MiCOM P721 & P723

High Impedance Differential Protection

P72x/EN T/D21

Software Version 12.B

Technical Guide

Schneider Electric

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

Publication: P72x/EN T/D21

Publishing: Schneider Electric
09/2017

MiCOM P721 & P723
HIGH IMPEDANCE DIFFERENTIAL PROTECTION
TECHNICAL GUIDE

CONTENTS

Safety Section	**Pxxxx/EN SS/G11**
Introduction	**P72x/EN IT/C21**
Handling, Installation and Case Dimensions	**P72x/EN IN/C21**
User Guide	**P72x/EN FT/D21**
Menu Content Tables	**P72x/EN HI/D21**
Technical Data	**P72x/EN TD/D21**
Getting Started	**P72x/EN GS/C21**
Application	**P72x/EN AP/C21**
Communication Database	**P72x/EN CT/A11**
Commissioning and Maintenance Guide	**P72x/EN CM/C21**
Connection Diagrams	**P72x/EN CO/A11**
Commissioning Test & Records Sheets	**P72x/EN RS/A11**
Hardware/Software Version History and Compatibility	**P72x/EN VC/D21**

BLANK PAGE

SAFETY SECTION

STANDARD SAFETY STATEMENTS AND EXTERNAL LABEL INFORMATION FOR SCHNEIDER ELECTRIC EQUIPMENT

1.	**INTRODUCTION**	**3**
2.	**HEALTH AND SAFETY**	**3**
3.	**SYMBOLS AND EXTERNAL LABELS ON THE EQUIPMENT**	**4**
3.1	**Symbols**	**4**
3.2	**Labels**	**4**
4.	**INSTALLING, COMMISSIONING AND SERVICING**	**4**
5.	**DECOMMISSIONING AND DISPOSAL**	**7**
6.	**TECHNICAL SPECIFICATIONS FOR SAFETY**	**8**
6.1	**Protective fuse rating**	**8**
6.2	**Protective Class**	**8**
6.3	**Installation Category**	**8**
6.4	**Environment**	**8**

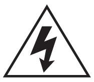
BLANK PAGE

1. INTRODUCTION

This guide and the relevant equipment documentation provide full information on safe handling, commissioning and testing of this equipment. This Safety Guide also includes descriptions of equipment label markings.

Documentation for equipment ordered from Schneider Electric is despatched separately from manufactured goods and may not be received at the same time. 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 safety guide is typical only, see the technical data section of the relevant product publication(s) for data specific to a particular equipment.



Before carrying out any work on the equipment the user should be familiar with the contents of this Safety Guide and the ratings on the equipment's rating label.

Reference should be made to the external connection diagram before the equipment is installed, commissioned or serviced.

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

2. HEALTH AND SAFETY

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

It is assumed that everyone who will be associated with the equipment will be familiar with the contents of that Safety Section, or this Safety Guide.

When electrical equipment is in operation, dangerous voltages will be present in certain parts of the equipment. Failure to observe warning notices, incorrect use, or improper use may endanger personnel and equipment and also cause personal injury or physical damage.

Before working in the terminal strip area, the equipment must be isolated.

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:

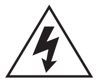
- Are familiar with the installation, commissioning, and operation of the equipment and of the system to which it is being connected;
- Are able to safely perform switching operations in accordance with accepted safety engineering practices and are authorised to energize and de-energize equipment and 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).

The equipment documentation 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.

3. SYMBOLS AND EXTERNAL 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.

*NOTE: THE TERM EARTH USED THROUGHOUT THIS GUIDE IS THE DIRECT EQUIVALENT OF THE NORTH AMERICAN TERM GROUND.

3.2 Labels

See Safety Guide (SFTY/4L M/G11) for equipment labelling information.

4. INSTALLING, COMMISSIONING AND SERVICING

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) precautions 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.

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 mm^2 (3.3 mm^2 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.

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.

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 MMLG, MMLB and MiCOM P990 types, hazardous voltages may be accessible when using these. *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.

Fiber optic communication

Where fiber optic communication devices are fitted, these should not be viewed directly. 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. DECOMMISSIONING 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.

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

6.2 Protective Class

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

6.3 Installation Category

IEC 60255-27: 2005	Installation Category III (Overvoltage Category III):
EN 60255-27: 2006	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 or 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 Altitude - Operation up to 2000m	Compliance is demonstrated by reference to safety standards.

IEC 60255-27:2005

EN 60255-27: 2006

INTRODUCTION

CONTENTS

1. INTRODUCTION 3

2. HOW TO USE THIS MANUAL 4

3. INTRODUCTION TO THE MiCOM RANGE 5

4. INTRODUCTION TO THE MiCOM P721 & P723 PROTECTIONS 6

5. MAIN FUNCTIONS 7

5.1 Main functions 7

5.2 General functions 7

5.3 Ordering options 9

BLANK PAGE

1. INTRODUCTION

The differential protections of the MiCOM P72x range are Schneider Electric numerical high impedance differential protection. MiCOM P721 and P723 have been designed to provide differential protection and a high impedance differential protection

The differential protection consists to measure the summation of n Current Transformers (CTs) secondary currents. Without internal fault, this sum is null. If an internal fault occurs, the protection measures the leak current. If an external fault occurs (with non-saturated CT), the Kirchhoff's law is conserved and no current is measured.

The high impedance differential protection main application is a CT saturation in a busbar (when a serious and external fault occurs).

2. HOW TO USE THIS MANUAL

This manual provides a description of **MiCOM P721** and **P723** functions and settings. The goal of this manual is to allow the user to become familiar with the application, installation, setting and commissioning of these relays.

This manual has the following format:

P72x/EN IT	*Introduction*
	The introduction presents the documentation structure and a brief presentation of the relay, including functions.
P72x/EN IN	*Handling, installation and case dimensions*
	This section provides logistics general instructions for handling, installing and stocking..
P72x/EN FT	*User Guide*
	This section provides relay settings with a brief explanation of each setting and detailed description. It also provides recording and measurements functions including the configuration of the event and disturbance recorder and measurement functions.
P72x/EN HI	*Menu content tables*
	This section shows the menu structure of the relays, with a complete list of all of the menu settings.
P72x/EN AP	*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.
P72x/EN TD	*Technical data and curve characteristics*
	This section provides technical data including setting ranges, accuracy limits, recommended operating conditions, ratings and performance data. Compliance with norms and international standards is quoted where appropriate.
P72x/EN CT	*Communication database*
	This section provides an overview regarding the 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.
P72x/EN CM	*Commissioning and Maintenance Guide*
	Instructions on how to commission the relay, comprising checks on the calibration and functionality of the relay.
P72x/EN CO	*Connection diagrams*
	This section provides the mechanical and electrical description. External wiring connections to the relay are indicated.
P72x/EN RS	*Commissioning test and records sheets*
	This section contains checks on the calibration and functionality of the relay.
P72x/EN VC	*Hardware/Software version history and compatibility*
	History of all hardware and software releases for the product.

3. INTRODUCTION TO THE MiCOM RANGE

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

MiCOM provides the ability to define an application solution and, through extensive communication capabilities, to integrate this solution 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 a power system, using disturbance and fault records.

They can also provide measurements of the power system at regular intervals to a control centre enabling remote monitoring and control to take place.

For up-to-date information on any MiCOM product, refer to the technical publications, which can be obtained from: Schneider Electric or your local sales office; alternatively visit our web site.

www.schneider-electric.com

4. INTRODUCTION TO THE MiCOM P721 & P723 PROTECTIONS

The range of MiCOM protection relays is built on the success of the MIDOS, K and MODN ranges by incorporating the last changes in digital technology. Relays from the MiCOM P72x range are fully compatible and use the same modular box concept.

MiCOM P721 and P723 high impedance differential protections provide differential protection and high impedance differential protection (with P79x high impedance accessory) for machines, power transformers and busbar installations as well as for other applications where differential protection is required.

The P721 relay provides simple restricted earth current fault protection. Furthermore, P723 relay is used for 3-phases fault protection.

In addition to its protective functions, each relay offers control and recording features. They can be fully integrated to a control system so protection, control, data acquisition and recording of faults, events and disturbances can be made available.

The relays are equipped on the front panel with a liquid crystal display (LCD) with 2 x 16 back-lit alphanumerical characters, a tactile 7 button keypad (to access all settings, clear alarms and read measurements) and 8 LEDs that indicate the status of MiCOM P721 and P723 protections.

In addition, the use of the RS485 communication port makes it possible to read, reinitialise and change the settings of the relays, if required, from a local or remote PC computer loaded with MiCOM S1 software.

Its flexibility of use, reduced maintenance requirements and ease of integration allow the MiCOM P72x range to provide an adaptable solution for the problems of the protection of electric networks.

5. MAIN FUNCTIONS

5.1 Main functions

The following table shows the functions available for the different models of the MiCOM P72x range of relays.

ANSI CODES	FEATURES	P721	P723
87	Phase segregated high impedance current differential protection		•
95	Phase bus-wire supervision		•
87N	Restricted earth fault protection	•	•
95N	Earth bus-wire supervision	•	•
87CZ	Check zone input		•
50BF	Breaker failure detection	•	•

5.2 General functions

The following table shows the general features available.

GENERAL FEATURES		P721	P723
Number of digital inputs		2	5
Total number of outputs relays		4	8
Events recording		250	250
Fault recording		25	25
Disturbance recording		5	5
Instantaneous records		5	5
Setting group		2	2
Auxiliary timers		2	4
Communication	IEC60870-5-103, DNP 3.0 & Modbus RTU (rear and front port)	•	•
Settings software	MiCOM S1	•	•
Logic equation	AND, OR and NOT gates (8 equations)	•	•
Measurements	Neutral supervision / differential currents (INdiff)	•	•
	Phase supervision / differential currents (IAdiff, IBdiff and ICdiff)		•
	Maximum differential currents (ImaxAdiff, ImaxBdiff, and ImaxCdiff)		•
	Maximum differential neutral currents (ImaxNdiff	•	•

Application overview

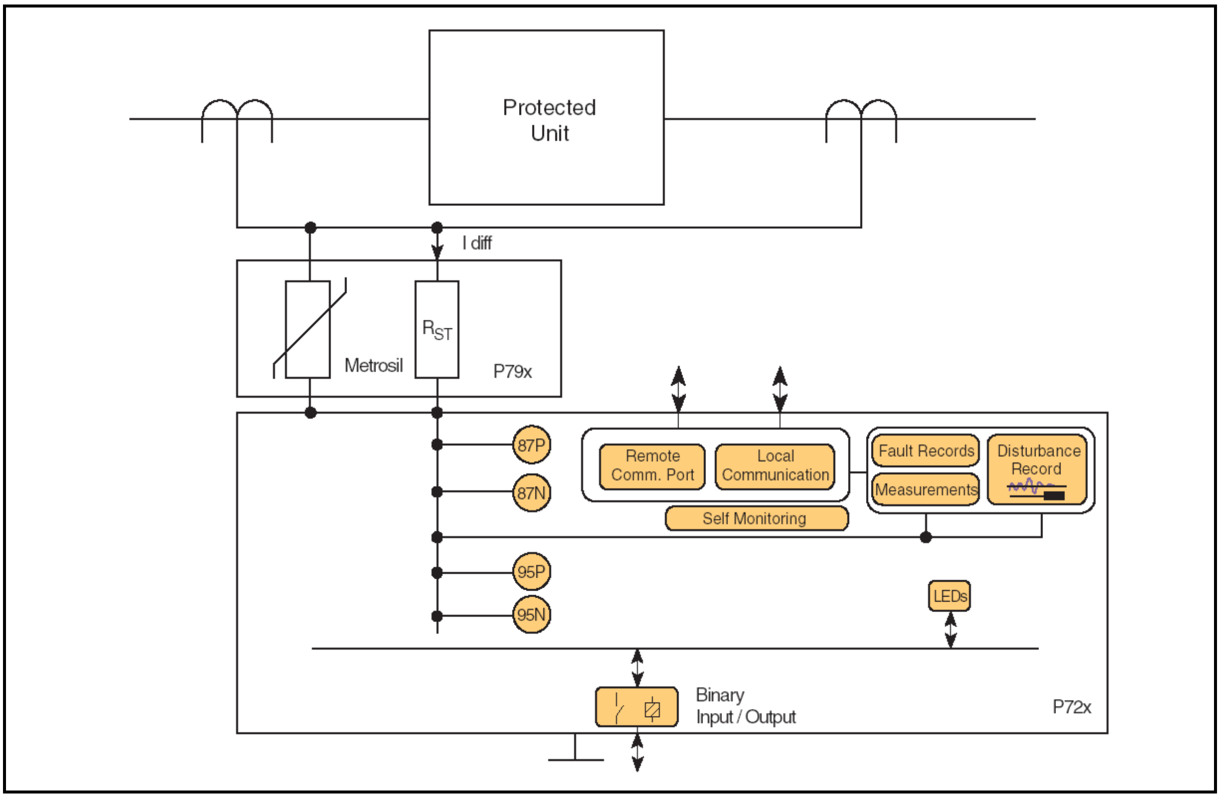


FIGURE 1: FUNCTIONAL DIAGRAM

5.3 Ordering options

Information Required with Order

Relay Type (differential protection)	P72		0	0	0							

Variant

Simple phase high impedance differential protection	1
Simple phase or three phase high impedance protection with binary I/O extension	3

Auxiliary and digital input voltage

Auxiliary voltage	digital input voltage	
48-250 Vdc / 48-240 Vac	105-145 Vdc (1)	H
48-250 Vdc / 48-240 Vac	48-250 Vdc (ENA UK)	T
48-250 Vdc / 48-240 Vac	110 Vdc –30% / +20% (1)	V
48-250 Vdc / 48-240 Vac	220 Vdc –30% / +20% (1)	W
24-250Vdc / 48-240Vac	24-250 Vdc / 24 / 240 Vdc	Z

Rear port communication interface

Modbus	1
K-Bus/Courier	2
IEC 60870-5-103	3
DNP 3.0	4

Default HMI language

French	0
English / American	1
Spanish	2
German	3
Italian	4
Portuguese	7

Platform

phase 2 with standard software	2

Software

Unless specified the latest version will be delivered

Mounting option

None (default) (2)	0
Pre-fixed HMI (no withdrawability)	1
Sealed cover (2)	2
Pre-fixed HMI + Sealed cover	3

(1) : special application

(2) : : not available

BLANK PAGE

HANDLING, INSTALLATION AND CASE DIMENSIONS

CONTENTS

1. GENERAL CONSIDERATIONS 3

1.1 Receipt of relays 3

1.2 Electrostatic discharge (ESD) 3

2. HANDLING OF ELECTRONIC EQUIPMENT 4

3. RELAY MOUNTING 5

4. UNPACKING 6

5. STORAGE 7

6. DIMENSIONS 8

6.1 Connection of power terminals, and Signals terminals 8

6.2 Communication port RS485 9

6.3 Earthing 9

7. CASE DIMENSIONS 10

BLANK PAGE

1. GENERAL CONSIDERATIONS

BEFORE CARRYING OUT ANY WORK ON THE EQUIPMENT, THE USER SHOULD BE FAMILIAR WITH THE CONTENTS OF THE SAFETY GUIDE SFTY/4LM/E11 OR LATER ISSUE, OR THE SAFETY AND TECHNICAL DATA SECTIONS OF THE TECHNICAL MANUAL AND ALSO THE RATINGS ON THE EQUIPMENT RATING LABEL.

1.1 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 damage has been sustained in transit. If damage has been sustained during transit a claim should be made to the transport contractor and Schneider Electric should be promptly notified.

Relays that are supplied unmounted and not intended to be installed immediately should be returned with their protective polythene bags.

1.2 Electrostatic discharge (ESD)

The relays use components that are sensitive to electrostatic discharges.

The electronic circuits are well protected by the metal case and the internal module should not be withdrawn unnecessarily. When handling the module outside its case, care should be taken to avoid contact with components and electrical connections. If removed from the case for storage, the module should be placed in an electrically conducting antistatic bag.

There are no setting adjustments within the module and it is advised that it is not unnecessarily disassembled. Although the printed circuit boards are plugged together, the connectors are a manufacturing aid and not intended for frequent dismantling; in fact considerable effort may be required to separate them. Touching the printed circuit board should be avoided, since complementary metal oxide semiconductors (CMOS) are used, which can be damaged by static electricity discharged from the body.

2. HANDLING OF ELECTRONIC EQUIPMENT

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 often may not be immediately apparent but the reliability of the circuit will have been reduced.

The electronic circuits are completely safe from electrostatic discharge when housed in the case. Do not expose them to risk of damage by withdrawing modules unnecessarily.

Each module incorporates the highest practicable protection for its semiconductor devices. However, if it becomes necessary to withdraw a module, the following precautions should be taken to preserve the high reliability and long life for which the equipment has been designed and manufactured.

1. Before removing a module, ensure that you are at the same electrostatic potential as the equipment by touching the case.
2. Handle the module by its frontplate, frame or edges of the printed circuit board. Avoid touching the electronic components, printed circuit track or connectors.
3. Do not pass the module to another person without first ensuring you are both at the same electrostatic potential. Shaking hands achieves equipotential.
4. Place the module on an antistatic surface, or on a conducting surface which is at the same potential as yourself.
5. Store or transport the module in a conductive bag.

If you are making measurements on the internal electronic circuitry of an equipment 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 – 10MΩ.

If a wrist strap is not available you should maintain regular contact with the case to prevent a build-up of static. Instrumentation which may be used for making measurements should be earthed to the case whenever possible.

More information on safe working procedures for all electronic equipment can be found in BS5783 and IEC 147-OF. 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 above-mentioned BS and IEC documents.

3. RELAY MOUNTING

Relays are dispatched either individually or as part of a panel/rack assembly.

If an MMLG test block is to be included it should be positioned at the right-hand side of the assembly (viewed from the front). Modules should remain protected by their metal case during assembly into a panel or rack.

For individually mounted relays an outline diagram is supplied in section 6 of this chapter showing the panel cut-outs and hole centres.

4. UNPACKING

Care must be taken when unpacking and installing the relays so that none of the parts is damaged or the settings altered. Relays must only be handled by skilled personnel. The installation should be clean, dry and reasonably free from dust and excessive vibration. The site should be well lit to facilitate inspection. Relays that have been removed from their cases should not be left in situations where they are exposed to dust or damp. This particularly applies to installations which are being carried out at the same time as construction work.

5. 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 has been exposed to ambient conditions and may be restored by gently heating the bag for about an hour, prior to replacing it in the carton.

Dust which collects on a carton may, on subsequent unpacking, find its way into the relay; in damp conditions the carton and packing may become impregnated with moisture and the de-humifier will lose its efficiency.

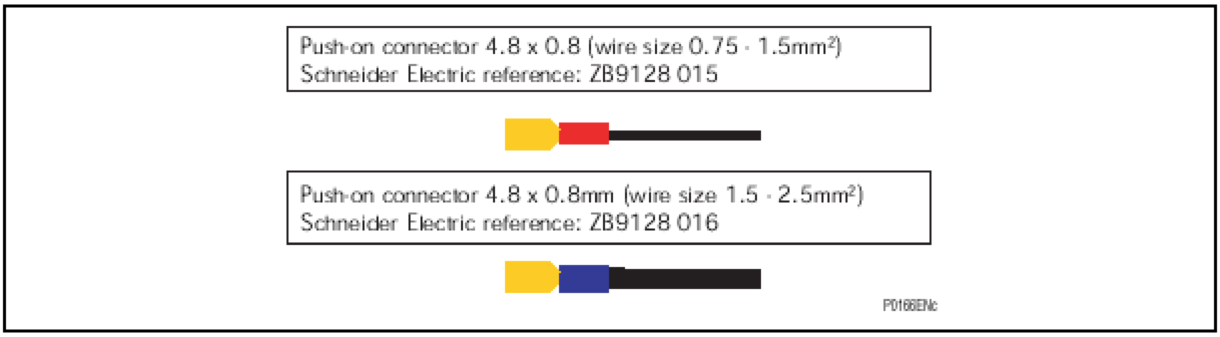
Storage temperature: –25°C to +70°C.

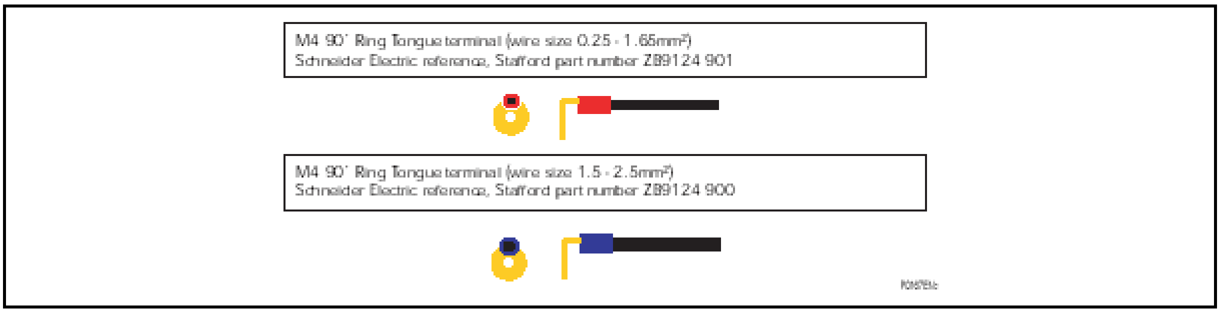
6. DIMENSIONS

6.1 Connection of power terminals, and Signals terminals

The individual equipment are delivered with sufficient M4 screws to connect the relay via annular terminals, with a maximum recommended of two annular terminals per contact.

If necessary, Schneider Electric can provide annular terminals to crimp. 5 references exist according to the section of the wire (see below). Each reference corresponds to a sachet of 100 terminals.





To insure the insulation of the terminals and to respect the security and safety instructions, an isolated sleeve can be used.

We recommend the following cable cross-sections:

–	Auxiliary sources	Vaux: 1.5 mm²
–	Communication Port	see paragraph 6.2
–	Other circuits	1.0 mm²

Because of the limitations of the annular terminals, the maximum wire cross-section which can be used for the connector blocks (for current inputs and signals) is of 6mm² by using non -insulated annular terminals. When only pre- insulated terminals can be used, the maximum wire cross-section is reduced to 2, 63 mm² per annular terminal. If a more significant wire cross-section is necessary, two wires can be put in parallel, each one finished by a separate annular terminal.

All the terminal blocks used for connections, except of the port RS485, must be able to withstand a nominal voltage of minimum 300V peak value.

We recommend to protect the auxiliary source connection by using a fuse of type NIT or TIA with a breaking capacity of 16A. For security reasons, do never install fuses in current transformers circuits. The other circuits must be protected by fuses.

6.2 Communication port RS485

Connections to RS485 is made using annular terminals. It is recommended that a two core screened cable, is used with a maximum total length of 1000 m or a200nF total cable capacitance.

Typical specification:

–	Each core:	16/0.2 mm copper conductor, PVC insulated.
–	Nominal conductor area:	0.5 mm² per core
–	Screen:	Overall braid, PVC sheathed

– Linear capacitance between conductor and earth: 100pF/m

6.3 Earthing

Each equipment must be connected to a local earth terminal by the intermediary of a M4 earth terminals. We recommend a wire of minimal section of 2.5 mm², with annular terminals on the side of the equipment. Because of the limitations of the annular terminals, the possible maximum section is of 6mm² by wire. If a larger section is necessary, one can use cables connected in parallel, each one ending with an annular terminal separated on the side of the equipment. One can also use a metal bar.

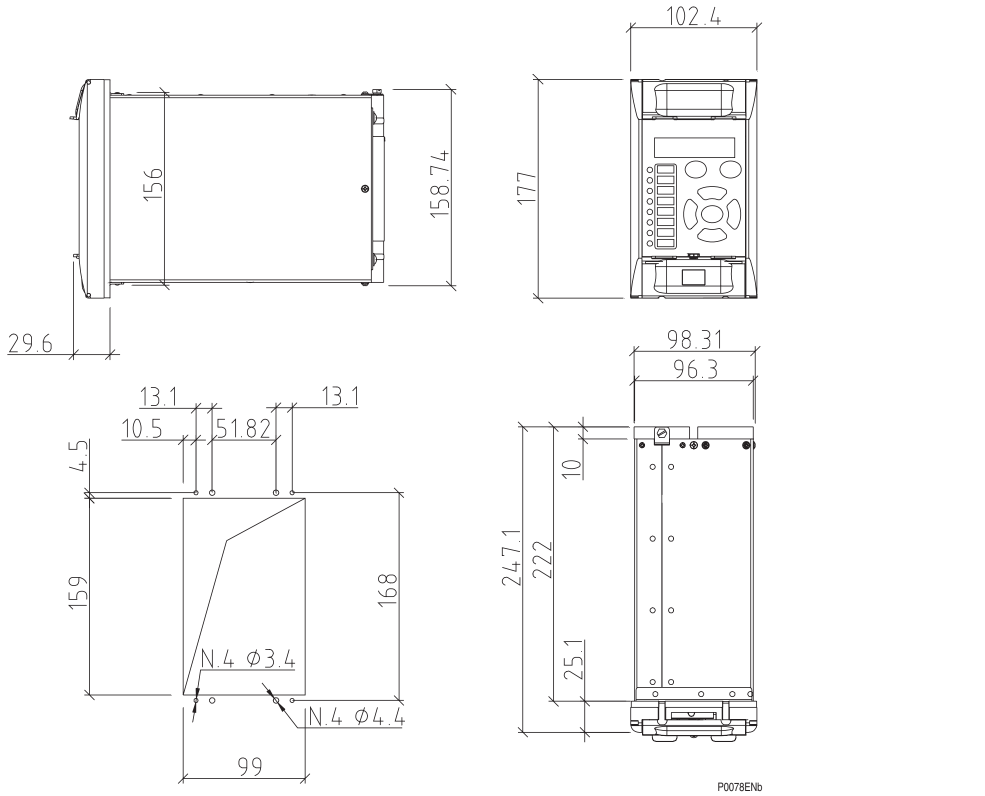
NOTE: To prevent any electrolytic risk between copper conductor or brass conductor and the back plate of the equipment, it is necessary to take precautions to isolate them one from the other. This can be done in several ways, for example by inserting between the conductor and the case a plated nickel or insulated ring washer or by using a tin terminals.

7. CASE DIMENSIONS

MiCOM P721 and **P723** relays are available in a 4U metal case for panel or flush mounting.

Weight: 1.7 to 2.1 Kg

External size:			
	Height	case	152 mm
		front panel	177 mm
	Width	case	97 mm
		front panel	103 mm
	Depth	case	226 mm
		front panel + case	252 mm



MiCOM P721 AND P723 RELAYS CASE DIMENSIONS

NOTE: The chassis is normally secured in the case by four screws (Self tap screws 6x1.4), to ensure good seating. The fixing screws should be fitted in normal service (do not add washers). Do not discard these screws.

USER GUIDE

CONTENTS

1.	**PRESENTATION OF MiCOM P721 AND P723 PROTECTIONS**	**3**
1.1	**USER INTERFACE**	**4**
1.1.1	Relay Overview	4
1.1.2	Front panel description	5
1.1.3	LCD display and keypad description	6
1.1.4	LEDs	7
1.1.5	Description of the two areas under the top and bottom flaps	8
1.1.6	The USB/RS232 cable (to power and set the relay)	8
1.2	**Menu structure**	**9**
1.3	**Password**	**9**
1.3.1	Password protection	9
1.3.2	Password entry	9
1.3.3	Changing the password	10
1.3.4	Change of setting invalidation	10
1.4	**Displays of Alarm & Warning Messages**	**10**
1.4.1	Electrical Network Alarms	10
2.	**MENUS**	**13**
2.1	**Default display**	**13**
2.2	**Menu contents description**	**13**
2.3	**OP PARAMETERS Menu**	**14**
2.4	**CONFIGURATION menu**	**15**
2.4.1	Submenu CONFIGURATION	15
2.4.2	Submenus LED 5 to 8	16
2.4.3	Submenu GROUP SELECT	18
2.4.4	Submenu ALARMS	18
2.4.5	Submenu INPUTS	19
2.4.6	Submenu OUTPUT RELAYS	19
2.5	**MEASUREMENTS Menu**	**20**
2.5.1	If Earth protection is selected	20
2.5.2	If Phase protection is selected (P723 only)	20
2.6	**COMMUNICATION Menu**	**21**
2.7	**PROTECTION Menu**	**22**
2.7.1	Earth protection configuration	22
2.7.2	Phase protection configuration	24
2.8	**AUTOMAT. CTRL Menu**	**25**
2.8.1	Submenu Trip Commands	25
2.8.2	Submenu Latch of trip output relay by Function	26
2.8.3	Submenu Blocking Logic 1 / 2	27
2.8.4	Outputs Relays submenu	27

2.8.5	Latch of the auxiliary output relays (RL2 to RL8)	29
2.8.6	Inputs submenu	29
2.8.7	CIRCUIT BREAKER FAILURE submenu	31
2.8.8	Submenu Logic Equations	31
2.9	**RECORDS Menu**	**34**
2.9.1	Fault Record submenu	34
2.9.2	INSTANTANEOUS RECORDS submenu	35
2.9.3	DISTURBANCE RECORD submenu	35
3.	**WIRING**	**36**
3.1	**Auxiliary supply**	**36**
3.2	**Current measurement inputs**	**36**
3.3	**Logic inputs**	**36**
3.4	**Output relays**	**36**
3.5	**Communication**	**37**
3.5.1	RS485 rear communication port	37
3.5.2	RS232 front communication port	37

1. PRESENTATION OF MiCOM P721 AND P723 PROTECTIONS

MiCOM P721 and **P723** are fully numerical relays designed to perform electrical protection and control functions.

