 (SH 1 to 2) 10P54502 (SH 1 to 2) 10P54503 (SH 1 to 2) 10P54600 10P54604 (SH 1 to 2) 10P54605 (SH 1 to 2) 10P54606 (SH 1 to 2) P547: 10P54702xx (xx = 01 to 02) 10P54703xx (xx = 01 to 02) 10P54704xx (xx = 01 to 02) 10P54705xx (xx = 01 to 02) P64x (P642, P643 & P645): 10P642xx (xx = 1 to 10) 10P643xx (xx = 1 to 6) 10P645xx (xx = 1 to 9) P74x (P741, P742 & P743): 10P740xx (xx = 01 to 07) P746: 10P746xx (xx = 00 to 21) P841: 10P84100 10P84101 (SH 1 to 2) 10P84102 (SH 1 to 2) 10P84103 (SH 1 to 2) 10P84104 (SH 1 to 2) 10P84105 (SH 1 to 2) P849: 10P849xx (xx = 01 to 06)	

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FIGURES

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1 PARALLEL REDUNDANCY PROTOCOL (PRP) NOTES

1.1 Introduction to PRP

This section gives an introduction to the Parallel Redundancy Protocol (PRP); and how it is implemented on MiCOM-based products manufactured by Schneider Electric.

1.2 Protocols

Industrial real-time Ethernets typically need much better levels of availability and uninterrupted operation than normal office-type Ethernet solutions. For power networks, even a short loss of connectivity may result in a significant loss of functionality or impaired safety. To recover from a network failure, various redundancy schemes have been considered, including: Rapid Spanning Tree Protocol (RSTP), Media Redundancy Protocol (MRP) and Parallel Redundancy Protocol (PRP). The key properties of these are as follows:

RSTP this uses mesh-based topologies or ring topology and computes a tree, based on path costs and priorities. In case of network failure, a typical reset time for RSTP-based system is normally a few seconds.

MRP This uses ring-based topologies. In case of network failure, the network is broken into two separate lines, which are reconnected by de-blocking the previously blocked part. The guaranteed reset time for MRP protocol-based systems is typically around 100ms.

PRP this does not change the active topology as it uses two independent networks. Each message is replicated and sent over both networks. The first network node to receive it acts on it, with all later copies of the message being discarded. Importantly, these details are controlled by the low-level PRP layer of the network architecture, with the two networks being hidden from the higher level layers. Consequently, PRP-based networks are continuously available.

Power networks need to be able to respond to problems very quickly (typically in less than 10ms), and PRP is an available protocol which is robust enough to achieve this. The PRP protocol used in the MiCOM relay/IEDs is defined in the IEC62439-3 (2012) standard and is configured using the existing redundant Ethernet card(s).

1.3 PRP Summary (IEC 62439-3 Clause 4)

A summary of the main PRP features is given below:

- Ethernet redundancy method independent of any Ethernet protocol or topology (tree, ring or mesh)
- Seamless switchover and recovery in case of failure, which supports real-time communication
- Supervises redundancy continuously for better management of network devices
- Suitable for hot swap - 24 hour/365 day operation in substations
- Allows the mixing of devices with single and double network attached nodes on the same Local Area Network (LAN)
- Allows laptops and workstations to be connected to the network with standard Ethernet adapters (on double or single attached nodes)
- Particularly suited for substation automation, high-speed drives and transportation

1.4 Example of a PRP Network

Essentially a PRP network is a pair of similar Local Area Networks (LANs) which can be any topology (tree, ring or mesh). An example of a PRP network is shown in Figure 1:

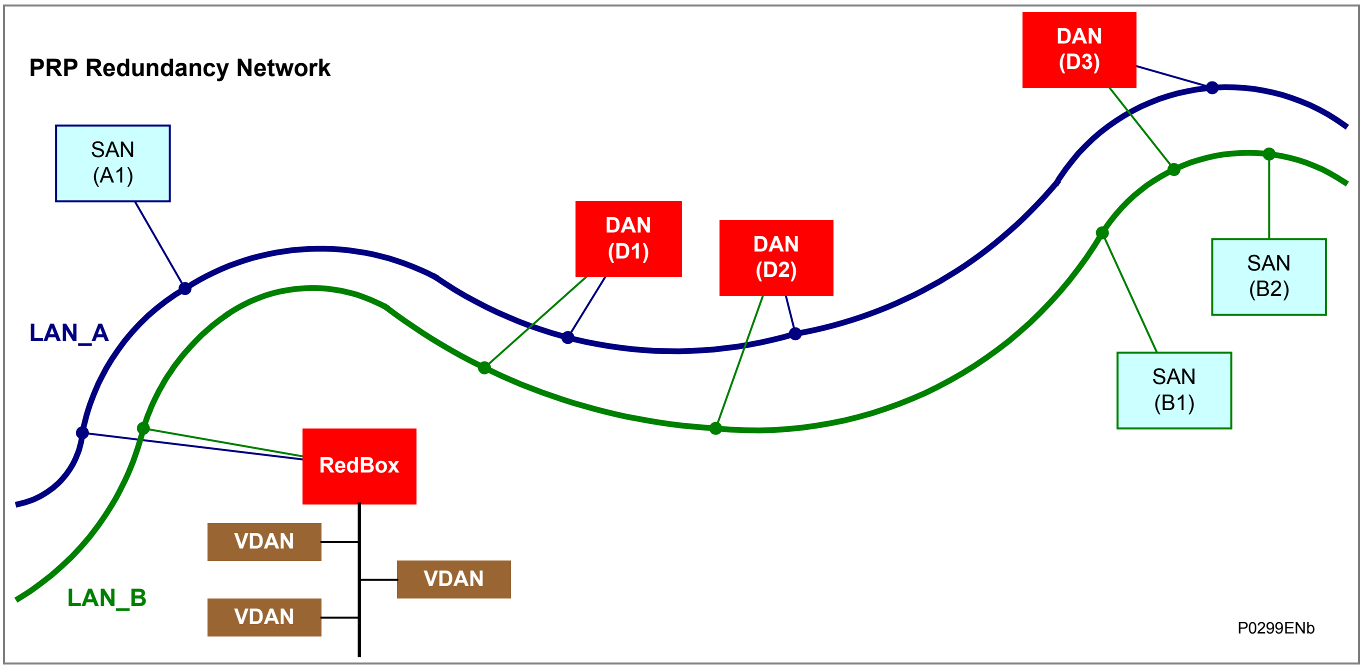

Figure 1 - PRP Redundancy Network

Figure 1 shows two similar Local Area Networks (LANs) which have various Nodes in common. The key features of these networks include:

- With the exception of a RedBox (see below), no direct cable connections can be made between the two LANs.
- Each of these LANs can have one or more Single Attached Nodes (SANs). These are normally non-critical devices that are attached only to a single network. SANs can talk to one another, but only if they are on the same LAN.
- Matched pairs of devices which are critical to the operation of the overall scheme are connected one to each network as Doubly Attached Nodes (DANs).
- To be sure that network messages (also known as frames) are transferred correctly to each DAN, each DAN must have the same Media Access Control (MAC) code and Internet Protocol (IP) address. This will also mean that TCP/IP traffic will automatically communicate with both of the paired devices, so it will be unaware of any two-layer redundancy or frame duplication issues.
- A Redundancy Box (RedBox) is used when a single interface node has to be connected to both networks. The RedBox can talk to all other nodes. So far as other nodes are concerned, the RedBox behaves like a DAN, so a SAN that is connected through a RedBox is also called a Virtual Doubly Attached Node (VDAN). The RedBox must have its own unique IP address.
- Transmission delays can be different between related Nodes of the two LANs.
- Each LAN (i.e. LAN_A and LAN_B) must be powered from a different power source and must be failure independent.

The two LANs can differ in terms of performance and topology. The redundant Ethernet interface can be made using an optical fiber connection with an LC or ST connector type or with RJ45 copper connector type. There is no need for an optical interface away from the relay.

1.5 PRP Network Structure

PRP uses two independent LANs. The topology of each of these LANs is arbitrary, and ring, star, bus and meshed topologies are possible.

The main advantage of PRP is loss-free data transmission with an active (transit) LAN. When the terminal device receives no packets from one of the LANs, the second (transit) LAN maintains the connection. As long as 1 (transit) LAN is available, repairs and maintenance on the other (transit) LAN have no impact on the data packet transmission.

The elementary devices of a PRP network are known as RedBox (Redundancy Box) and DANP (Double Attached Node implementing PRP).

Both devices have one connection each to the (transit) LANs.

The devices in the (transit) LAN are conventional switches that do not require any PRP support. The devices transmit PRP data packets transparently, without evaluating the RCT information.

Terminal devices that are connected directly to a device in the (transit) LAN are known as SAN (Single Attached Node). If there is an interruption, these terminal devices cannot be reached via the redundant line. To use the uninterruptible redundancy of the PRP network, you integrate your device into the PRP network via a RedBox.

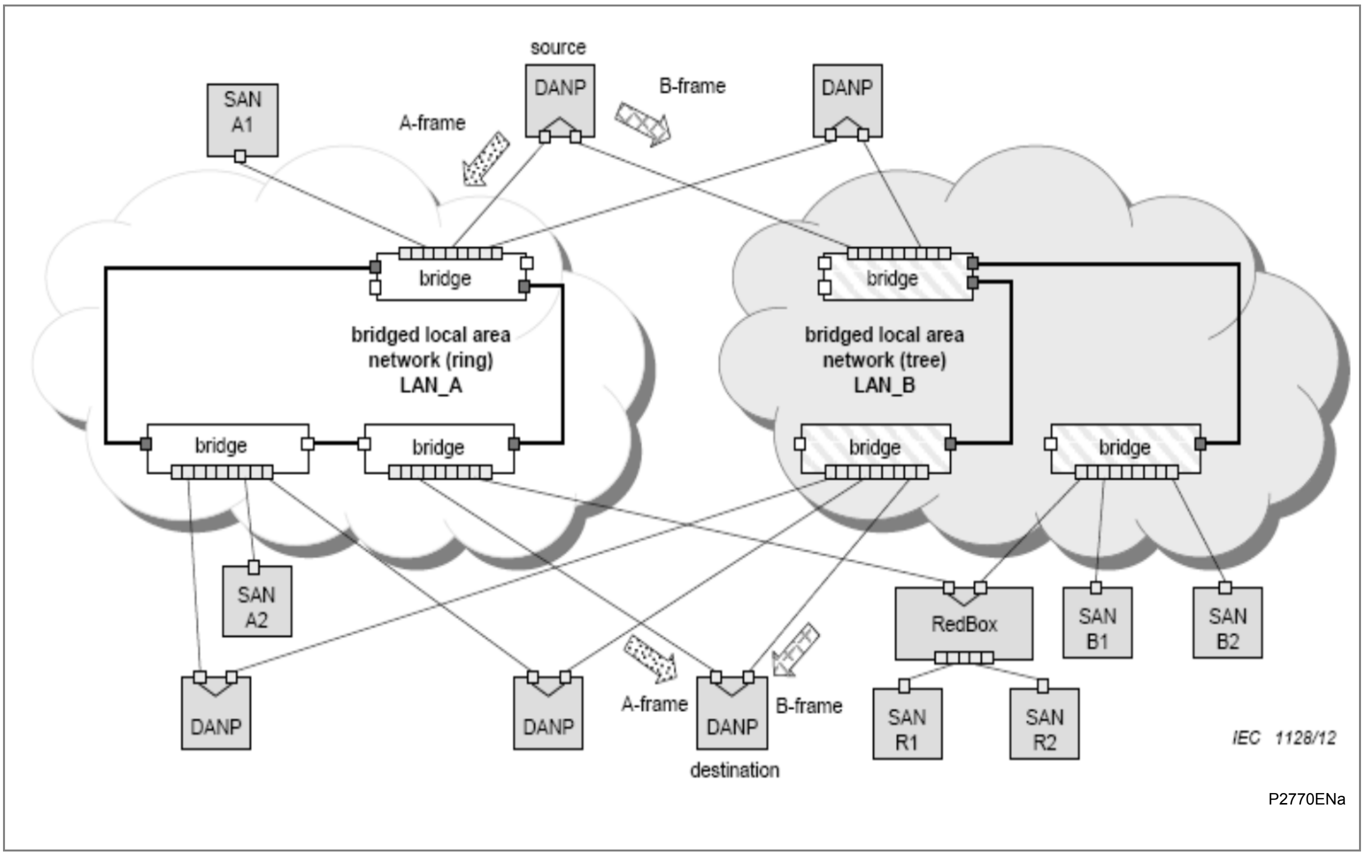

Figure 2 - PRP example of general redundant network

1.6 Structure of a DAN

A MiCOM P40 relay working in PRP Mode works as a DAN within the overall network topology. Each DAN has two ports that operate in parallel. They are attached to the upper layers of the communications stack through the Link Redundancy Entity (LRE) as in Figure 3:

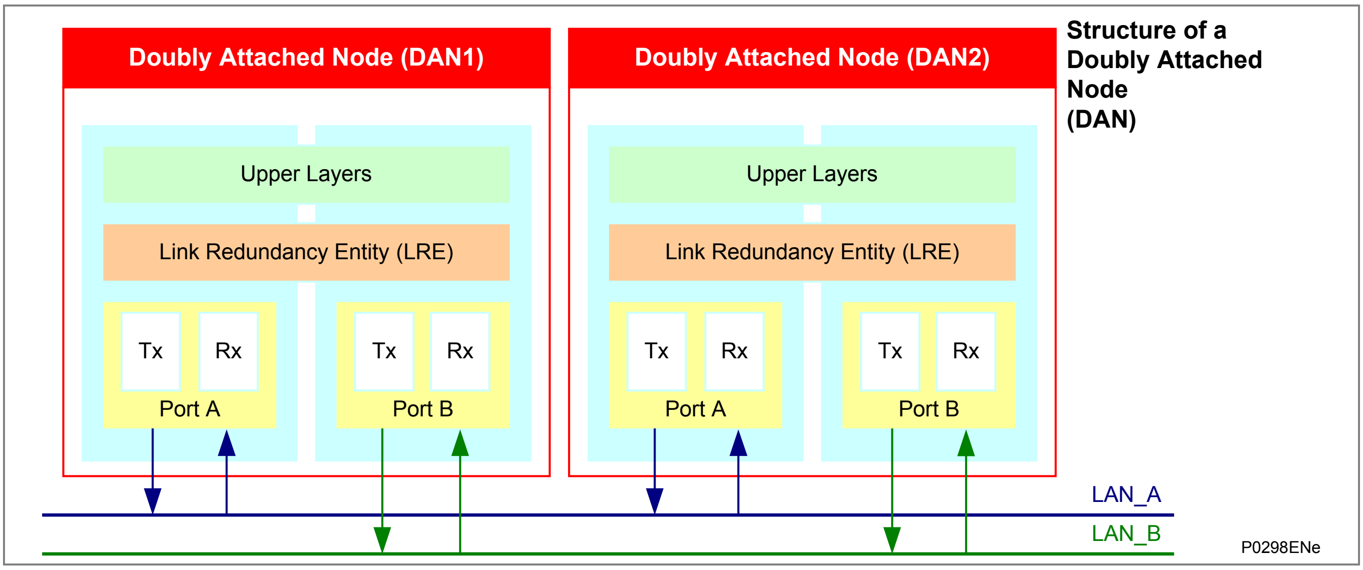

Figure 3 - Communication between two DANs (in PRP)

The LRE has two main tasks:

- handling message frames and
- management of redundancy

When an upper layer sends a frame to the LRE, the LRE replicates the frame and sends it through both its ports at nearly the same time. The two frames move through the two LANs with slightly different delays, ideally arriving at the destination node within a small time window.

When receiving frames, the LRE forwards the first frame it received to its upper layers and then discards the duplicate.

As both DAN nodes have the same MAC and IP addresses, this makes redundancy transparent to the upper layers. This allows the Address Resolution Protocol (ARP) to work in the same way as with a SAN. Accordingly, to the upper layers of a DAN, the LRE layer shows the same interface as the network adapter of a non-redundant adapter.

To manage redundancy, the LRE:

- Adds a 32-bit Redundancy Check Tag (RCT) to each frame it sends and
- Removes the RCT from each frame it receives

1.7 Communication between SANs and DANs

A SAN can be connected to any LAN and can communicate with any other SAN on the same LAN or any DAN. However, a SAN which connected to one LAN can not communicate directly to a SAN which is connected to the other LAN.

A DAN is connected to both LANs and can communicate with any RedBox or any other DANs or any SANs on either network. For communication purposes, a DAN “views” a SAN connected through a RedBox as a VDAN.

When a SAN generates a basic frame, it sends the frame only onto the LAN to which it is connected.

Originating at the SAN, a typical frame contains these parameters:

- dest_addr Destination Address
- src_addr Source Address
- type Type
- data
- fcs Frame Check Sequence (i.e. extra checksum characters added to allow error detection and correction)

The frame from the SAN is then received by the DAN; which sends the frame to its upper layers, which act accordingly.

When a DAN generates a frame, it needs to send the frame onto both of the LANs to which it is connected. When it does this, it extends the frame by adding the 48-bit Redundancy Control Trailer (RCT) into the frame.

The RCT consists of these parameters:

- 16-bit Sequence Number
- 4-bit LAN identifier, 1010 (0xA) for LAN_A and 1011 (0xB) for LAN_B
- 12-bit frame size
- PRP suffix

Note	*The Sequence number is a measure of the number of messages which have been sent since the last system reset. Each time the link layer sends a frame to a particular destination the sender increases the sequence number corresponding to that destination and sends the (nearly) identical frames over both LANs.*

Accordingly, originating at the DAN, a typical frame then contains these parameters:

- dest_addr Destination Address
- src_addr Source Address
- type Type
- lsdu Link Service Data Unit
- Padding if needed
- RCT data:
    - 16-bit sequence number:
      4-bit LAN identifier
      12-bit frame size
    - 16-bit PRP suffix (0X88 0XFB)
- fcs Frame Check Sequence

LSDU	*The Link Service Data Unit (LSDU) data allows PRP frames to be distinguished from none-PRP frames.*
Padding	*After the LSDU data, there may be some data padding. This is added to frames which would otherwise be too short for conventional network traffic (minimum frame size is 64 octets).*

Size	*The frame size will vary depending on the contents of the frame and how it has been tagged by the various SANs and DANs. In VLANs, frame tags may be added or removed during transit through a switch. To make the length field independent of tagging, only the LSDU and the RCT are considered in the size.*

Figure 4 shows the frame types with different types of data.