The following section describes the MiCOM P72x range and the main differences between the different models.

MiCOM relays are powered either from a DC (2 voltage ranges) or an AC auxiliary power supply.

Using the front panel, the user can easily navigate through the menu and access data, change settings, read measurements, etc.

Eight LEDs situated in the front panel help the user to quickly know the status of the relay and the presence of alarms. Alarms that have been detected are stored and can be displayed on the back-lit LCD.

Any short time voltage interruption (<50ms) is filtered and regulated through the auxiliary power supply.

Regarding current inputs, **MiCOM P721** has one earth current input available for 1A and 5A rated CTs.

MiCOM P723 has 3 phase and 1 earth current inputs available for 1 and 5 Amps rated CTs. On each one of these relays, it is possible to combine 1 and 5 Amp current inputs together (i-e a mix between 1A for earth fault and 5A for phase connections).

MiCOM P721 and **P723** relays continuously measure phase and earth currents and take into account the true RMS current value up to 10th harmonic (at 50 Hz).

Output relays are freely configurable and can be activated by any of the control or protection functions available in the relay. Logic inputs can also be assigned to various control functions.

On their rear terminals **MiCOM P721** and **P723** have a standard RS485 port available. When ordering, the user can choose between the following communication protocols: ModBus RTU, IEC 60870-5-103 or DNP3.0.

Using RS485 communication channel, all stored information (measurements, alarms, and parameters) can be read and settings can be modified when the chosen protocol allows it.

Reading and modification of this data can be carried out on site with a standard PC loaded with Schneider Electric setting software.

Thanks to its RS485 based communication, **MiCOM P721** and **P723** relays can be connected directly to a digital control system. All the available data can then be gathered by a substation control system and be processed either locally or remotely.

1.1 USER INTERFACE

1.1.1 Relay Overview

The next figures show the P721 and P723 protections.

The table shows the case size.

Height	Depth	Width
4U (177mm)	226mm	20 TE

The hinged covers at the top and bottom of the relay are shown closed. Extra physical protection for the front panel can be provided by an optional transparent front cover; this allows read only access to the relays settings and data but does not affect the relays IP rating. When full access to the relay keypad is required to edit the settings, the transparent cover can be unclipped and removed when the top and bottom hinged covers are open.

1.1.2 Front panel description

MiCOM P721 and **P723** relay front panel allows the user to easily enter relay settings, display measured values and alarms and to clearly display the status of the relay.

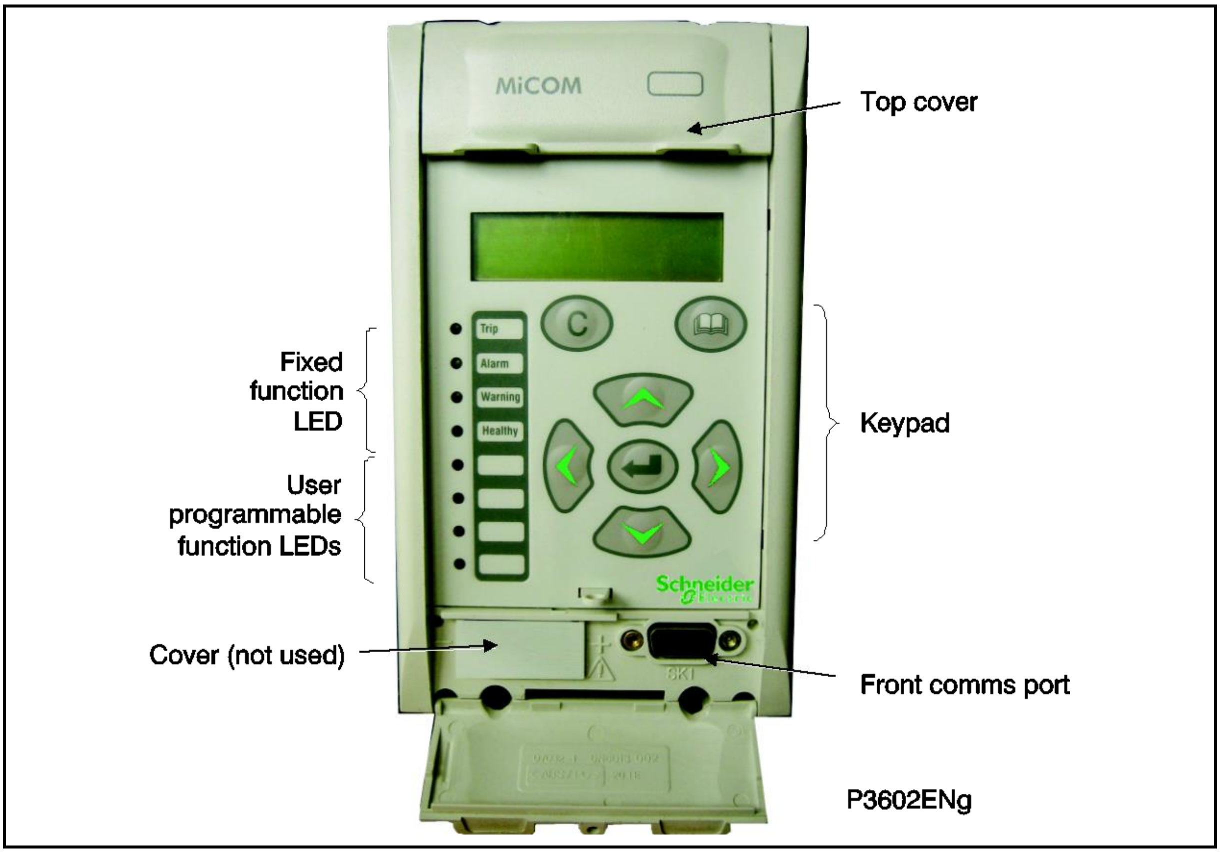


FIGURE 1: MiCOM P721 AND P723 FRONT PANEL DESCRIPTION

The front panel of the relay has three separate sections:

1. The LCD display and the keypad,
2. The LEDs
3. The two zones under the upper and lower flaps.

1.1.3 LCD display and keypad description

The front panel components are shown below. The front panel functionality is identical for the P721 and P723 relays.

1.1.3.1 LCD display

In the front panel, a liquid crystal display (LCD) displays settings, measured values and alarms. Data is accessed through a menu structure.

The LCD has two lines, with sixteen characters each. A back-light is activated when a key is pressed and will remain lit for five minutes after the last key press. This allows the user to be able to read the display in most lighting conditions.

1.1.3.2 Keypad

The keypad has seven keys divided into two groups:

- Two keys located just under the screen (keys ⓒ and 📖).

Keys ⓒ and 📖 are used to read and acknowledge alarms. To display successive alarms, press key 📖. Alarms are displayed in reverse order of their detection (the most recent alarm first, the oldest alarm last). To acknowledge the alarms, the user can either acknowledge each alarm using ⓒ or go to the end of the ALARM menu and acknowledge all the alarms at the same time.

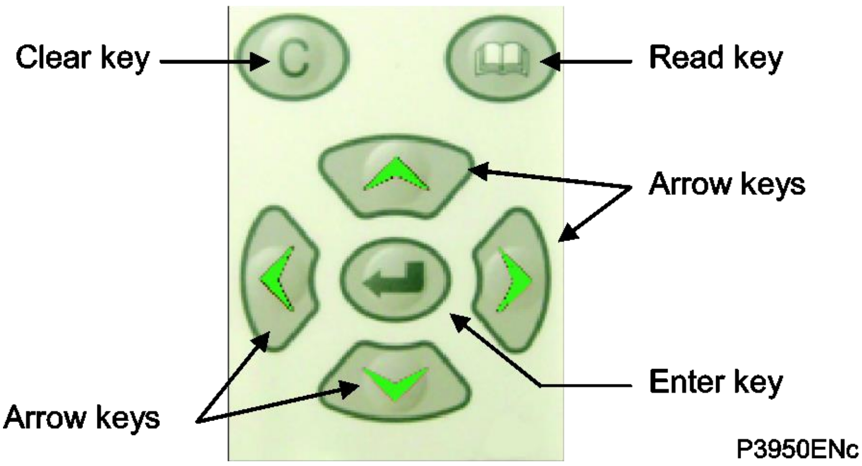
When navigating through submenus, key ⓒ is also used to come back to the head line of the corresponding menu.

NOTE: To acknowledge a relay latched refer to the corresponding submenu section.

- Four main keys ↓, →, ←, ↑ located in the middle of the front panel.

They are used to navigate through the different menus and submenus and to do the setting of the relay.

The key ↵ is used to validate a choice or a value (modification of settings).

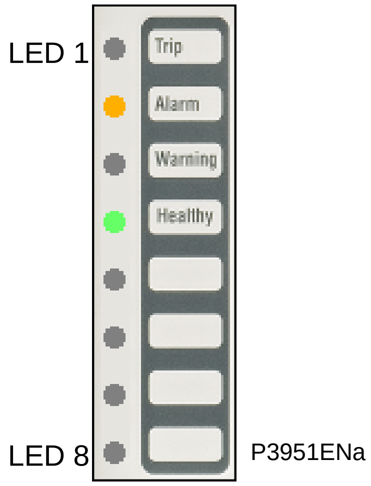


1.1.4 LEDs

The LED labels on the front panel are by default written in English, however the user has self-adhesive labels available with **MiCOM** relays on which it is possible to write using a ball point pen.

The top four LEDs indicate the status of the relay (Trip condition, alarm LED, equipment failure, auxiliary supply).

The four lower LEDs are freely programmable by the user and can be assigned to display a threshold crossing for example (available for all models) or to show the status of the logic inputs.The description of each one of these eight LEDs located in the left side of the front view is given hereafter (numbered from the top to bottom from 1 to 8):



LED 1 ***Colour: RED*** ***Label: Trip***

LED 1 indicates that the relay has issued a trip order to the cut-off element. This LED recopies the trip order issued to the Trip logic output. Its normal state is unlit. As soon as a triggering order is issued, the LED lights up. It is cleared when the associated alarm is acknowledged either through the front panel, or by a remote command, a digital input, or by a new fault (CONFIGURATION/Alarms menu).

LED 2 ***Colour: ORANGE*** ***Label: ALARM***

LED 2 indicates that the relay has detected an alarm. This alarm can either be a threshold crossing (instantaneous), or a trip order (time delayed). As soon as an alarm is detected, the LED starts blinking. After all the alarms have been read, the LED lights up continuously.

After acknowledgement of all the alarms, the LED is extinguished.

NOTE: It is possible to configure the instantaneous alarms to be self reset or not by choosing Yes or No in the CONFIGURATION/Alarms Menu.

The alarm LED can be reset either through the front panel, or by remote command, by a digital input, or by a new fault (CONFIGURATION/Alarms menu).

LED 3 ***Colour: ORANGE*** ***Label: Warning***

LED 3 indicates internal alarms of the relay. When the relay detects a « non critical » internal alarm (typically a communication failure), the LED starts blinking continuously. When the relay detects a fault that is considered as « critical », the LED lights up continuously. Only the disappearance of the cause of the fault can clear this LED (repair of the module, clearance of the Fault).

LED 4 ***Colour: GREEN*** ***Label: Healthy***

LED 4 indicates that the relay is powered by an auxiliary source at the nominal range.

LED 5 to 8 ***Colour: RED*** ***Label: Aux.1 to 4.***

These LEDs are user programmable and can be set to display information about instantaneous and time-delayed thresholds as well as the status of the logic inputs. Under the CONFIGURATION/LED menu of the relay, the user can select the information he wishes to associate with each LED. He can affect more than one function to one LED. The LED will then light up when at least one of the associated information is valid (OR gate). The LED is cleared when all the associated alarms are acknowledged.

1.1.5 Description of the two areas under the top and bottom flaps

1.1.5.1 Relay Identification

Under the upper flap, a label identifies the relay according to its model number (order number) and its serial number. This information defines the product in a way that is unique. In all your requests, please make reference to these two numbers.

Under the model and serial number, you will find information about the level of voltage of the auxiliary supply and the nominal earth current value.

1.1.5.2 Lower flap

Under the lower flap, a RS232 port is available in all MiCOM relays. It can be used either to download a new version of the application software version into the relay flash memory or to download/retrieve settings plugging a laptop loaded with MiCOM S1 setting software.

To withdraw more easily the active part of the MiCOM relay (i-e the chassis) from its case, open and remove the two flaps, then with a 3mm screwdriver, turn the extractor located under the upper flap, and pull it out of its case pulling the flaps towards you.

1.1.6 The USB/RS232 cable (to power and set the relay)

The USB/RS232 cable is able to perform the following functions:

1. It is able to power the relay from its front port. This allows the user to view or modify data on the relay even when the auxiliary power supply of the relay has failed or when the relay is not connected to any power supply. The USB port of the PC supplies the power necessary to energize the relay. This lasts as long as the battery of the PC can last.

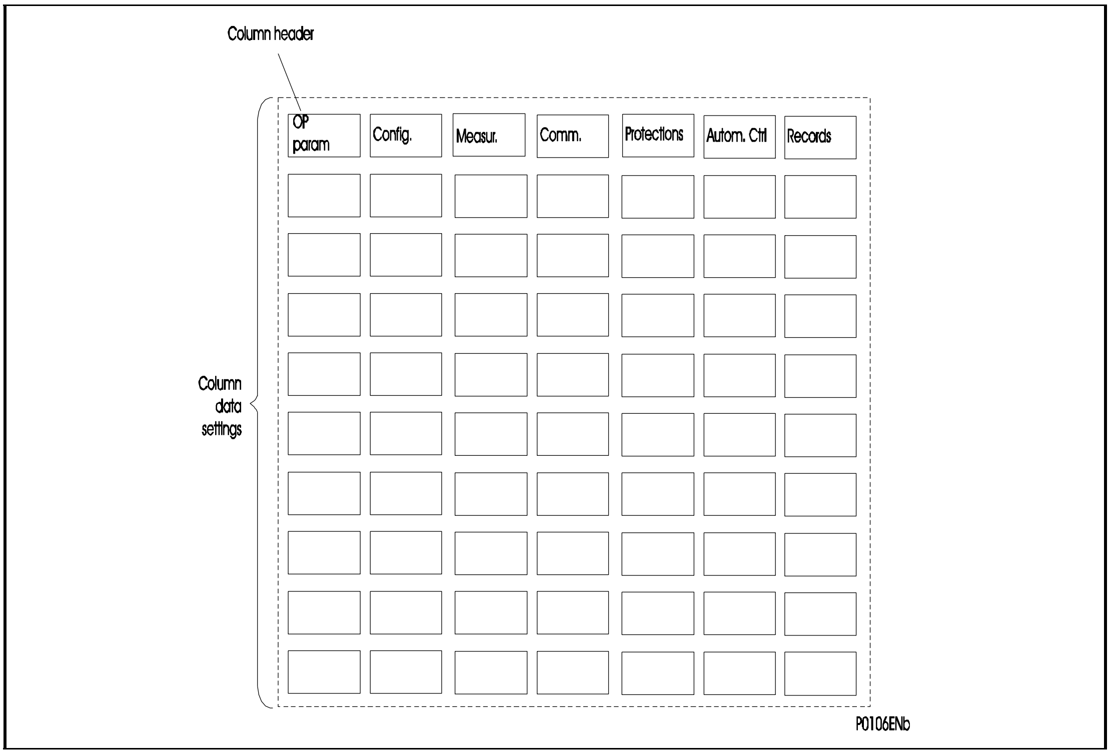
2. It provides an USB / RS 232 interface between the MiCOM relay and the PC. This allows the user to be able to change the setting of the relay using a PC with its USB port.

It eases the use of the relay allowing the retrieval of records and disturbance files for example when the auxiliary supply has failed or is not available.

The associated driver (supplied with the relay) needs to be installed in the PC. For more information, refer to MiCOM E2 User Guide.

1.2 Menu structure

The relay's menu is arranged in a tabular structure. Each setting in the menu is referred to as a cell, and each cell in the menu may be accessed by reference to a row and column address. The settings are arranged so that each column contains related settings, for example all of the disturbance recorder settings are contained within the same column. As shown in the figure, 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 Menu Content tables (P72x/EH HI section).



MENU STRUCTURE

1.3 Password

1.3.1 Password protection

A password is required for relay settings, especially when changing the various thresholds, time delays, communication parameters, allocation of inputs and outputs relays.

The password consists of four capital characters. When leaving factory, the password is set to **AAAA**. The user can define his own combination of four characters.

Should the password be lost or forgotten, the modification of the stored parameters is blocked. It is then necessary to contact the manufacturer or his representative and a stand-by password specific to the relay may be obtained.

The programming mode is indicated with the letter "P" on the right hand side of the display on each menu heading. The letter **"P"** remains present as long as the password is active (**5 minutes** if there is no action on the keypad).

1.3.2 Password entry

The input of the password is requested as soon as a modification of a parameter is made for any one of the six/eight menus and the submenus. The user enters each one of the 4 characters and then validates the entire password with ↵.

After 5 seconds, the display returns to the point of the preceding menu.

If no key is pressed inside of 5 minutes, the password is deactivated. A new password request is associated with any subsequent parameter modification.

1.3.3 Changing the password

To change an active password, go to the OP. PARAMETERS menu and then to the Password submenu. Enter the current password and validate it. Then press and enter the new password character by character and validate the new password using .

The message NEW PASSWORD OK is displayed to indicate that the new password has been accepted.

1.3.4 Change of setting invalidation

The procedure to modify a setting is described in the following sections of this manual.

If there is a need to get back to the old setting push key before validating the setting change. The following message will then appear on the LCD for a few seconds and the old setting will remain unchanged.

UPGRADE
CANCEL

1.4 Displays of Alarm & Warning Messages

Alarm messages are displayed directly on the front panel LCD. They have priority over the default display presenting measured current values. As soon as the relay detects an alarm condition (crossing of a threshold for example), the associated message is displayed on the front panel LCD and the LED Alarm (LED 2) lights up.

We distinguish two types of alarm and warning messages:

- Alarm messages generated by the electrical power network.
- Warning messages caused by hardware or software faults from the relay.

1.4.1 Electrical Network Alarms

Any crossing of a threshold (instantaneous or time delay) generates an "electrical network alarm". The involved threshold is indicated. Regarding the phase thresholds, the phase designation (A, B or C) is also displayed.

If several alarms are triggered, they are all stored in their order of appearance and presented on the LCD in reverse order of their detection (the most recent alarm first, the oldest alarm last). Each alarm message is numbered and the total number of alarm messages is displayed.

The user can read all the alarm messages pressing .

The user acknowledges and clears the alarm messages from the LCD pressing .

The user can acknowledge each alarm message one by one or all by going to the end of the list to acknowledge, and clear, all the alarm messages pressing .

The control of the ALARM LED (LED 2) is directly assigned to the status of the alarm messages stored in the memory.

If one or several messages are NOT READ and NOT ACKNOWLEDGED, the ALARM LED (LED 2) flashes.

If all the messages have been READ but NOT ACKNOWLEDGED, the ALARM LED (LED 2) lights up continuously.

If all the messages have been ACKNOWLEDGED, and cleared, if the cause that generated the alarm disappears, the ALARM LED (LED 2) is extinguished.

The different electrical system alarms are listed below:

Alarm	Signification
[95] SUP + phase fault indication	Phase bus-wire supervision alarm (phase A, B or C).
[95] tSUP + phase fault indication	Time delayed phase bus-wire supervision alarm (phase A, B or C). This alarm acknowledges [95] SUP alarm.
[87] DIFF + phase fault indication	Phase segregated high impedance current differential protection alarm (phase A, B or C).
[87] tDIFF + phase fault indication	Phase segregated high impedance current differential protection alarm (phase A, B or C). This alarm acknowledges [87] DIFF alarm.
[95N] SUP	Earth bus-wire supervision alarm.
[95N] tSUP	Time delayed earth bus-wire supervision alarm. This alarm acknowledges [95N] SUP alarm.
[87N] DIFF	Earth high impedance current differential protection alarm
[87N] tDIFF	Time delayed earth high impedance current differential protection alarm. This alarm acknowledges [87N] DIFF alarm.
[87CZ] check zone	Check zone input. This alarm appears after [95] tSUP.
Buswire shorting	Buswire shorting information.
tAux 1 / tAux2 / tAux3 / tAux4	t AUX1, t AUX2, t AUX 3 and t AUX 4 time-out. These alarms can be inhibited using CONFIGURATION/ALARMS menu
tEquation A to H	t Equation A, B, C, D, E F,G and H
CB Failure (50BF)	Circuit breaker failure indication (the CB does not trip on tBF time. tBF can be set under the AUTOMAT. CTRL/CIRCUIT BREAKER Fail menu.
Logical output relays latched	At least one output relay is latched.
Maintenance Mode	The relay is in maintenance mode.

Relay Hardware or Software Warning Messages

Any software or hardware fault internal to MiCOM relay generates a "hardware/software alarm" that is stored in memory as a "Hardware Alarm". If several hardware alarms are detected they are all stored in their order of appearance. The warning messages are presented on the LCD in reverse order of their detection (the most recent first and the oldest last). Each warning message is numbered and the total stored is shown.

The user can read all warning messages pressing ⊚, without entering the password.

It is not possible to acknowledge and clear warning messages caused by internal relay hardware or software failure. This message can only be cleared once the cause of the hardware or software failure has been removed.

The control of the WARNING LED (LED 3) is directly assigned to the status of the warning messages stored in the memory.

If the internal hardware or software failure is major (i.e. the relay cannot perform protection functions), the WARNING LED (LED 3) lights up continuously.

– major fault: Protection and automation functions of the equipment are blocked. In this condition, the protection relay detects the corresponding fault and activates RL0 Watch Dog relay (35-36 terminals contact is closed).

  For instance: the “DEF. ANA” fault (fault in the analog circuit channel) is considered as a major fault because the protection functions will not operate correctly.

– minor fault: Protection and automation functions of the relay operate. A minor fault will not activate RL0 Watch Dog relay (35-36 terminals contact is closed, 36-37 terminals is open). This fault causes a LED alarm and is displayed on the LCD panel.

The Watch Dog relay controls the correct operation of the protection and automation function. This relay fault "RL0 relay" is activated if the following functions or checks are faulty:

– microprocessor operation,

– power supply check,

– reconstituted internal power supply check,

– heating of a circuit board component monitoring,

– analog channel monitoring (acquisition sampling),

– program execution monitoring,

– communication ports monitoring.

If the internal hardware or software failure is minor (like a communication failure that has no influence on the protection and automation functions), the WARNING LED (LED 3) will flash.

Possible Hardware or Software alarm messages are:

<u>Major fault:</u>

The protection and automation functions are stopped.
The RL0 watchdog relay is de-energised (35-36 contact closed).

<< CALIBRATION ERROR.>>: Calibration zone failure

<< CT ERROR >>: Analog channel failure

<< DEFAULT SETTINGS (*) >>

<< SETTING ERROR (**) >>

(*) DEFAULT SETTINGS: Each time the relay is powered ON it will check its memory contents to determine whether the settings are set to the factory defaults. If the relay detects that the default settings are loaded an alarm is raised. The **ALARM LED (YELLOW)** will light up and the Watch Dog contact will be activated.

Only one parameter in the relay's menu needs to be changed to suppress these messages and to reset the watch dog. This alarm is only an indication to the user that the relay has its default settings applied.

(**) SETTING ERROR: Each time the relay is powered ON it will check the coherence of the setting data. If the relay detects a problem with the settings, a "**HARDWARE**" **ALARM** will appear on the LCD display followed by "**SETTING ERROR**" message (when pushing on the button).. The **ALARM LED (YELLOW)** will light up and the Watch Dog contact will be activated. To reset this alarm it is necessary to power **ON** and **OFF** the relay. Following this, the last unsuccessful setting change will then need to be re-applied. If the alarm persists, i.e. the **"SETTING ERROR"** alarm is still displayed, please contact Schneider Electric Customer Care Services for advice and assistance.

<u>Minor fault:</u>

The MiCOM relay is fully operational.
The RL0 watchdog relay is energised (35-36 contact open, 36-37 contact closed).

<< COMM.ERROR >>: Communication failure

<< CLOCK ERROR >>: Time tag failure

<< STATS RESET >>: Statistical data recorded (like CB supervision statistics (Number of CB opening, etc) have been reset.

2. MENUS

The menu of MiCOM P721 and P723 relays is divided into main menus and submenus. The available content depends on the model of the relay.

2.1 Default display

By default, the LCD displays the current value measured (selected phase or earth). As soon as an alarm is detected by the relay, that information is considered as more important and the alarm message is then displayed instead of the default value.

2.2 Menu contents description

The menu of MiCOM P72x relays is divided into eight main sections. To access these menus from the default display press . To return to the default display from these menus or sub-menus press .

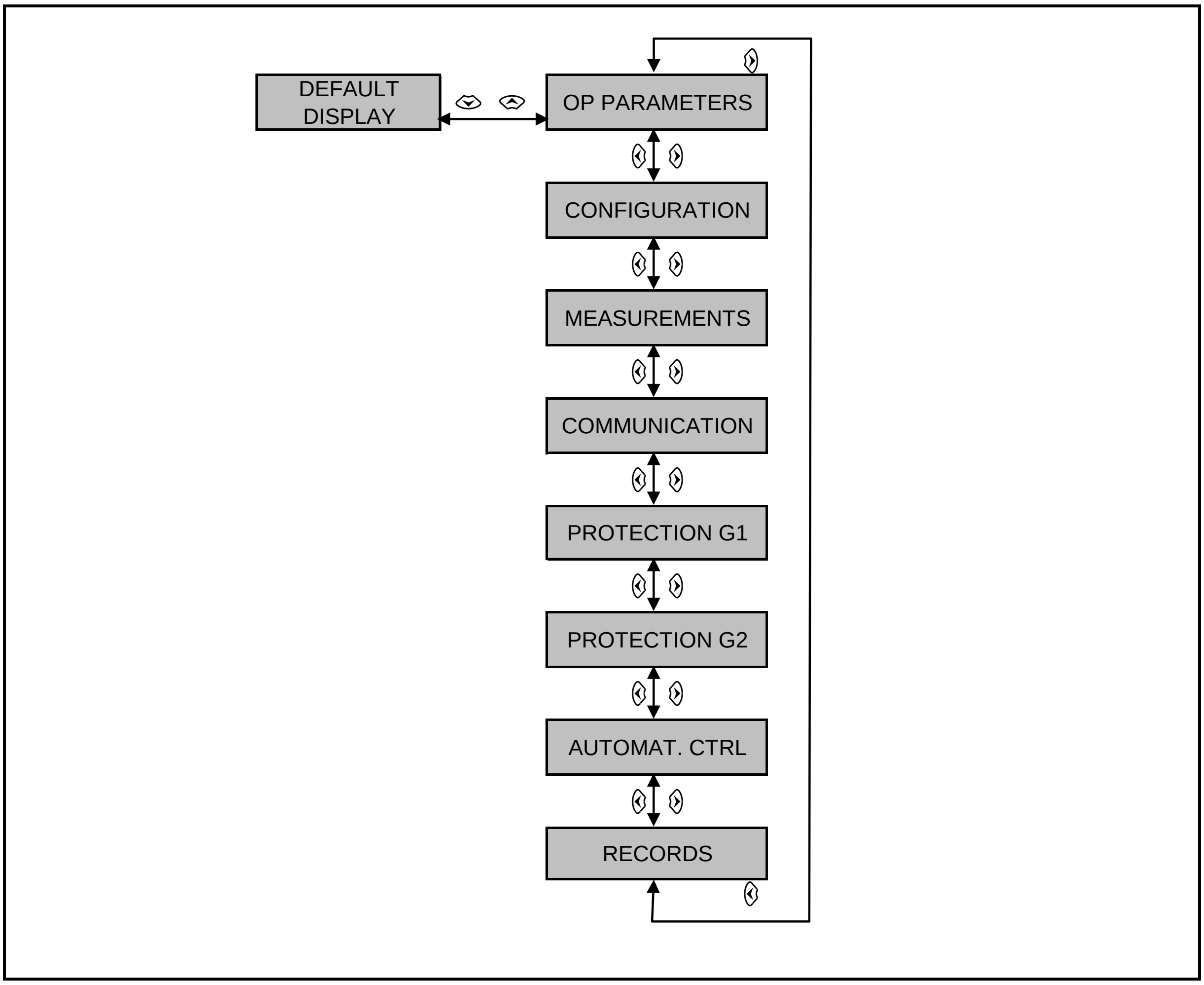


FIGURE 2: ORGANIZATION OF MiCOM P72X MAIN MENU

NOTE: The content of the menu is presented in the document P72x/EN HI. This table helps the user to navigate through the different menus and submenus.
For MiCOM P72x range, while navigating between submenu points, the user can press the key c to go back to the corresponding head menu.

Using MiCOM S1 Studio, the menu is displayed with a tree structure. A click on the “+” sign (or a double click on the menu title) opens the corresponding submenu.

The second column displays the corresponding value for each parameter.

2.3 OP PARAMETERS Menu

On the P72x front panel, press to access the menu OP PARAMETERS from the default display.