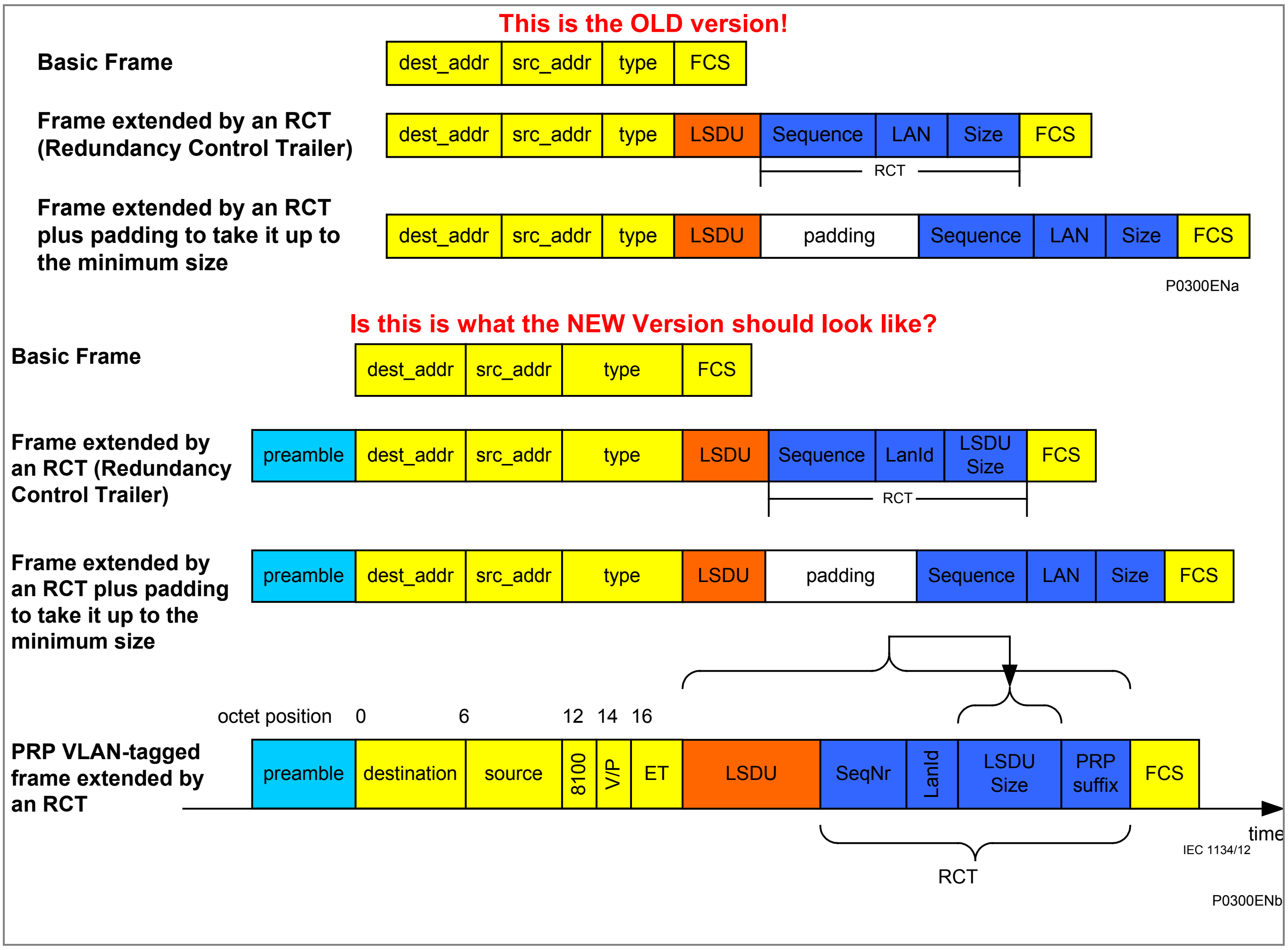

Figure 4 - Frames without and with RCT and padding

The key points about these differing frame structures is that:

- SANs do not implement any redundancy features, so they generate basic frames which SANs and DANs can understand.
- SANs can still understand the frames that come from DANs, as SANs ignore the RCT components in frames which come from DANs (a SAN cannot distinguish the RCT from the IEEE802.3 padding)
- If a DAN receives a frame which does not include the RCT component, it sends a single copy of the frame to its upper layers.
- If a DAN receives a frame which does include the RCT component, it does not send a duplicate copy of the frame to its upper layers.
- If a DANP cannot identify that the remote Node is a DAN, it inserts no RCT.

When using a Single Attached Nodes connected to the IED, a redbox is suggested to handle the case when the TPDU size for the client has been set above than 1024.

1.8 PRP Technical Data

- One VLAN tag supported.
- 128 publishers supported per receiver.
- Up to 100Mbit/s full duplex Ethernet.
- Dynamic frame memory allocation (page manager).
- Configurable duplicate detection.
- Wishbone interface for configuration and status registers.
- CPU port interface - Ethernet or Wishbone.
- Support for link-local protocols - CPU may send to specific ports only - CPU knows receive port.
- Configurable frame memory and queue length.
- Duplicate detection with configurable size and aging time.
- MAC address filtering (8 filter masks for interlink, 6 for CPU).
- Support for interfaces with or without Ethernet preamble.

Maximum Transmission Unit

According to the IEC 8802-3, the MTU (Ethernet maximum packet size) is:

- 1518 bytes without VLAN and without PRP
- 1522 bytes with VLAN and without PRP
- 1524 bytes without VLAN and with PRP
- 1528 bytes with VLAN and with PRP

Note: Check that the LAN switches setting for the MTU is at least 1528 bytes

2 PRP AND MICOM FUNCTIONS

2.1 MiCOM Products and PRP

The PRP functions being introduced as part of the overall MiCOM product range provide additional functionality, which is backwards compatible with existing Schneider Electric MiCOM equipment. This means that existing MiCOM relays/IEDS can be used on networks which use PRP functions, with no changes being made to those relays/IEDs.

The new MiCOM products that use the PRP, will interrogate other equipment to determine the equipment model number, and then use the model number to decide (at runtime), whether that particular item of equipment can support PRP or not.

MiCOM models which include the following Ethernet board assembly provide the possibility of PRP function support. This is denoted by Digit 7 where the Hardware option is N, P, Q or R, as shown in Table 1:

Hardware Option	Type	Model No format
"N" at Digit No 7	2 ST ports redundant Ethernet board (Modulated IRIG-B)	**Px4xxxNx6Mxxx8K**
"P" at Digit No 7	2 ST ports redundant Ethernet board (Un-modulated IRIG-B)	**Px4xxxPx6Mxxx8K**
"Q" at Digit No 7	2 LC + 1 RJ45 ports redundant Ethernet board (Modulated/ Un-modulated IRIG-B)	**Px4xxxQx6Mxxx8M**
"R" at Digit No 7	3 RJ45 ports redundant Ethernet board (Modulated/ Un-modulated IRIG-B)	**Px4xxxRx6Mxxx8M**

Table 1 - MiCOM model numbers for PRP options

The MiCOM relay/IED firmware has been modified to allow the PRP options to be accepted for the power-up tests in addition to the implementation of the supervision frame transmission.

2.2 MiCOM S1 Studio Software and the PRP Function

The addition of this function has no impact of the MiCOM S1 Studio support files so there is no need to upgrade any MiCOM S1 Studio software.

2.3 MiCOM Relay Configuration and the PRP Function

There is no need to change the configuration of any relay (as relays which include support for this function will be able to recognize other devices which support it).

2.4 Hardware Changes for PRP Protocol

This protocol is implemented using the existing redundant Ethernet and dual redundant Ethernet card as a starting point. The Frame management is achieved by re-programming the Field-Programmable Gate Array (FPGA).

The low-level management of the redundant frames is performed within the FPGA; this being defined as the Link Redundancy Entity (LRE). This will involve the addition of the Redundancy Check Tag (RCT) to a frame to be transmitted; this identifies the LAN and the sequence number of the message over the two networks. The FPGA is also responsible for the stripping of the RCT from received frames and discarding the duplicated messages such that only a single application frame is received by the Ethernet processor.

The LRE functionality of the supervision frame transmission is performed by the Ethernet processor card.

2.5 PRP Parameters

The Redundant Ethernet standard (IEC 62439-3:2012) defines several parameters for the PRP protocol; these being fixed at a default value within this release. The following values are set:

Parameter	Value	Description
Supervision Frame Multicast Address	01-15-4E-00-01-00	Target MAC Address for multicast supervision frame
Life Check Interval	2 seconds	Period between transmission of supervision frames
PRP Mode	Duplicate Discard	This is normal PRP mode, Duplicate address will not be supported.
Node Forget Time	60 s	This is the time after which a node entry is cleared.
Entry Forget Time	400 ms	Duration that the received message Sequence number will be held to discard a duplicate message.
Node Reboot Interval	500ms	Duration following reboot for which no PRP frames should be transmitted.

Table 2 - PRP parameter values (for PRP Protocol Version 1)

2.6 Product Implementation Features

Here is a list of the main Product Requirements for MiCOM products which support PRP:

- The MiCOM relay/IED provides two redundant Ethernet ports using PRP.
- The MiCOM relay/IED must be connected to the redundant Ethernet network as a Double Attached Node (DAN) using PRP (DAN using PRP is known as DANP)
- The redundant Ethernet interface can be made using an RJ45 or an optical fibre connection with an LC or ST connector type (Ethernet card dependent).
- The management of the PRP redundancy is transparent to the application data provided via the Ethernet interface.
- The PRP option is available with any of the existing protocol options via the Ethernet Interface (IEC61850 and/or DNPoE)
- Loss of one of the LAN connections to the device does not cause any loss or degradation to the Application data over the Ethernet interface.
- The MiCOM relay/IED supports the transmission of the PRP Supervision frame at a fixed time period (LifeCheckInterval) of 2s (+/- 100ms)
- Each supervision frame includes a sequence number as defined in the IEC 62439-3:2012 specification. This is incremented for each supervision message and the value starts from zero following a system restart.
- The MiCOM relay/IED does not process received supervision frames to provide supervision of the redundant network.
- The MiCOM relay/IED does not provide for the PRP management to be configured (via either the MiCOM relay/IED HMI or the Ethernet interface). Accordingly, the default values (as defined within this document) are used for all PRP parameters.
- The performance of the Ethernet Interface is not degraded by using the PRP interface.

2.6.1 Abbreviations and Acronyms

Abbreviations / Acronyms	Meaning
CRC	Cyclic Redundancy Check
DAN	Doubly Attached Nodes
DANP	Doubly Attached Node implementing PRP
FPGA	Field-Programmable Gate Array
HMI	Human Machine Interface
IED	Intelligent Electronic Devices
IP	Internet Protocol
LAN	Local Area Network
LRE	Link Redundancy Entity
MAC	Media Access Control
MRP	Media Redundancy Protocol
PRP	Parallel Redundancy Protocol
RCT	Redundancy Check Tag
RedBox	Redundancy Box
RSTP	Rapid Spanning Tree Protocol
SAN	Singly Attached Node
TCP	Transmission Control Protocol
VDAN	Virtual Doubly Attached Node

Notes:

HSR NOTES

CHAPTER 21

Date (month/year):	11/2016			
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.			
Hardware Suffix:	P141/P142/P143	L	P54x (P543/P544/P545/P546)	M
	P145	M	P642	L
	P241	L	P643/P645	M
	P242/P243	M	P741/P743	M
	P342	L	P742	L
	P343/P344/P345	M	P746	M
	P391	A	P74x (P741, P743)	K
	P445	L	P841A (one circuit breaker)	M
	P44x (P441/P442/P444)	K	P841B (two circuit breakers)	M
	P44x (P442/P444)	M	P849	M
	P44y (P443/P446)	M		
Software Version:	P14x (P141/P142/P143/P145)	B0/B2	P54x (P543/P544/P545/P546)	H4
	P24x (P241/P242/P243)	D0	P64x (P642/P643/P645)	B2
	P34x (P342/P343/P344/P345/P391)	B0	P746	B3/C3
	P445	J4	P74x (P741/P742/P743)	B0
	P44x (P442/P444)	E0/E1	P841A	G4
	P44y (P443/P446)	H4	P841B	H4
			P849	B0/B1
Connection Diagrams:	P14x (P141, P142, P143 & P145): 10P141xx (xx = 01 to 02) 10P142xx (xx = 01 to 05) 10P143xx (xx = 01 to 11) 10P145xx (xx = 01 to 11) P24x (P241, P242 & P243): 10P241xx (xx = 01 to 02) 10P242xx (xx = 01) 10P243xx (xx = 01) P34x (P342, P343, P344, P345 & P391): 10P342xx (xx = 01 to 17) 10P343xx (xx = 01 to 19) 10P344xx (xx = 01 to 12) 10P345xx (xx = 01 to 07) 10P391xx (xx = 01 to 02) P445: 10P445xx (xx = 01 to 04) P44x(P442 & P444): 10P44101 (SH 1 & 2) 10P44201 (SH 1 & 2) 10P44202 (SH 1) 10P44203 (SH 1 & 2) 10P44401 (SH 1) 10P44402 (SH 1) 10P44403 (SH 1 & 2) 10P44404 (SH 1) 10P44405 (SH 1) 10P44407 (SH 1 & 2) P44y (P443 & P446): 10P44303 (SH 01 and 03) 10P44304 (SH 01 and 03) 10P44305 (SH 01 and 03) 10P44306 (SH 01 and 03) 10P44600 10P44601 (SH 1 to 2) 10P44602 (SH 1 to 2) 10P44603 (SH 1 to 2)		P54x (P543, P544, P545 & P546): 10P54302 (SH 1 to 2) 10P54303 (SH 1 to 2) 10P54400 10P54404 (SH 1 to 2) 10P54405 (SH 1 to 2) 10P54502 (SH 1 to 2) 10P54503 (SH 1 to 2) 10P54600 10P54604 (SH 1 to 2) 10P54605 (SH 1 to 2) 10P54606 (SH 1 to 2) P547: 10P54702xx (xx = 01 to 02) 10P54703xx (xx = 01 to 02) 10P54704xx (xx = 01 to 02) 10P54705xx (xx = 01 to 02) P64x (P642, P643 & P645): 10P642xx (xx = 1 to 10) 10P643xx (xx = 1 to 6) 10P645xx (xx = 1 to 9) P74x (P741, P742 & P743): 10P740xx (xx = 01 to 07) P746: 10P746xx (xx = 00 to 21) P841: 10P84100 10P84101 (SH 1 to 2) 10P84102 (SH 1 to 2) 10P84103 (SH 1 to 2) 10P84104 (SH 1 to 2) 10P84105 (SH 1 to 2) P849: 10P849xx (xx = 01 to 06)	

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1 INTRODUCTION TO HSR

1.1 Introduction to High-availability Seamless Redundancy (HSR)

This section gives an introduction to the High-availability Seamless Redundancy (HSR); and how it is implemented on MiCOM-based products manufactured by Schneider Electric.

1.2 Protocols

Industrial real-time Ethernets typically need much better levels of availability and uninterrupted operation than normal office-type Ethernet solutions. For power networks, even a short loss of connectivity may result in a significant loss of functionality or impaired safety. To recover from a network failure, various redundancy schemes have been considered, including: Rapid Spanning Tree Protocol (RSTP), Media Redundancy Protocol (MRP), High-availability Seamless Redundancy (HSR). The key properties of these are as follows:

RSTP This uses mesh-based topologies or ring topology and computes a tree, based on path costs and priorities. In case of network failure, a typical reset time for RSTP-based system is normally a few seconds.

MRP This uses ring-based topologies. In case of network failure, the network is broken into two separate lines, which are reconnected by de-blocking the previously blocked part. The guaranteed reset time for MRP protocol-based systems is typically around 100ms.

HSR HSR basically uses ring topology, This Clause describes the application of the HSR principles (Clause 5) to implement a High-availability Seamless Redundancy (HSR), retaining the PRP property of zero recovery time, applicable to any topology, in particular rings and rings of rings. With respect to PRP, HSR allows to roughly halve the network infrastructure. With respect to rings based on IEEE 802.1D (RSTP), IEC 62439-2 (MRP), IEC 62439-6 (DRP) or IEC 62439-7 (RRP), the available network bandwidth for network traffic is somewhat reduced depending on the type of traffic. Nodes within the ring are restricted to be HSR-capable bridging nodes, thus avoiding the use of dedicated bridges. Singly Attached Nodes (SANs) such as laptops or printers cannot be attached directly to the ring, but need attachment through a RedBox (redundancy box).

Power networks need to be able to respond to problems very quickly (typically in less than 10ms), and HSR is an available protocol which is robust enough to achieve this. The HSR protocol used in the MiCOM relay/IED is defined in the IEC62439-3 (2012) standard and is configured using the existing redundant Ethernet card(s).

1.3 HSR Summary (IEC 62439-3 Clause 5)

A summary of the main HSR features is given below:

- HSR Ethernet redundancy method independent of any industrial Ethernet protocol and typically used in a ring topology
- Seamless switchover and recovery in case of failure, which supports real-time communication
- Supervises redundancy continuously for better management of network devices
- Suitable for hot swap, 24 hour/365 day operation in substations
- Allows laptops and workstations to be connected to the network with HSR Redbox
- Particularly suited for substation automation, high-speed drives and transportation

1.4 Example of an HSR Network

Essentially a HSR network is a ring topology. An example of a HSR network is shown in Figure 1:

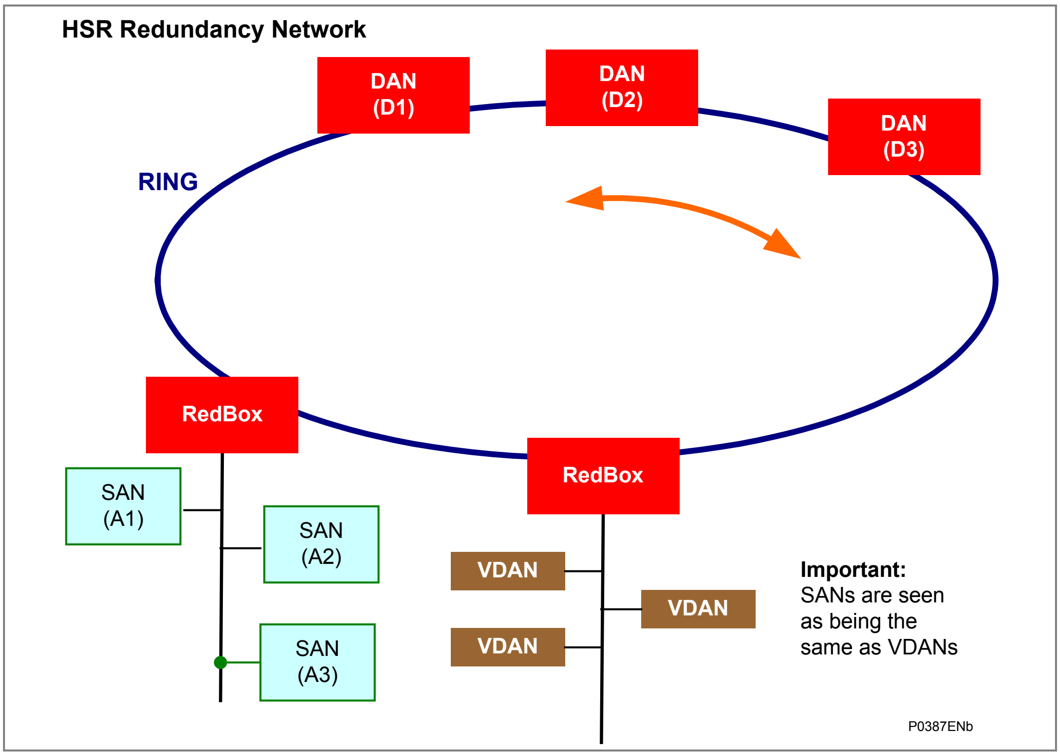

Figure 1 - HSR Redundancy Network

Figure 1 shows typical ring networks that have various Nodes in common.

The key features of the network include:

- Nodes within the ring are restricted to be HSR-capable bridging nodes, thus avoiding the use of dedicated bridges
- Singly Attached Nodes (SANs) such as laptops or printers cannot be attached directly to the ring, but need attachment through a RedBox (redundancy box)
- A simple HSR network consists of doubly attached bridging nodes, each having two ports, interconnected by full-duplex link
- A source DANH sends a frame passed from its upper layers, prefixes it by an HSR tag to identify frame duplicates and sends the frame over each port
- A destination DANH receives, in the fault-free state, two identical frames from each port within a certain interval, if it is a multicast frame, it instantaneously forwards it on the ring (see Note *), removes the HSR tag of the first frame before passing it to its upper layers and discards any duplicate.

*Note **	*In particular, the node will not forward a frame that it injected into the ring.*
*Note **	*A destination node of a unicast frame does not forward a frame for which it is the only destination, except for testing.*

1.5 Structure of a DAN

A MiCOM P40 relay working in HSR Mode works as a DAN within the overall network topology. Each DAN has two ports that operate in parallel. As in Figure 2, The two HSR ports A and B and the device port C are connected by the LRE, which includes a switching matrix allowing to forward frames from one port to the other. The switching matrix allows cut-through bridging. The Link Redundancy Entity (LRE) presents to the higher layers the same interface as a standard Ethernet transceiver would do.

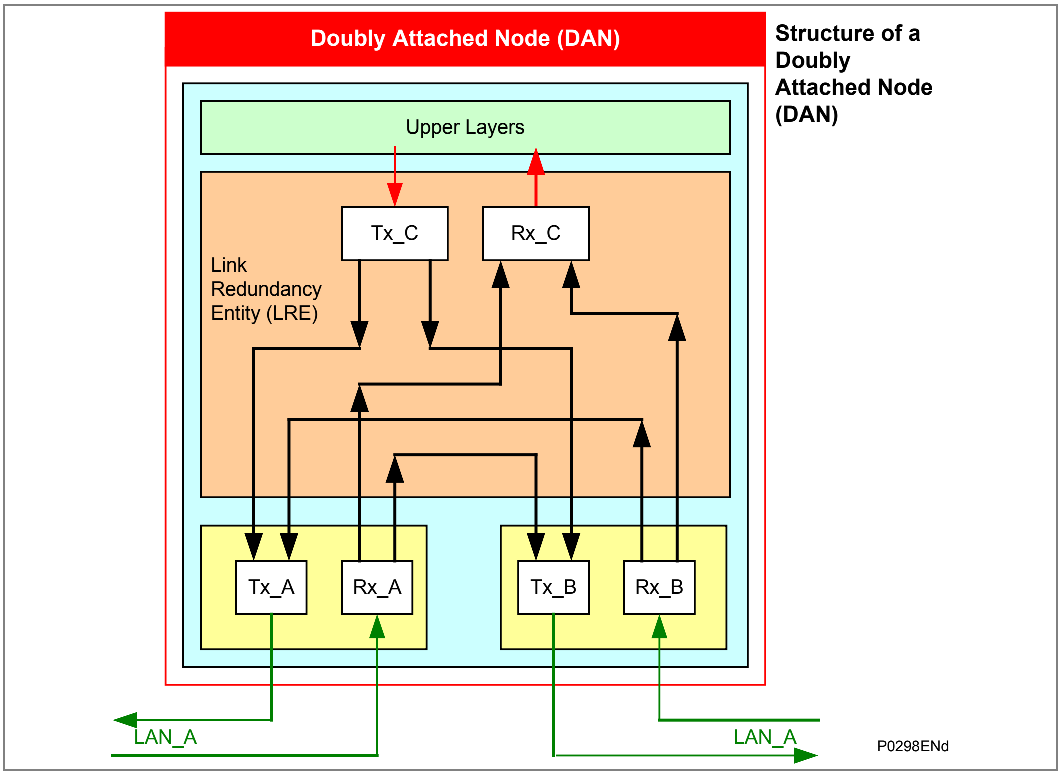

Figure 2 - DAN communication between two paths (in HSR)

DAN node is operable in HSR-tagged forwarding mode, the DAN inserts the HSR tag on behalf of its host and forwards the ring traffic, except for frames sent by the node itself. Duplicate frames and frames where the node is the unicast destination is not forwarded.

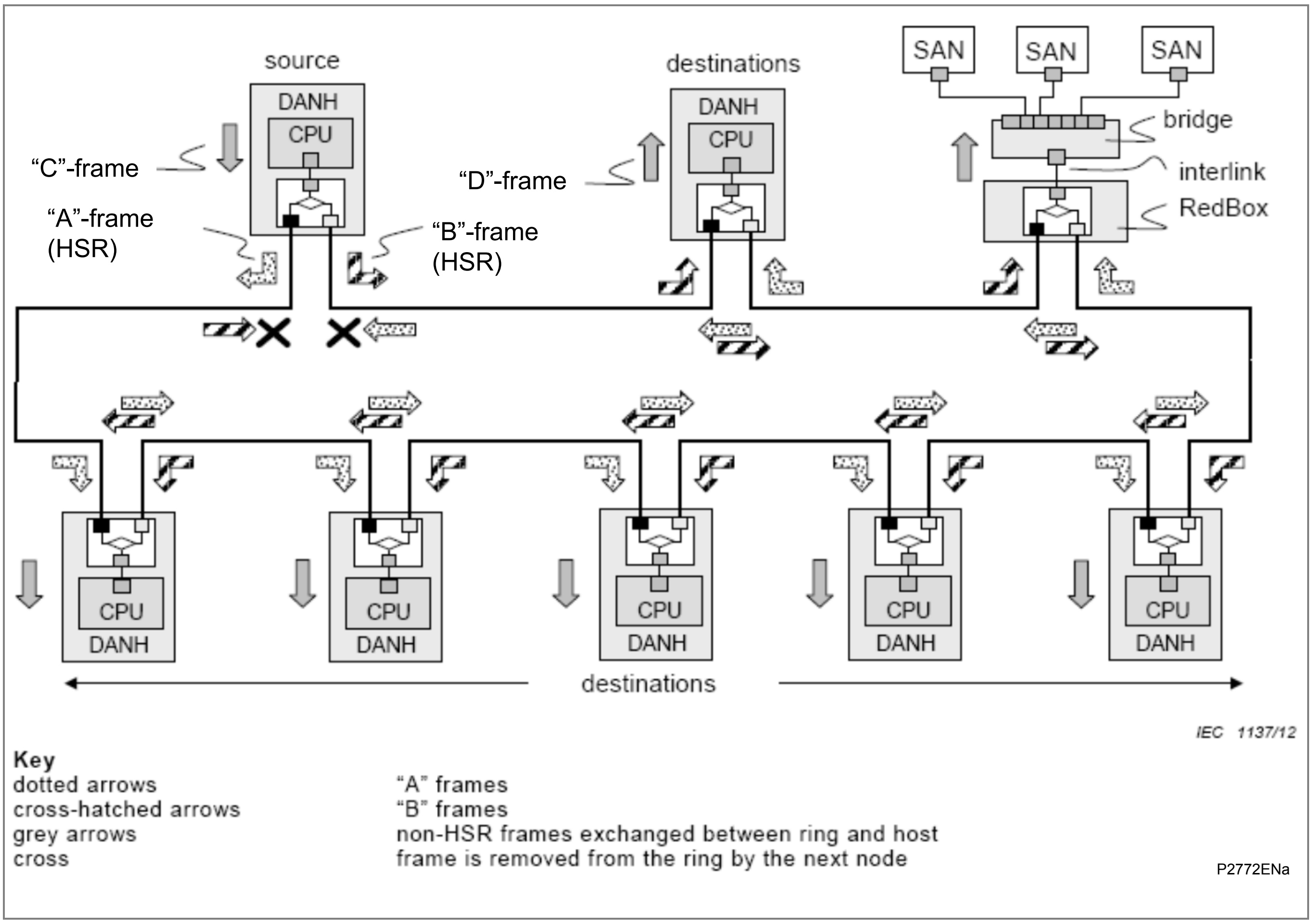

Figure 3 - HSR example of ring configuration for multicast traffic

1.6 Structure of a RedBox

The RedBox has a LRE that performs the duties of the HSR protocol, in particular:

- forwards the frames received from one HSR port to the other HSR port, unless the frame receives frames addressed to its own upper protocols
- prefixes the frames sent by its own upper layers with the corresponding HSR tag before sending two copies over its HSR ports

The switching logic is incorporated into the RedBox, so interlink becomes an internal connection.

A simple RedBox is present in every node, since the LRE makes a transition to a single non-HSR host. In addition, it is usual to have more than one host in a node, since a port for maintenance often exists.

A node does not send over a port a frame that is a duplicate of a frame previously sent over that port in that same direction.

For the purpose of Duplicate Discard, a frame is identified by:

- its source MAC address;
- its sequence number.

The Duplicate Discard method forgets an entry identified by <Source MAC Address><Sequence number> after a time EntryForgetTime.

1.7 Communication between SANs, DANs and RedBoxs

Singly Attached Nodes (SANs), for instance maintenance laptops or printers cannot be inserted directly into the ring since they have only one port and cannot interpret the HSR tag in the frames. SANs communicate with ring devices through a RedBox (Redundancy Box) that acts as a proxy for the SANs attached to it.

A source DANH sends a frame passed from its upper layers, and prefixes it by an HSR tag to identify frame duplicates and sends the frame over both ports.

A destination DANH receives, in the fault-free state, two identical frames from each port within a certain interval, if it is a multicast frame, it instantaneously forwards it on the ring, removes the HSR tag of the first frame before passing it to its upper layers and discards any duplicate.

A typical frame contains these parameters:

- dest_addr Destination Address
- src_addr Source Address
- type Type
- data
- fcs Frame Check Sequence (i.e. extra checksum characters added to allow error detection and correction)

HSR frames are identified uniquely by their HSR tag.

The HSR tag consists of these parameters:

- 16-bit Ethertype (HSR_EtherType = 0x892F)
- 4-bit path identifier (PathId), 0000 for both HSR nodes A and B, and 0010-1111 for one of 7 PRP networks (A/B).
- 12-bit frame size (LSDUsize)
- 16-bit Sequence Number (SeqNr)

Note	*The 4-bit PathId field prevents reinjection of frames coming from one PRP network to another PRP network.*

Accordingly, a typical HSR frame then contains these parameters:

- dest_addr Destination Address
- src_addr Source Address
- HSR tag data:
  - 16-bit Ethertype (HSR_EtherType = 0x892F)
  - 4-bit path identifier
  - 12-bit frame size
  - 16-bit sequence number:
- type Type
- payload Payload
- Padding if needed
- fcs Frame Check Sequence

Padding	*After the payload data, there may be some data padding. This is added to frames which would otherwise be too short for conventional network traffic (minimum frame size is 70 octets).*
Size	*The frame size will vary depending on the contents of the frame and how it has been tagged by the various SANs and DANs. In VLANs, frame tags may be added or removed during transit through a switch. To make the length field independent of tagging, only the original LPDU and the HSR tag are considered in the size.*

Figure 4 and Figure 5 shows the frame types with different types of data.

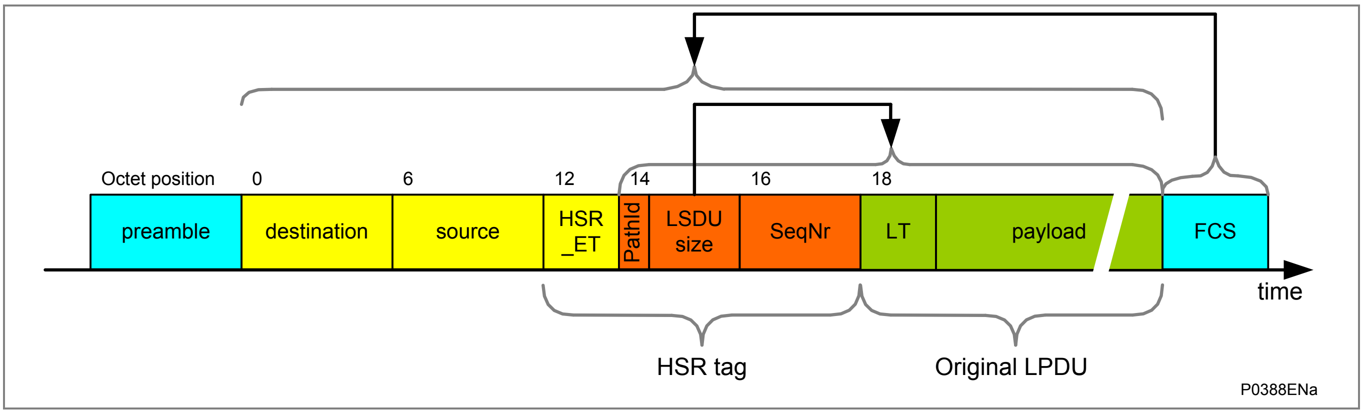

Figure 4 - HSR frame without a VLAN tag

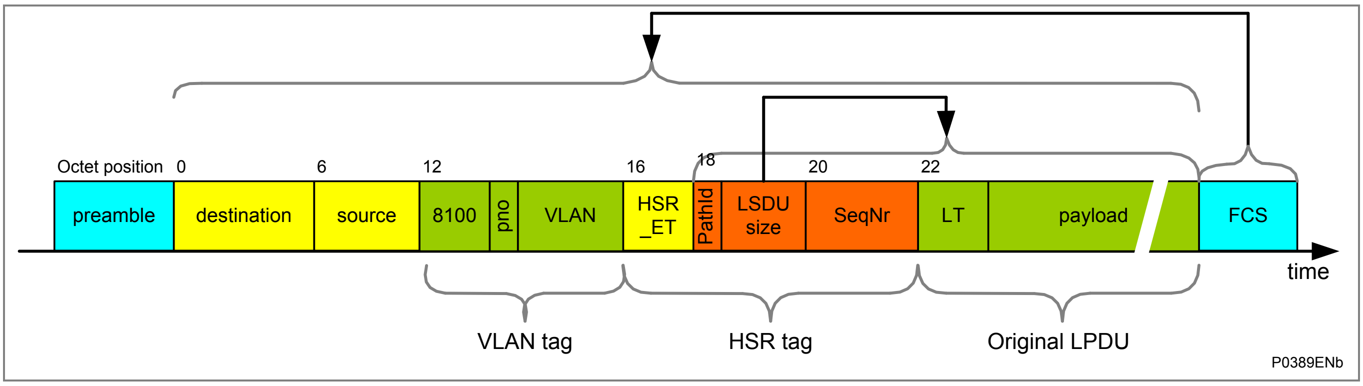

Figure 5 - HSR frame with VLAN tag

The key points about these differing frame structures are that:

- Unlike PRP, SANs cannot be attached directly to such a duplicated network unless they are able to interpret the HSR tag.
- In particular, the node will not forward a frame that it injected into the ring.
- A destination node of a unicast frame does not forward a frame for which it is the only destination, except for testing.
- DANH receiving from an HSR port, if this frame is not HSR-tagged and is a link local traffic, consume the frame and do not forward it.
- DANH receiving from an HSR port, if this frame is HSR-tagged and this node is not a destination, do not pass the frame to the link layer interface.
- A node accepts an HSR tagged frame also if the LanId does not correspond to the PortId and if the LSDUsize does not match the frame size.

1.8 HSR Technical Data

- One VLAN tag supported
- Up to 128 devices supported
- Up to 100Mbit/s full duplex Ethernet
- Dynamic frame memory allocation (page manager)
- Configurable duplicate detection
- Wishbone interface for configuration and status registers
- CPU port interface - Wishbone
- Support for link-local protocols - CPU may send to specific ports only - CPU knows receive port
- Configurable frame memory and queue length
- Duplicate detection with configurable size and aging time

- MAC address filtering (8 filter masks for interlink port, 6 for CPU port)
- Support for interfaces with or without Ethernet preamble

Limitations:

Number of IEDs on a same ring at 100Mbit/s:

Each hop (IED or RedBox) not only carries its own messages but also all the other IED messages thus the bandwidth used is proportional to the number of IEDs.

The maximum number of hops is around 20 when the GOOSE messages are highly used or 40 if the number and importance of GOOSE messages is not high.

When Precision Time Protocol («IEEE1588/IEC 61588») is used:

As the GPS receiver inaccuracy is 200ns and as each hop (IED or RedBox) can add a 50ns inaccuracy, the maximum number of hops is 16 if 1µs accuracy is required (PMU application or Process Bus)

2 HSR AND MICOM FUNCTIONS

2.1 MiCOM Products and HSR

The HSR functions being introduced as part of the overall MiCOM product range provide additional functionality, which is backwards compatible with existing Schneider Electric MiCOM equipment. This means that existing MiCOM relays/IEDS can be used on networks, which use HSR functions, with no changes being made to those relays/IEDs.

The new MiCOM products that use the HSR, will interrogate other equipment to determine the equipment model number, and then use the model number to decide (at runtime), whether that particular item of equipment can support HSR or not.

MiCOM models which include the following Ethernet board assembly provide the possibility of HSR function support. This is denoted by Digit 7 where the Hardware option is Q or R, as shown below:

Hardware Option	Type	Model No format
"Q" at Digit No 7	2 LC + 1 RJ45 ports redundant Ethernet board (Modulated/ Un-modulated IRIG-B)	**Px4xxxQx6Mxxx8M**
"R" at Digit No 7	3 RJ45 ports redundant Ethernet board (Modulated/ Un-modulated IRIG-B)	**Px4xxxRx6Mxxx8M**

Table 1 - Hardware option numbers with HSR functions

The MiCOM relay/IED firmware has been modified to allow the HSR options to be accepted for the power-up tests in addition to the implementation of the supervision frame transmission.

2.2 MiCOM S1 Studio Software and the HSR Function

The addition of this function has no impact of the MiCOM S1 Studio support files so there is no need to upgrade any MiCOM S1 Studio software.

2.3 MiCOM Relay Configuration and the HSR Function

There is no need to change the configuration of any relay (as relays which include support for this function will be able to recognize other devices which support it).

2.4 Hardware Changes for HSR Protocol

This protocol is implemented using the redundant Ethernet card as a starting point. The Frame management is achieved by programming the Field-Programmable Gate Array (FPGA).
The low-level management of the redundant frames is performed within the FPGA; this being defined as the Link Redundancy Entity (LRE). This will add the HSR tag to a frame to be transmitted. The FPGA is also responsible for the stripping of the HSR tag from received frames and discarding the duplicated messages so that only a single application frame is received by the Ethernet processor.
The LRE functionality of the supervision frame transmission is performed by the NIOS II.

The new version of the redundant Ethernet card is based on the 2072069A01 and 2072071A01 (both have modulated and un-modulated IRIG-B).

2.5 HSR Parameters

The Redundant Ethernet standard (IEC 62439-3:2012/FDIS) defines several parameters for the HSR protocol; these being fixed at a default value within this release. The following values are set:

Parameter	Value	Description
Supervision Frame Multicast Address	01-15-4E-00-01-00	Target MAC Address for multicast supervision frame
Life Check Interval	2 seconds	Period between transmission of supervision frames
HSR Mode	Duplicate Discard	This is normal HSR mode, Duplicate address will not be supported.
Node Forget Time	60 s	This is the time after which a node entry is cleared.
Entry Forget Time	400 ms	Duration that the received message Sequence number will be held to discard a duplicate message.
Node Reboot Interval	500ms	Duration following reboot for which no HSR frames should be transmitted.
MulticastFilterSize	16	Number of multicast addresses to be filtered

Table 2 - HSR parameter values

2.6 Product Implementation Features

Here is a list of the main Product Requirements for MiCOM products that support HSR:

- The MiCOM relay/IED provides two redundant Ethernet ports using HSR.
- The MiCOM relay/IED must be connected to the redundant Ethernet network as a Double Attached Node (DAN) using HSR (DAN using HSR is known as DANH)
- The redundant Ethernet interface can be made using an RJ45 or an optical fibre connection with an LC connector type.
- The management of the HSR redundancy is transparent to the application data provided via the Ethernet interface.
- The HSR option is available with any of the existing protocol options via the Ethernet Interface (IEC61850 and/or DNPoE)
- Loss of one of the Node connections to the device does not cause any loss or degradation to the Application data over the Ethernet interface.
- The MiCOM relay/IED supports the transmission of the HSR Supervision frame at a fixed time period (LifeCheckInterval) of 2s (+/- 100ms)
- Each supervision frame includes a sequence number as defined in the IEC 62439-3:2012/FDIS specification. This will be incremented for each supervision message and the value will start from zero following a system restart.
- The MiCOM relay/IED support SNMP.
- The MiCOM relay/IED does not provide for the HSR management to be configured (via either the MiCOM relay/IED HMI or the Ethernet interface). Accordingly, the default values (as defined within this document) are used for all HSR parameters.
- The performance of the Ethernet Interface is not degraded by using the HSR interface.