OP PARAMETERS	Heading of the OP PARAMETERS menu Press to access the menu content.
Password *** * * ***	Password entry. This password is required when modifying relay settings and parameters (see § 1.3).
Password **AAAA**	To enter a password, enter it letter by letter using to go up or down in the alphabet. After each letter, press to enter the following letter. At the end, press to validate the password. If the password is correct, the message « PASSWORD OK » is displayed on the screen. NOTE: The password is initially set in factory to AAAA.

WARNING: NO SETTING CHANGES DONE EITHER LOCALLY (THROUGH RS232) OR REMOTELY (THROUGH RS485) WILL BE ALLOWED DURING THE 5 FIRST MINUTES FOLLOWING A CHANGE OF PASSWORD.

Language **ENGLISH**	Indicates the default language used by the device. Possible choices are English, French, German, Spanish, Italian and Portuguese languages.
Description **Pxxx**	Indicates the type of relay.
Reference **MiCOM**	Displays the reference that lists the equipment associated with the relay.
Software version **XX**	Displays the version of the software
Frequency **50 Hz**	Nominal value of the network frequency. Select either 50 or 60Hz.
Active Group **1**	Displays the active protection and automation group. This value can be either 1 or 2.
Input 54321 **Status 10110**	Displays the status of the logic Inputs Logic Inputs are numbered from 1 to 5 for P723, 1 to 2 for P721. When the status of one input is: - state 0: it means that the input is de-energised, - state 1: it means that the input is energised.
Relay 87654321 **Status 01011101**	Displays the status of the logic outputs. Logic Outputs are numbered from 1 to 8 for P723 and 1 to 4 for P721. When The state of each output is: - state 0: it means that the output relay is activated, - state 1: it means that the output relay is not activated. To activate an unlatching operation, the password is requested. NOTE: The Watch-dog output (RL0) is not displayed in the output status menu.
Date **12/08/09**	Displays the date (12/08/09 = 12 August 2009).
Time **13:57:44**	Displays the time (13:57:44 = 1:57:44 pm).

Product code **P723xxxxxxxxx**	Displays the product code.
Serial number **XXXXXXXX**	Displays the serial number

2.4 CONFIGURATION menu

Under this menu, the different submenus are:

CONFIGUR-ATION			
Connection	**led 5**	**Led 6**	**Led 7**
Led 8	**Group select**	**Alarms**	**Inputs**
Output relays			

Press to access the CONFIGURATION menu from the default display, then until the desired submenu header is displayed.

2.4.1 Submenu CONFIGURATION

CONFIGURATION	Heading of the CONFIGURATION menu.
Connection	Heading of the Connection submenu. This submenu is used to select and configure earth or phase protection,
Protection line select. **EARTH**	P723 only. This menu is used to select the configuration of the protection (phase or earth supervision). Protection choices: Earth or Phase.
Input selection **Current**	The input selection menu is used to select Voltage unit instead of Current. Possible choices: Voltage or Current.

2.4.1.1 Submenu Configuration with Earth protection selected

E/Gnd Text **N**	Choose a label (displayed with the associated values) for E/Gnd. Possible choices are N, E, or G.
Stabiliz Resist. N **30 Ω**	This stabilizing resistor N (E or G) value is displayed only if the analogue input mode is the Voltage mode. It is used to set the resistor value of the P79x resistor inserted in the outside input circuit of the protection. Setting choice: 30Ω to 4000Ω, accuracy 0.1Ω. The value is settable digit by digit, using or keys to change the value, and or key to modify an other digit.
E/Gnd CT Primary **1000 A**	Choose the rated primary current of the earth CT. Setting range: from 1 to 9999 – step 1.0000

Menu	Description
E/Gnd CT sec **1 A**	Choose the rated secondary current of the earth CT. Setting value: 1 or 5.

2.4.1.2 Submenu Configuration with Phase selected (P723 only)

Menu	Description
Phases Text **L1, L2, L3**	Choose a label (displayed with the associated measurement value) for the 3 phases. Possible choices are “L1, L2, L3”, “A, B, C” or “R, S, T”. The values are modified after entering the password.
Stabiliz Resist. L1 **30 Ω**	This stabilizing resistor L1 (A or R) value is displayed only if the analogue input mode is the Voltage mode. It is used to set the resistor value of the P79x resistor inserted in the outside input circuit of the protection (phase L1). Setting choice: 30Ω to 4000Ω, accuracy 0.1Ω. The value is settable digit by digit, using or keys to change the value, and or key to modify an other digit.
Stabiliz Resist. L2 **30 Ω**	As above for phase L2 (or B or S).
Stabiliz Resist. L3 **30 Ω**	As above for phase L2 (or C or T).
Line CT Primary **1000 A**	Choose the rated primary current of the CT. Setting range: from 1 to 9999 – step 1.0000
Line CT sec **1 A**	Choose the rated secondary current of the CT. Setting value: 1 or 5.

2.4.2 Submenus LED 5 to 8

The LED 5 to LED 8 configuration submenu is used to assignate to a LED a protection function (the LED lights up when the protection function is active).

The following table lists the protection functions that can be assigned to the LEDs (5 to 8) for each model of relay.

Function	P721	P723	Information
[87] Diff		X	Phase differential protection threshold
[87N] Diff	X	X	Earth differential protection threshold
[87] tDiff		X	Time delayed phase differential protection threshold
[87N] tDiff	X	X	Time delayed earth differential protection threshold
[87CZ] Check zone		X	Check Zone status
[95] Sup		X	Phase high impedance differential threshold (buswire supervision)
[95N] Sup		X	Earth high impedance differential threshold (buswire supervision)
[95] tSup		X	Time delayed phase high impedance differential threshold (buswire supervision)
[95N] tSup	X	X	Time delayed earth high impedance differential threshold (buswire supervision)

Function	P721	P723	Information
[95A] tSupA		X	Time delayed phase A (or L1, or R) high impedance differential threshold (buswire supervision)
[95B] tSupB		X	As above for phase B (or L2 or S)
[95C] tSupC		X	As above for phase C (or L3 or T)
Input 1	X	X	Copy of the status of the Logic Input n°1 ("automat ctrl/inputs" menu)
Input 2	X	X	Copy of the status of the Logic Input n°2
Input 3		X	Copy of the status of the Logic Input n°3
Input 4		X	Copy of the status of the Logic Input n°4
Input 5		X	Copy of the status of the Logic Input n°5
tAux 1	X	X	Copy of Aux1 Logic Input delayed by Aux1 time time (Aux1 logic input and aux1 time are set with "automat ctrl/inputs" menu)
tAux 2	X	X	Copy of Aux2 Logic Input delayed by Aux2 time
tAux 3		X	Copy of Aux3 Logic Input delayed by Aux3 time
tAux 4		X	Copy of Aux4 Logic Input delayed by Aux4 time
tEqu.A	X	X	Time delayed logical output of Equation A.
tEqu.B	X	X	Time delayed logical output of Equation B.
tEqu.C	X	X	Time delayed logical output of Equation C.
tEqu.D	X	X	Time delayed logical output of Equation D.
tEqu.E	X	X	Time delayed logical output of Equation E.
tEqu.F	X	X	Time delayed logical output of Equation F.
tEqu.G	X	X	Time delayed logical output of Equation G.
tEqu.H	X	X	Time delayed logical output of Equation H.

NOTES: ⇒ Each parameter can be assigned to one or more LED's.
⇒ One or more parameters (OR logic) can provocate each LED to light up.

<u>MiCOM S1 Studio setting:</u>

The LED 5 (6, 7 or 8) submenu contains up to 3 lines parameter settings. In the value column, each line represents a setting value. State "1" means that the corresponding parameter is associated to the LED.

The corresponding parameters are displayed in the setting panel: from 00 (last digit) up to 1E (first digit).

P72x Front panel setting:

Press to access the LED 5 CONFIGURATION submenu, then twice (press to access to others LEDs CONFIGURATION submenus).

Select "Yes" to assignate a LED to a function.

CONFIGURATION	
Led 5	Heading LED 5 submenu.
Led 5 **Function No**	Activate (select choice "Yes" or inhibit ("No") LED 5 operation when: - an alarm is exceeded, - a threshold time delay has elapsed. Refer to previous tables for protection functions list.

2.4.3 Submenu GROUP SELECT

The submenu "GROUP SELECT" is used to select the active protection group

CONFIGURATION	
Group Select	Heading of the "GROUP SELECT" sub-menu.
Change Group **Input = INPUT**	Setting choice : MENU or INPUT MENU is used to change settings group via HMI and/or RS485 port. If MENU is selected, the following menu is displayed:
Setting Group **1**	Select active setting protection group 1 or 2.

2.4.4 Submenu ALARMS

CONFIGURATION	
Alarms	Heading of the Alarms submenu. Setting choices: Yes or No.
Inst. Self-reset ? **No**	Setting choice Yes: the alarms that are instantaneous will be self reset when they come back to a normal value (below the threshold). Setting choice No: the alarms that are instantaneous will be need to be acknowledged by the user to be reset.
Reset led on **fault ? No**	Yes: the LED associated with an old alarm will be automatically reset when a new fault occurs. This is done to avoid a display of numerous alarms that are not active any more. No: the appearance of a new fault will not automatically reset LEDs associated with an old fault.
Alarm tAux1 **inhib No**	Yes: auxiliary timer 1 output will not raise an alarm. Alarm LED stays OFF, no message will be displayed on the HMI. No: auxiliary timer 1 will raise an alarm.
Alarm tAux2 **inhib No**	As above with timer 2.

Alarm tAux3 inhib No	As above with timer 3 (P723 only)
Alarm tAux4 inhib No	As above with timer 4.(P723 only)
Alarm tAux5 inhib No	As above with timer 5 (P723 only).
Shorted Buswire Alarm Yes	Setting choice Yes: the alarm of Short Buswire will always appear when protection trips or Supervision of CT circuit function trigs or protection is out of service. Setting choice No: there will be no alarm of Shorted Buswire when protection trips or Supervision of CT circuit function trigs or protection is out of service.

2.4.5 Submenu INPUTS

A digital input can be configured to be activated either on low level or on high level. Low level (or high level) depends of the application of the digital inputs.

The user has to set under the Menu CONFIGURATION the auxiliary voltage (AC or DC) for the digital inputs. This setting is necessary because of the time filtering which is different in DC and AC. The inversion of the logic input in this menu inverts its allocated function status in the logic inputs allocation (AUTOMAT CTRL/INPUTS menu). For example: if EL 2 logic input is 1, then tAux1 = 0 when logic input is 1 and tAux1 = 1 when logic input is 0.

CONFIGURATION	
Inputs	Heading of the CONFIGURATION INPUTS submenu.
Inputs 5 4 3 2 1 1 0 1 1 0	P721 (2 inputs) and P723 (5 inputs). This menu is used to assign active high or low functionality to each logic input. 0 = active low, 1 = active high
Voltage input DC	Setting choice: AC or DC power supply for the digital input. The power supply for any input is the same as the power supply of the relay.

2.4.6 Submenu OUTPUT RELAYS

CONFIGURATION	
Output Relays	Heading of the CONFIGURATION RELAYS MAINTENANCE submenu.
Fail Safe R.87654321 0000000	P721 (4 relays), P723 (8 relays). This menu allows the user to invert each of the output relay contacts for the de-energised state. 1 = relay activated when driving signal is not active 0 = relay not activated when driving signal is not active
Maintenance Mode No	Choose if you want to activate the MAINTENANCE MODE of the relay. If Yes is selected, output relays are disconnected from the protection and automation functions.

Relays CMD 8765W4321 **000000000**	P721 (4 relays + watchdog) and P723 (8 relays + watchdog). If the MAINTENANCE MODE is activated (set to Yes), this menu allows the user to activate each one of the output relay (from RL1 to RL8, W = Watchdog) 1 = relay activated 0 = relay not activated

2.5 MEASUREMENTS Menu

Under the MEASUREMENTS menu, the user can read the various measurement values.

To access the MEASUREMENTS menu from the default display, press ⇔ then ⇩ 2 times.

MEASUREMENTS	Heading of the MEASUREMENTS menu.

2.5.1 If Earth protection is selected

INdiff= **0.00A**	Displays the average earth differential current value C (True RMS value):
Frequency **9.99Hz**	Displays the network frequency calculated from phase currents.
Max & Average I **RST = [C]**	Allows the user to clear the maximum (peak) and average (rolling) memorised values of the current. Press ⓒ to clear these values (password required).
Indiff Maximum **0.00A**	Displays the maximum earth differential current value (True RMS value).

2.5.2 If Phase protection is selected (P723 only)

Idiff= 0.00A **0.00A 0.00A**	Displays the differential current values for phases A, B and C (or L1, L2, L3, or R, S, T) (True RMS value) as follows: **Phase A** **Phase B Phase C**
Frequency **9.99Hz**	Displays the network frequency calculated from earth currents
Max & Average I **RST = [C]**	Allows the user to clear the maximum (peak) and average (rolling) memorised values of the current. Press ⓒ to clear these values (password required).
Idiff M 0.00A **0.00A 0.00A**	Displays the peak differential current value for phases A, B and C. This value is the True RMS maximum value.

2.6 COMMUNICATION Menu

The COMMUNICATION menu content depends on the communication protocol of the relay. Three protocols are available: MODBUS, IEC 60870-5-103 and DNP3.0.

To access the MEASUREMENTS menu from the default display, press ⊗ then ◊ until the menu is reached.

WARNING: A MODBUS NETWORK IS LIMITED TO 31 RELAY + 1 RELAY MASTER ADDRESSES ON THE SAME MODBUS SUB-LAN.

COMMUNICATION	Heading of the COMMUNICATION menu.
Communication ? **Yes**	Activates IEC 60870-5-103 communication via the RS485 port on the rear terminals of the relay.
Rear Comm. Address 1	This cell sets the unique address for the rear communication port such that only one relay is accessed by master station software. Select from 1 to 255.
Baud Rate **9600 bd**	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. Select from: 300, 600, 1200, 2400, 4800, 9600, 19200 or 38400 bd.
Parity **None**	Choose the parity in the IEC data frame. Select parity: “Even”, “Odd” or “None”.
Data Bits **8**	Choose the number of data bits in the IEC data frame. Select stop bit: 8 or 7.
Stop Bits **1**	Choose the number of stop bits in the IEC data frame. Select stop bit: 0 or 1.
Spont. Event **Enabl. All**	IEC 60870-5-103 communication only The events created by the relay have two formats (see P72x/EN CT chapter): - public range, using IEC protocol, - private range, using private number format. This command activates or deactivates private and public format transmission of the events to the master station Possible choice: Enabl. All – Enabl. IEC. only – Enabl. none
Command Blocking **No**	IEC 60870-5-103 communication only Allows or blocks remote commands. Setting choice: Yes – No
Signal Blocking **No**	IEC 60870-5-103 communication only Activates or deactivates signal transmission from relay to the master station. Setting choice: Yes – No

Measure Enabling Asdu 3.4&9	IEC 60870-5-103 communication only Selects the measures transmission filtering mode. ASDU 3.4 option allows communication of earth current measures (IN) to the master station. ASDU 9 option allows communication to the master station of: - phase current measures (IA, IB and IC), - frequency measures. Setting Choice: ASDU 3.4&9 – ASDU 3.4 – ASDU 9 or none
Front Comm. Address 29	This cell sets the unique address for the relay such that only one relay is accessed by master station software. Select an address from 1 to 255 for Modbus front port communication.
Date format Private	Choose the format of the date, either PRIVATE for private protocol or IEC protocol for public protocol for the front port Modbus communication.

2.7 PROTECTION Menu

The protection menu is divided into two groups: PROTECTION G1 for the first setting group and PROTECTION G2 for the second setting group.

To access the PROTECTION menu from the default display, press then until the menu is reached.

The different submenus are:

Earth Protection		Phase protection (P723 only)	
PROTECTION G1 / G2		**PROTECTION G1 / G2**	
[87N] Earth diff protection	**[95N] earth bus-wire supervision**	**[87] phase diff protection**	**[95] phase bus-wire supervision**

2.7.1 Earth protection configuration

2.7.1.1 Submenu [87N] Earth differential protection

PROTECTION G1	
[87N] Earth diff protection	Heading of the earth differential current protection submenu (“[87N] Earth diff protection”).
[87N] Earth diff prot? No	Setting choice: Yes or No Yes: the [87N] Earth differential current protection is enabled. The following menus are displayed. No: the [87N] Earth differential current protection is not enabled, and no menu is displayed.
[87N] Threshold I diff= 1 In	This menu is displayed when current input selection is configured. It sets the value for the earth current differential threshold, from 0.01In up to 1In (step 0.01In)
[87N] Threshold V diff= 200.0V	This menu is displayed when voltage input selection is configured. it sets the value for the earth voltage differential threshold, from 0.5V to 200V (step 0.1V)

PROTECTION G1	
[87N] Flt Timer **t Diff 0s**	The fault timer tDiff sets the time delayed earth differential protection threshold. The setting range is from 0s to 2s (step 10ms).
[87N] Rst Timer **tReset= 0s**	The Reset timer menu sets the reset time, from 0 to 600s (step 10ms)
[87N] Measure **Filter Fast**	The measurement filter is used to select sample mode, fast mode or Fourier mode for threshold detection. Setting choice: sample mode, fast mode or Fourier mode.

2.7.1.2 Submenu [95N] Earth bus-wire supervision

PROTECTION G1	
[95N] Earth bus-wire **supervision**	Heading of the earth high impedance differential current buswire supervision submenu ("[87N] Earth diff protection").
[95N] Earth bus-wire **sup? No**	Setting choice: Yes or No Yes: the [95N] Earth high impedance differential buswire supervision is enabled. The following menus are displayed. No: the [95N] Earth high impedance differential protection is not enabled, and no menu is displayed.
[95N] Threshold **I Sup= 1 In**	This menu is displayed when current input selection is configured. It sets the value for the earth current high impedance differential threshold, from 0.01In up to 1In (step 0.01In)
[95N] Threshold **V Sup= 200.0V**	This menu is displayed when voltage input selection is configured. it sets the value for the earth voltage high impedance differential threshold, from 0.5V to 200V (step 0.1V)
[95N] Flt Timer **t Sup 0s**	The fault timer tSup sets the time delay for the earth high impedance differential threshold. The setting range is from 0.5s to 3s (step 10ms).
[95N] Rst Timer **tReset= 0s**	The Reset timer menu sets the reset time, from 0 to 600s (step 10ms)
[95N] Measure **Filter Fast**	The measurement filter is used to select sample mode, fast mode or Fourier mode for threshold detection. Setting choice: sample, fast or Fourier mode.

2.7.2 Phase protection configuration

2.7.2.1 Submenu [87] Phase differential protection (P723 only)

Menu	Description
PROTECTION G1	
[87] Phase diff protection	Heading of the phase differential current protection submenu ("[87] Phase diff protection").
[87] Phase diff prot? No	Setting choice: Yes or No Yes: the [87] Phase differential current protection is enabled. The following menus are displayed. No: the [87] Phase differential current protection is not enabled, and no menu is displayed.
[87] Threshold I diff= 1 In	This menu is displayed when current input selection is configured. It sets the value for the phase current differential threshold, from 0.02In up to 2In (step 0.01In)
[87] Threshold V diff= 200.0V	This menu is displayed when voltage input selection is configured. it sets the value for the phase voltage differential threshold, from 1V to 400V (step 0.1V)
[87] Flt Timer t Diff 0s	The fault timer tDiff sets the time delayed phase differential protection threshold. The setting range is from 0s to 2s (step 10ms).
[87] Check Zone? No	Setting choice: Yes or No Yes: the check zone trip permission (logic input) is enabled, No: the check zone is disabled.
[87] Rst Timer tReset= 0s	The Reset timer menu sets the reset time, from 0 to 600s (step 10ms)
[87] Measure Filter Fast	The measurement filter is used to select sample mode, fast mode or Fourier mode for threshold detection. Setting choice: sample, fast or Fourier mode.

2.7.2.2 Submenu [95] Phase bus-wire supervision (P723 only)

Menu	Description
PROTECTION G1	
[95] Phase bus-wire supervision	Heading of the phase high impedance differential current supervision submenu ("[87N] Phase diff protection").
[95] Phase bus-wire sup? No	Setting choice: Yes or No Yes: the [95] Phase high impedance differential protection is enabled. The following menus are displayed. No: the [95] Phase high impedance differential protection is not enabled, and no menu is displayed.
[95] Threshold I Sup= 1 In	This menu is displayed when current input selection is configured. It sets the value for the phase current high impedance differential threshold, from 0.02In up to 2In (step 0.01In)
[95] Threshold V Sup= 400.0V	This menu is displayed when voltage input selection is configured. it sets the value for the phase voltage high impedance differential threshold, from 1V to 400V (step 0.1V)

PROTECTION G1

[95] Phase bus-wire supervision	Heading of the phase high impedance differential current supervision submenu ("[87N] Phase diff protection").
[95] Flt Timer t Sup 0s	The fault timer tSup sets the time delay for the phase high impedance differential threshold. The setting range is from 0s to 3s (step 10ms).
[95] Rst Timer tReset= 0s	The Reset timer menu sets the reset time, from 0 to 600s (step 10ms)
[95] Measure Filter Fast	The measurement filter is used to select sample mode, fast mode or Fourier mode for threshold detection. Setting choice: sample, fast or Fourier mode.

2.8 AUTOMAT. CTRL Menu

Under the AUTOMAT. CTRL Menu, the user can program the different automation functions available in the MiCOM P721 and P723.

The different submenus are:

AUTOMAT. CTRL

Trip Commands	**Latch Functions**	**Blocking logic 1/2**	**Output relays**
Latch output Relays	**Inputs**	**Circuit Breaker Fail**	**Logic Equations**

To access the AUTOMAT. CTRL Menu, press then until the menu is reached.

2.8.1 Submenu Trip Commands

This submenu makes it possible to assign some or all the selected following thresholds to the trip output relay.

Function	P721	P723	INFORMATION and COMMENTS
Trip [87] tDiff		X	Time delayed phase differential protection threshold
Trip [87N] tDiff	X	X	Time delayed earth differential protection threshold
Trip tAux 1	X	X	Time delayed auxiliary input Aux 1.
Trip tAux 2	X	X	Time delayed auxiliary input Aux 2.
Trip tAux 3	X	X	Time delayed auxiliary input Aux 3.
Trip tAux 4		X	Time delayed auxiliary input Aux 4.
Control Trip		X	Control Trip function to the trip output relay RL1.
Trip Equ A	X	X	Logical output of Boolean Equation A.
Trip Equ B	X	X	Logical output of Boolean Equation B.
Trip Equ C	X	X	Logical output of Boolean Equation C.
Trip Equ D	X	X	Logical output of Boolean Equation D.
Trip Equ E	X	X	Logical output of Boolean Equation E.
Trip Equ F	X	X	Logical output of Boolean Equation F.
Trip Equ G	X	X	Logical output of Boolean Equation G.

Function	**P721**	**P723**	**INFORMATION and COMMENTS**
Trip Equ H	X	X	Logical output of Boolean Equation H.

AUTOMAT. CTRL	Heading of the AUTOMAT.CTRL
Trip Commands	Heading of the Trip ORDER sub-menu.
Function **Yes / No**	Setting choice Yes: Assign the corresponding function to the trip output relay RL1. Then the trip output relay (RL1) will be activated at the end of the corresponding time delay. Setting choice No: the trip output relay (RL1) will not be activated. Refer to previous table for protection functions list.

2.8.2 Submenu Latch of trip output relay by Function

With this submenu, the user can program the trip output relay associated with one or many thresholds so that it stays latched after the cause for activating these functions has disappeared.

Function	P721	P723	INFORMATION and COMMENTS
Latch [87N] tDiff	X	X	Time delayed earth differential protection threshold
Latch [87] tDiff		X	Time delayed phase differential protection threshold
Latch t Aux 1	X	X	Aux1 delayed by Aux1 time
Latch t Aux 2	X	X	Aux2 delayed by Aux2 time
Latch t Aux 3		X	Aux3 delayed by Aux 3 time
Latch t Aux 4		X	Aux4 delayed by Aux 4 time
Latch Control Trip	X	X	Control Trip function to the trip output relay RL1.
Latch tEqu.A	X	X	Time delayed logical output of Equation A.
Latch tEqu.B	X	X	Time delayed logical output of Equation B.
Latch tEqu.C	X	X	Time delayed logical output of Equation C.
Latch tEqu.D	X	X	Time delayed logical output of Equation D.
Latch tEqu.E	X	X	Time delayed logical output of Equation E.
Latch tEqu.F	X	X	Time delayed logical output of Equation F.
Latch tEqu.G	X	X	Time delayed logical output of Equation G.
Latch tEqu.H	X	X	Time delayed logical output of Equation H.

AUTOMAT. CTRL	Heading of the AUTOMAT. CTRL menu.
Latch Functions	Heading of the submenu.
Function **Yes**	Setting choice Yes: Latch the trip output relay associated with the corresponding protection function. The relay will be remain latched after the fault has disappeared. Setting choice No: The trip output relay will be active when the relevant command is active. The relay will not be active if the relevant command is reset. Refer to previous table for protection functions list and comments.

2.8.3 Submenu Blocking Logic 1 / 2

Through the Blocking Logic submenu, the user can block each delayed threshold using a " Start Block Logic 1 or 2" input (refer to Inputs menu). MiCOM P72x relays have the submenu Blocking Logic 1 and Blocking Logic 2 available for setting.

It is possible to enable or disable the “blocking” of most protection functions even if a logic input has been assigned to that function.

Function	P721	P723	INFORMATION and COMMENTS
Block [87N] tDiff	X	X	Time delayed earth differential protection threshold
Block [87] tDiff		X	Time delayed phase differential protection threshold
Block tAux 1	X	X	Aux1 Logic Input delayed by Aux1 time
Block tAux 2	X	X	Aux2 Logic Input delayed by Aux2 time
Block tAux 3		X	Aux3 Logic Input delayed by Aux3 time
Block tAux 4		X	Aux4 Logic Input delayed by Aux4 time

AUTOMAT. CTRL	
Blocking Logic 1 / 2	Heading of the Blocking Logic 1 or 2 submenu.
Block Function **No**	Enables or disables blocking logic of the function on the level (logic state =1) of logic input “Start Block Logic 1 or 2” Refer to previous table for protection functions list.

2.8.4 Outputs Relays submenu

This submenu makes it possible to assign various alarm and trip thresholds (instantaneous and/or time delay) to a logic output. Excepted from this option are the Watchdog (RL0) and the Tripping (RL1) outputs (refer to Trip Commands submenu).

The total number of programmable logic outputs for the three relay models is listed in the table:

Model	P721	P723
Output relays	3	7

RL2 relay is a change over relay. The others RL3 to RL8 are normally open relays.

The following protection functions can be assigned to output relays using this submenu.

Function	P721	P723	INFORMATION and COMMENTS
[87N] Diff	X	X	Earth differential protection threshold
[87N] tDiff	X	X	Time delayed earth differential protection threshold
[87] Diff		X	Phase differential protection threshold
[87] tDiff		X	Time delayed phase differential protection threshold
[87CZ] ChkZone		X	Check Zone status
[95N] Sup	X	X	Earth high impedance differential threshold (buswire supervision)
[95N] tSup	X	X	Time delayed phase high impedance differential threshold (buswire supervision)
[95] Sup		X	Phase high impedance differential threshold (buswire supervision)
[95] tSup		X	Time delayed phase high impedance differential threshold (buswire supervision)
Buswire Short	X	X	Buswires is short-circuited (power protection)
[95A] tSup A		X	Time delayed phase A (or L1, or R) high impedance differential threshold (buswire supervision)
[95B] tSup B		X	As above for phase B (or L2 or S)
[95C] tSup C		X	As above for phase C (or L3 or T)
CB Fail	X	X	Circuit Breaker does not operate.
t Aux 1	X	X	Aux1 auxiliary input delayed by tAux1 time.
t Aux 2	X	X	Aux2 auxiliary input delayed by tAux2 time.
t Aux 3		X	Aux3 auxiliary input delayed by tAux3 time.
t Aux 4		X	Aux4 auxiliary input delayed by tAux4 time.
Active group	X	X	Group 2 is active (setting)
Control trip	X	X	Control Trip function to the trip output relay RL1.
Input1	X	X	Opto input 1 energized.
Input2	X	X	Opto input 2 energized.
Input3		X	Opto input 3 energized.
Input4		X	Opto input 4 energized.
Input5		X	Opto input 5 energized.
tEqu. A	X	X	Logic output of Boolean Equation A.
tEqu. B	X	X	Logic output of Boolean Equation B.
tEqu. C	X	X	Logic output of Boolean Equation C.
tEqu D	X	X	Logic output of Boolean Equation D.
tEqu E	X	X	Logic output of Boolean Equation E.
tEqu. F	X	X	Logic output of Boolean Equation F.
tEqu. G	X	X	Logic output of Boolean Equation G.
tEqu. H	X	X	Logic output of Boolean Equation H.

AUTOMAT. CTRL	
Output Relays	Heading of the Output Relays submenu.
Function 8765432 **1100010**	Assigning the corresponding protection function to the output relays; i.e. to output 3 (RL3) Setting choice: 1 assigns the output relay; 0 no assignement
Function 432 **010**	Submenu for P721.

2.8.5 Latch of the auxiliary output relays (RL2 to RL8)

With the following menu the user can set each output relay as latched or not latched.