2.6.1 Abbreviations and Acronyms

Abbreviations / Acronyms	Meaning
CRC	Cyclic Redundancy Check
DAN	Doubly Attached Nodes
DANH	Doubly Attached Node implementing HSR
FPGA	Field-Programmable Gate Array
HMI	Human Machine Interface
HSR	High-availability Seamless Redundancy
IED	Intelligent Electronic Devices
IP	Internet Protocol
LAN	Local Area Network
LRE	Link Redundancy Entity
MAC	Media Access Control
MRP	Media Redundancy Protocol
PRP	Parallel Redundancy Protocol
HSR	High-availability Seamless Redundancy
RedBox	Redundancy Box
RSTP	Rapid Spanning Tree Protocol
SAN	Singly Attached Node
TCP	Transmission Control Protocol
VDAN	Virtual Doubly Attached Node (effectively seen as a DAN)

Notes:

VERSION HISTORY

CHAPTER 22

Date:	05/2017
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.
Hardware suffix:	L (P241) & M (P242 & P243)
Software version:	D1
Connection diagrams:	10P241xx (xx = 01 to 02) 10P242xx (xx = 01) 10P243xx (xx = 01)

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Notes:

1 VERSION HISTORY

The Easergy Studio (MiCOM S1 Studio) product is updated periodically. These updates provide support for new features (such as allowing you to manage new MiCOM products, as well as using new software releases and hardware suffixes). The updates may also include fixes. **Accordingly, we strongly advise customers to use the latest Schneider Electric version of Easergy Studio (MiCOM S1 Studio).**

Software version		Hardware suffix	Original date of issue	Description of changes	S1 compat-ibility	Technical document-ation
Major	Minor					
A3.0 (00) P241 only		A	Jul 1999	Original issue of software	V2.09 or later	TG1.1555
A3.1 (00) P241 only		A	Jul 1999	Inclusion of momentary warning message on the user interface if there is an error correlating ambient air by RTD to the RTD number by the user. Modification of texts in language file(.dfn) regarding "stall-rotor-start/run" and "RTD invalid conf". Resolved dependency of active group and it’s relevant data during fault on MiCOM S1 . Addition of cells and modbus addresses required by south park and SINCOR. Alteration of platform task priorities to comply with common architecture. CO 50300.C0642. Resolved overflow problem in zero volt check to offset DC in system platform	V2.09 or later	TG1.1555
A3.1(02) P241 only	A	A	Nov 1999	Resolved problem of asynchronomism between analog and digital channels on disturbance record (10 ms time shift was corrected). Resolved resetting RTD trip and alarm flags when RTD protection is disabled. Resolved problem of filtering of some of the measured quantities in fault record column. Minimum delay setting on loss of load protection function is changed and step size is reduced to 0.01 s (initially 0.1 s). Resolved problem of 3 phase power factor calculation. Bug fix related to reset number of start. Bug fix related to RTD trip counters. Resolved problem of correlation of the motor running hours with mapping of opto CB closed. Resolved problem of saving the fan number for VDEW in BBRAM (every 3 seconds). Resolved problem when disabling the commissioning test with the port status. Resolved problem on default language for MiCOM S1 front port courier. Resolved problem of not including accountability of secondary phase CT ratio in normalization table. Corrected for calculation of thermal coefficient K	V2.09 or later	TG1.1555
A3.1(02) P241 only	B	A	Nov 1999	Resolved problem of restoring state of trip LED after re-boot of relay. Resolved incorrect dependency of emergency re-start cell on courier. Resolved problem in the out-of-step element to take into account the sign of Sin(θ) as well. Resolved problem in display of negative power factor	V2.09 or later	TG1.1555
A3.1(02) P241 only	C	A	Dec 1999	Resolved incorrect dependency of emergency re-start cell on courier. Resolved problem of 3 phase reactive power calculation	V2.09 or later	TG1.1555

Software version		Hardware suffix	Original date of issue	Description of changes	S1 compat-ibility	Technical document-ation
Major	Minor					
A3.1(04) P241 only	D	A	Jul 2000	Inclusion of two new cells to describe events: location and index. Modification to modbus address for event recorder. Modification of modbus address in "System Data" column. Modification of modbus address in "RTD protection" column. Data type G29 (three 16 bit registers) is replaced with data type G125 (short float IEEE754 floating point format) to avoid truncation error on measurements. Default text is changed. Modbus cell address dedicated to Ubc phase angle measurement is changed to 30266. Resolved problem of inappropriate measurement algorithm of reverse 3 phase active and reactive power measurement	V2.09 or later	TG1.1555
A3.1(07) P241 only Cont.	E	A		Inclusion of filters for event recorder. RDF file is modified. Courier co-ordinates in the communication column are modified to relieve inconsistency in courier communication cell [0Exx] numbering	V2.09 or later	TG1.1555
A4.0(03) P241 only		A	Feb 2000	Inclusion of an alarm threshold on energy measurement facility. Inclusion of a second stage in short circuit protection function. Inclusion of derived earth fault protection function. Inclusion of a second stage in loss of load/under power protection function. Inclusion of reverse power protection function. Power supply regulator for RTD circuit is changed to 78M05 to establish secure supply. Modification to RTD PCB (01-ZN001001 issue D). Resolved sequencing errors on platform RTD PCB ZN0010001 for acquisition of measurement at the boundary of 25 degree Celsius. Resolved problem in a modbus method function to cater for data type G10. Resolved problem of restoring trip LED state after re-boot of relay. Resolved initialization problem related to state of LEDs during the first boot of relay. Resolved problem of text inversion in stall protection function	V2.09 or later	TG1.1555

Software version		Hardware suffix	Original date of issue	Description of changes	S1 compat-ibility	Technical document-ation
Major	Minor					
A4.0(06) P241 only	A	A	Oct 2000	Two new cells for describing events (location and index) are Added. Modbus addresses are modified in system data column. Modbus addresses are modified in RTD protection column. Data type G29 (three 16 bit registers) is replaced with data type G125 (short float IEEE754 floating point format) to avoid truncation error on measurements such as KWh. Default text is changed. Data types G4, G18 and G26 are modified. Modbus cell address dedicated to Ubc phase angle measurement is changed to 30266. Modbus addressing problem for event file is resolved to be compliant with other Px40 products. Resolved problem of opto reset latches not turning off trip LED to be compliant with other Px40 products. Resolved problem of inappropriate measurement algorithm of reverse 3 phase active and reactive power measurement. Resolved problem of timer initialization on 51LR protection function. Inclusion of the option "reset energies" in " measurement 2" column. Resolved problem of incorrect calculation methodology in measurement of time to next start. Resolved problem of not resetting on software counter used for "emergency re-start". Resolved problem of counting methodology for the "number of hot(cold) starts". Resolved problem of visibility on LCD. Resolved missing modbus address (operand) of the cell 091D. Resolved courier coordinate cell error regarding second stage overcurrent pickup setting	V2.09 or later	TG1.1555
A4.0(06) P241 only	A	A	Oct 2000	Resolved correlation problem between relay output 3 operation and CB operating time counter. Hysteresis for under/over frequency protection function is reduced to 0.05 Hz	V2.09 or later	TG1.1555
A4.1 (08) P241 only	B	A	Dec 2000	Resolved problem of inaccuracies in KWh measurement which arises after a long period of operation. The two thresholds of the overcurrent protection function are changed from 1 A to 0.2 A. Also the second threshold of the I2 overcurrent protection function is changed from 0.2 A to 0.05 A	V2.09 or later	TG1.1555
A4.1 (08) P241 only	C	A	Feb 2001	Resolved problem of timer start initialization for drop off time of the out-of-step protection function. Resolved problem of opto command to change setting group. Resolved problem of cold(hot) number of start after re-boot of relay. Resolved problem of inaccuracies in KWh measurement	V2.09 or later	TG1.1555
A4.1 (08) P241 only	D	A	Apr 2001	Correction for number of registers declared in the modbus (2 instead of 3 on G125 only) . Resolved problem of fault current measurement via modbus with G125 format	V2.09 or later	TG1.1555
A4.1 (08) P241 only	E	A	Sep 2001	Resolved incorrect generation of error code 0x9300ffd2 which occurred during short circuit test at 70 Hz. Corrected for wrong phase indication at the time of undervoltage protection activity	V2.09 or later	TG1.1555

Software version		Hardware suffix	Original date of issue	Description of changes	S1 compat-ibility	Technical document-ation
Major	**Minor**					
A4.1 (08) P241 only	F	A	Nov 2001	Corrected for proper RTD number indication when corresponding RTD trip cell is active. Correction for intermittent twice resetting requirement of trip LED. Resolved initialization problem related to protection/PSL programs secondary effect on LEDs and output relays	V2.09 or later	TG1.1555
A4.1 (08) P241 only	G	A	Nov 2001	Resolved initialization problem related to protection/PSL programs secondary effect on LEDs and output relays	V2.09 or later	TG1.1555
A4.1 (08) P241 only	H	A	Nov 2001	Resolved incorrect timing for trip operation under second stage negative phase sequence protection function	V2.09 or later	TG1.1555
A4.1 (08) P241 only		A	Mar 2002	Resolved generation of plerr error code on MODBUS to enhance data access method. Courier co-ordinates in the communication column are modified to relieve inconsistency in courier communication cell [0Exx] numbering. Corrected for mal-operation of thermal over load function after battery back-up RAM initialization when no RTD module is present	V2.09 or later	TG1.1555
A4.1(09) P241 only	A	A	Mar 2002	Correction of the method by which I2 magnitude is calculated when "D E/F" function is enabled. Resolved incorrect correlation between CT ratio and derived E/F threshold	V2.09 or later	TG1.1555
A4.1(09) P241 only	B	A	Jun 2002	Resolved problem of continuous EEPROM test (P241 only). Resolved problem of long polling duration of thermal protection function as well as correction for IMAX on the same function (P241 only)	V2.09 or later	TG1.1555
A4.1(09) P241 only	C	A	Aug 2002	Resolved problem of unwanted disabling of I2>1 when thermal overload function is enabled (P241 only)	V2.09 or Later	TG1.1555
A4.1(09) P241 only	E	A	Apr 2004	Resolved intermittent locking out the user interface and COMMS and loss of data when disturbance recorder is triggered. Resolved modbus frame reception problem due to timer mismanagement	V2.09 or later	TG1.1555
A4.1(09) P241 only	F	A	Dec 2004	Resolved problem of resolution on analog channels. Resolved problem of correct acquisition of 5 A CT choice	V2.09 or later	TG1.1555
A4.1(09) P241 only	E	A	Aug 2004	Resolved problem with disturbance recorder triggering which could cause loss of record data. Resolved unreliable MODBUS framing	V2.09 or Later	TG1.1555
A4.1(09) P241 only	F	A	Jan 2005	Software enhanced to reduce CPU usage during Event log. Correction for 5 A CT connection. Correction for flickering effect on LCD at low input current	V2.09 or Later	TG1.1555
A4.2 (09) P241 only	G	A	Apr 2005	Correction of missing error codes during re-boots when S/W is upgraded from A 4.1F	V2.09 or Later	TG1.1555

Software version		Hardware suffix	Original date of issue	Description of changes	S1 compat-ibility	Technical document-ation
Major	Minor					
B1.0 (20)		C	Jul 2004	Addition of 2 new P24x relay models P242 and P243. P242 is the same as P241 but with additional inputs/outputs. P243 is the same as P242 except it has additional differential protection. P242/3 use Eight channel OPTO input card and Eight channel Relay Output card, increasing the total programmable inputs to 16 and the total programmable outputs to 16. . User alarms are added and number of existing alarms are increased by 32. Addition of Circuit Breaker Failure function. Optional addition of 4 analog inputs and 4 analog outputs (current loop input output - CLIO) function. Each analog/transducer input and output selectable as 0-1/0-10/0-20/4-20 mA. . Addition of measurement of I2/I1 to " measurement 1 " column. Addition of hottest RTD measurement and its assigned number to "measurement 1" column. Addition of Clear Event selection to "record control" column. Extra disturbance recorder channel is added to the disturbance recorder to increase the total to Eight. Addition of numeric alarm setting to all four WHr and VArHr energy measurement functions in the "measurement setup" column. Relay OUTPUTs and LEDs test facility via MODBUS is disabled to improve safety. Minimum current threshold for the second stage unbalance protection function is changed from 200 mA to 50 mA	V2.09 or later	TG1.1555 & P24x/EN T/A11
B1.0 (20)				Enhancement of motor start detection method by including current in conjunction with circuit breaker auxiliary contact. Inclusion of temperature measurement in Fahrenheit unit as well as Ni100 and Ni120 options to RTDs temperature measurement . Enhancement of programmable opto input module to operate at a wider range of voltage supply. Inclusion of ddb signal DDB_ALARM_BATTERY_FAIL. Inclusion of ddb signal for password control. Number of available DDB elements increased to 1024. Average current is replaced with RMS current in calculation of Ieq in thermal protection algorithm. Resolved generation of plerr error code on MODBUS to enhance data access method. Minor navigation bug (in cell 0804) removed. Addition of third setting "test mode" in the commissioning tests column with options disable/enable. Courier co-ordinates in the communication column are modified to relieve inconsistency in Courier communication cell numbering . Resolved incorrect generation of error code 0x9300ffd2 which occurred during short circuit test at 70 Hz. Correction for wrong phase indication at the time of undervoltage protection function activity. Correction for RTD temperature measurement in MODBUS fault records		

Software version		Hardware suffix	Original date of issue	Description of changes	S1 compat-ibility	Technical document-ation
Major	Minor					
B1.0 (20)				Correction for proper operation of the counter used for "number of start" function when the function is disabled and "stall detection" function is enabled at the same time. Correction for proper RTD number indication when corresponding RTD trip cell is active. Correction for intermittent twice-resetting requirement of trip LED. Resolved initialization of protection/PSL programs secondary effect on LEDs and output relays. Resolved re-scaling problem for I^ maintenance and I^ lockout settings arising from a change in Broken I^ setting in the MICOM S1 setting file. Resolved incorrect timing for trip operation under second stage negative phase sequence function. Resolved zero sequence current measurement algorithm. The quantity was obtained from derived nominal current rather than measured nominal current. Correction for mal-operation of thermal over load function after battery back-up RAM initialization when no RTD module is present. Correction of the method by which negative phase sequence current magnitude is calculated when "derived E/F" function in the "configuration" column is enabled. Resolved incorrect correlation between CT ratio and derived E/F threshold. Removal of undesirable command for continuous test of EEPROM.		
B1.0 (20)				Change of the acquisition time for thermal protection function from 50 ms to 20 ms. Resolved momentary miss-representation of positive and negative phase sequence current magnitudes and mal-functioning of first stage I2 trip function when thermal over load function is enabled. Resolved mal-operation of Derived E/F function when under test condition due to missing I2 polarizing quantity. Resolved improper dependency rules concerning RTD label in second group setting column		
B1.0 (20)	A	C	Aug 2005	Correction to acquisition of voltage inputs.	V2.09 or later	TG1.1555 & P24x/EN T/A11
B1.0 (20)	B	C	Jan 2005	Resolved scaling problem of analog outputs on CLIO board write register. Resolved problem of correct acquisition of 5 A CT choice. Resolved problem of resolution on analog channels. Resolved scaling problem of analog outputs on CLIO board write register. Resolved problem of correct acquisition of 5 A CT choice. Resolved problem of not recording the IA2 data on disturbance recorder. Resolved problem of resolution on analog channels. Resolved problem of downloading default PSL via front port of P241 due to incompatibility of the platform version	V2.09 or later	TG1.1555 & P24x/EN T/A11
B1.2 (31)	A	C	Jun 2005	Resolved problem of upgrading software version from A4.1e to A4.1f on P241 which caused cyclic reboot. Resolved problem on MODBUS driver giving rise to cyclic reboot at 60 Hz	V2.11 or later	TG1.1555 & P24x/EN T/A11

Software version		Hardware suffix	Original date of issue	Description of changes	S1 compat-ibility	Technical document-ation
Major	Minor					
B1.3 (32)	A	C	Mar 2006	Resolved display of IA2,IB2 and IC2 differential bias on measurement 1 column of P242. Resolved problem of resetting trip relay and led after protection function operation and function is disabled. Resolved intermittent problem of not recognizing RTD module. 30 ms delay was included. Resolved problem of re-setting back to default setting (24/27 V) of universal Vcc setting of programmable inputs following a reboot. Resolved problem of re-setting LED alarm for "CB failed trip" on the front panel. Resolved error code 0x8439007C - unexpected event related to “Watt Fwd Alarm" . Resolved "IN Derived Mag" measurement problem, CT ratio dependency was using the SEF CT ratio instead of phase CT ratio, Derived E/F protection is not affected.	V2.11 or later	TG1.1555 & P24x/EN T/A11
B1.4 (33)	A	C	Mar 2007	Addition of Hour run meter feature. Resolved conflict between "commissioning test" being enabled "test mode" blocked and operation of output relays. Resolved initialization problem of KWh metering after relay is powered down and back to ON	V2.14 (requires modification)	TG1.1555 & P24x/EN T/A11
B1.5 (33)	B	C	Mar 2007	Resolved re-boot error code 0x8232ffd2 which was generated on P243 set at 60Hz. Resolved initialization problem of KWh metering after relay is powered down and back to ON	V2.14 (requires modification)	TG1.1555 & P24x/EN T/A11
A4.3 (09) P241 only		A	Apr 2007	Adaptation to recognize new RTD board ZN0044-1 (and of course previous board ZN0010-1). ZN0044 design has improved filtering. Resolved initialization problem of KWh metering after relay is powered down and back to ON	V2.09 or later	TG1.1555 & P24x/EN T/A11
B1.6(33)		C	Oct 2007	Resolved problem of events extraction by PACiS system via modbus communication due to the system being unable to synchronize P24x	V2.14 (requires modification)	TG1.1555 & P24x/EN T/A11
B1.7(33)		C	Nov 2007	Resolved problem of all latched relay contacts dropping off for 5 ms on relay board 2 if another relay contact is set ON. This only affects P242/3 relays which have 2 relay boards of 8 contacts. Resolved problem of relay contacts dropping off for 3ms when another relay is set on after a relay reboot. Resolved problem of Out Of Service LEDs not turning off after Commission Tests Test Mode setting is disabled	V2.14 (requires modification)	TG1.1555 & P24x/EN T/A11
B1.8(33)		C	Dec 2008	Fixes major bug (when using multiple setting groups, changes of setting group using Courier or PAST will not update PSL group after first change)	V2.14 (requires modification)	TG1.1555 & P24x/EN T/A11
B2.0(34)		C	July 2009	Control inputs have been included (remote CB control using IEC 103 is now possible). Resolved issue of Modbus error when master station requests “Motor Run time” and the corresponding value is greater than 328 hours.	V2.14 and S1 Studio 3.1.0	TG1.1555 & P24x/EN T/A11

Software version		Hardware suffix	Original date of issue	Description of changes	S1 compat-ibility	Technical document-ation
Major	Minor					
C1.1 (40)		J(P241) K(P242/3)	Jan 2008	Includes Field Failure protection function (40). Includes Anti Backspin protection function (27 remanant). Hot keys and programmable function keys (P242/3 only) have been added. Second rear communication port (EIA(RS)232/EIA(RS)485) has been added. Tri-State color LED`s (P242/3 only) have been added. Dual characteristics optos and opto filter control have been added. Control inputs have been included (remote CB control using IEC 103 is now possible).	V2.14 or later	TG1.1555 & P24x/EN M/A11
C2.0 (41)		J(P241) K(P242/3)	May 2008	A new DDB#118 Trip LED has been added. Default PSL is modified to include new DDB#118 Trip LED. Trip relay 3 restriction is removed. 3 Phase volt check to ensure correct phase sequence before start has been added. Measurement 4 menu is amended to include Number of Field Failure 1 Trip, Number of Field Failure 2 Trip, Number of I>3 Trip and Number of I>4 trip. PSL positional data extraction facility has been included	V2.14 or later	TG1.1555 & P24x/EN M/A11
C3.0 (45)		J(P241) K(P242/3)	Aug 2008	Short Circuit Protection function is enhanced to include 2 stages of IDMT and 2 stages of DT. A new non-protection function "Phase Rotation" has been added. Visibility conflict between Out of Step and Field Failure protection functions is removed	V2.14 or later	TG1.1555 & P24x/EN M/A11
C4.0 (46)		J(P241) K(P242/3)	Dec 2008	Inclusion of CT and VT supervision. Supports Chinese and Russian HMI. Additional 4 opto inputs and 4 relay outputs as an option (P241 only). Migrate DDB from 1024 to 2048. Resolved Emergency Restart problem. Resolved RTD calibration problem. Resolved visibility issue between “Nb Emergency Rst” and “Reset Nb.Em.Rst” cells in Measurement 3 column not being coherent with “Emergency Rest.” Cell. Resolved problem of changing field failure cell In configuration column not being taken into account by the relay. Resolved visibility issues with Micom S1 on Derived E/F and Sensitive E/F: reset characteristics should be always DT (for IEC/UK curves). Resolved inconsistency between the PSL used and the active setting group when changing setting group via the commands in S&R Courier or PAST. Removed dependency of “Limit Nb Starts” on “Stall detection” start criteria. Hence no need to enable “Stall Detection” to activate “Limit Nb Starts” Relay 4 in the default PSL and associated default LEDs on front panel will now operate correctly.	V2.14 and S1 Studio 3.1.0	TG1.1555 & P24x/EN M/A11
C4.0 (47)		J(P241) K(P242/3)	Aug 2009	Resolved issue of incorrect file headers in data model 46. Data model 46 has been removed from cortec configurator.	V2.14 and S1 Studio 3.1.0	P24x/EN M/C22
C5.1 (51)		J(P241) K(P242/3)	Jan 2009	IEC 61850 Phase II Enhancements. Read Only Mode. Resolved problem with Stall detection threshold. Resolved problem of CLIO output over flow	V2.14 and S1 Studio 3.1.0	P24x/EN M/C32