A “0” assigned to an output relay means that the relay is not latched. The output relay will be active when the relevant command will be active; the relay will not be active when the relevant command will reset.

A “1” setting assigned to an output relay means that the relay is latched. The output relay will be active when the relevant command will be active; the relay will remain active, if the relevant command will reset.

The active latched output relays can be reset by a logic input assigned to this function.

Further, the active latched output relays can be reset from the front panel by pushing ©. This action is available if the window status Output Relays in OP. PARAMETERS submenu is displayed.

The alarm string “Latched Relays” appears on LCD and the yellow LED is lighted.

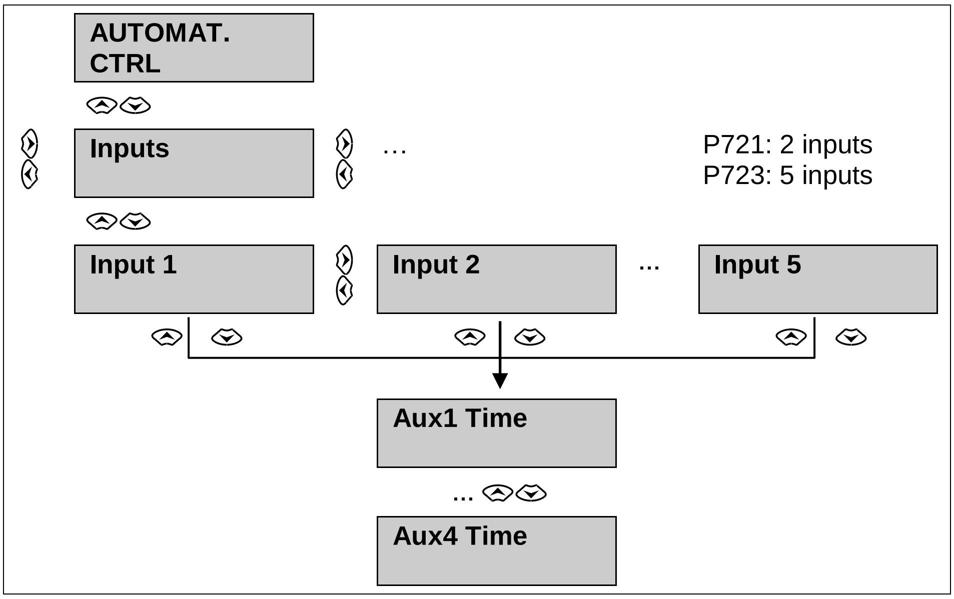
AUTOMAT. CTRL	
Latch Output Relays	Heading of the Latch Output Relays submenu.
Latch 8765432 **Relays 0100100**	In this example, the output relays set to Latch function are number 4 and 7 (RL4 & RL7).
Latch 432 **Relays 000**	Submenu for P721.

2.8.6 Inputs submenu

This submenu makes it possible to assign a single function or multiple automation functions to each logic input. The following functions are available for mapping to a logic input:

Label	P721	P723	Function
Unlatch	X	X	Unlocks latched output relays
Aux 1	X	X	Assign external information to input Aux1
Aux 2	X	X	Assign external information to input Aux2
Aux 3		X	Assign the input the external information Aux 3
Aux 4		X	Assign the input the external information Aux 4
Block Logic 2	X	X	Blocking logic 2
Start Disturb	X	X	Starting of the disturbance recording function

Label	P721	P723	Function
Start Block Logic 1	X	X	Blocking logic 1
Start Block Logic 2	X	X	Blocking logic 2
Change setting	X	X	Change of setting group (default setting group 1)
Reset Leds	X	X	Reset of the "Trip" & "Alarm" leds
Maint. Mode	X	X	Maintenance Mode ON/OFF change
Local Mode	X	X	Local mode condition (if activated,any remote command to the output relays is forbidden)
Synchro	X	X	Assign a Time synchronisation input
[87CZ] Chk Zone		X	Check Zone



2.8.6.1 Function assignement to a logic input

AUTOMAT. CTRL	
Inputs	Heading of the Inputs sub-menu.
Input 1 / 2 /3 /4 / 5 **[87N] Diff**	Assigning label [87N] Diff to logic input 1, 2, 3, 4 or 5 See the previous table for input choices.
Aux1 Time **t Aux1 10s**	Displays setting value of timer assigned to logic input Aux1, from 0ms to 200s (steps of 10ms).
Aux2 Time **t Aux2 10s**	As above for Aux2.
Aux3 Time **t Aux3 10s**	P723 only As above for Aux3.
Aux4 Time **t Aux4 10s**	P723 only As above for Aux4.

2.8.7 CIRCUIT BREAKER FAILURE submenu

With the CB Fail submenu, circuit breaker failure can be detected and associated parameters can be set.

Menu	Description
AUTOMAT. CTRL	
CB Fail	Heading of the CB Fail submenu.
CB Fail ? **Yes**	Selection of the circuit breaker failure function. If Yes is selected, the following menu is displayed: If No is selected, the CB Fail function is inactive.
I Diff < = **0.1 In**	Selection of the undercurrent differential protection threshold associated to the CB failure detection function, from 0.01In to 1In (step 0.01In).
V Diff < = **5V**	P723 with voltage input selection only. Selection of the undercurrent differential protection threshold associated to the CB failure detection function, from 0.5V to 200V (step 100mV).
CB Fail Time **tBF** **40 ms**	Selection of the circuit breaker failure time delay from 10ms to 10s (step 10ms).

2.8.8 Submenu Logic Equations

2.8.8.1 Parameters

With the Logic Equations submenu, it is possible to form complex Boolean functions using NOT, AND and OR operators (indicated from highest to lowest priority). Up to 16 operands can be used in any single equation. The following logic signals are available for mapping to an equation:

Function	P721	P723	Information
Null	X	X	the condition is null (low level)
Not Null	X	X	the condition is not null (high level
[87] Diff		X	Phase differential protection threshold
[87N] Diff	X	X	Earth differential protection threshold
[87] tDiff		X	Time delayed phase differential protection threshold
[87N] tDiff	X	X	Time delayed earth differential protection threshold
[87CZ] Check zone		X	Check Zone status
[95] Sup		X	Phase high impedance differential threshold (buswire supervision)
[95N] Sup		X	Earth high impedance differential threshold (buswire supervision)
[95] tSup		X	Time delayed phase high impedance differential threshold (buswire supervision)
[95N] tSup	X	X	Time delayed earth high impedance differential threshold (buswire supervision)
[95A] tSupA		X	Time delayed phase A (or L1, or R) high impedance differential threshold (buswire supervision)
[95B] tSupB		X	As above for phase B (or L2 or S)

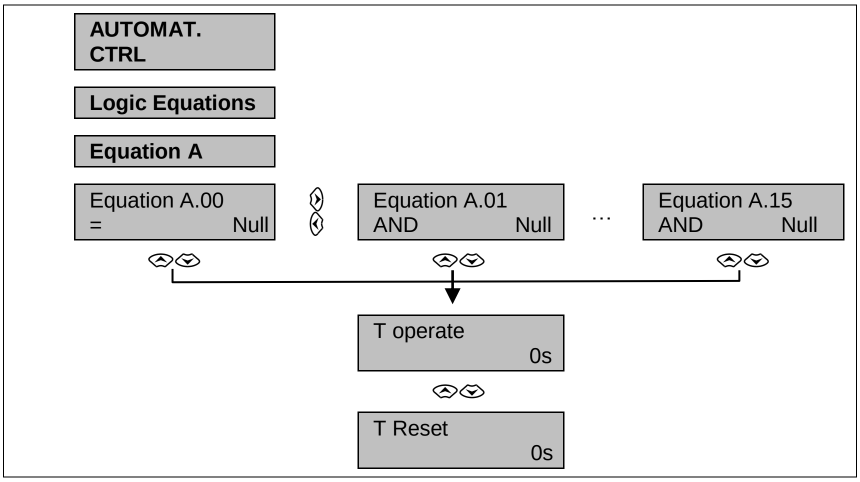
Function	P721	P723	Information
[95C] tSupC		X	As above for phase C (or L3 or T)
Buswire Short		X	Buswires short-circuited
tAux 1	X	X	Copy of the status of the Logic Input tAux 1
tAux 2	X	X	Copy of the status of the Logic Input tAux 2
tAux 3		X	Copy of the status of the Logic Input tAux 3
tAux 4		X	Copy of the status of the Logic Input tAux 4
tAux 5		X	Copy of the status of the Logic Input tAux 5
Input 1	X	X	Instantaneous digital input 1
Input 2	X	X	Instantaneous digital input 2
Input 3		X	Instantaneous digital input 3
Input 4		X	Instantaneous digital input 4
Input 5		X	Instantaneous digital input 5
Group 2	X	X	Group 2 is active (setting)
CB Fail	X	X	Circuit Breaker does not operate

2.8.8.2 Interface

The Logic equation has the following structure:

– "Equation A.00" to "Equation A.15" views are accessible using and keys,

– Pressing key will open "T Operate" menu.



In order to modify an "Equation A.xx" menu:

– Press key to access to the menu (if necessary, enter password).

Equation A.00	
Boolean	Logic

press or key to access to Boolean operator or Logic signal

press or key to modify the corresponding value.

– Press to validate or to cancel the setting.

AUTOMAT. CTRL	
Logic Equations	
Equation A	Heading of Equation A submenu.

The following submenu is identical from A.01 to A.15.

Equation A.00 **=** **Null**	Boolean function (left lower part of the LED panel): selects the Boolean function associated to the logic signal. Presence or not presence of the corresponding logic signal can selected and combined to the previous equation with an OR or AND condition. Setting choices: - for A.00: "=", "= Not" - for A.01 to A.15: "OR", "OR NOT", "AND" or "AND NOT", Note: AND operator has priority to OR operator (refer to the following note)
Equation A.00 **=** **Null**	Logic signal (right lower part): Is used to select the logic signal corresponding to the Boolean equation. Refer to the previous table to see the text corresponding to each signal. Setting Choice: Null and logic signals.
T Operate **0s**	The time of operation setting is used to set the minimum time of truth of the selected conditions before validating the truth of the logic operation. Setting choice: from 0 to 600s, step 10ms
T Reset **0s**	The reset time sets a minimum time before the logic operation is not true when at least one condition is not true. Setting choice: from 0 to 600s, step 10ms

Example of Equation A settings:

Equation A.00 "= not" "tAux 1" + Equation A.01 "and not" "tAux 2"
means not tAux 1 and not tAux 2.

NOTE: AND operator has priority on OR operator:

– "A or B and C" means "A or (B and C)".

– To obtain "A and (B or C)", select "A and B or A and C".

2.9 RECORDS Menu

Through the RECORDS menu, stored data, events, disturbances and monitoring information can be displayed and read.

The different submenus are:

RECORDS		
Fault Record	Instantaneous records	Disturbance records

2.9.1 Fault Record submenu

The Fault Record submenu makes it possible to read up to twenty five stored fault records. Information about a fault is recorded when a threshold is crossed.

RECORDS	
Fault Record	Heading of the trip commands (fault records) submenu.
fault Record **2**	Selection of the fault record number to be displayed (select either 1, 2, 3, 4 or 5).
fault Time **12:05:23:42**	Displays the time when the fault was recorded. The format of the time is hh:mm:ss. In this example the fault was recorded at 12:05:23 pm (and 420ms).
fault Date **12/11/99**	Displays the date when the fault was recorded. The format of the Date is DD/MM/YY. In this example, the fault was recorded on November 12th 1999.
Active Set Group **1**	Displays the active setting group (1 or 2).
Faulted Phase **Earth**	Displays the phase, where a fault occurred, for the chosen fault record.
Threshold **[87] tDiff**	Displays the origin of the fault that generated the trip order.
Fault Magnitude **1200 A**	Displays the magnitude value of the fault: Voltage, current, earth power. The value is based on the amplitude at 50 or 60 Hz.
IA Diff R.M.S **1200 A**	Displays the magnitude value of the phase A current at the time of the fault.
IB Diff R.M.S **500 A**	As above for phase B.
IC Diff R.M.S **480 A**	As above for phase C.
In Diff R.M.S **103 A**	As above for earth current.

2.9.2 INSTANTANEOUS RECORDS submenu

Through the INSTANANEOUS RECORDS submenu, it is possible to read recorded values associated with the crossing of a threshold (start information).

RECORDS	
Instantaneous Records	Heading of the Instantaneous records submenu.
Number **5**	Select the number of Instantaneous records to be displayed (maximum 5).
Hour **13:07:15:53**	Displays the time when the instantaneous record was recorded. The format of the time is hh:mm:ss: ms. In this example the fault was recorded at 1:07:15 pm and 530 ms.
Date **12/11/01**	Displays the date when the instantaneous record was recorded. The format of the Date is DD/MM/YY. In this example, the fault was recorded on November 12th 2001.
Origin **Ie>**	Displays which threshold has been crossed.
Length **57 ms**	Displays the period of time during which the threshold has been exceeded.
Trip **No**	Displays if a trip followed the crossing of the threshold or not.

2.9.3 DISTURBANCE RECORD submenu

The Disturb Record submenu makes it possible to set and read up to 5 disturbance records of 3 seconds each. The beginning of the record can be adjusted with a selected pre-time.

RECORD	
Disturb Record	Heading of the Disturb Record submenu.
Pre-Time **0.2 s**	Set the disturbance record pre-time, from 100ms to 3s (step 100ms). The pre-time adjusts the beginning of the disturbance record: In this example, the record starts 200ms before the disturbance. Its length is fixed.
Post-Time **0.2 s**	Set the disturbance record post-time, from 100 ms to 3s (step 100ms). The total disturbance recording time is 3 seconds (pre-time + post-time).
Disturb Rec Trig **ON INST.**	Select which criteria will start the disturbance record function. Setting choices are ON INST. (starts recording on instantaneous thresholds) or ON TRIP (starts recording after a trip happened).

3. WIRING

MiCOM P72x range of relays have the same terminal layout for common elements.

3.1 Auxiliary supply

The auxiliary power supply for the MiCOM P721 and P723 relays can be either direct current with a voltage range of 24-60 VDC, 48-250 VDC,or alternative current with a voltage range of 48-250 VAC/ 50-60 Hz or 24-250Vdc/24-240Vac. The voltage range (Ua) is specified on the adhesive paper label under the top hinged cover on the front of the relay.

The auxiliary power supply must be connected only to terminals 33 and 34.

3.2 Current measurement inputs

MiCOM P721 and P723 have 3 phase and 1 earth current inputs available for 1 and 5 Amps rated CTs. On each one of these relays, it is possible to combine 1 and 5 Amp current inputs together (i-e a mix between 1A for earth fault and 5A for phase connections) (refer to the wiring diagram).

NOTE: All phase inputs must have the same rating (1 or 5 Amps).

3.3 Logic inputs

The number of logic inputs depends on the relay model. The relays have programmable opto-isolated logic inputs, which can be assigned to any available label or function**.**

Logic inputs for each relay model:

Model	P721	P723
Logic inputs	2	5

On the same MiCOM **P72x** relay, the user can mix different voltage levels as logic inputs are fully independent (e.g. Uaux = 48-250 Vdc, Input 1= 48 Vdc, Input 2-5= 110 Vdc).

If the user sets the supply of the logic input as AC they are active from 24 to 240Vac.

The automation functions that can be assigned to these logic inputs can be selected from the AUTOMAT. CTRL Menu.

NOTE: Do not forget to select in the CONFIGURATION/Configuration Inputs Menu weither the voltage input is "AC" or "DC". .

3.4 Output relays

The number of logic outputs depends on the relay model. The relays have configurable logic outputs, which can be assigned to any available function.

The number of logic outputs available for each relay model is presented in the following table:

Model	P721	P723
Logic outputs	4	8

The first logic output (RL0) is dedicated to indicate a relay fault (Watchdog, WD) and is not part of this table.

The normally closed (NC) contact of the Watchdog (RL0) can not be configured. The other contacts can be configured to be activated on activation of the different functions available in the relay. A basic output matrix is included in the relay.

Some logic outputs have changeover contacts (RL1 and RL2). The other relays (RL3, to RL 8) are normally open contacts.

The protection and control functions that can be assigned to these output relays can be selected from the AUTOMAT. CTRL Menu.

3.5 Communication

3.5.1 RS485 rear communication port

All MiCOM relays have an RS485 rear communication port.

The terminals 29-30-31-32 are dedicated to the RS485 communication port. See wiring diagrams in chapter P72y/EN CO of the Technical Guide.

3.5.2 RS232 front communication port

MiCOM P72x relays provide a RS 232 communication port. This port is dedicated to Setting software MiCOM S1.

The cable between the **relay** and the PC is a standard RS 232 shielded-cable.

The relay requires a RS232 cable with a 9-pin male connector.

The RS232 cable has to be wired as indicated below:

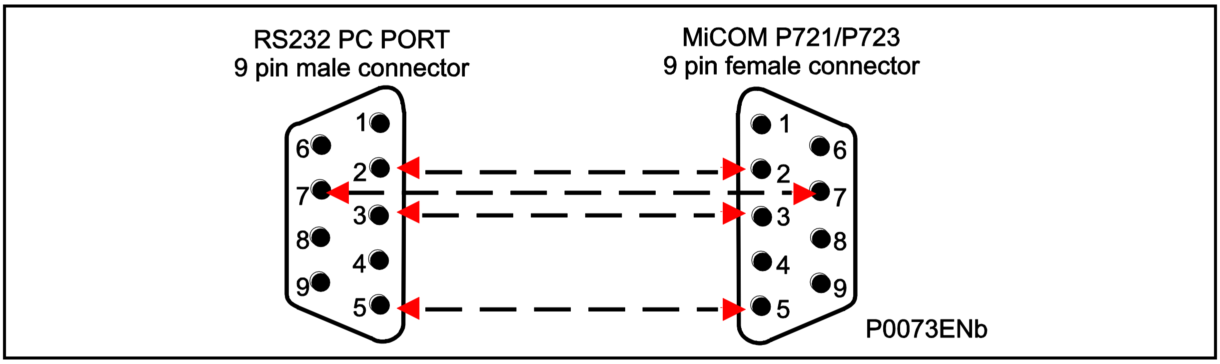


FIGURE 3: FRONT PANEL PORT COMMUNICATION RS232 CABLE WIRING

A USB/RS232 cable can also be used to communicate to the relay.

BLANK PAGE

MENU CONTENT TABLES

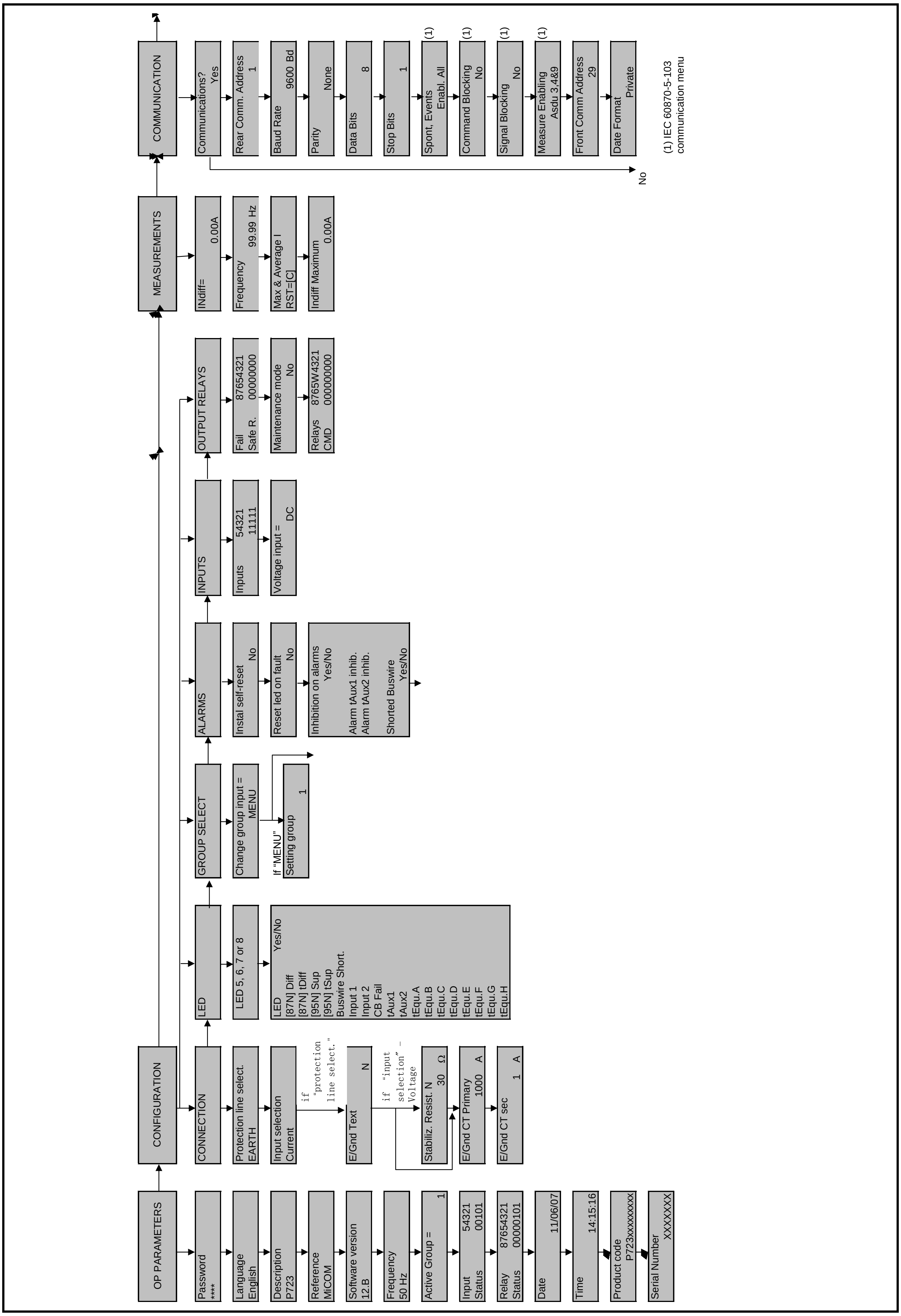
BLANK PAGE

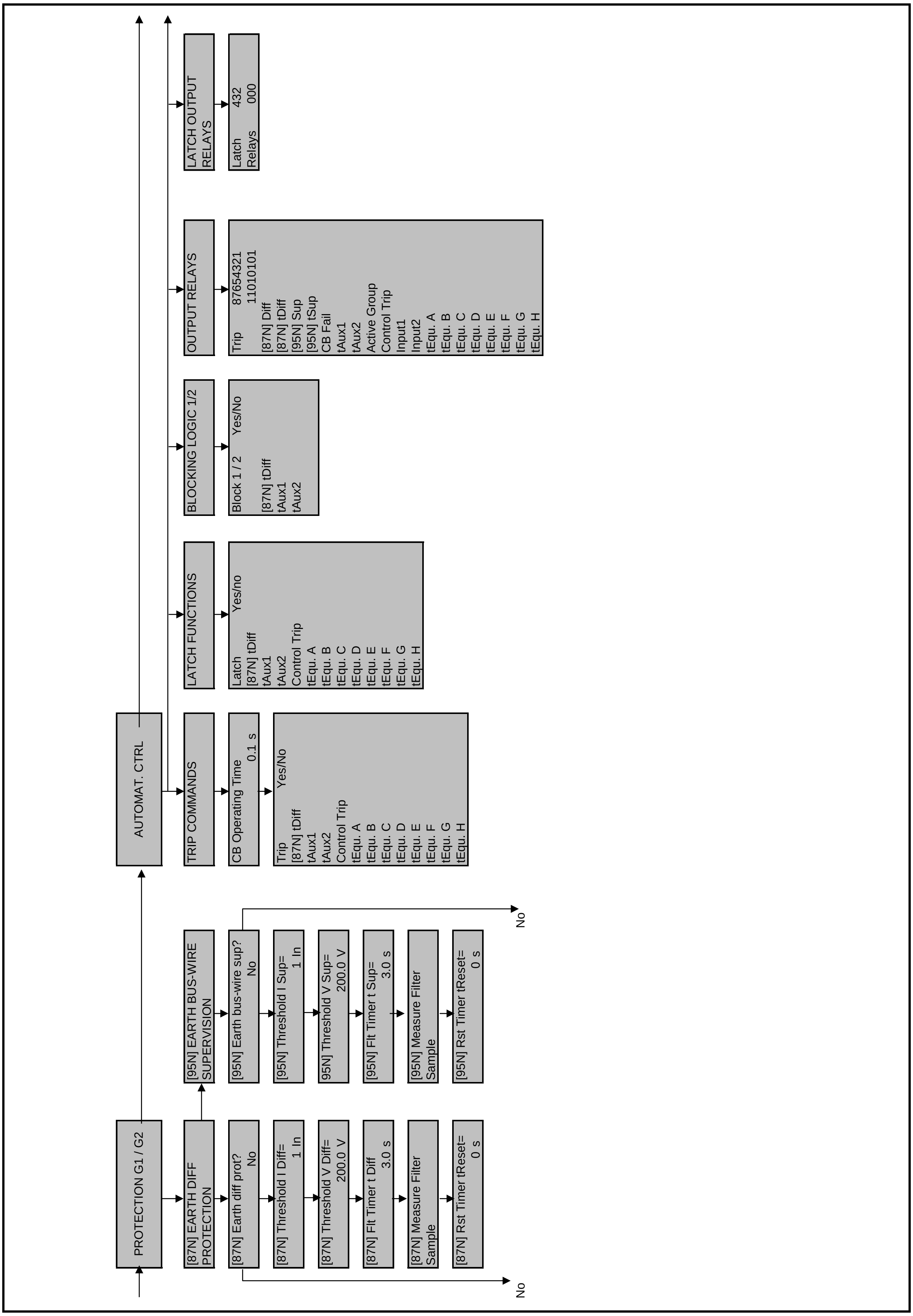
CONTENTS

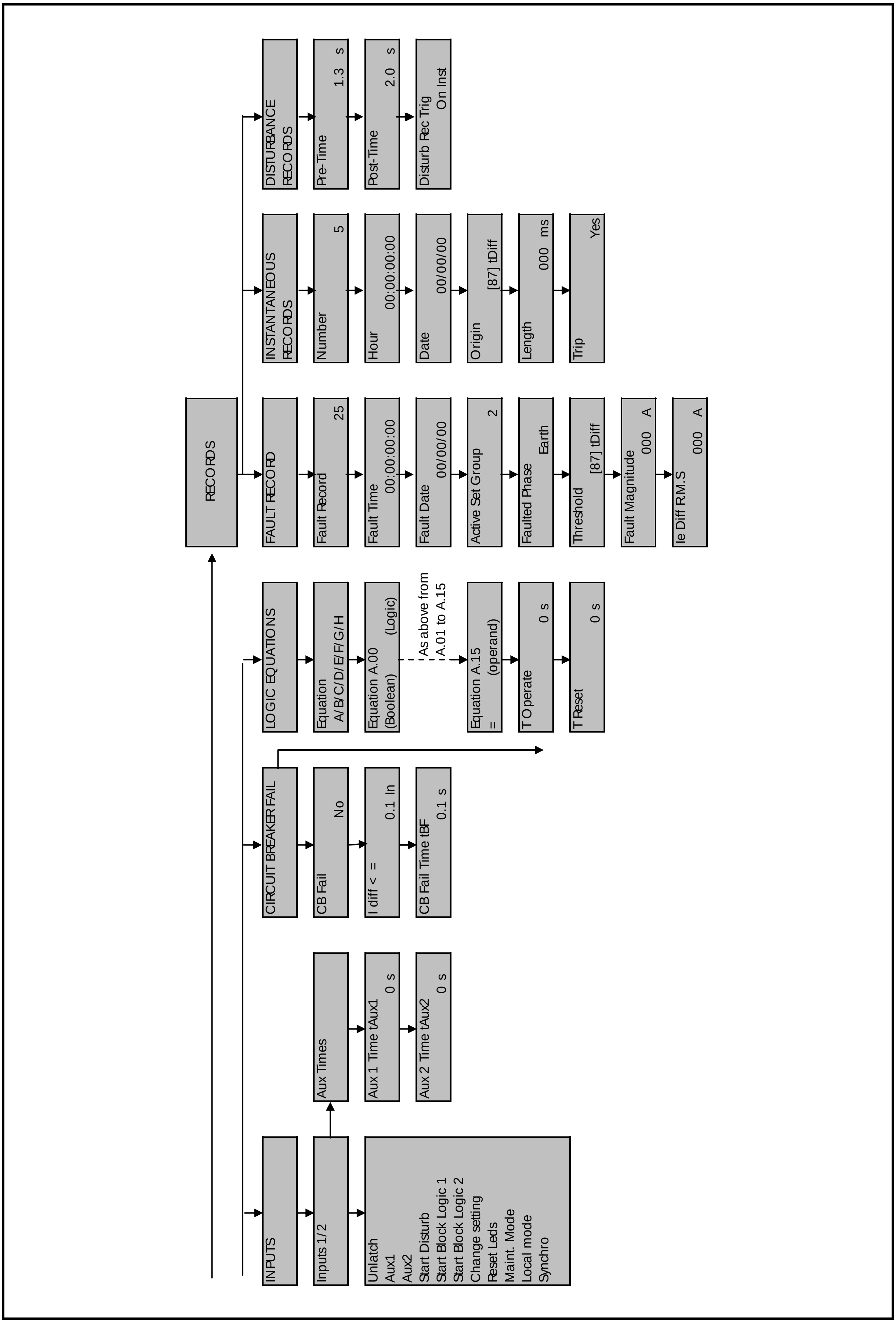
1.	**MICOM P721 – V12.B SOFTWARE**	**3**
2.	**MICOM P723 – V12.B SOFTWARE**	**6**

BLANK PAGE

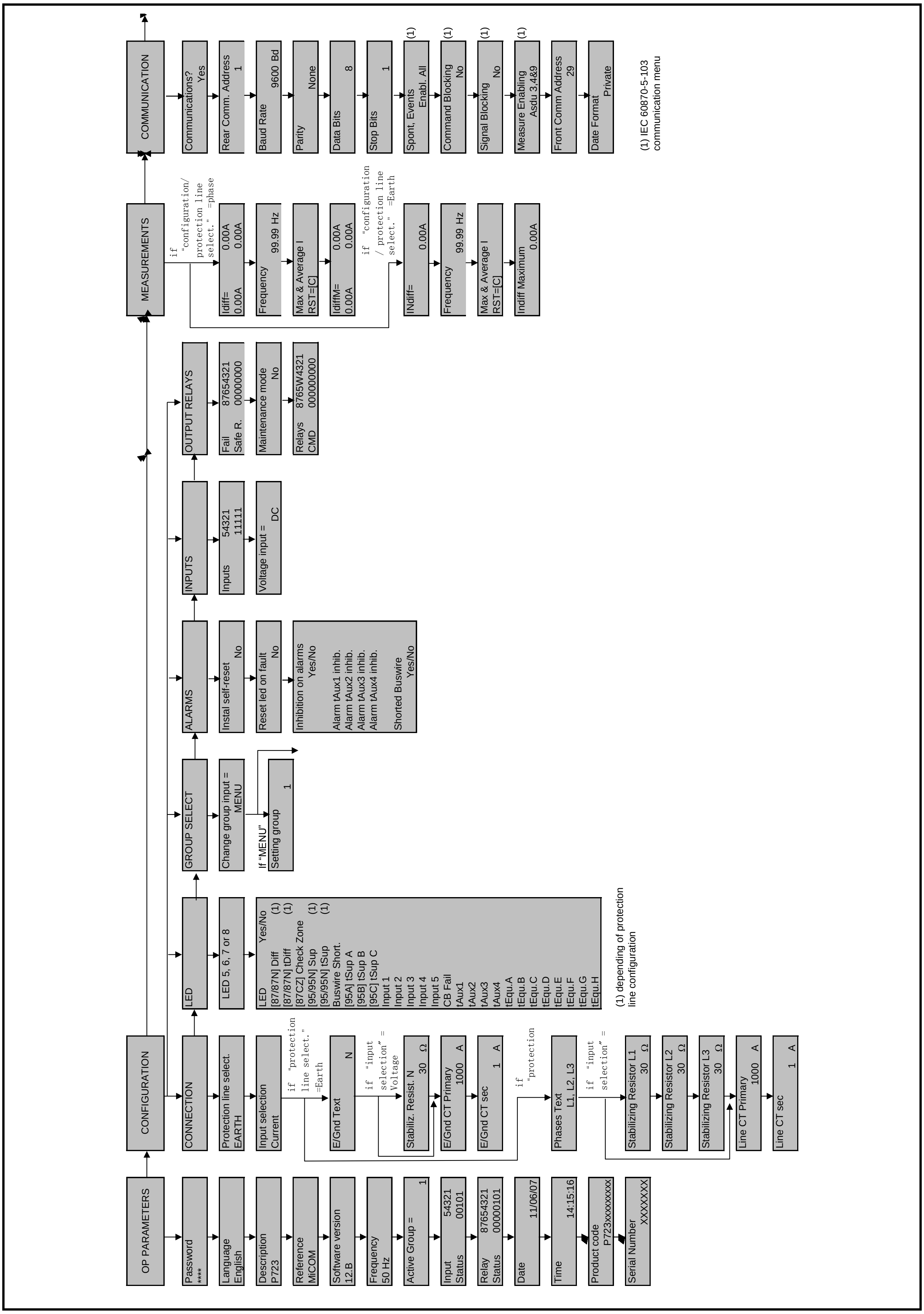
1. MiCOM P721 – V12.B SOFTWARE

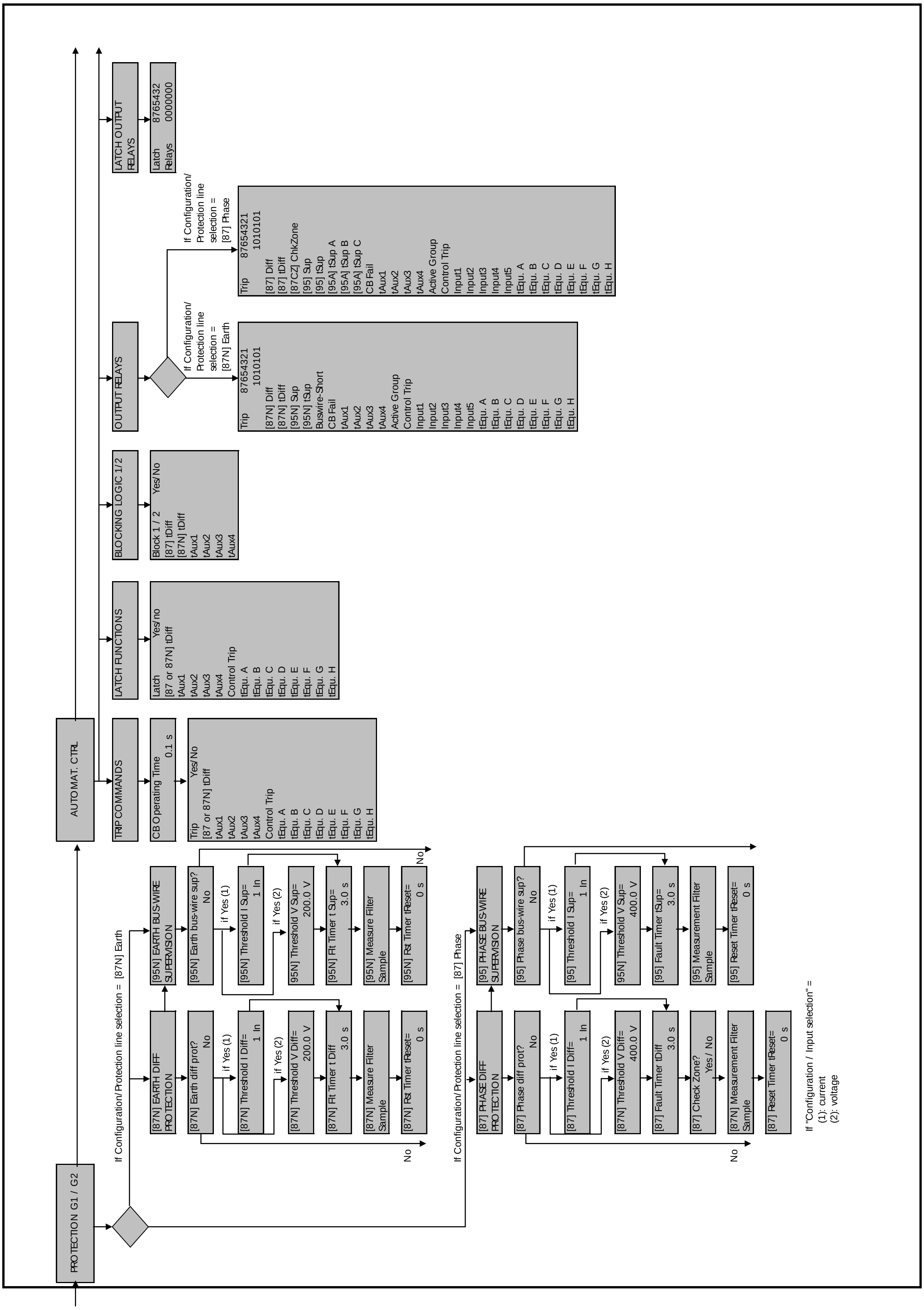


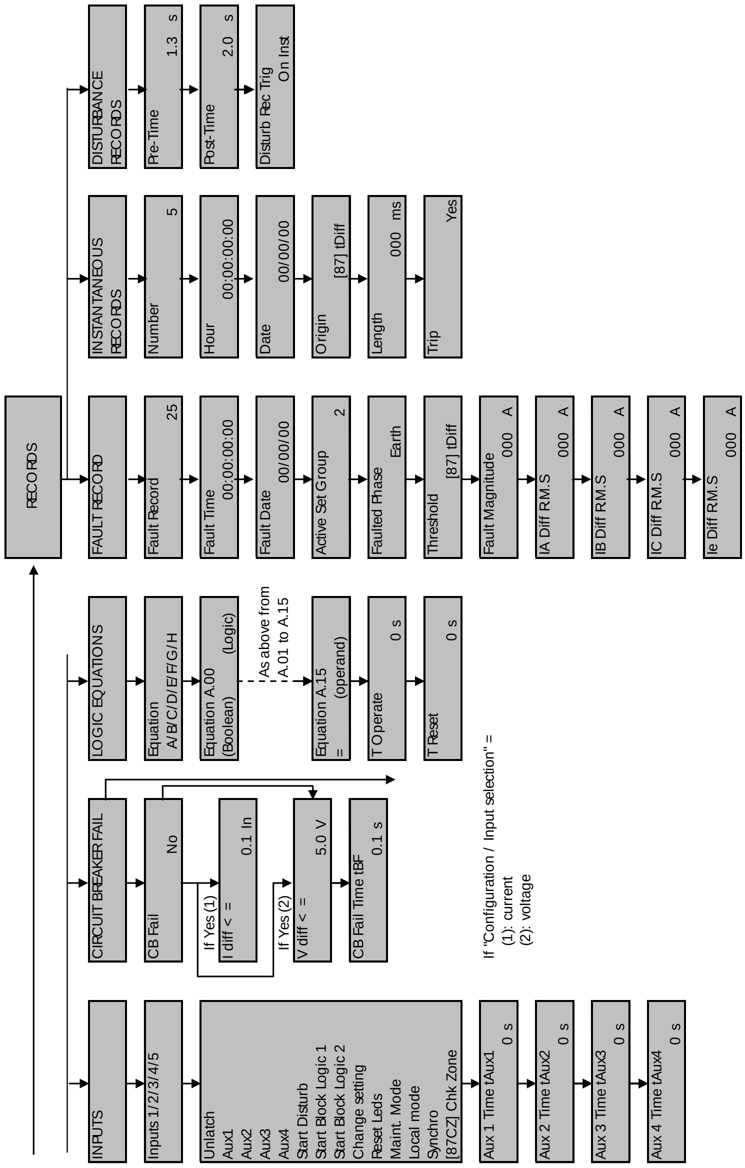

PROTECTION G1 / G2
AUTOMAT. CTRL
[87N] EARTH DIFF PROTECTION
[87N] Earth diff prot? No
[87N] Threshold I Diff= 1 In
[87N] Threshold V Diff= 200.0 V
[87N] Flt Timer t Diff 3.0 s
[87N] Measure Filter Sample
[87N] Rst Timer tReset= 0 s
No
[95N] EARTH BUS-WIRE SUPERVISION
[95N] Earth bus-wire sup? No
[95N] Threshold I Sup= 1 In
[95N] Threshold V Sup= 200.0 V
[95N] Flt Timer t Sup= 3.0 s
[95N] Measure Filter Sample
[95N] Rst Timer tReset= 0 s
No
TRIP COMMANDS
CB Operating Time 0.1 s
Trip Yes/No
[87N] tDiff
tAux1
tAux2
Control Trip
tEqu. A
tEqu. B
tEqu. C
tEqu. D
tEqu. E
tEqu. F
tEqu. G
tEqu. H
LATCH FUNCTIONS
Latch Yes/no
[87N] tDiff
tAux1
tAux2
Control Trip
tEqu. A
tEqu. B
tEqu. C
tEqu. D
tEqu. E
tEqu. F
tEqu. G
tEqu. H
BLOCKING LOGIC 1/2
Block 1 / 2 Yes/No
[87N] tDiff
tAux1
tAux2
OUTPUT RELAYS
Trip 87654321
11010101
[87N] Diff
[87N] tDiff
[95N] Sup
[95N] tSup
CB Fail
tAux1
tAux2
Active Group
Control Trip
Input1
Input2
tEqu. A
tEqu. B
tEqu. C
tEqu. D
tEqu. E
tEqu. F
tEqu. G
tEqu. H
LATCH OUTPUT RELAYS
Latch 432
Relays 000


RECORDS
INPUTS
Inputs 1/2
Unlatch
Aux1
Aux2
Start Disturb
Start Block Logic 1
Start Block Logic 2
Change setting
Reset Leds
Maint. Mode
Local mode
Synchro
Aux Times
Aux 1 Time tAux1 0 s
Aux 2 Time tAux2 0 s
CIRCUIT BREAKER FAIL
CB Fail No
I diff < = 0.1 In
CB Fail Time tBF 0.1 s
LOGIC EQUATIONS
Equation A/B/C/D/E/F/G/H
Equation A.00 (Logic) (Boolean)
As above from A.01 to A.15
Equation A.15 = (operand)
T Operate 0 s
T Reset 0 s
FAULT RECORD
Fault Record 25
Fault Time 00:00:00:00
Fault Date 00/00/00
Active Set Group 2
Faulted Phase Earth
Threshold [87] tDiff
Fault Magnitude 000 A
Ie Diff R.M.S 000 A
INSTANTANEOUS RECORDS
Number 5
Hour 00:00:00:00
Date 00/00/00
Origin [87] tDiff
Length 000 ms
Trip Yes
DISTURBANCE RECORDS
Pre-Time 1.3 s
Post-Time 2.0 s
Disturb Rec Trig On Inst

2. MiCOM P723 – V12.B SOFTWARE




PROTECTION G1 / G2
AUTOMAT. CTRL
If Configuration/Protection line selection = [87N] Earth
[87N] EARTH DIFF PROTECTION
[87N] Earth diff prot? No
if Yes (1)
[87N] Threshold I Diff= 1 In
if Yes (2)
[87N] Threshold V Diff= 200.0 V
[87N] Flt Timer t Diff 3.0 s
[87N] Measure Filter Sample
[87N] Rst Timer tReset= 0 s
No
[95N] EARTH BUS-WIRE SUPERVISION
[95N] Earth bus-wire sup? No
[95N] Threshold I Sup= 1 In
[95N] Threshold V Sup= 200.0 V
[95N] Flt Timer t Sup= 3.0 s
[95N] Measure Filter Sample
[95N] Rst Timer tReset= 0 s
If Configuration/Protection line selection = [87] Phase
[87] PHASE DIFF PROTECTION
[87] Phase diff prot? No
[87] Threshold I Diff= 1 In
[87] Threshold V Diff= 400.0 V
[87] Fault Timer tDiff 3.0 s
[87] Check Zone? Yes / No
[87N] Measurement Filter Sample
[87] Reset Timer tReset= 0 s
[95] PHASE BUS-WIRE SUPERVISION
[95] Phase bus-wire sup? No
[95] Threshold I Sup= 1 In
[95N] Threshold V Sup= 400.0 V
[95] Fault Timer tSup= 3.0 s
[95] Measurement Filter Sample
[95] Reset Timer tReset= 0 s
If "Configuration / Input selection" = (1): current (2): voltage
TRIP COMMANDS
CB Operating Time 0.1 s
Trip Yes/No
[87 or 87N] tDiff
tAux1
tAux2
tAux3
tAux4
Control Trip
tEqu. A
tEqu. B
tEqu. C
tEqu. D
tEqu. E
tEqu. F
tEqu. G
tEqu. H
LATCH FUNCTIONS
Latch Yes/no
[87 or 87N] tDiff
tAux1
tAux2
tAux3
tAux4
Control Trip
tEqu. A
tEqu. B
tEqu. C
tEqu. D
tEqu. E
tEqu. F
tEqu. G
tEqu. H
BLOCKING LOGIC 1/2
Block 1 / 2 Yes/No
[87] tDiff
[87N] tDiff
tAux1
tAux2
tAux3
tAux4
OUTPUT RELAYS
If Configuration/ Protection line selection = [87N] Earth
Trip 87654321 1010101
[87N] Diff
[87N] tDiff
[95N] Sup
[95N] tSup
Buswire-Short
CB Fail
tAux1
tAux2
tAux3
tAux4
Active Group
Control Trip
Input1
Input2
Input3
Input4
Input5
tEqu. A
tEqu. B
tEqu. C
tEqu. D
tEqu. E
tEqu. F
tEqu. G
tEqu. H
If Configuration/ Protection line selection = [87] Phase
Trip 87654321 1010101
[87] Diff
[87] tDiff
[87CZ] ChkZone
[95] Sup
[95] tSup
[95A] tSup A
[95A] tSup B
[95A] tSup C
CB Fail
tAux1
tAux2
tAux3
tAux4
Active Group
Control Trip
Input1
Input2
Input3
Input4
Input5
tEqu. A
tEqu. B
tEqu. C
tEqu. D
tEqu. E
tEqu. F
tEqu. G
tEqu. H
LATCH OUTPUT RELAYS
Latch Relays 8765432 0000000


RECORDS
DISTURBANCE RECORDS
Pre-Time 1.3 s
Post-Time 2.0 s
Disturb Rec Trig On Inst
INSTANTANEOUS RECORDS
Number 5
Hour 00:00:00:00
Date 00/00/00
Origin [87] tDiff
Length 000 ms
Trip Yes
FAULT RECORD
Fault Record 25
Fault Time 00:00:00:00
Fault Date 00/00/00
Active Set Group 2
Faulted Phase Earth
Threshold [87] tDiff
Fault Magnitude 000 A
IA Diff RM.S 000 A
IB Diff RM.S 000 A
IC Diff RM.S 000 A
Ie Diff RM.S 000 A
LOGIC EQUATIONS
Equation A/B/C/D/E/F/G/H
Equation A.00 (Logic) (Boolean)
As above from A.01 to A.15
Equation A.15 (operand) =
T Operate 0 s
T Reset 0 s
CIRCUIT BREAKER FAIL
CB Fail No
If Yes (1) I diff < = 0.1 In
If Yes (2) V diff < = 5.0 V
CB Fail Time tBF 0.1 s
If "Configuration / Input selection" =
(1): current
(2): voltage
INPUTS
Inputs 1/2/3/4/5
Unlatch
Aux1
Aux2
Aux3
Aux4
Start Disturb
Start Block Logic 1
Start Block Logic 2
Change setting
Reset Leds
Maint. Mode
Local mode
Synchro
[87CZ] Chk Zone
Aux 1 Time tAux1 0 s
Aux 2 Time tAux2 0 s
Aux 3 Time tAux3 0 s
Aux 4 Time tAux4 0 s

TECHNICAL DATA

CONTENT

1. RATINGS 3

1.1 Power Supply 3

1.2 Frequency 3

1.3 Current Inputs 3

1.4 Phase and earth current transformers consumption 3

1.4.1 P72x phase CT consumption 3

1.4.2 P72x earth CT consumption 4

1.5 Logic Inputs 4

1.5.1 Supply 4

1.6 Output Relay Characteristic 5

2. INSULATION 5

3. EMC TESTS 6

4. ENVIRONMENT 7

5. EU DIRECTIVE 8

5.1 EMC compliance 8

5.2 Product safety 8

6. DEVIATION OF PROTECTION ELEMENTS 9

7. DEVIATION OF AUTOMATION FUNCTIONS TIMERS 9

8. DEVIATION OF MEASUREMENTS 9

9. PROTECTION SETTING RANGES 10

9.1 [87N] Earth differential protection 10

9.1.1 Protection Setting Ranges 10

9.2 [95N] Earth bus-wire supervision 10

9.2.1 Protection Setting Ranges 10

9.3 [87] Phase differential protection (P723 only) 10

9.3.1 Protection Setting Ranges 10

9.4 [95] Phase bus-wire supervision (P723 only) 11

9.4.1 Protection Setting Ranges 11

10. AUTOMATION CONTROL FUNCTIONS 12
10.1 Trip commands 12
10.2 Latch functions 12
10.3 Blocking logic 12
10.4 Output relays 12
10.5 Latch of the auxiliary output relays 12
10.6 Inputs 12
10.6.1 Inputs assignation 12
10.6.2 Auxiliary timers 12
10.7 Circuit Breaker Failure 13
10.7.1 CB Fail Setting Ranges 13
10.8 Logic Equations 13
10.8.1 Timer Setting Ranges 13
10.8.2 Available logical gates 14
10.8.3 Available signals 14
11. RECORDING FUNCTIONS 16
11.1 Fault Record 16
11.2 Instantaneous recorder 16
11.3 Disturbance Records 16
11.3.1 Triggers; Data; Setting Ranges 16
12. COMMUNICATION 17

1. RATINGS

1.1 Power Supply

Nominal auxiliary voltage Vx	24-60Vdc; 48 -250Vdc/ 48-250 Vac 24-250Vdc/ 24-240Vac
Operating range	DC: ± 20% of Vx AC: – 20%, +10% of Vx
Residual ripple	Up to 12%
Stored energy time	≥50 ms for interruption of Vx
Burden	Stand by: <3W DC or <8VA AC Max: <6W DC or <14VA AC

1.2 Frequency

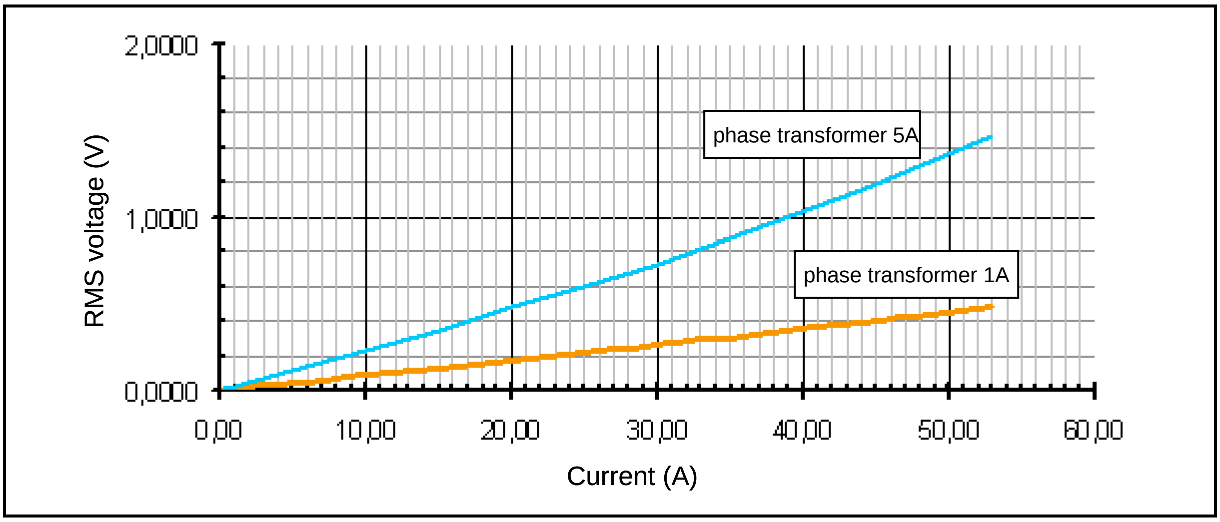
Frequency protection functions	nominal frequency ±5Hz
Nominal frequency	50/60Hz

1.3 Current Inputs

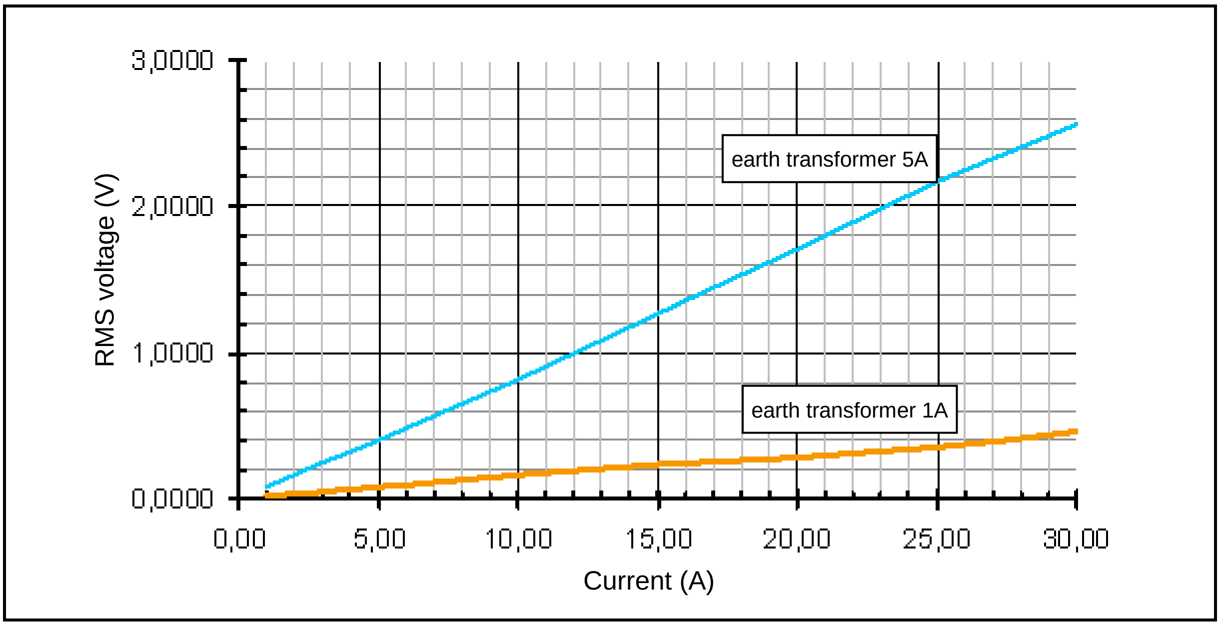
Phase current inputs	1 and 5A by connection
Earth current inputs	1 and 5A by connection
Operating range	Selected at order (Cortec)
Burden Phase Current	< 0.025 VA (1A) < 0.3 VA (5A)
Burden Earth Current	< 0.08 VA (1A) < 0.42 VA (5A)
Thermal withstand	1s @ 100 x rated current 2s @ 40 x rated current continuous @ 4 x rated current

1.4 Phase and earth current transformers consumption

1.4.1 P72x phase CT consumption



1.4.2 P72x earth CT consumption



1.5 Logic Inputs

Logic input type	**Independent optically insulated**
Logic input burden	< 10 mAmps per input
Logic input recognition time (DC inputs)	< 5ms in a 50Hz system < 4ms in a 60Hz system
Logic input recognition time (AC inputs)	<7ms in a 50Hz system < 6ms in a 60Hz system
Logic input recognition time (ENA inputs)	<15ms in a 50Hz system < 12ms in a 60Hz system

1.5.1 Supply

Ordering Code	Relay auxiliary power supply		Logic Inputs				
	Nominal voltage range Vx	Operating voltage range	Nominal Voltage range	Minimal polarisation voltage	Maximum polarisation current	Holding current after 2 ms	Maximum continuous withstand
T	48 – 250 Vdc 48 – 240 Vac Special ENA (**)	38.4 – 300 Vdc 38.4 – 264 Vac	24 – 250 Vdc 24 – 240 Vac	19,2 Vdc 19,2 Vac	35 mA	2.3 mA	300 Vdc 264 Vac
H	48 – 250 Vdc 48 – 240 Vac	38.4 – 300 Vdc 38.4 – 264 Vac	129 Vdc	105 Vdc	3.0 mA @ 129 Vdc		145 Vdc
V	48 – 250 Vdc 48 – 240 Vac	38.4 – 300 Vdc 38.4 – 264 Vac	110 Vdc	77 Vdc	7.3 mA @ 110 Vdc		132 Vdc
W	48 – 250 Vdc 48 – 240 Vac	38.4 – 300 Vdc 38.4 – 264 Vac	220 Vdc	154 Vdc	3.4 mA @ 220 Vdc		262 Vdc
Z	24 – 250Vdc 48 – 240Vac	19.2 – 300 Vdc 38.4 – 264 Vac	24 – 250 Vdc 24 – 240 Vac	19.2 Vdc 19.2 Vac	35 mA	2.3 mA	300 Vdc 264 Vac

(**) Logic input recognition time for ENA approval. Dedicated filtering on 24 samples (15 ms at 50 Hz)

1.6 Output Relay Characteristic

Contact rating	
Contact relay	Dry contact Ag Ni
Make current	Max. 30A and carry for 3s
Carry capacity	5A continuous
Rated Voltage	250Vac
Breaking characteristic	
Breaking capacity AC	1500 VA resistive 1500 VA inductive (P.F. = 0.5) 220 Vac, 5A (cos φ = 0.6)
Breaking capacity DC	135 Vdc, 0.3A (L/R = 30 ms) 250 Vdc, 50W resistive or 25W inductive (L/R=40ms)
Operation time	<7ms
Durability	
Loaded contact	10000 operation minimum
Unloaded contact	100000 operation minimum

2. INSULATION

Dielectric withstand	IEC 60255-5 : 2000	2 kV common mode 1 kV differential mode
	ANSI/IEEE C37.90-1989 (reaffirmed 1994)	1.5 kV rms AC for 1 minute, across normally open contacts.
Impulse voltage	IEC 60255-5 : 2000	5 kV common mode 1 kV differential mode
Insulation resistance	IEC 60255-5 : 2000	> 1000 MΩ

3. EMC TESTS

High Frequency Disturbance

IEC 60255-22-1:1988	2.5kV common mode, Class III 1kV differential mode, Class III

Electrostatic Discharge

EN 61000-4-2: 1995 and IEC 60255-22-2: 1996	8kV contact discharge, Class 4 15kV air discharge, Class 4

Fast Transient

IEC 60255-22-4:2002, Class A	2kV 5kHz, terminal block comms. 4kV 2.5kHz, all circuits excluding comms.
EN 61000-4-4:1995, Level 4	4kV 5kHz, power supply 2kV 5kHz, all circuits excluding power supply.