Software version		Hardware suffix	Original date of issue	Description of changes	S1 compat-ibility	Technical document-ation
Major	Minor					
C6.2 (57)		J(P241) K(P242/3)	Nov 2009	User programmable curve facility enhancement for Thermal, Short Circuit, Derived Earth Fault and Sensitive Earth Fault protection. IEC 61850 Phase 2.1 enhancement. Phase 2.1 includes; Energy measurements and Reset controls for demand and thermal measurements using the MMTR Logical Node. Also Unit multipliers are provided for all measurements. Redundant Ethernet communication enhancement . Opto inputs 1 ms time stamping accuracy enhancement. Resolved the issue of maximum pre-time duration being too short in the Disturbance Recorder (DR). Pre fault trig time in DR increased to 5 sec at 50 HZ. . Resolved problem of DR not handling DDBs > 1024. Resolved issue of Modbus error when master station requests “Motor Run time” and the corresponding value is greater than 328 hours. Dependency of “No. of Starts” with “Thermal Protection” function is removed. Thermal state will be evaluated whether or not “Thermal Protection” function is enabled. . Minimum current and voltage thresholds (20 mA and 1 V for In =1A and Vn = 100/120 V, 100 mA and 1 V for In = 5A and Vn = 100/120 V) are included in the “Out of Step” protection function. This function is blocked if current and voltage are less than threshold. Dependency of “Stall detection” threshold with I_{th} setting is removed.	V2.14 and S1 Studio 3.1.0	P24x/EN M/C52
C6.2 (57)		J(P241) K(P242/3)	Nov 2009	CLIO output “maximum power” setting is increased to 30 MW. Resolved problem of reading negative angles in Measurement Viewer, Courier Device browser and PAST. Resolved problem of reading non zero Active, reactive and apparent power when breaker is open. These measurements will read zero when current is less than 5% Inom and voltage is less than 10% Unom. Resolved issue of non-trip when 1<I/Ith<1.1 in IDMT curves. Trip time will be the the same as when I/Ith = 1.1 . Resolved issue of not reporting in Gooses when “Virtual Output x” DDB is disabled in “Record Control”. IEEE TD setting range is changed from 0.5~15 to 0.01~100. Resolved problem of Short Circuit setting changes via LCD or Courier device browser not taking effect before reboot or another Short Circuit column change. Resolved problem of missing “Hz” and “%” characters in default display when language is set to Chinese.	V2.14 and S1 Studio 3.1.0	P24x/EN M/C52
C6.2 (57)		J(P241) K(P242/3)	Jun 2012	Correction to Page 15-23 in the Installation chapter (Figure 11 : P243 Case Dimensions) to show the correct dimensions.	V2.14 and S1 Studio 3.1.0	P24x/EN M/D52
C6.2 (57)		J(P241) K(P242/3)	Sept 2012	Correction to the Installation chapter (new figure which shows P241 external connection diagram (40TE) - 12 Inputs + 11 Outputs board). Clarification of how to use the Stall Detection function.	V2.14 and S1 Studio 3.1.0	P24x/EN M/E52

Software version		Hardware suffix	Original date of issue	Description of changes	S1 compat-ibility	Technical document-ation
Major	Minor					
C6.3 (57)		J(P241) K(P242/3)		Resolved issue of: - Associated cell is not updated when RTD input status is changing. - Some labels not supported by Hardware are displayed in Digital Input X cells. - Modbus read for "Reset Energies" some cell unexpected value, - Measurement 4 Nb decl I>3 and Measurement 4 Nb decl I>4 is missing in Modbus table. - Plant Reference AREVA with “MICOM” as re-branding - Add “_S” at the end of the version number.	V2.14 and S1 Studio 3.1.0	P24x/EN M/F63
C7.A		J(P241) K(P242/3)		Resolved issue of: - Fault Record on LCD Start elements are missing. - Limits and step of the setting "Starting current" in Stall Detection on version C6. - Field Failure characteristic modification. - Software reference modification. - Undervoltage operating mode modif. has options either "Phase-Phase" mode or "Phase - Neutral" mode.	V2.14 and S1 Studio 3.1.0	P24x/EN M/F63
C7.B		J(P241) K(P242/3)		Resolved issue of: 1 unexpected rotor block detection during a motor restart. 2. IEC61850 communications terminate after operating a control with control status in RCB. 3. Modif. Bit field parameters defined in the L&F 4. Exeptionnal corrupt group of message displayed on LCD on specific application. 5. minor problem folowing the integration of XCPU3 platform code 6. Occasionally an opto-input change of state is not registered in System\OptGGIO1.ST. 7. Occasional increased delay between Virtual Output and GOOSE message transmitted with new state when relay under current & voltage load on IEC 61850 Phase 2 version. 8.The SNTP Stack size should be set to 1200, but the stack size is set to 1024. 9. Applying XCBR1.CO.Pos Open/Close via IEDScout can cause the relay to reply with Invalid Position 10. IEC61850 - A quickly toggled state may cause the interim state change to be not reported.	V2.14 and S1 Studio 3.1.0	P24x/EN M/F63
C7.B		J(P241) K(P242/3)		11. When client requests GetServerDirectory with "unknowfile", P24x returns root directory. 12. Type of BCR (Binary Counter Reading) is INT128. 13. On specific cases the latched relay is still closed when the fault has removed and the alarm has been acknowledged. 14. Measurement problem of CLIO Input. 15.GOOSE Subscribing, System\GosGGIO1\Ind46.stVal is not available in ICD template.	V2.14 and S1 Studio 3.1.0	P24x/EN M/F63

Software version		Hardware suffix	Original date of issue	Description of changes	S1 compat-ibility	Technical document-ation
Major	Minor					
C7.C		J(P241) K(P242/3)		Resolved issue of the high traffic of unicast frames leads to blocking of the GOOSE sbuscription by the Px40 relays. GOOSE publishing and MMS services remains working correctly.	V2.14 and S1 Studio 3.1.0	P24x/EN M/F63
C8.A		J(P241) K(P242/3)		Resolved issue of: 1, no diff values in P243 fault recorder if the latest fault record is not triggered by diff protection. 2. DDB's language text are not match with actual DDB functions for P241 12optos +11 relays option. 3. Energy value range is small for primary values in IEC61850. 4. Set appropriate Thresholds for all currents and voltage value, then error code occurs and trip operation is blocked. 5. Change step of Stall Setting from 50%In to 10%In. 6. Logical Note of OptGGIO1.ST don't represent the correct status of Opto changes on the special case. 7. Disturbance record can not be extracted correctly via IEC61850. 8. Buffered events can not be sent to the client before GI reports sent via IEC61850. 9.Occasional, after the MCL file is downloaded to the Relay, use IEDScout to modify some of the deadband settings, then those deadbands are not correct as set in the MCL file. 10. When a dataset configured with "quality" and DA level, the dataset was mapped to a report and not mapped to a GOOSE control block, then the quality displayed as "Data Access Error,	V2.14 and S1 Studio 5.0.1	P24x/EN M/F63
C8.A		J(P241) K(P242/3)		11.When dataset include the data which data source is function type data and the status changed, report send twice even 12. IEC61850 buffered report of a Px40 device can not work when the physical connection broken. 13. MMS communication of IEC61850 of device may get lost after perform control operations (Control\XCBR1\Pos) 14. MMS server returns an error when users write [111111] to TrgOps field of a RCB, thus the writing operation is failed. 15. All SPS/origin in Px40 System/PloGGIO1$ST are writeable which is expected not to be writeable. 16. After downloaded a MCL file to a Relay, the modified configurable DAs such as deadbands will take effect no matter whether "Restore MCL" command is executed or not. 17. Following ST properties shall be readonly 1) 18. IEC61850 communication, if the dataset has only DAs, GOOSE may sent a wrong status of "FALSE" after IED reboot. 19. IEC61850 Ed1 conformance test with TPCL 1.7, TISSUE #275 states that the TrgOps GI shall be set by default after start-up.	V2.14 and S1 Studio 5.0.1	P24x/EN M/F63

Software version		Hardware suffix	Original date of issue	Description of changes	S1 compat-ibility	Technical document-ation
Major	Minor					
C8.B		J(P241) K(P242/3)		Resolved issue of/ 1. the type of bypass in SCL is enumeration and in IED is bit string. Change from enumeration and bit string to INT16U. 2. P24x do not reject the select/operate command 3. Subscribe GOOSE with inconformity AppID is not discarded. 4. P24x can not receive correct GOOSE message on the specified condition. 5. A number 3600001 can be successfully set to BufTm. 6. Close command signal can not continue enough time when CB is controlled through IEC61850. 7. Missing IEC61850 report on rapid change of a DDB signal. 8. P24x can only subscribe 32 GOOSE with different AppID values. 9. Sometimes when VT is disconnect suddenly, VTS is no operation and under voltage is mal-operation. 10. IN value is different in disturbance record and fault record when IN CT ratio secondary is 5.	V2.14 and S1 Studio 5.0.1	P24x/EN M/F63
C8.B		J(P241) K(P242/3)	May 2015	11. When client requests GetServerDirectory with "unknowfile", P24x returns root directory. 12. Type of BCR (Binary Counter Reading) is INT128. 13. On specific cases the latched relay is still closed when the fault has removed and the alarm has been acknowledged. 14. Measurement problem of CLIO Input. 15.GOOSE Subscribing, System\GosGGIO1\Ind46.stVal is not available in ICD template.	V2.14 and S1 Studio 5.0.1	P24x/EN M/F63
D0	A	L(P241) M(P242/3)	Jun 2015	**Hardware:** The 24-48 Vdc power supply range has been changed to cover 24-32 Vdc only. Three new Ethernet boards released. **Software:** IEC 61850 Ed.2 and Ed.1 by configuration. GOOSE number and GOOSE performance enhancement. Disturbance Record LN RDRE Enhancement. Time Synchronization via LTIM/LTMS. Monitor DDB for port physical link status. High-availability Seamless Redundancy (HSR). Parallel Redundancy Protocol (PRP) Dual Ethernet communications (Dual IP).	S1 Studio 5.1 and later	P24x/EN M/F63
D1	A	L(P241) M(P242/3)	April 2017	This release integrated the Cyber Security RBAC and provided the option for the user if they want/don't want to use the Cyber Security which depends on the protocol options. CLS0 - Simple password management - No Security Administration Tool (SAT) required. CLS1 - Advanced user account right management, security logs/events and secure administration capability - Security Administration Tool (SAT) required. Courier Tunneling via Secured Communication. Latest Fault Record via IEC61850. User Alarms Labels. Virtual I/O Naming. New DDB: Logic 0 and IRIGB Valid. Restore Record Clear Functions. User Alarms increased to 32. Bug Fixes.	S1 Studio 5.1 and later	P24x/EN M/G73

The Easergy Studio (MiCOM S1 Studio) product is updated periodically. These updates provide support for new features (such as allowing you to manage new MiCOM products, as well as using new software releases and hardware suffixes). The updates may also include fixes. **Accordingly, we strongly advise customers to use the latest Schneider Electric version of Easergy Studio (MiCOM S1 Studio).**

2 SETTING FILE AND RELAY SOFTWARE VERSION

2.1 Setting File and Relay Software Version (P241 only)

	Relay Software Version (P241 only)													
Setting File	A3.0 (00)	A3.1 (00)	A3.1 (02)	A3.1 (04)	A3.1 (07)	A4.0 (03)	A4.0 (06)	A4.0 (08)	A4.1 (08)	A4.1 (09)	A4.2 (09)	A4.3 (09)	D0	D1
00	✓	✓	×	×	×	×	×	×	×	×	×	×	×	
02	×	×	✓	×	×	×	×	×	×	×	×	×	×	×
04	×	×	×	✓	×	×	×	×	×	×	×	×	×	×
07	×	×	×	×	✓	×	×	×	×	×	×	×	×	×
03	×	×	×	×	×	✓	×	×	×	×	×	×	×	×
06	×	×	×	×	×	×	✓	×	×	×	×	×	×	×
08	×	×	×	×	×	×	×	✓	✓	×	×	×	×	×
09	×	×	×	×	×	×	×	×	×	✓	✓	✓	×	×
D0	×	×	×	×	×	×	×	×	×	×	×	×	✓	×
D1	×	×	×	×	×	×	×	×	×	×	×	×	×	✓

2.2 Setting File and Relay Software Version (P242 and P243)

	Relay Software Version (P242 and P243)																			
Sett-ing File	B1.0 (20)	B1.0 (20A)	B1.0 (20B)	B1.2 (31)	B1.3 (32)	B1.4 (33)	B1.5 (33)	B1.6 (33)	B1.7 (33)	B1.8 (33)	B2.0 (34)	C1.1 (40)	C2.0 (41)	C3.0 (45)	C4.0 (46)	C4.0 (47)	C5.1 (51)	C6.2 (57)	D0	D1
20	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×
30	×	×	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×
31	×	×	×	✓	✓	✓	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×
32	×	×	×	×	✓	✓	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×
33	×	×	×	×	×	×	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×
34	×	×	×	×	×	×	×	×	×	×	✓	×	×	×	×	×	×	×	×	×
40	×	×	×	×	×	×	×	×	×	×	×	✓	✓	✓	✓	✓	✓	✓	×	×
41	×	×	×	×	×	×	×	×	×	×	×	×	✓	✓	✓	✓	✓	✓	×	×
45	×	×	×	×	×	×	×	×	×	×	×	×	×	✓	✓	✓	✓	✓	×	×
46	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓	✓	✓	✓	×	×
47	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓	✓	✓	×	×
51	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓	✓	×	×
57	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓	×	×
D0	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓	×
D1	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓

3 PSL FILE AND RELAY SOFTWARE VERSION

3.1 PSL File and Relay Software Version (P241 only)

	Relay Software Version (P241 only)													
PSL File	**A3.0 (00)**	**A3.1 (00)**	**A3.1 (02)**	**A3.1 (04)**	**A3.1 (07)**	**A4.0 (03)**	**A4.0 (06)**	**A4.0 (08)**	**A4.1 (08)**	**A4.1 (09)**	**A4.2 (09)**	**A4.3 (09)**	**D0**	**D1**
00	✓	✓	×	×	×	×	×	×	×	×	×	×	×	×
02	×	×	✓	×	×	×	×	×	×	×	×	×	×	×
04	×	×	×	✓	×	×	×	×	×	×	×	×	×	×
07	×	×	×	×	✓	×	×	×	×	×	×	×	×	×
03	×	×	×	×	×	✓	×	×	×	×	×	×	×	×
06	×	×	×	×	×	×	✓	×	×	×	×	×	×	×
08	×	×	×	×	×	×	×	✓	✓	×	×	×	×	×
09	×	×	×	×	×	×	×	×	×	✓	✓	✓	×	×
D0	×	×	×	×	×	×	×	×	×	×	×	×	✓	×
D0	×	×	×	×	×	×	×	×	×	×	×	×	×	✓

3.2 PSL File and Relay Software Version (P242 & P243)

	Relay Software Version (P242 & P243)																			
PSL file	**B1.0 (20)**	**B1.0 (20A)**	**B1.0 (20B)**	**B1.2 (31)**	**B1.3 (32)**	**B1.4 (33)**	**B1.5 (33)**	**B1.6 (33)**	**B1.7 (33)**	**B1.8 (33)**	**B2.0 (34)**	**C1.1 (40)**	**C2.0 (41)**	**C3.0 (45)**	**C4.0 (46)**	**C4.0 (47)**	**C5.1 (51)**	**C6.2 (57)**	**D0**	**D1**
20	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×
30	×	×	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×
31	×	×	×	✓	✓	✓	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×
32	×	×	×	×	✓	✓	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×
33	×	×	×	×	×	✓	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×
34	×	×	×	×	×	✓	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×
40	×	×	×	×	×	×	×	×	×	×	×	✓	✓	×	×	×	×	×	×	×
41	×	×	×	×	×	×	×	×	×	×	×	×	✓	×	×	×	×	×	×	×
45	×	×	×	×	×	×	×	×	×	×	×	×	×	✓	×	×	×	×	×	×
46	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓	✓	✓	✓	×	×
47	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓	✓	✓	×	×
51	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓	✓	×	×
57	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓	×	×
D0	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓	×
D1	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓

4 MENU TEXT FILE AND RELAY SOFTWARE VERSION

4.1 Menu Text File and Relay Software Version (P241 only)

	Relay Software Version (P241 only)													
Menu Text File	A3.0 (00)	A3.1 (00)	A3.1 (02)	A3.1 (04)	A3.1 (07)	A4.0 (03)	A4.0 (06)	A4.0 (08)	A4.1 (08)	A4.1 (09)	A4.2 (09)	A4.3 (09)	D0	D1
00	✓	✓	×	×	×	×	×	×	×	×	×	×	×	×
02	×	×	✓	×	×	×	×	×	×	×	×	×	×	×
04	×	×	×	✓	×	×	×	×	×	×	×	×	×	×
07	×	×	×	×	✓	×	×		×	×	×	×	×	×
03	×	×	×	×	×	✓	×	×	×	×	×	×	×	×
06	×	×	×	×	×	×	✓	✓	✓	×	×	×	×	×
08	×	×	×	×	×	×	×	✓	✓	×	×	×	×	×
09	×	×	×	×	×	×	×	×	×	✓	✓	✓	×	×
D0	×	×	×	×	×	×	×	×	×	×	×	×	✓	×
D1	×	×	×	×	×	×	×	×	×	×	×	×	×	✓

4.2 Menu Text File and Relay Software Version (P242 and P243)

	Relay Software Version (P242 and P243)																			
Menu Text File	B1.0 (20)	B1.0 (20a)	B1.0 (20b)	B1.2 (31)	B1.3 (32)	B1.4 (33)	B1.5 (33)	B1.6 (33)	B1.7 (33)	B1.8 (33)	B2.0 (34)	C1.1 (40)	C2.0 (41)	C3.0 (45)	C4.0 (46)	C4.0 (47)	C5.1 (51)	C6.2 (57)	D0	D1
20	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×
30	×	×	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×
31	×	×	×	✓	✓	✓	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×
32	×	×	×	×	✓	✓	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×
33	×	×	×	×	×	✓	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×
34	×	×	×	×	×	✓	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×
40	×	×	×	×	×	×	×	×	×	×	×	✓	✓	×	×	×	×	×	×	×
41	×	×	×	×	×	×	×	×	×	×	×	×	✓	×	×	×	×	×	×	×
45	×	×	×	×	×	×	×	×	×	×	×	×	×	✓	×	×	×	×	×	×
46	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓	✓	✓	✓	×	×
47	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓	✓	✓	×	×
51	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓	✓	×	×
57	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓	×	×
D0	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓	×
D1	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓
Menu text remains compatible within each software version but is not compatible across different versions																				