Surge

EN 61000-4-5:1995 and IEC 60255-22-5:2002	4kV common mode, Level 4 2kV differential mode, Level 4

Conducted Emissions

EN 55022: 1998	0.15 - 0.5MHz, 79dBµV (quasi peak) 66dBµV (average) 0.5 - 30MHz, 73dBµV (quasi peak) 60dBµV (average).

Radiated Emissions

EN 55022: 1998	30 - 230MHz, 40dBµV/m at 10m measurement distance 230 - 1GHz, 47dBµV/m at 10m measurement distance.

Conducted Immunity

EN 61000-4-6:1996	Level 3, 10V rms @ 1kHz 80% am, 150kHz to 80MHz

Radiated Immunity

EN 61000-4-3:2002 ANSI/IEEE C37.90.2:2004	Level 3, 10V/m 80MHz to 1GHz @ 1kHz 80% am 35V/m 80MHz to 1GHz @ 1kHz 80% am 35V/m 80MHz to 1GHz @ 100% pulse modulated front face only.

Radiated immunity from digital telephones

EN 61000-4-3:2002	Level 4, 30V/m 800MHz to 960MHz and 1.4GHz to 2GHz @ 1kHz 80% am

ANSI Surge Withstand Capability

IEEE/ANSI C37.90.1: 2002	4kV fast transient and 2.5kV oscillatory applied common mode and differential mode

Magnetic Field Immunity

IEC 61000-4-8: 1994 IEC 61000-4-9: 1993 IEC 61000-4-10: 1993	Level 5, 100A/m applied continuously, 1000A/m for 3s. Level 5, 1000A/m. Level 5, 100A/m at 100kHz and 1MHz.

4. ENVIRONMENT

Temperature	IEC 60068-2-1 : 1993 IEC 60068-2-2: 1993	Storage –25 °C to +70 °C Operation: –25 °C to + 55 °C –25°C to 70° (*) (*) The upper limit is permissible for a single 6 hour duration within any 24 hour period.
Humidity dam heat	IEC 60068-2-78:2001	56 days at 93% RH and 40 °C
Enclosure protection	IEC 60-529: 2001	Dust IP50 (whole case), Front IP 52, Back IP 10
Sinusoidal Vibrations	IEC 60255-21-1:1998	Response and endurance, class 2
Shocks	IEC 60255-21-2:1998	Response and withstand, class 2
Shock withstand & Bump	IEC 60255-21-2:1998	Response and withstand, class 1
Seismic	IEC 60255-21-3:1993	Class 2

Corrosive Environments :

Per IEC 60068-2-60: 1995, 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, NO^2, Cl^2 and SO^2.

5. EU DIRECTIVE

5.1 EMC compliance

CE 89/336/EEC
93/31/EEC

Compliance with European Commission EMC Directive.

Generic standards were used to establish conformity:

EN50081-2: 1994

EN60952-2: 1995

5.2 Product safety

CE 2006/95/EC
(replacing 73/23/EEC from 01/2007)

Compliance with European Commission Low Voltage Directive. Compliance is demonstrated by reference to generic safety standards:

- EN61010-1: 1993/A2: 1995
- EN60950: 1992/A11: 1997

6. DEVIATION OF PROTECTION ELEMENTS

Element	Range	Deviation	Fault timer	Reset timer
Earth differential protection I diff (V diff)	0.01In to 1In (0.5 to 200V)	± 2%	0s - 2s	0 to 600s
Phase differential protection I diff (V diff)	0.02 to 2In (1 to 400V)	± 2%	0s – 2s	0 to 600s
Earth bus-wire supervision	0.01 to 1 In (0.5 to 200V)	± 2%	0.5s – 3s	0 to 600s
Phase bus-wire supervision I Sup (V Sup)	0.01 to 1In (1 to 400V)	± 2%	0.5s – 3s	0 to 600s

7. DEVIATION OF AUTOMATION FUNCTIONS TIMERS

CB fail & CB monitoring timers	±2%
Auxiliary timers tAUX1, tAUX2, tAUX3, tAUX4	±2%

8. DEVIATION OF MEASUREMENTS

Measurement	Range	Deviation
Phase current	0.02In to 10In	Typical ±0.5% at In
Earth current	0.004In to 2In	Typical ±0.5% at In

9. PROTECTION SETTING RANGES

9.1 [87N] Earth differential protection

9.1.1 Protection Setting Ranges

[87N] Earth differential protection	Setting Range		
	Min	Max	Step
[87N] Earth differential protection	Yes / No		
[87N] Threshold I diff	0.01In	1In	0.01In
[87N] Threshold V diff	0.5V	200V	0.1V
[87N] Filter timer t Diff	0s	2s	10ms
[87N] Reset timer tReset	0	600s	10ms
Measurement Filter	Sample mode / Fast mode / Fourier mode		

9.2 [95N] Earth bus-wire supervision

9.2.1 Protection Setting Ranges

[95N] Earth bus-wire supervision	Setting Range		
	Min	Max	Step
[95N] Earth bus-wire supervision	Yes / No		
[95N] Threshold I Sup	0.01In	1In	0.01In
[95N] Threshold V Sup	0.5V	200V	0.1V
[95N] Filter timer t Sup	0.5s	3s	10ms
[95N] Reset timer tReset	0	600s	10ms
Measurement Filter	Sample mode / Fast mode / Fourier mode		

9.3 [87] Phase differential protection (P723 only)

9.3.1 Protection Setting Ranges

[87] Phase differential protection	Setting Range		
	Min	Max	Step
[87] Phase differential protection	Yes / No		
[87] Threshold I diff	0.02In	2In	0.01In
[87] Threshold V diff	1V	400V	0.1V
[87] Filter timer t Diff	0s	2s	10ms
[87] Check zone?	Yes / No		
[87] Reset timer tReset	0	600s	10ms
Measurement Filter	Sample mode / Fast mode / Fourier mode		

9.4 [95] Phase bus-wire supervision (P723 only)

9.4.1 Protection Setting Ranges

[95] Phase bus-wire supervision	**Setting Range**		
	Min	**Max**	**Step**
[95] Phase bus-wire supervision	Yes / No		
[95] Threshold I Sup	0.02In	2In	0.01In
[95] Threshold V Sup	1V	400V	0.1V
[95] Filter timer t Sup	0.5s	3s	10ms
[95] Reset timer tReset	0	600s	10ms
Measurement Filter	Sample mode / Fast mode / Fourier mode		

10. AUTOMATION CONTROL FUNCTIONS

10.1 Trip commands

Assignation of the following thresholds to trip output relay:

- all models: [87N] tDiff, t Aux 1, t Aux 2, Control Trip, tEqu.A, tEqu.B, tEqu.C, tEqu.D, tEqu.E, tEqu.F, tEqu.G, tEqu.H,
- P723 additional functions: [87] tDiff, t Aux 3 and t Aux 4

10.2 Latch functions

Trip output relay programmable with one or many thresholds:

- all models: [87N] tDiff, t Aux 1, t Aux 2, Control Trip, tEqu.A, tEqu.B, tEqu.C, tEqu.D, tEqu.E, tEqu.F, tEqu.G, tEqu.H.
- P723 additional functions: [87] tDiff, t Aux 3, t Aux 4.

10.3 Blocking logic

Possibility to block the following delayed thresholds:

- all models: [87N] tDiff, t Aux 1, t Aux 2,
- P723 additional functions: [87] tDiff, t Aux 3 and t Aux 4, [95] tSup, [87CZ]

10.4 Output relays

Alarm and trip threshold assignation to a logic output: 3 relays (P721) and 7 relays (P723).

Assignable functions:

- all models: [87N] Diff, [87N] tDiff, [95N] Sup, [95N] tSup, Buswire Short, CB Fail, t Aux 1, t Aux 2, Active group, Control trip, Input1, Input2, tEqu. A , tEqu. B, tEqu. C, tEqu D, tEqu E, tEqu. F , tEqu. G, tEqu. H.
- P723 additional functions: [87] Diff, [87] tDiff, [87CZ] ChkZone, [95] Sup, [95] tSup, [95A] tSup A, [95B] tSup B, [95C] tSup C, t Aux 3, t Aux 4, Input3, Input4, Input5

10.5 Latch of the auxiliary output relays

Possibility to latch output relays:

- P721: Output 2 to 4,
- P723: Output 2 to 8.

10.6 Inputs

10.6.1 Inputs assignation

Single function or multiple automation functions assignable to 4 logic inputs:

- all models: Unlatch, Aux 1, Aux 2, Blocking Logic 1, Blocking Logic 2, Start Disturb Change setting, Reset Leds, Maint. Mode, Local Mode, Synchro
- P723 additional functions: Aux 3, Aux 4, [87CZ] Chk Zone

10.6.2 Auxiliary timers

Auxiliary timers	Setting range		
	Min	Max	Step
Aux1 time tAux1	0	200s	10ms
Aux2 time tAux2	0	200s	10ms
Aux3 time tAux3	0	200s	10ms
Aux4 time tAux4	0	200s	10ms

10.7 Circuit Breaker Failure

10.7.1 CB Fail Setting Ranges

CB Fail	Setting range		
	Min	Max	Step
CB Fail ?	Yes or No		
I Diff <	0.01 In	1In	0.01 In
V Diff <	0.5V	200V	100mV
CB Fail Time tBF	0	10s	0.01s

10.8 Logic Equations

The MiCOM P721 and P723 relays integrate complete logic equations to allow customization of the product based on customer application.

Up to 8 independent Boolean equations can be used (from A to H). Every result of equation can be time delayed and assigned to any output relays, trip, trip latching and/or HMI LEDs.

Up to 16 operands can be used (from 00 to 15). Within operands, there are two parts:

– (1/2) : **logical gates** (NOT, OR, AND, NOT AND, NOT OR)

– (2/2) : **signals** ([87N] Diff, [95N] tSup, tAux, input…etc)

10.8.1 Timer Setting Ranges

Logic equat T delay	Setting range		
	Min	Max	Step
EQU. A Toperat	0 s	600 s	0.01 s
EQU. A Treset	0 s	600 s	0.01 s
EQU. B Toperat	0 s	600 s	0.01 s
EQU. B Treset	0 s	600 s	0.01 s
EQU. C Toperat	0 s	600 s	0.01 s
EQU. C Treset	0 s	600 s	0.01 s
EQU. D Toperat	0 s	600 s	0.01 s
EQU. D Treset	0 s	600 s	0.01 s
EQU. E Toperat	0 s	600 s	0.01 s
EQU. E Treset	0 s	600 s	0.01 s
EQU. F Toperat	0 s	600 s	0.01 s
EQU. F Treset	0 s	600 s	0.01 s
EQU. G Toperat	0 s	600 s	0.01 s
EQU. G Treset	0 s	600 s	0.01 s
EQU. H Toperat	0 s	600 s	0.01 s
EQU. H Treset	0 s	600 s	0.01 s

10.8.2 Available logical gates

Logical gates	Availability (1/2)
NOT	A00 B00 C00 D00 E00 F00 G00 H00
OR (by default) AND AND NOT OR NOT	A01 to A15 B01 to B15 C01 to C15 D01 to D15 E01 to E15 F01 to F15 G01 to G15 H01 to H15

10.8.3 Available signals

With the Logic Equations submenu, 16 operands can be used in any single equation. The following logic signals are available for mapping to an equation:

TEXT	Signals (2/2)
P721 and P723:	
Null	Condition is Null
Not Null	Condition is not Null
[87N] Diff	Earth differential protection threshold
[87N] tDiff	Time delayed earth differential protection threshold
[95N] tSup	Time delayed earth high impedance differential threshold (buswire supervision)
tAux 1	Copy of the status of the Logic Input tAux 1
tAux 2	Copy of the status of the Logic Input tAux 2
Input 1	Instantaneous digital input 1
Input 2	Instantaneous digital input 2
Group 2	Group 2 is active (setting)
CB Fail	Circuit Breaker does not operate
P723 only:	
[87] Diff	Phase differential protection threshold
[87] tDiff	Time delayed phase differential protection threshold
[87CZ] Check zone	Check Zone status
[95] Sup	Phase high impedance differential threshold (buswire supervision)
[95N] Sup	Earth high impedance differential threshold (buswire supervision)
[95] tSup	Time delayed phase high impedance differential threshold (buswire supervision)
[95A] tSupA	Time delayed phase A (or L1, or R) high impedance differential threshold (buswire supervision)

TEXT	Signals (2/2)
[95B] tSupB	As above for phase B (or L2 or S)
[95C] tSupC	As above for phase C (or L3 or T)
Buswire Short	Buswires short-circuited
tAux 3	Copy of the status of the Logic Input tAux 3
tAux 4	Copy of the status of the Logic Input tAux 4
Input 3	Instantaneous digital input 3
Input 4	Instantaneous digital input 4
Input 5	Instantaneous digital input 5

11. RECORDING FUNCTIONS

11.1 Fault Record

Capacity	25 faults
Time-tag	1 millisecond
Triggers	Any selected protection alarm and threshold
Data	Fault date, Active setting Group, Faulted phase, Threshold, Fault magnitude, [87] tDIFF fault (tripping) [87N] tDIFF fault (tripping) tAux 1 fault (tripping) tAux 2 fault (tripping) tAux 3 fault (tripping) tAux 4 fault (tripping) tEquation A, B, C, D, E, F, G and H fault (tripping) Control trip

11.2 Instantaneous recorder

Capacity	5 starting informations (instantaneous
Time-tag	1 millisecond
Triggers	Any selected protection alarm and threshold
Data	date, hour origin (any protection alarm) length (duration of the instantaneous trip yes or no

11.3 Disturbance Records

11.3.1 Triggers; Data; Setting Ranges

Triggers	Any selected protection alarm and threshold, logic input, remote command			
Data	AC input channels digital input and output states frequency value			
	Default value	**Setting range**		
	P72x	**Min**	**Max**	**Step**
Pre-Time	1.0s	0.1s	3s	0.1s
Post-Time	2.0s	0.1s	3s	0.1s
Disturb rec Trig	ON INST	ON TRIP or ON INST.		
Trigger	Any selected protection alarm and threshold Logic input Remote command			

12. COMMUNICATION

Type Port	Relay position	Physical Link	Connectors	Data Rate	Protocol
RS485	Rear port	Screened twister pair	Screws or snap-on	300 to 38400 baud (programmable)	ModBus RTU, Courier, IEC60870-5-103, DNP3.0
RS232	Front port	Screened twister pair	Sub–D 9 pin female connector	300 to 38400 baud (programmable)	ModBus RTU

BLANK PAGE

GETTING STARTED

CONTENT

1.	**ENERGISING THE RELAY**	**3**
1.1	**System Connections**	**3**
1.2	**Auxiliary Power Supply Connections**	**3**
2.	**USER INTERFACE AND MENU STRUCTURE**	**4**
2.1	**User interfaces and menu structure**	**4**
2.1.1	“Default settings” alarm	4
2.1.2	Password protection	4
2.1.3	Setting the language	5
2.1.4	Setting Date and time	5
2.1.5	Menu navigation	5
2.2	**Menu structure**	**6**
3.	**LOCAL CONNECTION TO A PC**	**7**
3.1	**Configuration**	**7**
3.1.1	REMOTE connection	7
3.2	**Products plugged in the same panel**	**8**
3.3	**Communication between distant products**	**8**
3.4	**MiCOM S1 and MiCOM S1 Studio relay communications basics**	**9**
3.5	**MiCOM S1 Studio**	**9**
3.5.1	Data Model Management	9
3.5.2	“Quick Connection” to the relay using MiCOM S1 Studio	12
3.5.3	Create a system	15
3.5.4	Create a new substation	16
3.5.5	Create a new voltage level	17
3.5.6	Create a new bay	17
3.5.7	Create a new device	18
3.5.8	Open Settings File	19
3.6	**Presentation and analysis od disturbance**	**21**
4.	**WITHDRAWING MODULE FROM CASE**	**22**
5.	**COMPANY CONTACT INFORMATION**	**24**

BLANK PAGE

1. ENERGISING THE RELAY

To energise the relay correctly, follow the following instructions carefully.

1.1 System Connections

1. Check the wiring scheme of your installation.
2. Check that the contacts of output relay **RL1** are included in your trip circuit.

1.2 Auxiliary Power Supply Connections

Connect a DC or AC (according to nominal supply rating Ua) voltage power supply.

POSITIVE Vaux TO TERMINAL 33
NEGATIVE Vaux TO TERMINAL 34
DO NOT FORGET TO CONNECT THE EARTH REFERENCE TO TERMINAL 29!

Turn on the auxiliary power supply and set to approximately rated voltage as shown on the front panel of the relay.

The display should show:

IA **1.00 A**	Displays the A phase current (true RMS value) taking into account the phase CT ratio (CONFIGURATION/CT RATIO submenu).

LEDs should be in the following configuration:

– Green LED L3 "Healthy" (Vaux) is iluminated

– All the other LEDs should be off.

2. USER INTERFACE AND MENU STRUCTURE

Before carrying out any work on the equipment, the user should be familiar with the contents of the safety section/safety guide SFTY/4LM/D11 or later issue, the technical data section and the ratings on the equipment rating label.

Refer to “GETTING STARTED” (GS) section for the description of the following procedures (interfaces and menu).

Before the initial operation of the relay, some of the parameter settings must be checked or modified (otherwise, “Setting alarm” is displayed).

Lift the upper and lower hinged covers and remove the transparent cover over the front panel. When the keypad is exposed, it provides full access to the menu options of the relay. The relevant information is displayed on the LCD.

2.1 User interfaces and menu structure

The settings and functions of the MiCOM 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.

The front panel of the relay includes a keypad, a 16-character alphanumeric liquid crystal display (LCD) and 8 LEDs.

2.1.1 “Default settings” alarm

When the relay is powered ON, it checks its memory contents. If the default settings are loaded, an alarm is raised and The ALARM yellow LED lights up.

To suppress this message and to reset the watch dog, change one parameter in the relay's menu:

– Press the button,

– Modify, for instance, the password or the language (“OP parameters” menu.

2.1.2 Password protection

Password protection is applicable to most of the relay parameter settings, especially to the selection of the various thresholds, time delays, communication parameters, allocation of logic inputs and logic outputs.

The password consists of four capital characters. When leaving the factory, the password is set to **AAAA**. The user can define any combination of four characters.

Should the password be lost or forgotten, the modification of stored parameters is blocked. It is then necessary to contact the manufacturer or his agent and by specifying the serial number of the relay, a stand-by password specific to the relay concerned may be obtained.

NOTE: The programming mode is indicated with the letter **"P"** on the right hand side of the display on each menu heading. The letter **"P"** remains present as long as the password is active (**5 minutes** if there is no action on the keypad).

– Go to the “OP. Parameters” menu by pressing and then to the “password” menu by pressing ,

– Enter the current password (default password = “AAAA”) and validate with (this operation is not necessary if the password has been entered some minutes ago),

– Enter the new password character by character, using and arrows to change a letter (maintain the key pressed to scroll through the letter in the alphabet). Use and arrows to select another character: a flashing cursor will indicate which character field of the password may be entered.,

– Validate using or cancel using . If the password is correct, the following message is displayed on the LCD: PASSWORD OK

As soon as the password has been entered, no setting change will be accepted via the remote or local communication port (RS485 or RS232).

Alternatively, the password can be entered by using the **Password** window in the **OP.PARAMETERS** menu. This password entry procedure is the same as above.

NOTE: In case of loss of password a back up password can be provided contacting Schneider Electric sale office or factory.

2.1.3 Setting the language

– Go to the “OP. Parameters” menu by pressing and then to the “Language” menu by pressing , ,

– If necessary, enter the current password and validate with ,

– Select the language using or arrows, and validate with ,

– Validate using or cancel using .

2.1.4 Setting Date and time

– Go to the “OP. Parameters” menu by pressing and then to the “Date” menu by pressing ,

– If necessary, enter the current password and validate with ,

– Set the date using or arrow, and validate with (10/11/08 means November 10th 2008),

NOTE: When you modify the date, the first digit for the day or the month can be selected according to the second digit. For instance, if 13/09/08 is displayed, you cannot select 33 for the day, or 29 for the month.

– Validate using or cancel using .

– Select the “Time ” menu by pressing 2 key,

– Set the date using or arrow, and validate with (14:21:42 means 2:21:42 pm)

2.1.5 Menu navigation

A simple menu structure (refer to P72x/EN HI section) allows setting and reading of parameters and functionality.

The keypad provides full access to the menu options, with informations displayed on the LCD.

– Press , , and keys for menu navigation:

- Press or keys to navigate from a menu heading to another menu heading (refer to the figure below),
- Press key to access to a sub menu, then navigate using or keys.

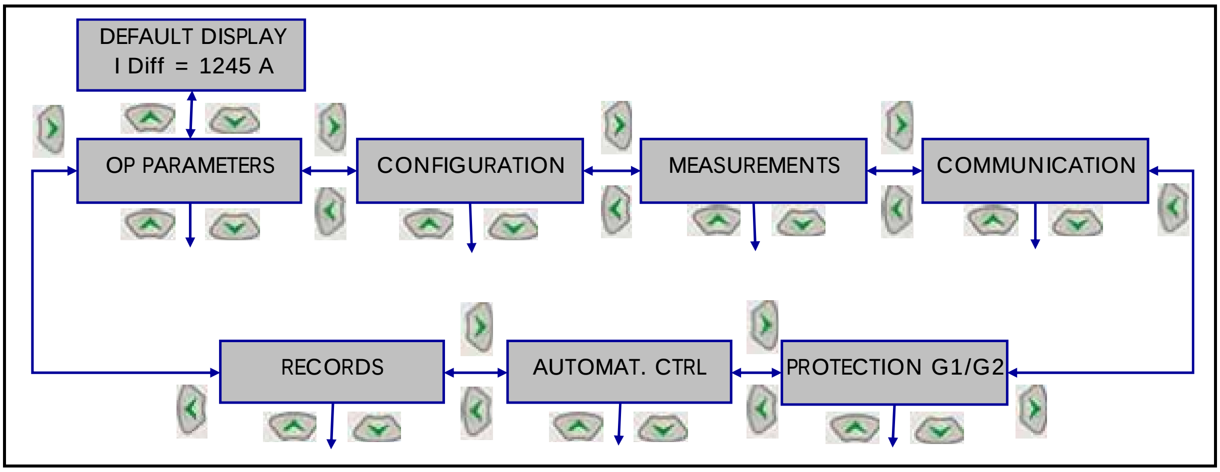
– Maintain these keys pressed to scroll through the menu,

– If necessary, modify a parameter by pressing key.

- Modify the corresponding parameter using arrows,
- Validate using , or cancel using .

2.2 Menu structure

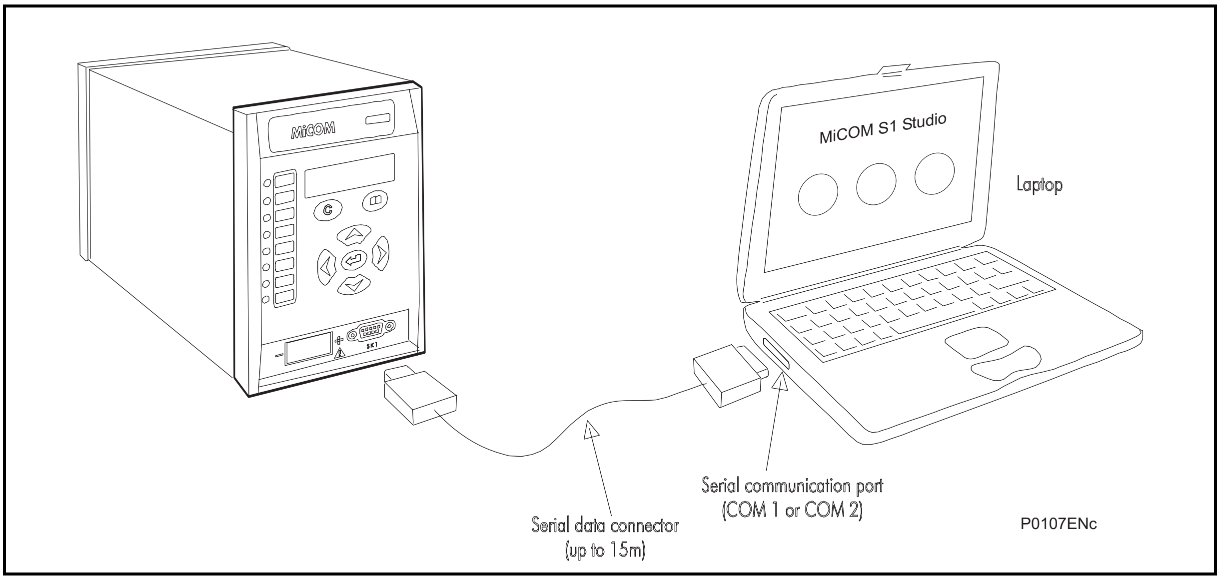
The menu structure is shown below.



Refer to P72y/EN HI section for the detail of the menu.

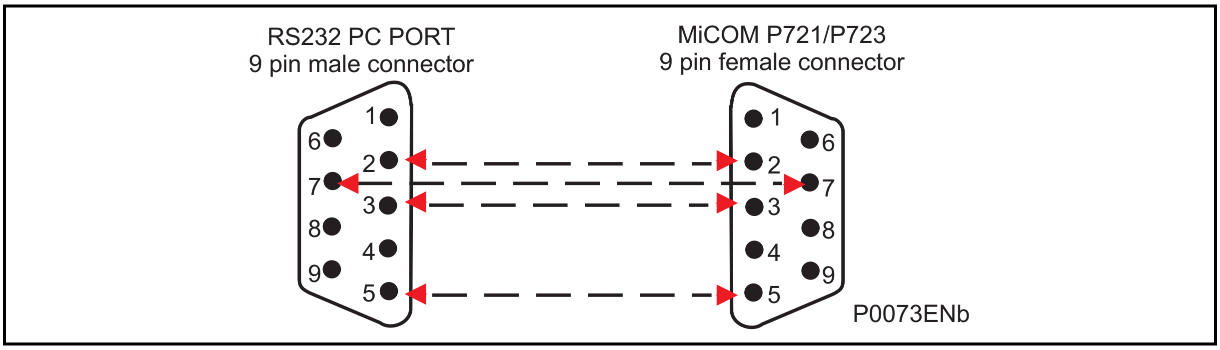
3. LOCAL CONNECTION TO A PC

3.1 Configuration



For a local connection between a PC and the relay, a serial cable with metallic shield should be used.

The wiring of the RS232 cable must be as shown in the following drawing.