SYMBOLS AND GLOSSARY

CHAPTER SG

Date	09/2016	
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.	
Hardware Suffix	All MiCOM Px4x products	
Software Version	All MiCOM Px4x products	
Connection Diagrams:	P14x (P141, P142, P143 & P145): 10P141xx (xx = 01 to 02) 10P142xx (xx = 01 to 05) 10P143xx (xx = 01 to 11) 10P145xx (xx = 01 to 11) P24x (P241, P242 & P243): 10P241xx (xx = 01 to 02) 10P242xx (xx = 01) 10P243xx (xx = 01) P34x (P342, P343, P344, P345 & P391): 10P342xx (xx = 01 to 17) 10P343xx (xx = 01 to 19) 10P344xx (xx = 01 to 12) 10P345xx (xx = 01 to 07) 10P391xx (xx = 01 to 02) P445: 10P445xx (xx = 01 to 04) P44x (P441, P442 & P444): 10P44101 (SH 1 & 2) 10P44201 (SH 1 & 2) 10P44202 (SH 1) 10P44203 (SH 1 & 2) 10P44401 (SH 1) 10P44402 (SH 1) 10P44403 (SH 1 & 2) 10P44404 (SH 1) 10P44405 (SH 1) 10P44407 (SH 1 & 2) P44y (P443 & P446): 10P44303 (SH 01 and 03) 10P44304 (SH 01 and 03) 10P44305 (SH 01 and 03) 10P44306 (SH 01 and 03) 10P44600 10P44601 (SH 1 to 2) 10P44602 (SH 1 to 2) 10P44603 (SH 1 to 2)	P54x (P543, P544, P545 & P546): 10P54302 (SH 1 to 2) 10P54303 (SH 1 to 2) 10P54400 10P54404 (SH 1 to 2) 10P54405 (SH 1 to 2) 10P54502 (SH 1 to 2) 10P54503 (SH 1 to 2) 10P54600 10P54604 (SH 1 to 2) 10P54605 (SH 1 to 2) 10P54606 (SH 1 to 2) P547: 10P54702xx (xx = 01 to 02) 10P54703xx (xx = 01 to 02) 10P54704xx (xx = 01 to 02) 10P54705xx (xx = 01 to 02) P64x (P642, P643 & P645): 10P642xx (xx = 1 to 10) 10P643xx (xx = 1 to 6) 10P645xx (xx = 1 to 9) P74x (P741, P742 & P743): 10P740xx (xx = 01 to 07) P746: 10P746xx (xx = 00 to 21) P841: 10P84100 10P84101 (SH 1 to 2) 10P84102 (SH 1 to 2) 10P84103 (SH 1 to 2) 10P84104 (SH 1 to 2) 10P84105 (SH 1 to 2) P849: 10P849xx (xx = 01 to 06)

CONTENTS

TABLES

FIGURES

Notes:

1 ACRONYMS AND ABBREVIATIONS

Term	Description
<	Less than: Used to indicate an “under” threshold, such as undercurrent (current dropout).
>	Greater than: Used to indicate an “over” threshold, such as overcurrent (current overload)
A	Ampere
AA	Application Association
AC / ac	Alternating Current
ACSI	Abstract Communication Service Interface
ACSR	Aluminum Conductor Steel Reinforced
ALF	Accuracy Limit Factor
AM	Amplitude Modulation
ANSI	American National Standards Institute
AR	Auto-Reclose
ARIP	Auto-Reclose In Progress
ASCII	American Standard Code for Information Interchange
ATEX	ATEX is the Potentially Explosive Atmospheres directive 94/9/EC
AUX / Aux	Auxiliary
AV	Anti virus
AWG	American Wire Gauge
BAR	Block Auto-Reclose signal
BCD	Binary Coded Decimal
BCR	Binary Counter Reading
BDEW	Bundesverband der Energie- und Wasserwirtschaft | Startseite (i.e. German Association of Energy and Water Industries)
BMP	BitMaP – a file format for a computer graphic
BN>	Neutral over susceptance in the context of the protection element: Reactive component of admittance calculation from neutral current and residual voltage.
BOP	Blocking Overreach Protection - a blocking aided-channel scheme.
BPDU	Bridge Protocol Data Unit
BRCB	Buffered Report Control Block
BRP	Beacon Redundancy Protocol
BU	Backup: Typically a back-up in the context of the protection element
Business Service Layer	This layer coordinates the application, processes commands, make logical decision and calculation according to the business rules
CA	Certification Authority
CAT	Computer Administration Tool , for replacing CMT
C/O	A ChangeOver contact having normally-closed and normally-open connections: Often called a “form C” contact.
CB	Circuit Breaker
CB Aux.	Circuit Breaker auxiliary contacts: Indication of the breaker open/closed status.
CBF	Circuit Breaker Failure in the context of protection element. Could be labelled 50BF in ANSI terminology.
CDC	Common Data Class
CET	Sepam Configuration tool
CF	Control Function
Ch	Channel: usually a communications or signaling channel

Term	Description
Check Synch	Check Synchronizing function
CID	Configured IED Description
CIFS	Common Internet File System. Microsoft protocol use to share resources on a network.
CIP	Critical Infrastructure Protection
CIP Standards	Critical Infrastructure Protection standards. NERC CIP standards have been given the force of law by the Federal Energy Regulatory Commission (FERC)
CLIO	Current Loop Input Output: 0-1 mA/0-10 mA/0-20 mA/4-20 mA transducer inputs and outputs CLI = current loop input - 0-1 mA/0-10 mA/0-20 mA/4-20 mA transducer input CLO = current loop output - 0-1 mA/0-10 mA/0-20 mA/4-20 mA transducer output
CLK / Clk	Clock
Cls	Close - generally used in the context of close functions in circuit breaker control.
CMC	Certificates Management over CMS. An IETF RFC for distribution and registration of public keys and certificates
CMP	Certificates Management Protocol. An IETF RFC for distribution and registration of public keys and certificates (RFC 4210)
CMV	Complex Measured Value
CNV	Current No Volts
COMFEDE	Common Format for Event Data Exchange
CPNI	Centre for the Protection of National Infrastructure
CRC	Cyclic Redundancy Check
CRL	Certificates Revocation List. A list of revoked certificates. Theoretically still valid, but forbidden by the Security Administrator or the Security Server
CRP	Cross-network Redundancy Protocol
CRV	Curve (file format for curve information)
CRx	Channel Receive: Typically used to indicate a teleprotection signal received.
Crypto Device	A small device embedding cryptographic capabilities and storage memory. It could be a smartcard, USB stick, serial dongle, etc.
CS	Cyber Security or Check Synchronism.
CSMS	Cyber Security Management System
CSV	Comma Separated Values (a file format for database information)
CT	Current Transformer
CTRL	Control - as used for the Control Inputs function
CTS	Current Transformer Supervision: To detect CT input failure.
CTx	Channel Transmit: Typically used to indicate a teleprotection signal send.
CUL	Canadian Underwriters Laboratory
CVT	Capacitor-coupled Voltage Transformer - equivalent to terminology CCVT.
CZ	Abbreviation of “Check Zone”: Zone taking into account only the feeders.
DA	Data Attribute
DAN	Double or Doubly Attached Node
DANH	Double or Doubly Attached Node with HSR protocol
DANP	Double or Doubly Attached Node implementing PRP
Data Layer	Consists of the domain-related objects and their relationships that are manipulated by the user during the interaction with the software
DAU	Data Acquisition Unit
DC	Data Concentrator

Term	Description
DC / dc	Direct Current
DCC	An Omicron compatible format
DCE	Data Communication Equipment
DCS	Distributed Control System
DDB	Digital Data Bus within the programmable scheme logic: A logic point that has a zero or 1 status. DDB signals are mapped in logic to customize the relay's operation.
DDR	Dynamic Disturbance Recorder
DEF	Directional Earth Fault (protection): A directionalized ground fault aided protection scheme. Could be labeled 67N in ANSI terminology.
df/dt	Rate of Change of Frequency (equivalent to ROCOF). Could be labeled 81R in ANSI terminology.
df/dt>1	First stage of df/dt in the context of protection element
DFT	Discrete Fourier Transform
DG	Distributed Generation
DHCP	Dynamic Host Configuration Protocol
DHM	Dual Homing Manager
DHP	Dual Homing Protocol
DHS	Dual Homing Star. Ethernet protocol allowing bumpless redundancy. Used with Redundant Ethernet board with dual homing protocol
Diff	Differential in the context of protection elements . Could be labeled 87 in ANSI terminology.
DIN	Deutsches Institut für Normung (German standards body)
Dist	Distance in the context of protection elements . Could be labeled 21 in ANSI terminology.
DITA	Darwinian Information Typing Architecture
DLDB	Dead-Line Dead-Bus: In system synchronism check, indication that both the line and bus are de-energized.
DLLB	Dead-Line Live-Bus: In system synchronism check, indication that the line is de-energised whilst the bus is energized.
DLR	Dynamic Line Rating
DLY / Dly	Time Delay
DMT	Definite Minimum Time
DNP	Distributed Network Protocol
DO	Data Object
DPWS	Device Profile for Web Services
DR	Disturbance Record
DREB	Dual Redundant Ethernet Board
DSP	Digital Signal Processor
DST	Daylight Saving Time
DT	Definite Time: in the context of protection elements: An element which always responds with the same constant time delay on operation. Or Abbreviation of "Dead Time" in the context of auto-reclose:
DTD	Document Type Definition
DTOC	Definite Time Overcurrent in the context of protection element
DTS	Date and Time Stamp
DVC	Direct Variable Cost
DZ	Dead Zone. Area between a CT and an open breaker or an open isolator.
EF or E/F	Earth Fault (directly equivalent to Ground Fault)
EIA	Electronic Industries Alliance

Term	Description
ELR	Environmental Lapse Rate
EMC	ElectroMagnetic Compatibility
ENA	Energy Networks Association
ER	Engineering Recommendation
ESD	ElectroStatic Discharge
ESP	Electronic Security Perimeter
ESS	Embedded Security Server
ETS	Element To Secure. An ETS is an entity that represents a tool, utility or application function block that can be protected within the tool suite. It gathers a list of corresponding permissions with their set of values. This list is pre-defined and cannot be edited by any business user. A same ETS can be associated to many roles with different set of authorizations.
FAA	Ageing Acceleration Factor: Used by Loss of Life (LOL) element
FCS	Frame Check Sequence
FFail	A field failure (loss of excitation) element: Could be labeled 40 in ANSI terminology.
FFT	Fast Fourier Transform
FIR	Finite Impulse Response
FLC	Full load current: The nominal rated current for the circuit.
FLT / Flt	Fault - typically used to indicate faulted phase selection.
Fn or FN	Function
FPGA	Field Programmable Gate Array
FPS	Frames Per Second
FTP	File Transfer Protocol or Foil Twisted Pair
FTPS	FTP over TLS protocol. The classic file transfer protocol (FTP) secured using TLS tunneling.
FWD, Fwd or Fwd.	Indicates an element responding to a flow in the “Forward” direction
Gen Diff	A generator differential element: Could be labeled 87G in ANSI terminology.
Gen-Xformer Diff	A generator-transformer differential element: Could be labeled 87GT in ANSI terminology.
GI	General Interrogation
GIF	Graphic Interchange Format – a file format for a computer graphic
GN>	Neutral over conductance in the context of protection element: Real component of admittance calculation from neutral current and residual voltage.
GND / Gnd	Ground: used in distance settings to identify settings that relate to ground (earth) faults.
GoCB	GOOSE Control Block
GOOSE	Generic Object Oriented Substation Event
GPS	Global Positioning System
GRP / Grp	Group. Typically an alternative setting group.
GSE	General Substation Event
GSSE	Generic Substation Status Event
GUESS	Generator Unintentional Energization at StandStill.
GUI	Graphical User Interface
HIPS	Host Intrusion Prevention System based on “white list” of accepted executables.
HMI	Human Machine Interface
HSR	High Availability Seamless Redundancy
HTML	Hypertext Markup Language

Term	Description
I	Current
I/O	Input/Output
I/P	Input
IANA	Internet Assigned Numbers Authority
ICAO	International Civil Aviation Organization
ICD	IED Capability Description
ID	Identifier or Identification. Often a label used to track a software version installed.
IDMT	Inverse Definite Minimum Time. A characteristic whose trip time depends on the measured input (e.g. current) according to an inverse-time curve.
IEC	International Electro-technical Commission
IED	Intelligent Electronic Device - a term used to describe microprocessor-based controllers of power system equipment. Common types of IEDs include protective relaying devices, load tap changer controllers, circuit breaker controllers, capacitor bank switches, recloser controllers, voltage regulators, etc.
IEEE	Institute of Electrical and Electronics Engineers
IET	IED Engineering ToolSuite. Similar to SET but dedicated to IED. Or IED Engineering Tool.
IETF	Internet Engineering Task Force
IID	Instantiated/Individual IED Description
IIR	Infinite Impulse Response
Inh	An Inhibit signal
Inst	An element with Instantaneous operation: i.e. having no deliberate time delay.
IP	Internet Protocol
IRIG	InterRange Instrumentation Group
ISA	International Standard Atmosphere or Instrumentation Systems and Automation Society
ISO	International Standards Organization
JPEG	Joint Photographic Experts Group – a file format for a computer graphic
L	Live
LAN	Local Area Network
LCB	Log Control Block
LCD	Liquid Crystal Display: The relay front-panel text display.
LD	Level Detector: An element responding to a current or voltage below its set threshold. Or Logical Device
LDAP	Lightweight Directory Access Protocol
LDOV	Level Detector for OverVoltage
LDUV	Level Detector for UnderVoltage
LED	Light Emitting Diode
LLDB	Live-Line Dead-Bus : In system synchronism check, indication that the line is energized whilst the bus is de-energized.
Ln	Natural logarithm
LN	Logical Node
LOGS	All the operations related to the security (connection, configuration…) are automatically caught in events that are logged in order to provide a good visibility of the previous actions to the security administrators.
LoL	A Loss of Load scheme, providing a fast distance trip without needing a signaling channel.
LPDU	Link Protocol Data Unit
LPHD	Logical Physical Device
LRE	Link Redundancy Entity

Term	Description
MAC	Media Access Control or Mandatory Access Control
MC	MultiCast
MCB	Miniature Circuit Breaker
MIB	Management Information Base
MICS	Model Implementation Conformance Statement
MMF	Magneto-Motive Force
MMS	Manufacturing Message Specification (IEC 61850)
MRP	Media Redundancy Protocol
MU	Merging Unit (function)
MV	Measured Value
N	Neutral
N/A	Not Applicable
N/C	A Normally Closed or “break” contact: Often called a “form B” contact.
N/O	A Normally Open or “make” contact: Often called a “form A” contact.
NERC	North American Reliability Corporation
NERO	NERC Electric Reliability Organization (ERO) certified by the Federal Energy Regulatory Commission to establish and enforce reliability standards for the bulk-power system.
NIC	Network Interface Card: i.e. the Ethernet card of the IED
NIST	National Institute of Standards and Technology
NPS	Negative Phase Sequence
NTP	The Network Time Protocol (NTP) is a protocol for synchronizing the clocks of computer systems.
NVD	Neutral Voltage Displacement: Equivalent to residual overvoltage protection.
NXT	Abbreviation of “Next”: In connection with hotkey menu navigation.
o	A small circle on the input or output of a logic gate: Indicates a NOT (invert) function.
O/C	Overcurrent
O/P	Output
OCB	Oil Circuit Breaker
OCSP	Online Certificate Status Protocol. An IETF RFC for online verification of certificates by servers (RFC 2560).
OID	Object IDentifier
OOS	Out-Of-Step
Opto	An Optically coupled logic input. Alternative terminology: binary input.
OSI	Open Systems Interconnection
PAP	Policy Administration Point. Software entity that manage the security Policy
PCB	Printed Circuit Board
PCT	Protective Conductor Terminal (Ground)
PDC	Phasor Data Concentrator
PDP	Policy Decision Point. Software entity that evaluates the applicable policy and takes an authorization decision
PEP	Policy Enforcement Point. Software entity that performs access control and enforces authorization decision.
Ph	Phase - used in distance settings to identify settings that relate to phase-phase faults.
PICS	Protocol Implementation Conformance Statement
PIP	Policy Information Point. Software entity acting as an information source for the PDP.
PKI	Public Key infrastructure

Term	Description
PMU	Phasor Measurement Unit
PNG	Portable Network Graphics – a file format for a computer graphic
Pol	Polarize - typically the polarizing voltage used in making directional decisions.
POR	A Permissive OverReaching transfer trip scheme (alternative terminology: POTT).
POTT	A Permissive Overreaching Transfer Trip scheme (alternative terminology: POR).
PRP	Parallel Redundancy Protocol
PSB	Power Swing Blocking, to detect power swing/out of step functions, could be labeled 78 in ANSI terminology.
PSL	Programmable Scheme Logic: The part of the relay’s logic configuration that can be modified by the user, using the graphical editor within MiCOM S1 Studio software.
PSlip	A Pole slip (out-of-step - OOS) element: could be labeled 78 in ANSI terminology.
PSP	Physical Security Perimeter
PSTN	Public Switched Telephone Network (RTC in French)
PT	Power Transformer
PTP	Precision Time Protocol
PUR	A Permissive UnderReaching transfer trip scheme (alternative terminology: PUTT).
PURR	A Permissive Underreaching Transfer Trip scheme (alternative terminology: PUR).
Q	Quantity defined as per unit value
Qx	Isolator number x
R	Resistance
RA	Registration Authority
R&TTE	Radio and Telecommunications Terminal Equipment
RBAC	Role Based Access Control. Authentication and authorization mechanism based on roles granted to a user. Roles are made of rights, themselves being actions that can be applied on objects. Each user’s action is authorized or not based on his roles
RBN	Lead burden for the neutral path.
RBPh	Lead burden for the phasepath.
RCA	Relay Characteristic Angle - The center of the directional characteristic.
RCB	Report Control Block
RCT	Redundancy Control Trailer or Redundancy Check Tag
REB	Redundant Ethernet Board
RedBox	Redundancy Box
REF	Restricted Earth Fault
Rev.	Indicates an element responding to a flow in the “reverse” direction
RMS / rms	Root mean square. The equivalent a.c. current: Taking into account the fundamental, plus the equivalent heating effect of any harmonics.
RoCoF	Rate of Change of Frequency
RP	Rear Port: The communication ports on the rear of the IED
RS232	A common serial communications standard defined by the EIA
RS485	A common serial communications standard defined by the EIA (multi-drop)
RST or Rst	Reset generally used in the context of reset functions in circuit breaker control.
RSTP	Rapid Spanning Tree Protocol.
RTCS	Real Time Certificate Status. Facility. An IETF draft for online certificates validation.
RTD	Resistance Temperature Device
RTU	Remote Terminal Unit

Term	Description
RX	Receive: Typically used to indicate a communication transmit line/pin.
SAM	Security Administration Module. Device in charge of security management on an IP-over-Ethernet network.
SAMU	Stand Alone Merging Unit (device)
SAN	Singly or Single Attached Node
SAS	Substation Automation Solutions / System
SAT	Security Administration Tool TSF based application used to define and create security configuration
SAU	Security Administration Utility
SBS	Straight Binary Second
SC	Synch-Check or system Synchronism Check.
SCADA	Supervisory Control and Data Acquisition
SCD	Substation Configuration Description
SCEP	Simple Certificate Enrollment Protocol. An IETF draft for distribution and registration of public keys and certificates
SCL	Substation Configuration Language. In IEC 61850, the definition of the configuration files.
SCSM	Specific Communication Service Mappings: In IEC 61850, the SCSMs define the actual information exchange mechanisms currently used (e.g. MMS).
SCU	Substation Control Unit
SCVP	Server-based Certificate Validation Protocol. An IETF RFC for online certificates validation.
SDEF	Sensitive Differential Earth Fault in the context of protection element. Could be labeled 87N in ANSI terminology.
SEF	Sensitive Earth Fault in the context of protection element
Sen	Sensitive
SET	System Engineering Tools. New Tools in place of SCE and SMT, to deal with complete life cycle for Systems (design, realization, testing, commissioning, maintenance).
SFTP	A Secured File Transfer Protocol based on SSH.
SGCB	Setting Group Control Block
SHM	Self-Healing Manager
SHP	Self Healing Protocol
SHR	Self Healing Ring: Ethernet protocol allowing bumpless redundancy. Used with Redundant Ethernet board with self-healing protocol.
SIR	Source Impedance Ratio
SLA	Service Level Agreement
SMB	Server Message Block. Microsoft protocol for network resources sharing. Called CIFS on NT
SMT	Substation Management Tool (previously used on PACIS project)
SMTP	Simple Mail Transfer Protocol (SMTP) is an Internet standard for electronic mail (e-mail) transmission across Internet Protocol (IP) networks.
SMV	Sampled Measured Values
SNMP	Simple Network Management Protocol (SNMP) is an "Internet-standard protocol for managing devices on IP networks
SNTP	Simple Network Time Protocol
SOA	Service Oriented Architecture
SOAP	Simple Object Access Protocol
SOC	Second of Century
SOTF	Switch on to Fault
SP	Single pole.
SPAR	Single pole auto-reclose.

Term	Description
SPC	Single Point Controllable
SPDT	Single Pole Dead Time. The dead time used in single pole auto-reclose cycles.
SPS	Single Point Status
SQRT	Square Root
SSD	Solid State Device
SSH	Secured Shell. A secured encrypted network protocol for remote administration of computers
SSL	Secured Socket Layer or Source Impedance Ratio or See TLS (TLS is based on SSLv3).
SSO	Single Sign On
STP	Shielded Twisted Pair or Spanning Tree Protocol
SUI	Substation User Interface
SV	Sampled Values
SVC	Static Var Compensator
SVM	Sampled Value Model
TAF	Turbine Abnormal Frequency
TAT	Transfer Administration Tool
TBD	To Be Defined
TCP	Transmission Control Protocol
TCS	Trip Circuit Supervision
TD	Time Dial. The time dial multiplier setting: Applied to inverse-time curves (ANSI/IEEE).
TE	Unit for case measurements: One inch = 5TE units
THD	Total Harmonic Distortion
TICS	Technical Issues Conformance Statement
TIFF	Tagged Image File Format – a file format for a computer graphic
TLS	Transport Layer Security network protocol successor to SSL. Or Transport Layer Security. Creates encrypted tunnel for TCP connections. Can guarantee authentication when used in a PKI.
TMS	Time Multiplier Setting: Applied to inverse-time curves (IEC)
TOC	Trip On Close (“line check”) (protection). Offers SOTF and TOR functionality.
TOR	Trip On Reclose (protection). Modified protection on autoreclosure of the circuit breaker.
TP	Two-Part
TSF	Tool Suite Foundation. Common framework for SET and IET. Mainly 3 parts Core, Workbench (for standardized HMI), Utilities (applicative components like trace viewer, installer)
TUC	Timed UnderCurrent
TVE	Total Vector Error
Tx	Transmit
UA	User Account. A user account is a logical representation of a person with some configurable parameters. It includes information about the user identity and gives him a login to be recognized within the tool suite. A user account is principally interesting when it is associated to some roles that will grant him authorizations.
UDP	User Datagram Protocol
UL	Underwriters Laboratory
UPCT	User Programmable Curve Tool
UTC	Universal Time Coordinated
V	Voltage

Term	Description
VA	Phase A voltage: Sometimes L1, or red phase
VB	Phase B voltage: Sometimes L2, or yellow phase
VC	Phase C voltage: Sometimes L3, or blue phase
VCO	Voltage Controlled Overcurrent element
VDAN	Virtual Double or Doubly Attached Node
VDEP OC>	A voltage dependent overcurrent element: could be a voltage controlled or voltage restrained overcurrent element and could be labeled 51V in ANSI terminology.
VDR	Voltage Dependent Resistor
VDS	Virtual Device Solution
V/Hz	An overfluxing element, flux is proportional to voltage/frequency: could be labeled 24 in ANSI terminology.
Vk	IEC knee point voltage of a current transformer.
VPN	Virtual Private Network (a secure private connection established on a public network or other unsecured environment).
VT	Voltage Transformer
VTS	Voltage Transformer Supervision: To detect VT failure.
WAN	Wide Area Network
XACML	eXtensible Access Control Markup Language. An OASIS standard defining an XML access control policy implementation.
Xformer	Transformer
XKMS	XML Keys Management Specifications. A 3C standard, XML based, for distribution and registration of public keys and certificates
XML	Extensible Markup Language
XSD	XML Schema Definition

Table 1 - Acronyms and abbreviations

2 COMPANY PROPRIETARY TERMS

Term	Description
Courier	Schneider Electric’s proprietary SCADA communications protocol
Easergy	Schneider Electric’s brand of protection relays and related software products
Metrosil	Brand of non-linear resistor produced by M&I Materials Ltd.
MiCOM	Schneider Electric’s brand of protection relays

Table 2 - Company-proprietary terms

3 ANSI TERMS

ANSI no.	Description
3PAR	Three pole auto-reclose.
3PDT	Three pole dead time. The dead time used in three pole auto-reclose cycles.
52a	A circuit breaker closed auxiliary contact: The contact is in the same state as the breaker primary contacts
52b	A circuit breaker open auxiliary contact: The contact is in the opposite state to the breaker primary contacts
64R	Rotor earth fault protection
64S	100% stator earth (ground) fault protection using a low frequency injection method.
89a	An Isolator closed auxiliary contact: The contact is in the same state as the breaker primary contacts.
89b	An Isolator open auxiliary contact: The contact is in the opposite state to the breaker primary contacts.

Table 3 - ANSI abbreviations

ANSI no.	Function	Description
Current Protection Functions		
50/51	Phase overcurrent	Three-phase protection against overloads and phase-to-phase short-circuits.
50N/51N	Earth fault	Earth fault protection based on measured or calculated residual current values: • 50N/51N: residual current calculated or measured by 3 phase current sensors
50G/51G	Sensitive earth fault	Sensitive earth fault protection based on measured residual current values: • 50G/51G: residual current measured directly by a specific sensor such as a core balance CT
50BF	Breaker failure	If a breaker fails to be triggered by a tripping order, as detected by the non-extinction of the fault current, this backup protection sends a tripping order to the upstream or adjacent breakers.
46	Negative sequence / unbalance	Protection against phase unbalance, detected by the measurement of negative sequence current: • sensitive protection to detect 2-phase faults at the ends of long lines • protection of equipment against temperature build-up, caused by an unbalanced power supply, phase inversion or loss of phase, and against phase current unbalance
46BC	Broken conductor protection	Protection against phase imbalance, detected by measurement of I2/I1.
49RMS	Thermal overload	Protection against thermal damage caused by overloads on machines (transformers, motors or generators). The thermal capacity used is calculated according to a mathematical model which takes into account: • current RMS values • ambient temperature • negative sequence current, a cause of motor rotor temperature rise
Re-Closer		
79	Recloser	Automation device used to limit down time after tripping due to transient or semipermanent faults on overhead lines. The recloser orders automatic reclosing of the breaking device after the time delay required to restore the insulation has elapsed. Recloser operation is easy to adapt for different operating modes by parameter setting.
Directional Current Protection		
67N/67NC type 1 and 67	Directional phase overcurrent	Phase-to-phase short-circuit protection, with selective tripping according to fault current direction. It comprises a phase overcurrent function associated with direction detection, and picks up if the phase overcurrent function in the chosen direction (line or busbar) is activated for at least one of the three phases.

ANSI no.	Function	Description
67N/67NC	Directional earth fault	Earth fault protection, with selective tripping according to fault current direction. Three types of operation: • Type 1: the protection function uses the projection of the I0 vector • Type 2: the protection function uses the I0 vector magnitude with half-plane tripping zone • Type 3: the protection function uses the I0 vector magnitude with angular sector tripping zone
67N/67NC type 1	Directional current protection	Directional earth fault protection for impedant, isolated or compensated neutral systems, based on the projection of measured residual current.
67N/67NC type 2	Directional current protection	Directional overcurrent protection for impedance and solidly earthed systems, based on measured or calculated residual current. It comprises an earth fault function associated with direction detection, and picks up if the earth fault function in the chosen direction (line or busbar) is activated.
67N/67NC type 3	Directional current protection	Directional overcurrent protection for distribution networks in which the neutral earthing system varies according to the operating mode, based on measured residual current. It comprises an earth fault function associated with direction detection (angular sector tripping zone defined by 2 adjustable angles), and picks up if the earth fault function in the chosen direction (line or busbar) is activated.
Directional Power Protection Functions		

32P	Directional active overpower	Two-way protection based on calculated active power, for the following applications:
		• active overpower protection to detect overloads and allow load shedding
		• reverse active power protection:
		  • against generators running like motors when the generators consume active power
		  • against motors running like generators when the motors supply active power

32Q/40	Directional reactive overpower	Two-way protection based on calculated reactive power to detect field loss on synchronous machines: • reactive overpower protection for motors which consume more reactive power with field loss • reverse reactive overpower protection for generators which consume reactive power with field loss.
Machine Protection Functions		
37	Phase undercurrent	Protection of pumps against the consequences of a loss of priming by the detection of motor no-load operation. It is sensitive to a minimum of current in phase 1, remains stable during breaker tripping and may be inhibited by a logic input.

48/51LR/14	Locked rotor / excessive starting time	Protection of motors against overheating caused by:
		• excessive motor starting time due to overloads (e.g. conveyor) or insufficient supply voltage.
		The reacceleration of a motor that is not shut down, indicated by a logic input, may be considered as starting.
		• locked rotor due to motor load (e.g. crusher):
		  • in normal operation, after a normal start
		  • directly upon starting, before the detection of excessive starting time, with detection of locked rotor by a zero speed detector connected to a logic input, or by the underspeed function.

66	Starts per hour	Protection against motor overheating caused by:
		• too frequent starts: motor energizing is inhibited when the maximum allowable number of starts is reached, after counting of:
		  • starts per hour (or adjustable period)
		  • consecutive motor hot or cold starts (reacceleration of a motor that is not shut down, indicated by a logic input, may be counted as a start)
		• starts too close together in time: motor re-energizing after a shutdown is only allowed after an adjustable waiting time.

ANSI no.	Function	Description
50V/51V	Voltage-restrained overcurrent	Phase-to-phase short-circuit protection, for generators. The current tripping set point is voltage-adjusted in order to be sensitive to faults close to the generator which cause voltage drops and lowers the short-circuit current.
26/63	Thermostat/Buchholz	Protection of transformers against temperature rise and internal faults via logic inputs linked to devices integrated in the transformer.
38/49T	Temperature monitoring	Protection that detects abnormal temperature build-up by measuring the temperature inside equipment fitted with sensors: • transformer: protection of primary and secondary windings • motor and generator: protection of stator windings and bearings.
Voltage Protection Functions		
27D	Positive sequence undervoltage	Protection of motors against faulty operation due to insufficient or unbalanced network voltage, and detection of reverse rotation direction.
27R	Remanent undervoltage	Protection used to check that remanent voltage sustained by rotating machines has been cleared before allowing the busbar supplying the machines to be re-energized, to avoid electrical and mechanical transients.
27	Undervoltage	Protection of motors against voltage sags or detection of abnormally low network voltage to trigger automatic load shedding or source transfer. Works with phase-to-phase voltage.
59	Overvoltage	Detection of abnormally high network voltage or checking for sufficient voltage to enable source transfer. Works with phase-to-phase or phase-to-neutral voltage, each voltage being monitored separately.
59N	Neutral voltage displacement	Detection of insulation faults by measuring residual voltage in isolated neutral systems.
47	Negative sequence overvoltage	Protection against phase unbalance resulting from phase inversion, unbalanced supply or distant fault, detected by the measurement of negative sequence voltage.
Frequency Protection Functions		
81O	Overfrequency	Detection of abnormally high frequency compared to the rated frequency, to monitor power supply quality. Other organizations may use 81H instead of 81O.
81U	Underfrequency	Detection of abnormally low frequency compared to the rated frequency, to monitor power supply quality. The protection may be used for overall tripping or load shedding. Protection stability is ensured in the event of the loss of the main source and presence of remanent voltage by a restraint in the event of a continuous decrease of the frequency, which is activated by parameter setting. Other organizations may use 81L instead of 81U.
81R	Rate of change of frequency	Protection function used for fast disconnection of a generator or load shedding control. Based on the calculation of the frequency variation, it is insensitive to transient voltage disturbances and therefore more stable than a phase-shift protection function. **Disconnection** In installations with autonomous production means connected to a utility, the “rate of change of frequency” protection function is used to detect loss of the main system in view of opening the incoming circuit breaker to: • protect the generators from a reconnection without checking synchronization • avoid supplying loads outside the installation. **Load shedding** The “rate of change of frequency” protection function is used for load shedding in combination with the underfrequency protection to: • either accelerate shedding in the event of a large overload • or inhibit shedding following a sudden drop in frequency due to a problem that should not be solved by shedding.
Dynamic Line Rating (DLR) Protection Functions		

ANSI no.	Function	Description
49DLR	Dynamic line rating (DLR)	Protection of overhead lines based on calculation of rating or ampacity to dynamically take into account the effect of prevailing weather conditions as monitored by external sensors for: • Ambient Temperature • Wind Velocity • Wind Direction • Solar Radiation

Table 4 - ANSI descriptions

4 CONCATENATED TERMS

Term
Undercurrent
Overcurrent
Overfrequency
Underfrequency
Undervoltage
Overvoltage

Table 5 - Concatenated terms

5 UNITS FOR DIGITAL COMMUNICATIONS

Unit	Description
b	bit
B	Byte
kb	Kilobit(s)
kbps	Kilobits per second
kB	Kilobyte(s)
Mb	Megabit(s)
Mbps	Megabits per second
MB	Megabyte(s)
Gb	Gigabit(s)
Gbps	Gigabits per second
GB	Gigabyte(s)
Tb	Terabit(s)
Tbps	Terabits per second
TB	Terabyte(s)

Table 6 - Units for digital communications

6 AMERICAN VS BRITISH ENGLISH TERMINOLOGY

British English	American English
…ae…	…e…
…ence	…ense
…ise	…ize
…oe…	…e…
…ogue	…og
…our	…or
…ourite	…orite
…que	…ck
…re	…er
…yse	…yze
Aluminium	Aluminum
Centre	Center
Earth	Ground
Fibre	Fiber
Ground	Earth
Speciality	Specialty

Table 7 - American vs British English terminology

7 LOGIC SYMBOLS AND TERMS

Symbol	Description	Units
&	Logical “AND”: Used in logic diagrams to show an AND-gate function.	
Σ	“Sigma”: Used to indicate a summation, such as cumulative current interrupted.	
τ	“Tau”: Used to indicate a time constant, often associated with thermal characteristics.	
ω	System angular frequency	rad
<	Less than: Used to indicate an “under” threshold, such as undercurrent (current dropout).	
>	Greater than: Used to indicate an “over” threshold, such as overcurrent (current overload)	
o	A small circle on the input or output of a logic gate: Indicates a NOT (invert) function.	
1	Logical “OR”: Used in logic diagrams to show an OR-gate function.	
ABC	Clockwise phase rotation.	
ACB	Anti-Clockwise phase rotation.	
C	Capacitance	A
df/dt	Rate of Change of Frequency protection	Hz/s
df/dt>1	First stage of df/dt protection	Hz/s
F<	Underfrequency protection: Could be labeled 81-U in ANSI terminology.	Hz
F>	Overfrequency protection: Could be labeled 81-O in ANSI terminology.	Hz
F<1	First stage of under frequency protection: Could be labeled 81-U in ANSI terminology.	Hz
F>1	First stage of over frequency protection: Could be labeled 81-O in ANSI terminology.	Hz
f_{max}	Maximum required operating frequency	Hz
f_{min}	Minimum required operating frequency	Hz
f_n	Nominal operating frequency	Hz
I	Current	A
I^	Current raised to a power: Such as when breaker statistics monitor the square of ruptured current squared (∧ power = 2).	An
I’f	Maximum internal secondary fault current (may also be expressed as a multiple of In)	A
I<	An undercurrent element: Responds to current dropout.	A
I>>	Current setting of short circuit element	In
I>	A phase overcurrent protection: Could be labeled 50/51 in ANSI terminology.	A
I>1	First stage of phase overcurrent protection: Could be labeled 51-1 in ANSI terminology.	A
I>2	Second stage of phase overcurrent protection: Could be labeled 51-2 in ANSI terminology.	A
I>3	Third stage of phase overcurrent protection: Could be labeled 51-3 in ANSI terminology.	A
I>4	Fourth stage of phase overcurrent protection: Could be labeled 51-4 in ANSI terminology.	A
I>BB	Minimum pick-up phase threshold for the local trip order confirmation.	A
I>DZ	Minimum pick-up phase threshold for the Dead Zone protection.	A
I_0	Earth fault current setting Zero sequence current: Equals one third of the measured neutral/residual current.	A
I_1	Positive sequence current.	A
I_2	Negative sequence current.	A
I2>	Negative sequence overcurrent protection (NPS element).	A
I2pol	Negative sequence polarizing current.	A
I2therm>	A negative sequence thermal element: Could be labeled 46T in ANSI terminology.	
IA	Phase A current: Might be phase L1, red phase.. or other, in customer terminology.	A
IB	Phase B current: Might be phase L2, yellow phase.. or other, in customer terminology.	A
IbiasPh> Cur.	SDEF blocking bias current threshold.	