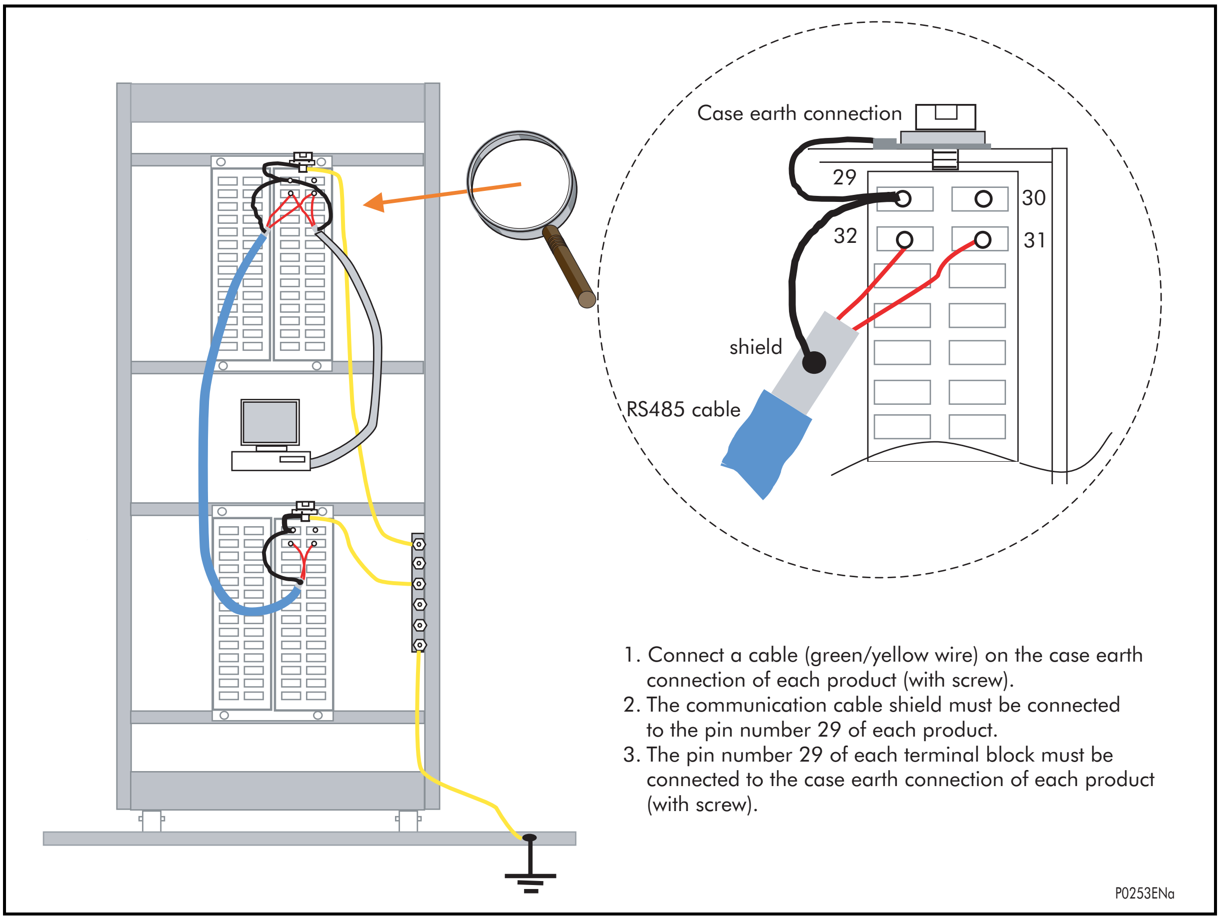


A USB/RS232 cable can also be used to communicate to the relay

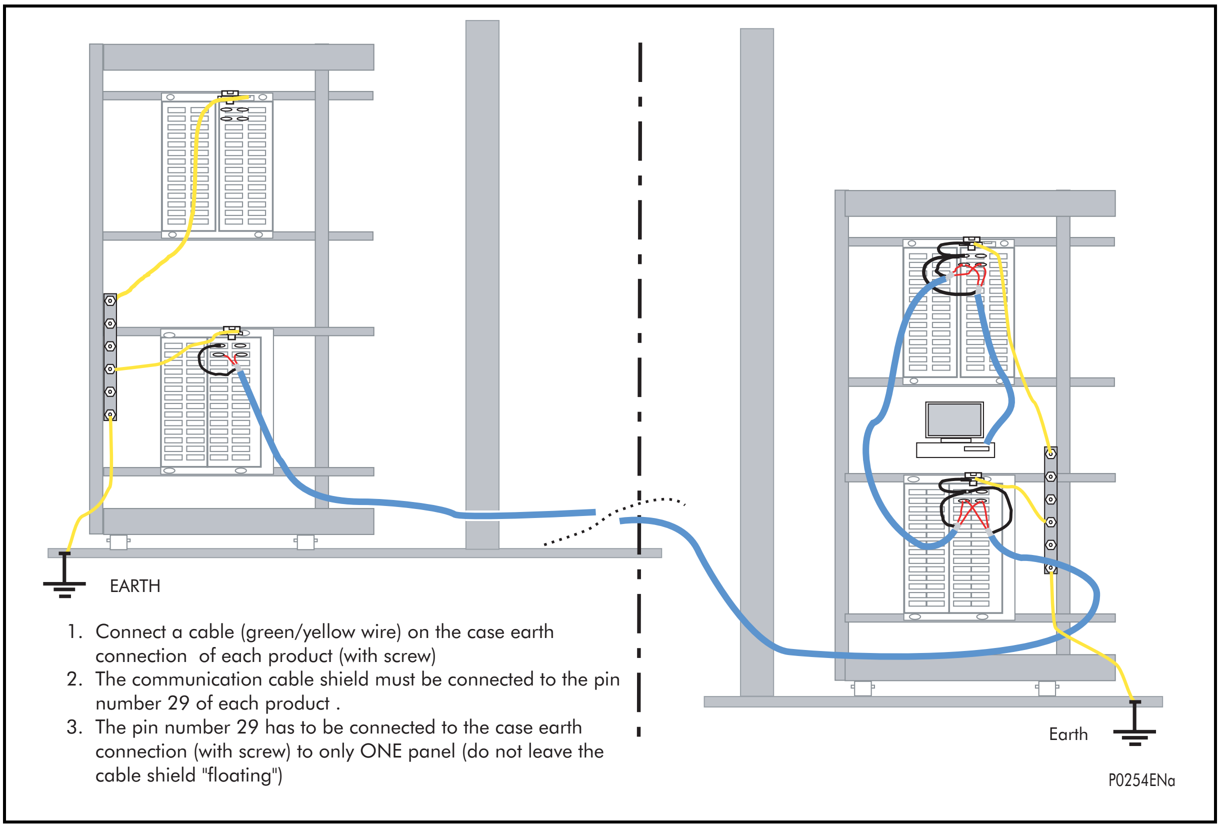
3.1.1 REMOTE connection

The figure shows the recommended way to connect a RS485 cable to the relay to build a local network.

3.2 Products plugged in the same panel



3.3 Communication between distant products



3.4 MiCOM S1 and MiCOM S1 Studio relay communications basics

MiCOM S1 Studio is the universal MiCOM IED Support Softwares and provide users a direct and convenient access to all stored data in any MiCOM IED using the EIA(RS)232 front communication port.

MiCOM S1 Studio provides full access to:

– MiCOM Px20, Px30, Px40 relays

– MiCOM Mx20 measurements units

The following sections give the main procedures to connect and to use MiCOM S1 Studio.

Before starting, verify that the EIA(RS)232 serial cable is properly connected to the EIA(RS)232 port on the front panel of the relay. Please follow the instructions in section 3.1 to ensure a proper connection is made between the PC and the relay before attempting to communicate with the relay.

This section is intended as a quick start guide to using MiCOM S1 Studio, and assumes you have a copy of MiCOM S1 Studio installed on your PC. Please refer to the MiCOM S1 Studio User Manual for more detailed information.

3.5 MiCOM S1 Studio

3.5.1 Data Model Management

The settings and parameters of the protection relay can be extracted from the relay or loaded usin Fata Model manager. The Data Model Manager can load any model from Local file, CD ROM or Internet server (if connected).

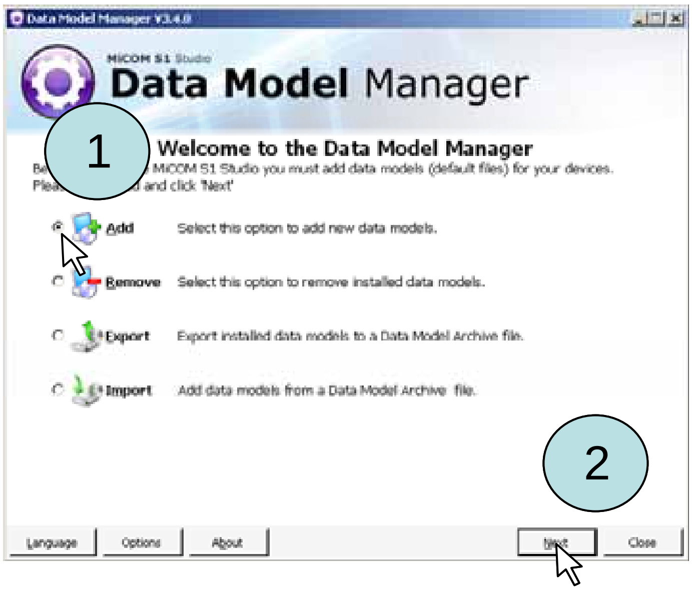
The Data Model Manager is used to add or to remove data models, to export and to import data model files.

It is necessary to close MiCOM S1 Studio when the Data Model Manager is opened.

To Open Data Model manager, click on the icon: 

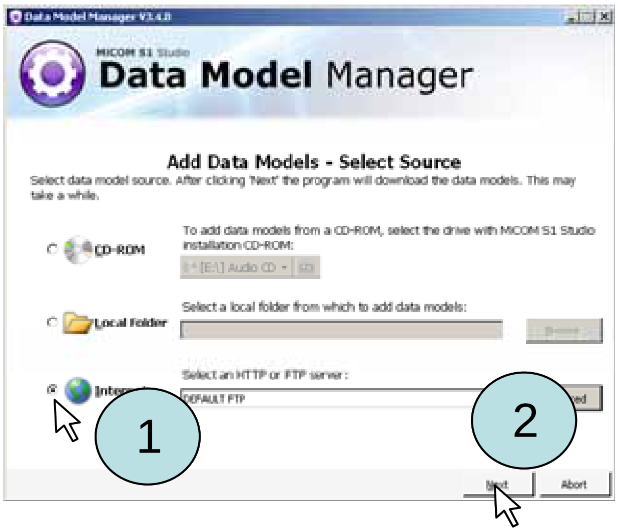
. Select "MiCOM S1 Studio" then "Data Model Manager" in the "Programs" menu.

The following panel is displayed:



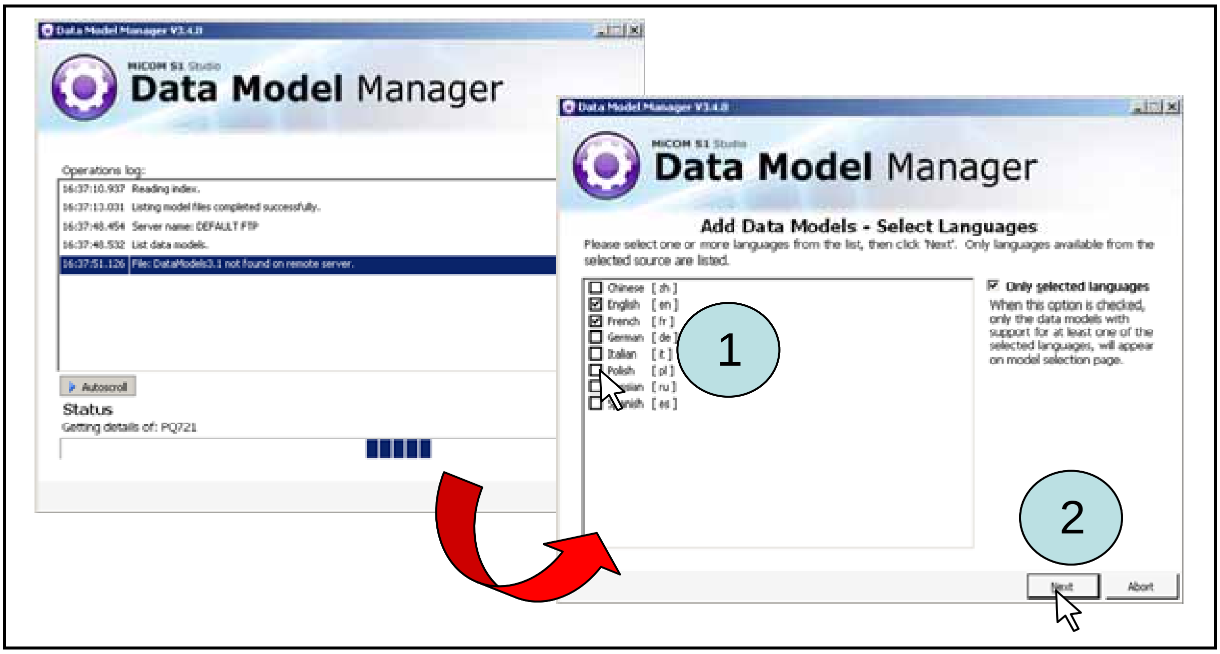
Select the “Add” option to add the new data model then click on the “next” button.

The next panel is used to select the model source (CD ROM, local folder or Areva T&D FTP server). Select the model source and click on the “next” button.

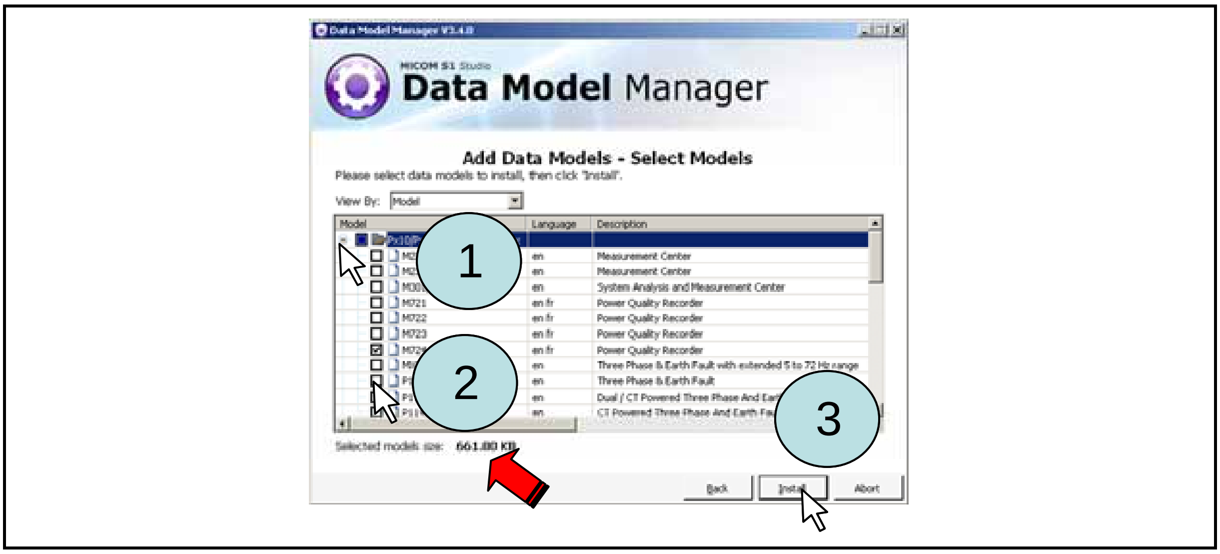


NOTE: the following procedure is given with FTP server selected.

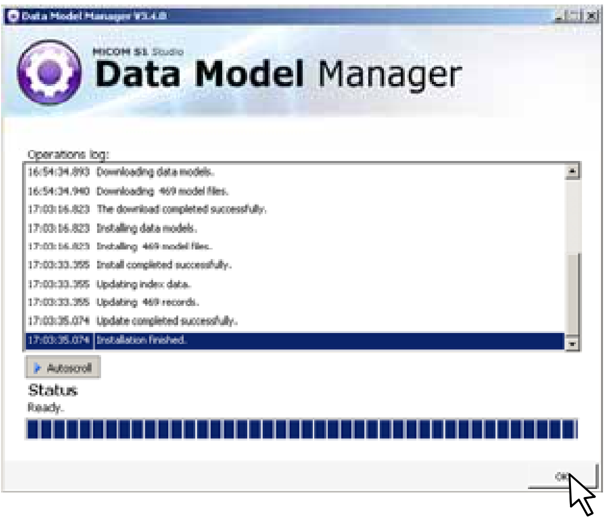
The Data Model Manager loads data models details then displays automatically the language selection option panel. Select the menu language and click the “next” button.



The data models panel is displayed. Select the data model for your product (for instance, to download P72x data models, Open the “Px10/Px20/Px20C/M/Modulex” sub-menu (click on “+” then select data model according to your product). When data models are selected, the Data Model Manager panel displays the selected models size to download.



Click on “Install button”. The model files are downloaded and updated in the system.



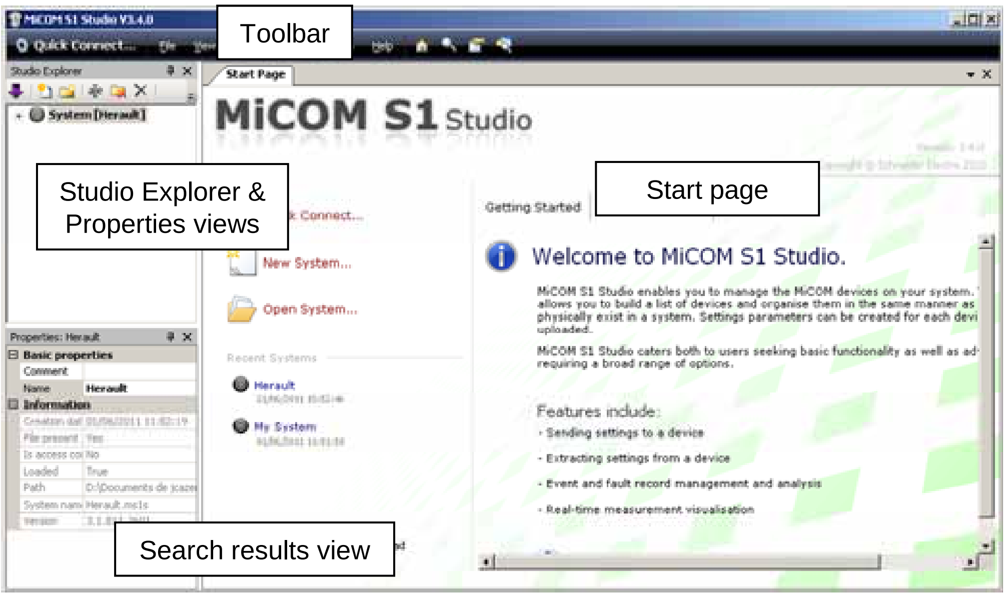
When installation has beeen completed, close the Data Model Manager. This Data Model is used with MiCOM S1 Studio when a system is opened or created. To open this default setting file, refer to § 3.5.8.

3.5.2 “Quick Connection” to the relay using MiCOM S1 Studio

To start MiCOM S1 Studio, click on the icon: 

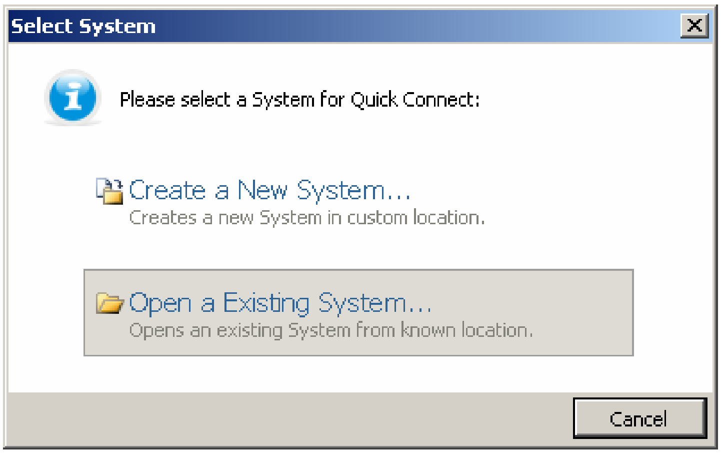
In the "Programs" menu, select "MiCOM S1 Studio".

The MiCOM S1 Studio launcher screen is displayed:

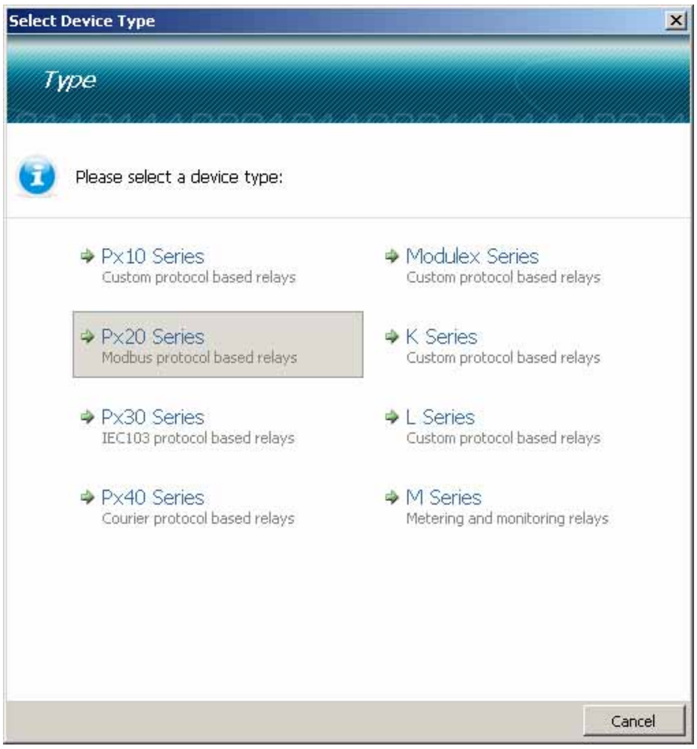


Click on the Quick Connect button at the top left of the application.

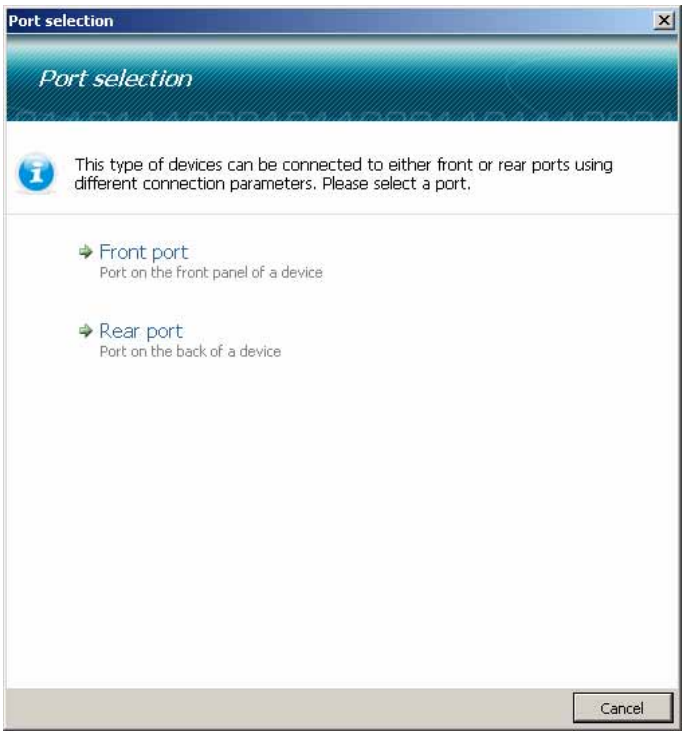
Create a new system or open an existing one:



Select “Px20 Series” from the presented options



Select a port from the presented options



Upon a successful connection a dialog will be displayed showing device type, model number and plant reference. Options for language, device name and comment are also available

The device is displayed in the Studio Explorer panel.

3.5.3 Create a system

In MiCOM S1 Studio, a System provides a root node in the Studio Explorer from which all subsequent nodes are created.

Add substations, bays, voltage levels and devices to the system.

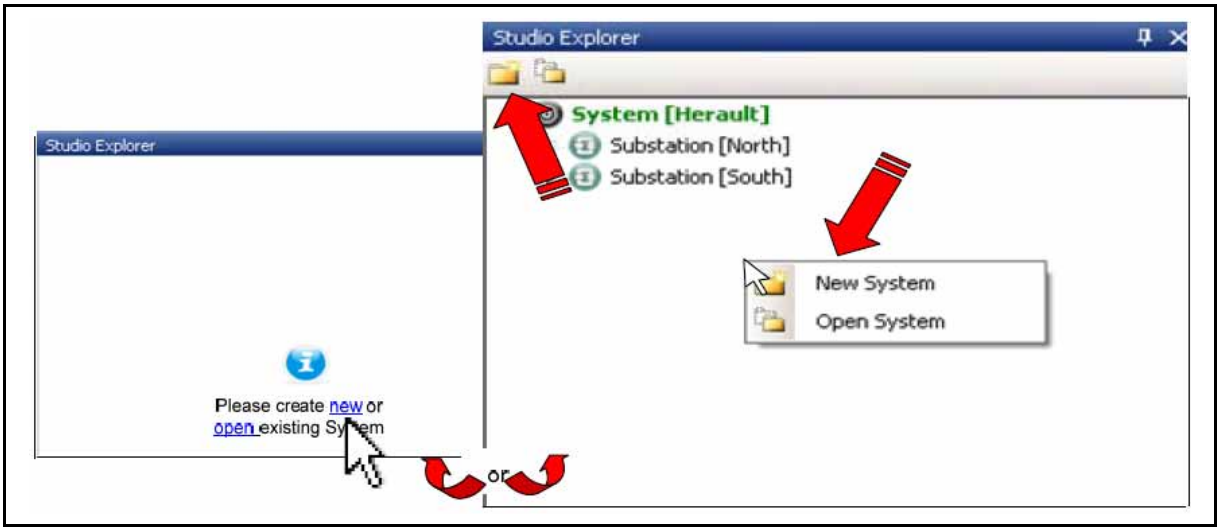
If a system is no longer needed, delete it using the delete command.

The use of Quick Connect will automatically create a default system, if one does not already exist. Systems are not opened automatically, unless Reopen last System at start-up is checked in Preferences.

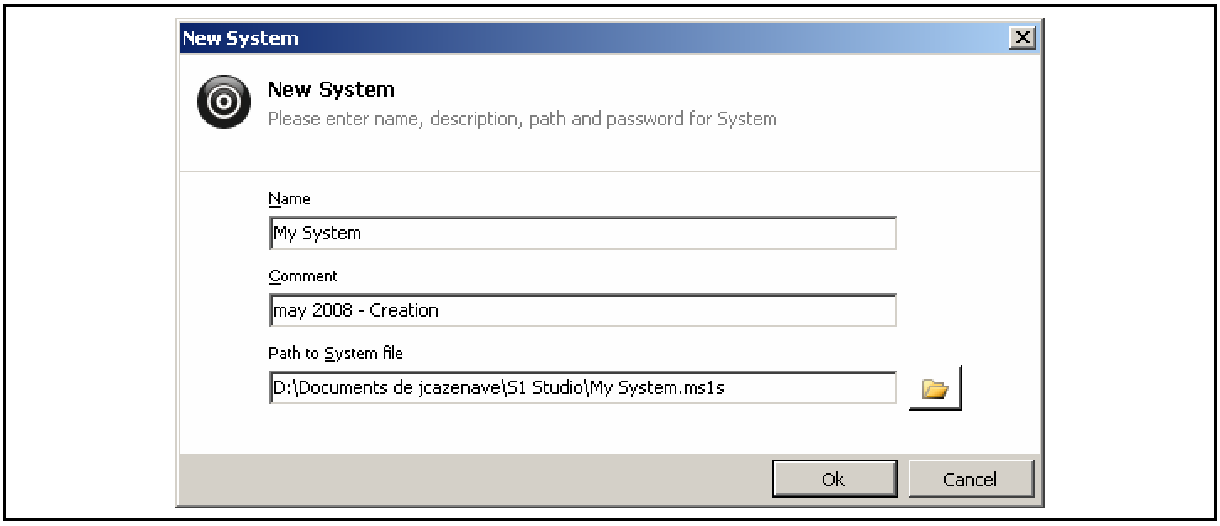
To create a new system:

– By default, the window displays the message “create new or open existing system”: click on “new to create a new system.

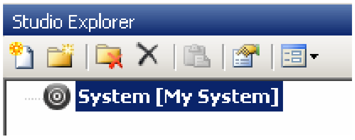
– If a system is loaded in the “Studio Explorer” window, right-click on the panel background and select New System or select the corresponding icon on Studio Explorer's toolbar.



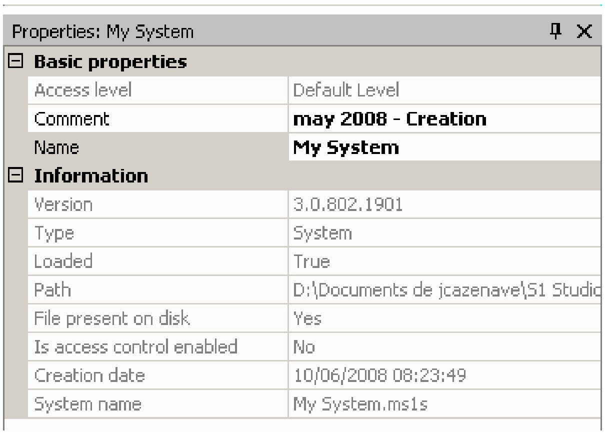
The following window is displayed: Enter the name of the system, and the path to save the system file.



The new System is displayed in the Studio Explorer panel:

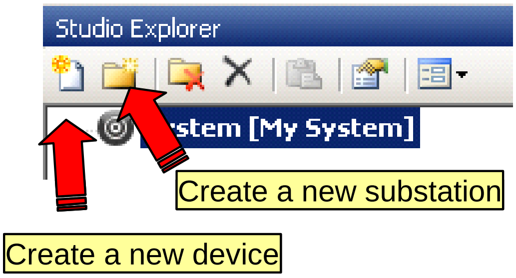


NOTE: In the Studio Explorer panel, if an item is selected, its properties are displayed in the "Properties" panel

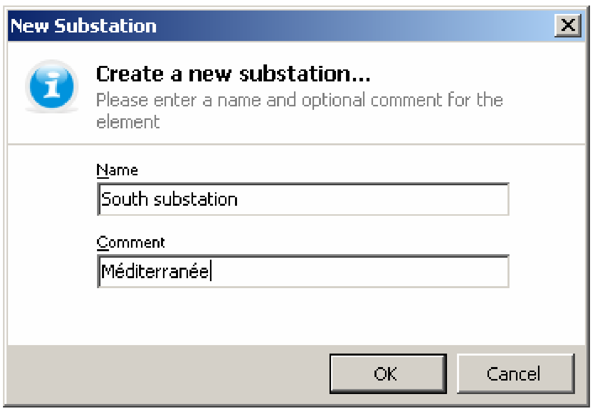


3.5.4 Create a new substation

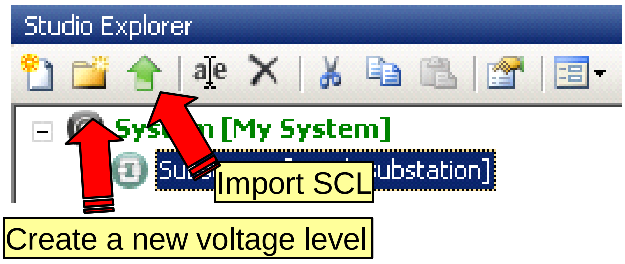
Select the system: the menu bar is updated with "new device", "new substation", "close", "delete", "paste", "properties" and "options" icons.