Symbol	Description	Units
IC	Phase C current: Might be phase L3, blue phase.. or other, in customer terminology.	A
ID>1	Minimum pick-up phase circuitry fault threshold.	
ID>2	Minimum pick-up differential phase element for all the zones.	
IDCZ>2	Minimum pick-up differential phase element for the Check Zone.	
Idiff	Current setting of biased differential element	A
IDN>1	Minimum pick-up neutral circuitry fault threshold.	
IDN>2	Minimum pick-up differential neutral element for all the zones.	
IDNCZ>2	Minimum pick-up differential neutral element for the Check Zone.	
IDZ	Minimum pick-up differential neutral element for the Check Zone.	
If	Maximum secondary through-fault current	A
If max	Maximum secondary fault current (same for all feeders)	A
If max int	Maximum secondary contribution from a feeder to an internal fault	A
If Z1	Maximum secondary phase fault current at Zone 1 reach point	A
Ife	Maximum secondary through fault earth current	A
IfeZ1	Maximum secondary earth fault current at Zone 1 reach point	A
Ifn	Maximum prospective secondary earth fault current or 31 x I> setting (whichever is lowest)	A
Ifp	Maximum prospective secondary phase fault current or 31 x I> setting (whichever is lowest)	A
I_m	Mutual current	A
IM64	InterMiCOM64.	
IMx	InterMiCOM64 bit (x=1 to 16)	
I_n	Current transformer nominal secondary current. The rated nominal current of the relay: Software selectable as 1 amp or 5 amp to match the line CT input.	A
IN	Neutral current, or residual current: This results from an internal summation of the three measured phase currents.	A
IN>	A neutral (residual) overcurrent element: Detects earth/ground faults.	A
IN>1	First stage of ground overcurrent protection: Could be labeled 51N-1 in ANSI terminology.	A
IN>2	Second stage of ground overcurrent protection: Could be labeled 51N-2 in ANSI terminology.	A
IN>BB	Minimum pick-up neutral threshold for the local trip order confirmation.	
IN>DZ	Minimum pick-up neutral threshold for the Dead Zone protection.	
Inst	An element with “instantaneous” operation: i.e. having no deliberate time delay.	
I/O	Inputs and Outputs - used in connection with the number of optocoupled inputs and output contacts within the relay.	
I/P	Input	
Iref	Reference current of P63x calculated from the reference power and nominal voltage	A
IREF>	A Restricted Earth Fault overcurrent element: Detects earth (ground) faults. Could be labeled 64 in ANSI terminology.	A
IRm2	Second knee-point bias current threshold setting of P63x biased differential element	A
Is	Value of stabilizing current	A
IS1	Differential current pick-up setting of biased differential element	A
IS2	Bias current threshold setting of biased differential element	A
I_{SEF}>	Sensitive Earth Fault overcurrent element.	A
Isn	Rated secondary current (I secondary nominal)	A
Isp	Stage 2 and 3 setting	A
Ist	Motor start up current referred to CT secondary side	A
K	Dimensioning factor	

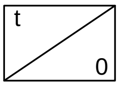
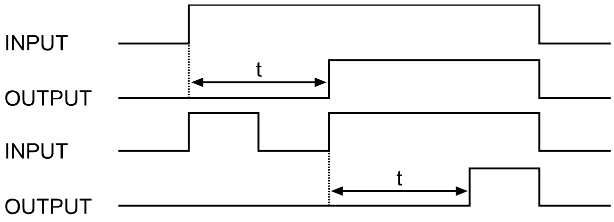
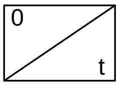
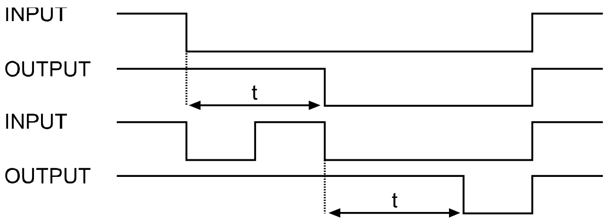
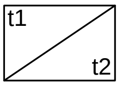
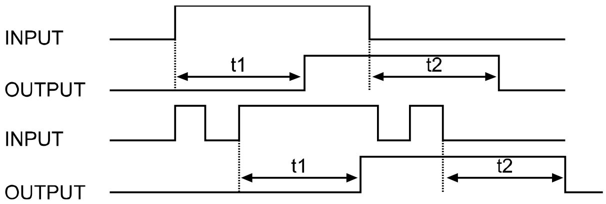
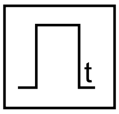
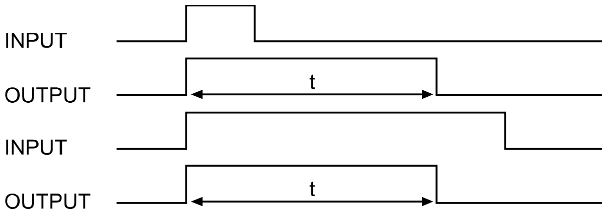
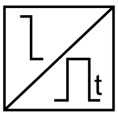
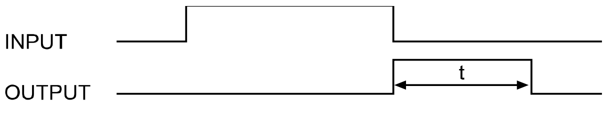
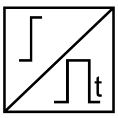
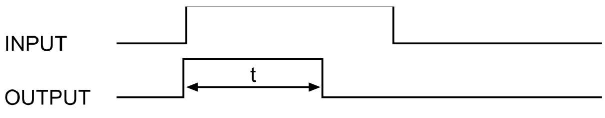
Symbol	Description	Units
K_1	Lower bias slope setting of biased differential element	%
K_2	Higher bias slope setting of biased differential element	%
KCZ	Slope of the differential phase element for the Check Zone.	
K_e	Dimensioning factor for earth fault	
km	Distance in kilometers	
K_{max}	Maximum dimensioning factor	
KNCZ	Slope of the differential neutral element for the Check Zone.	
K_{rpa}	Dimensioning factor for reach point accuracy	
K_s	Dimensioning factor dependent upon through fault current	
K_{ssc}	Short circuit current coefficient or ALF	
K_t	Dimensioning factor dependent upon operating time	
kZm	The mutual compensation factor (mutual compensation of distance elements and fault locator for parallel line coupling effects).	
kZN	The residual compensation factor: Ensuring correct reach for ground distance elements.	
L	Inductance	A
m1	Lower bias slope setting of P63x biased differential element	None
m2	Higher bias slope setting of P63x biased differential element	None
mi	Distance in miles.	
N	Indication of “Neutral” involvement in a fault: i.e. a ground (earth) fault.	
-P>	A reverse power (W) element: could be labeled 32R in ANSI terminology.	
P>	An overpower (W) element: could be labeled 32O in ANSI terminology.	
P<	A low forward power (W) element: could be labeled 32L in ANSI terminology.	
P1	Used in IEC terminology to identify the primary CT terminal polarity: Replace by a dot when using ANSI standards.	
P2	Used in IEC terminology to identify the primary CT terminal polarity: The non-dot terminal.	
P_n	Rotating plant rated single phase power	W
PN>	Wattmetric earth fault protection: Calculated using residual voltage and current quantities.	
Q<	A reactive under power (VAr) element	
R	Resistance (Ω)	Ω
R< or 64S R<	A 100% stator earth (ground) fault via low frequency injection under resistance element: could be labeled 64S in ANSI terminology.	
R Gnd.	A distance zone resistive reach setting: Used for ground (earth) faults.	
R Ph	A distance zone resistive reach setting used for Phase-Phase faults.	
Rct	Secondary winding resistance	Ω
RCT	Current transformer secondary resistance	Ω
Rl	Resistance of single lead from relay to current transformer	Ω
Rr	Resistance of any other protective relays sharing the current transformer	Ω
Rrn	Resistance of relay neutral current input	Ω
Rrp	Resistance of relay phase current input	Ω
Rs	Value of stabilizing resistor	Ω
Rx	Receive: typically used to indicate a communication receive line/pin.	
S<	An apparent under power (VA) element	
S1	Used in IEC terminology to identify the secondary CT terminal polarity: Replace by a dot when using ANSI standards.	

Symbol	Description	Units
S2	Used in IEC terminology to identify the secondary CT terminal polarity: The non-dot terminal. Also used to signify negative sequence apparent power, S2 = V2 x I2.	
S2>	A negative sequence apparent power element, S2 = V2 x I2.	
t	A time delay.	
t'	Duration of first current flow during auto-reclose cycle	s
T1	Primary system time constant	s
TF	Through Fault monitoring	
tfr	Auto-reclose dead time	s
Thermal I>	A stator thermal overload element: could be labeled 49 in ANSI terminology.	
Thru/TF	Through Fault monitoring	
tIdiff	Current differential operating time	s
Ts	Secondary system time constant	s
Tx	Transmit: typically used to indicate a communication transmit line/pin.	
V	Voltage.	V
V<	An undervoltage element: could be labeled 27 in ANSI terminology	V
V<1	First stage of undervoltage protection: Could be labeled 27-1 in ANSI terminology.	V
V<2	Second stage of undervoltage protection: Could be labeled 27-2 in ANSI terminology.	V
V>	An overvoltage element: could be labeled 59 in ANSI terminology	V
V>1	First stage of overvoltage protection: Could be labeled 59-1 in ANSI terminology.	V
V>2	Second stage of overvoltage protection: Could be labeled 59-2 in ANSI terminology.	V
V0	Zero sequence voltage: Equals one third of the measured neutral/residual voltage.	V
V1	Positive sequence voltage.	V
V2	Negative sequence voltage.	V
V2>	A Negative Phase Sequence (NPS) overvoltage element: could be labeled 47 in ANSI terminology.	
$V2_{pol}$	Negative sequence polarizing voltage.	V
V_A	Phase A voltage: Might be phase L1, red phase.. or other, in customer terminology.	V
V_B	Phase B voltage: Might be phase L2, yellow phase.. or other, in customer terminology.	V
V_C	Phase C voltage: Might be phase L3, blue phase.. or other, in customer terminology.	V
Vf	Theoretical maximum voltage produced if CT saturation did not occur	V
Vin	Input voltage e.g. to an opto-input	V
V_k	Required CT knee-point voltage. IEC knee point voltage of a current transformer.	V
VN	Neutral voltage displacement, or residual voltage.	V
VN>	A residual (neutral) overvoltage element: could be labeled 59N in ANSI terminology.	V
V_n	Nominal voltage	V
Vn	The rated nominal voltage of the relay: To match the line VT input.	V
VN>1	First stage of residual (neutral) overvoltage protection.	V
VN>2	Second stage of residual (neutral) overvoltage protection.	V
VN3H>	A 100% stator earth (ground) fault 3rd harmonic residual (neutral) overvoltage element: could be labeled 59TN in ANSI terminology.	
VN3H<	A 100% stator earth (ground) fault 3rd harmonic residual (neutral) undervoltage element: could be labeled 27TN in ANSI terminology.	
Vres.	Neutral voltage displacement, or residual voltage.	V
Vs	Value of stabilizing voltage	V
V_x	An auxiliary supply voltage: Typically the substation battery voltage used to power the relay.	V

Symbol	Description	Units
WI	Weak Infeed logic used in teleprotection schemes.	
X	Reactance	None
X/R	Primary system reactance/resistance ratio	None
Xe/Re	Primary system reactance/resistance ratio for earth loop	None
Xt	Transformer reactance (per unit)	p.u.
Y	Admittance	p.u.
YN>	Neutral overadmittance protection element: Non-directional neutral admittance protection calculated from neutral current and residual voltage.	
Z	Impedance	p.u.
Z<	An under impedance element: could be labeled 21 in ANSI terminology.	
Z0	Zero sequence impedance.	
Z1	Positive sequence impedance.	
Z1	Zone 1 distance protection.	
Z1X	Reach-stepped Zone 1X, for zone extension schemes used with auto-reclosure.	
Z2	Negative sequence impedance.	
Z2	Zone 2 distance protection.	
ZP	Programmable distance zone that can be set forward or reverse looking.	
Zs	Used to signify the source impedance behind the relay location.	
Φal	Accuracy limit flux	Wb
Ψr	Remanent flux	Wb
Ψs	Saturation flux	Wb

Table 8 - Logic Symbols and Terms

8 LOGIC TIMERS

Logic symbols	Explanation	Time chart
	Delay on pick-up timer, t	
	Delay on drop-off timer, t	
	Delay on pick-up/drop-off timer	
	Pulse timer	
	Pulse pick-up falling edge	
	Pulse pick-up raising edge	

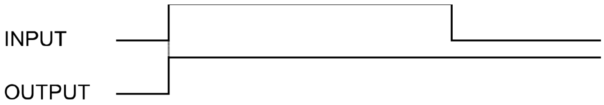
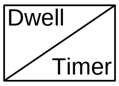
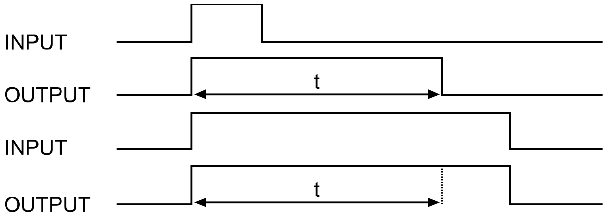
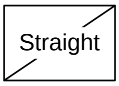
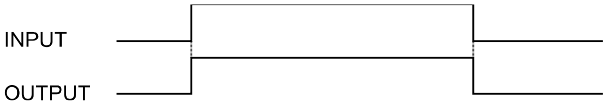
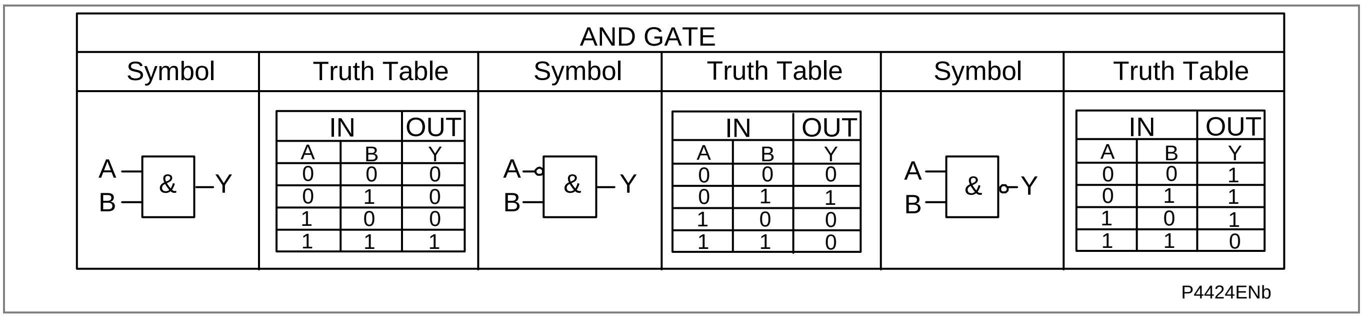
Logic symbols	Explanation	Time chart
	Latch	
	Dwell timer	
	Straight (non latching): Hold value until input reset signal	

Table 9 - Logic Timers

9 LOGIC GATES

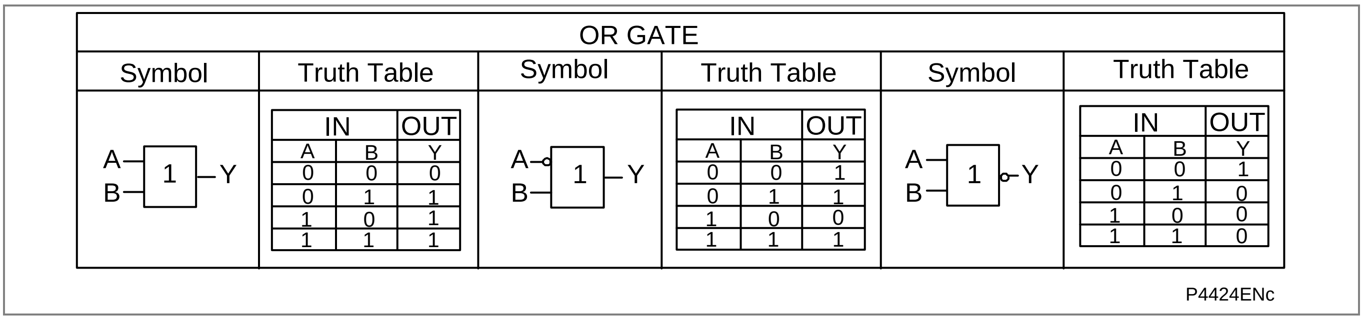


IN		OUT
A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

IN		OUT
A	B	Y
0	0	0
0	1	1
1	0	0
1	1	0

IN		OUT
A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

Figure 1 - Logic Gates - AND Gate

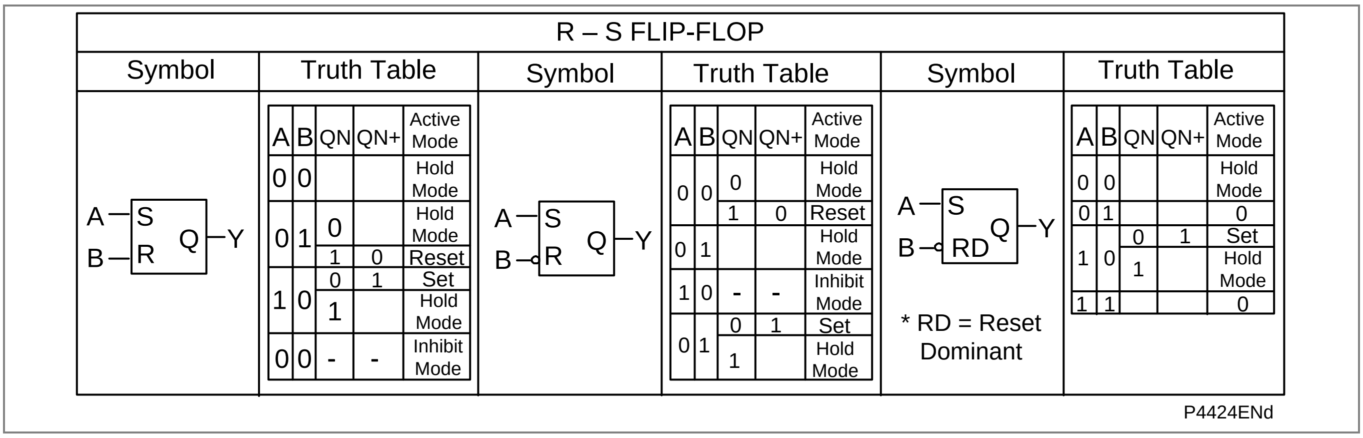


IN		OUT
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

IN		OUT
A	B	Y
0	0	1
0	1	1
1	0	0
1	1	1

IN		OUT
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

Figure 2 - Logic Gates - OR Gate

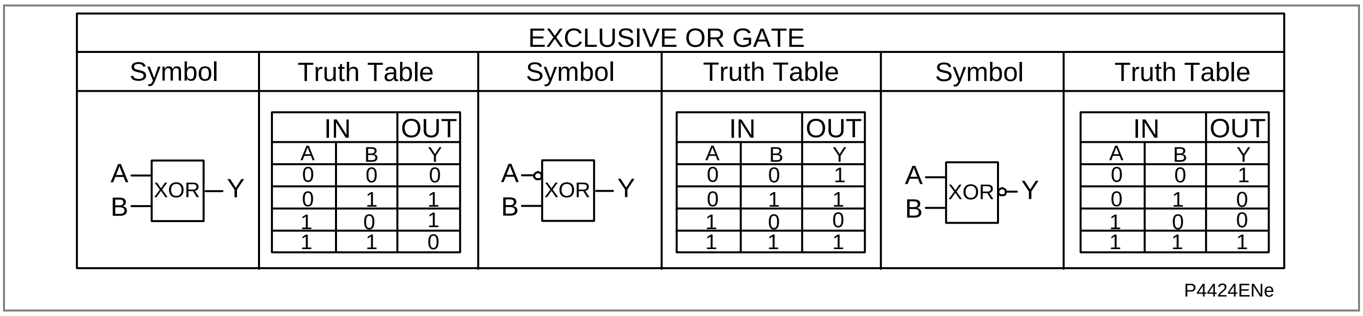


A	B	QN	QN+	Active Mode
0	0			Hold Mode
0	1	0		Hold Mode
		1	0	Reset
1	0	0	1	Set
		1		Hold Mode
0	0	-	-	Inhibit Mode

A	B	QN	QN+	Active Mode
0	0	0		Hold Mode
		1	0	Reset
0	1			Hold Mode
1	0	-	-	Inhibit Mode
0	1	0	1	Set
		1		Hold Mode

A	B	QN	QN+	Active Mode
0	0			Hold Mode
0	1			0
1	0	0	1	Set
		1		Hold Mode
1	1			0

Figure 3 - Logic Gates - R-S Flip-Flop Gate



IN		OUT
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

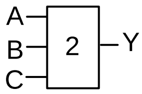
IN		OUT
A	B	Y
0	0	1
0	1	1
1	0	0
1	1	1

IN		OUT
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

Figure 4 - Logic Gates - Exclusive OR Gate

PROGRAMMABLE GATE

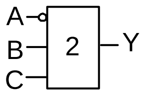
Symbol



Truth Table

IN			OUT
A	B	C	Y
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

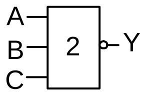
Symbol



Truth Table

IN			OUT
A	B	C	Y
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

Symbol



Truth Table

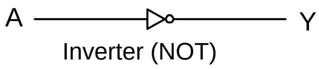
IN			OUT
A	B	C	Y
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	0

P4424ENf

Figure 5 - Logic Gates - Programmable Gate

NOT GATE

Symbol



Truth Table

IN	OUT
A	Y
0	1
1	0

P4424ENg

Figure 6 - Logic Gates - NOT Gate

Notes:

Customer Care Centre

http://www.schneider-electric.com/ccc

Schneider Electric

35 rue Joseph Monier
92506 Rueil-Malmaison
FRANCE

Phone: +33 (0) 1 41 29 70 00
Fax: +33 (0) 1 41 29 71 00

www.schneider-electric.com

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