Click on "new substation" icon (or select the menu using right-click). The following window is displayed:



The new substation is displayed and the menu bar is updated when a substation is selected:



Click on "Import SCL" button to import a Substation Configuration File.

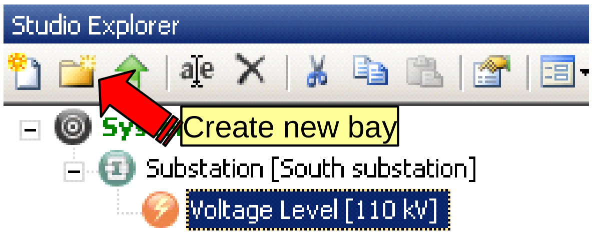
To create a substation configuration, click on "new voltage level" button.

3.5.5 Create a new voltage level

Select the substation and click on "new station level" button (or select the menu using right-click).

In the "Create a new voltage level", enter the voltage level of the station.

The "new voltage level" is displayed and the "new bay" icon is displayed.

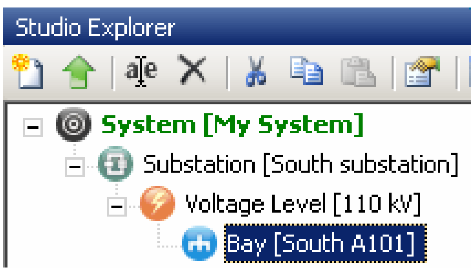


3.5.6 Create a new bay

Select the substation and click on "new bay" button (or select the menu using right-click).

In the "Create new bay…" window, enter the bay indication,

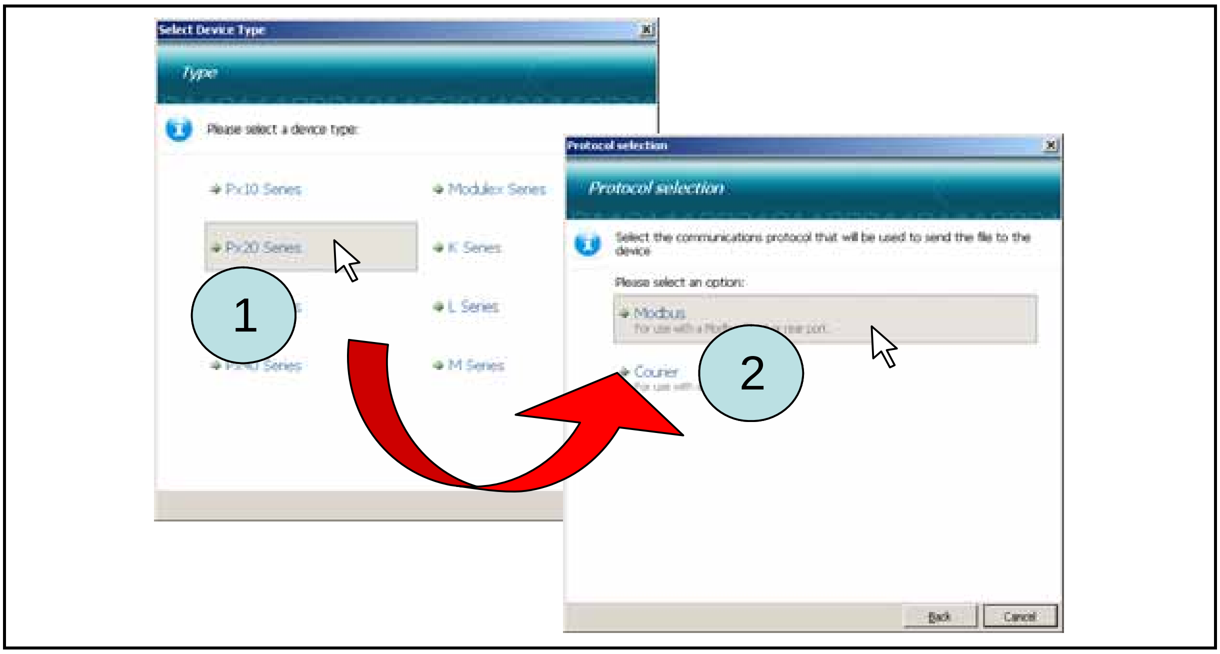
Th new bay is displayed.



3.5.7 Create a new device

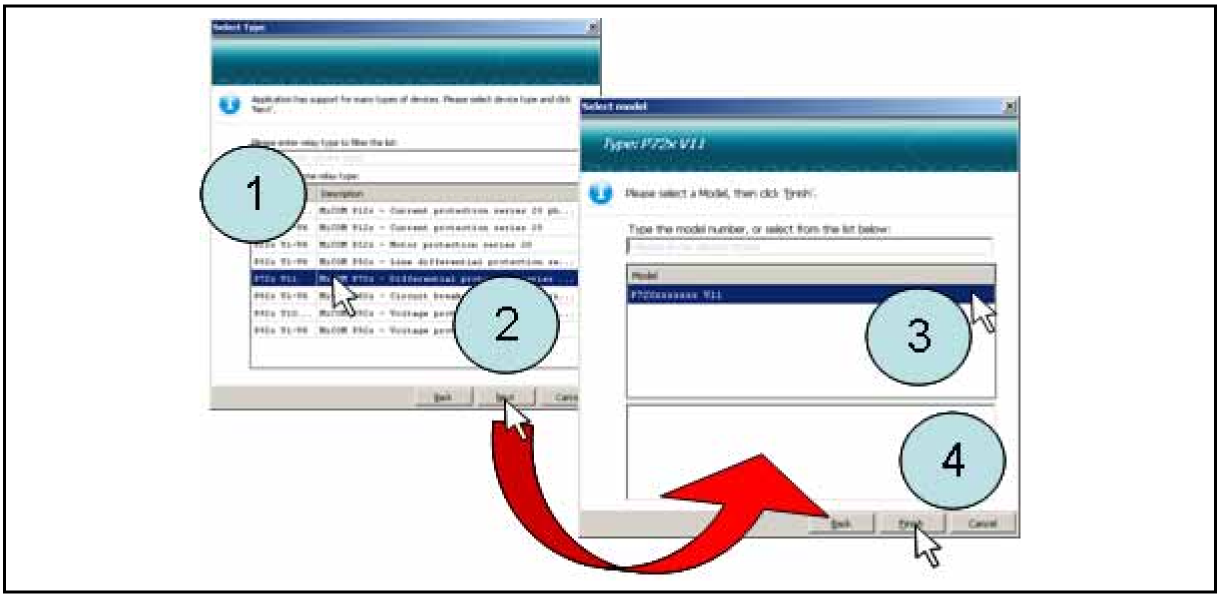
Click on “new device” button (or select the menu using right-click).

Select the device type and, if necessary, the communications protocole mode that will be used to send the file to the device.

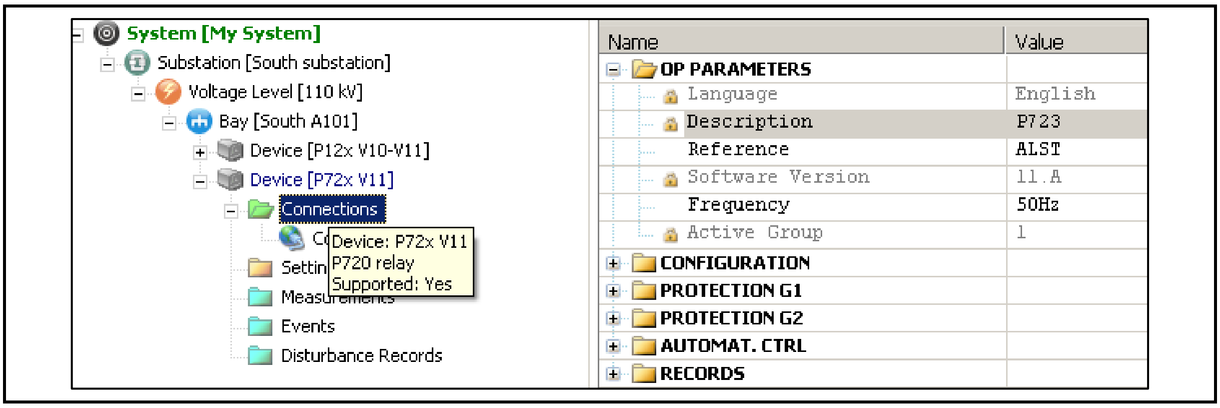


Select the device type, click “next” button.

Select the model and click “next” button.



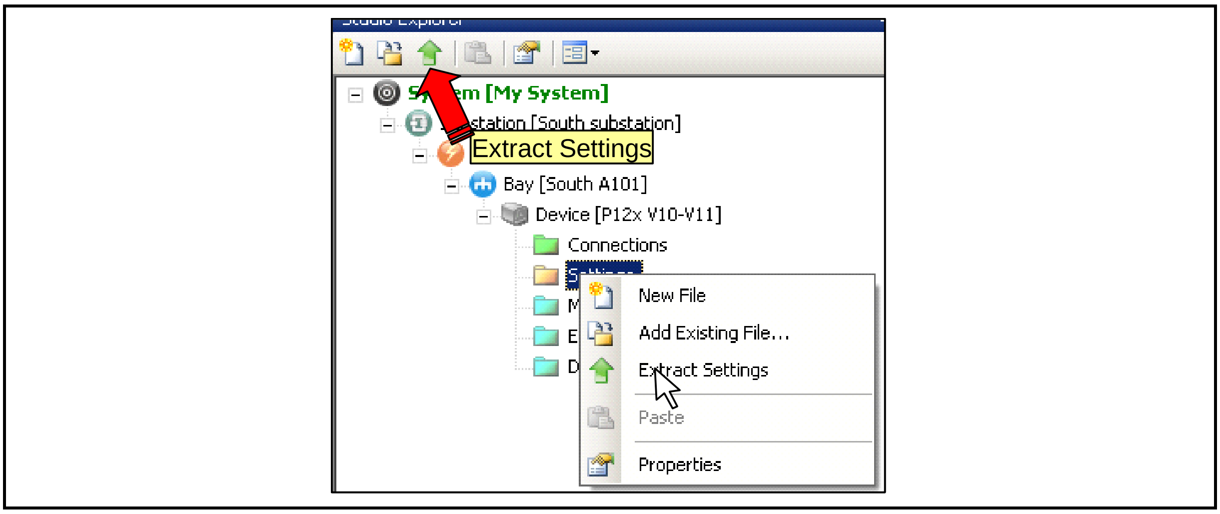
The new device is created and displayed. If necessary, select the MiCOM P72x model using the “OP PARAMETERS/Description” menu.



3.5.8 Open Settings File

To open an existing file:

- If the file is saved or if the relay is not connected: open the Settings folder and open the Settings file,
- If the relay is connected, extract the settings from the relay: click on the “Extract Settings” command or right click on the Settings folder

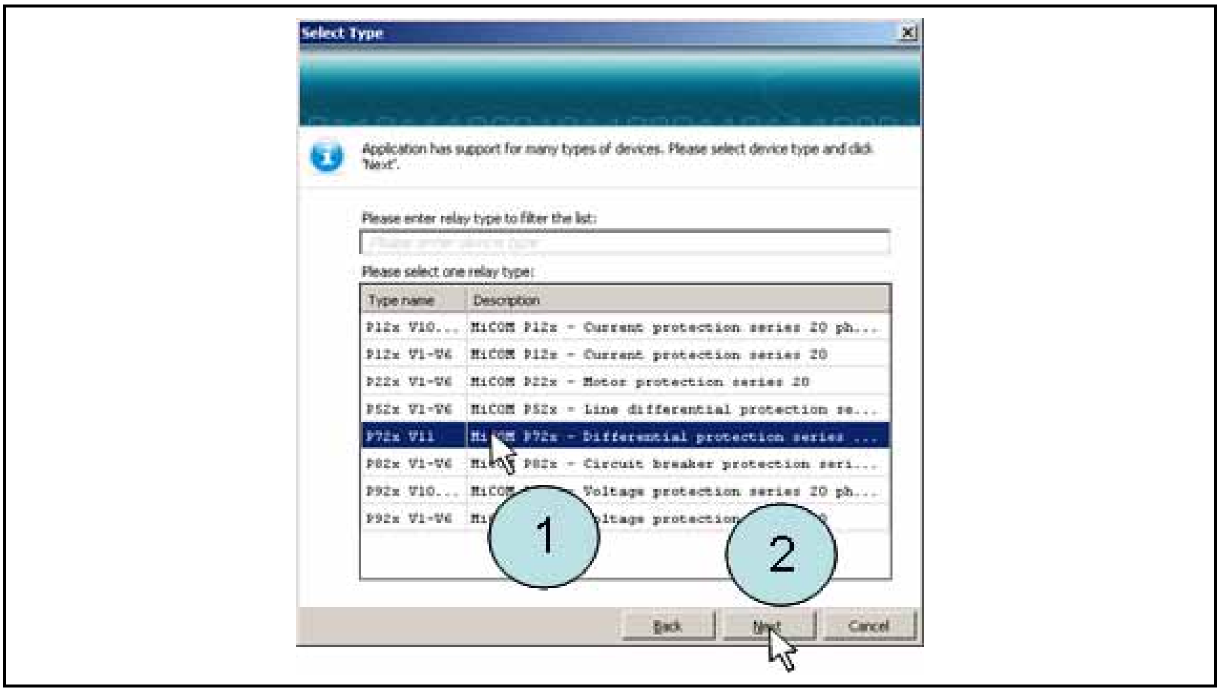


To open default settings:

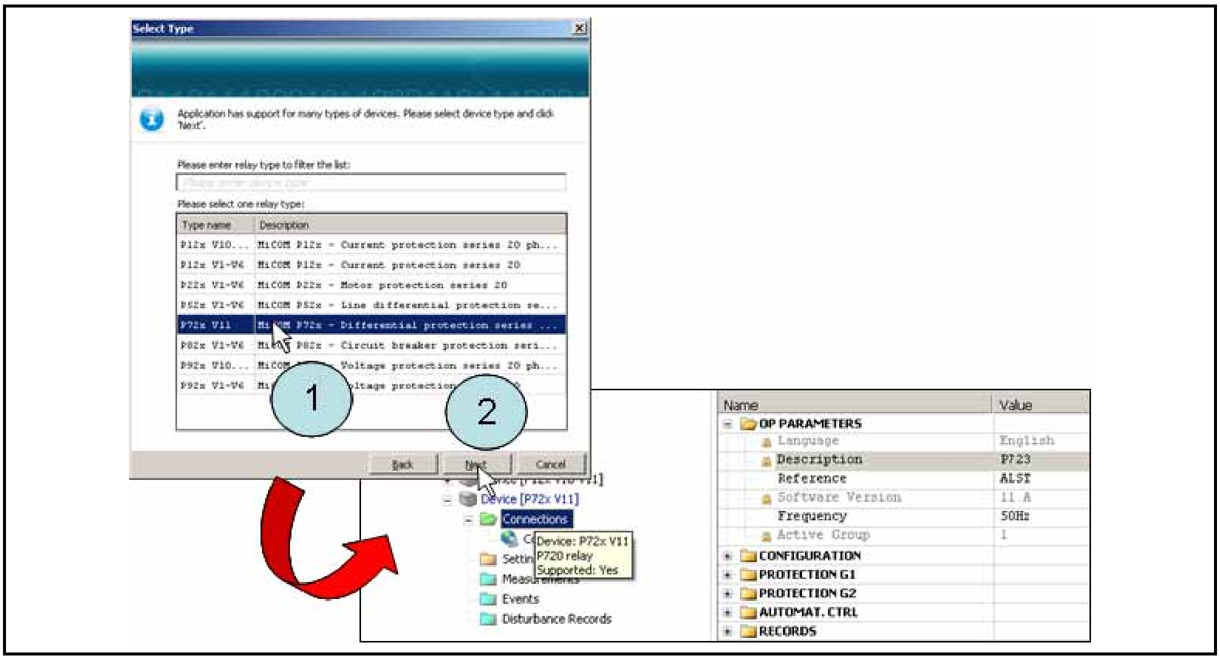
– Click on "Open Default Settings File" Option in the File menu.

– Select the device type then the communication protocol.

– Select the device type and click on the "Next" button:



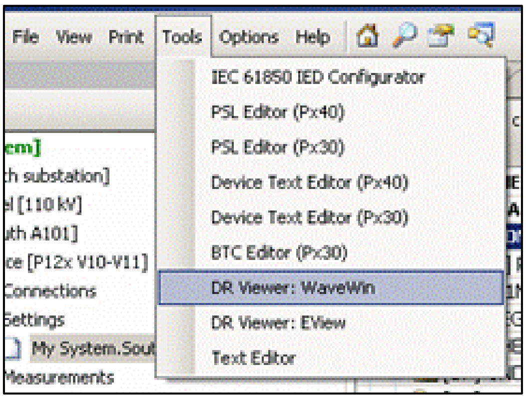
– Select the Model and click on the "Finish" button. The default settings are displayed.



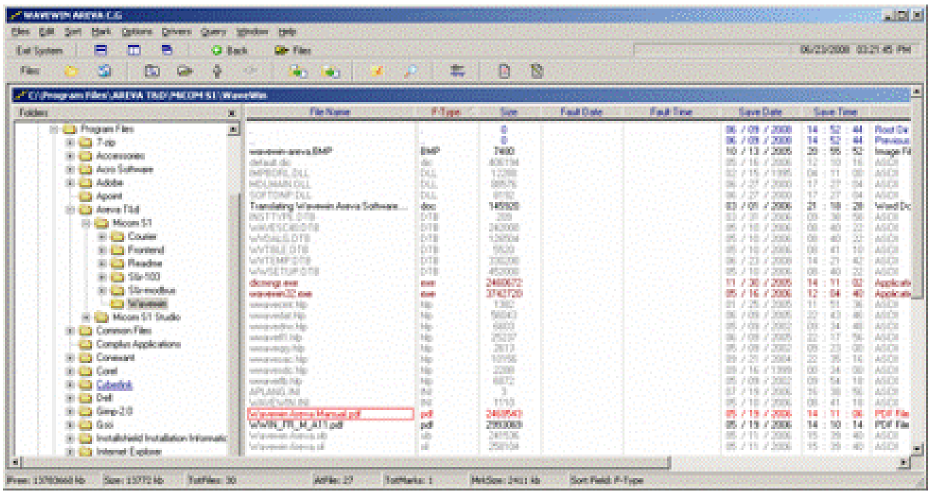
3.6 Presentation and analysis od disturbance

The reading and analisys of disturbance is performed using Wavewin.

To open Wavewin using “Tools” menu (MiCOM S1 Studio).



The Wavewin File Manager is displayed (refer to the Wavewin User’s guide to operate Wavewin).

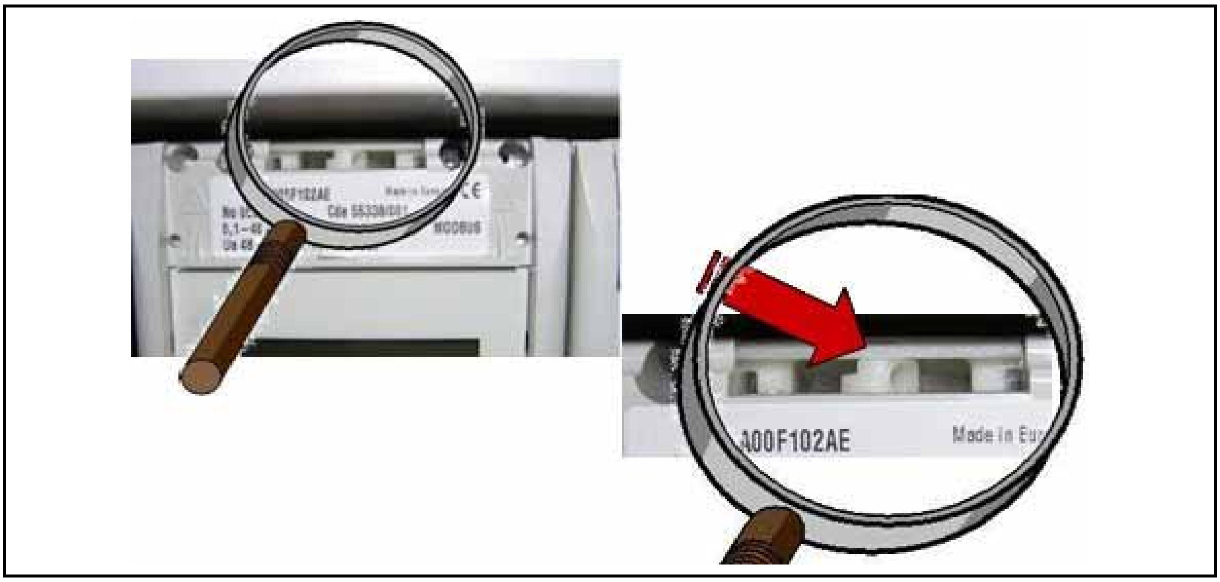


4. WITHDRAWING MODULE FROM CASE

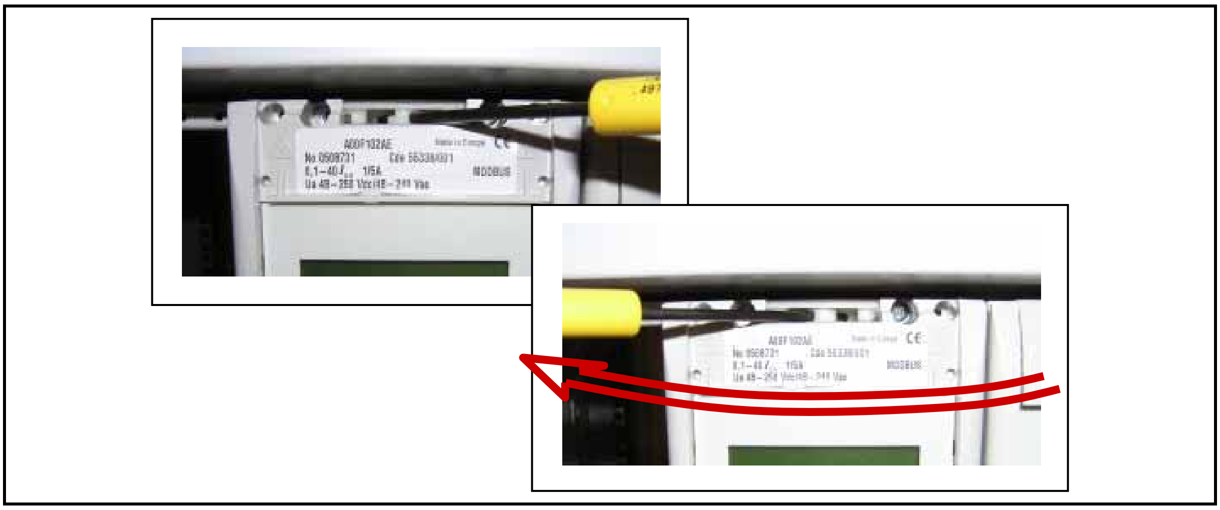
Remove the top and bottom hinged covers:

Depose the four retaining screws in the top and the bottom side of the relay. These screws retain the relay to the case.

Insert a 3mm screwdriver into the hole situated under the upper hinged cover above the LCD:



Turn the lock pin 90° to the left:



Insert the screwdriver into the second hole under the lower hinged cover, and the lower lock pin is turned 90° to the right.

By this turning action, push slightly forward the module and extract it by pulling on both sides of the front panel.

5. COMPANY CONTACT INFORMATION

If you need information pertaining to the operation of this MiCOM product that you have purchased, please contact your local Schneider Electric agent or the Customer Care Center (www.schneider-electric.com/ccc). Do not forget to give the serial number and reference of the MiCOM product.

The MiCOM product reference and serial numbers are documented under the upper hinged cover on the front of the relay. For more precise information, refer to the section "Relay Identification" in this chapter.

PLEASE GIVE THE FOLLOWING DATA WHEN MAKING A CALL TO SCHNEIDER ELECTRIC:

– CORTEC code of the MiCOM relay

– Serial number of the MiCOM relay

– Order reference

– Operator reference

APPLICATION GUIDE

CONTENTS

1.	**INTRODUCTION**	**3**
1.1	**P72x High Impedance Differential Relay**	**3**
1.2	**Busbar Protection**	**3**
1.3	**Reactor Protection**	**3**
1.4	**Transformer Protection**	**4**
1.5	**Generator/Motor Protection**	**4**
2.	**BUSBAR CONFIGURATIONS**	**5**
2.1	**Single busbar**	**5**
2.2	**Double busbar with transfer**	**5**
2.3	**Triple busbar**	**6**
2.4	**Mesh Busbar Scheme**	**7**
2.5	**One and a Half Breaker Scheme**	**8**
2.6	**High Impedance Differential Protection**	**9**
2.6.1	Use of non-linear resistors	13
2.7	**Current distribution - internal and external faults**	**15**
3.	**APPLYING THE MiCOM P72X**	**17**
3.1	**Single phase applications: restricted earth fault and balanced earth fault protection**	**17**
3.2	**Three phase applications**	**20**
3.3	**Buswire supervision**	**23**
3.4	**Circuit breaker failure**	**28**
4.	**SETTING EXAMPLES**	**29**
4.1	**Restricted earth fault application**	**29**
4.1.1	Example 1	29
4.1.2	Example 2	33
4.2	**Busbar applications**	**37**
4.2.1	Stability voltage calculation	39
4.2.2	Current transformers	40
4.2.3	Discriminating zone - Primary operating current	40
4.2.4	Check zone - Primary operating current calculation	41
4.2.5	Stabilizing resistor calculation	41
4.2.6	Non-linear resistor	42
4.2.7	Busbar supervision	42
4.2.8	Relay Settings	43
4.3	**Motor / generator applications**	**44**

5. SETTING GROUP SELECTION (P721 & P723 ONLY) 45

5.1 Change of setting group done by a digital input 45

5.2 Switch between active groups 45

5.3 Priority 46

6. MAINTENANCE MODE 47

7. LOGIC EQUATIONS (P721 & P723) 47

8. REAL TIME CLOCK SYNCHRONIZATION VIA OPTO-INPUTS 47

9. EVENT RECORDS 48

10. FAULT RECORDS 48

11. INSTANTANEOUS RECORDER 48

12. DISTURBANCE RECORDER 48

13. CT REQUIREMENTS 49

13.1 Restricted earth fault/Balanced earth fault (REF/BEF) applications 50

13.2 Busbar application 51

1. INTRODUCTION

1.1 P72x High Impedance Differential Relay

The P72x relay, used with a stabilizing resistor, is designed for applications where sensitive settings and stability on heavy through faults are required. It is recommended for balanced and restricted earth fault schemes, bus-zone and certain forms of differential protection for generators, auto-transformers, reactors and motors.

The sampling rate of the P72x is 32 samples per cycle. A Measurement Filter setting is available in the P72x, so that the relay may operate in three different modes. The first one is the Fourier mode, the relay is tuned to the supply frequency, and the harmonics and DC component produced by current transformer saturation are filtered. The second option is Sample mode. This mode is based on the peak to peak measurement of the differential current. A fault is detected when $\frac{I_{diff_{peak-peak}}}{2 \times \sqrt{2}} > \text{setting}$. Finally, the relay may be set to Fast sample mode, and a fault is detected when $I_{diff_{instantaneous}} > 2 \times \sqrt{2} \times \text{setting}$. In Fast sample mode a trip is issued if four consecutive differential current samples are above $2 \times \sqrt{2} \times \text{setting}$ in one half cycle.

1.2 Busbar Protection

Busbar protection must be completely reliable since the protection may only be called to operate once or twice in the life of the installation. Failure to operate under fault conditions is unacceptable because the damage that results from an uncleared fault may be extensive, for example, the loss of the station by fire. In addition, the protection must be high speed in operation to minimize damage and maintain system stability. It must also be absolutely stable under all through fault conditions because failure to stabilize would cause unnecessary widespread interruption of supply.

If the busbar is subdivided into sections, each of which is separately protected, a fault in one section does not involve the tripping of the complete busbar. Therefore, the protection must discriminate between sections of the busbars so that the minimum number of circuit breakers is tripped to isolate the fault.

The following are commonly used busbar protections:

- Frame to earth (leakage) protection
- Differential protection
- Directional comparison (blocking schemes) protection

The P72x relays operate on the high impedance principle. Therefore, the application of high impedance busbar protection in different busbar arrangements is considered in the following sections.

The high impedance differential scheme is simple and fast, but it requires good CT inputs with well matched ratios and high CT kneepoints. At 5In the typical operating times when the P72x is used in REF/BEF applications is 40 ms for Fourier, 34 ms for Fast and 52 ms for Sample. At 5In the typical operating times when the P72x is used in busbar applications is 18 ms for Fourier, 18 ms for Fast and 38 ms for Sample.

1.3 Reactor Protection

To calculate the stability voltage when protecting a reactor with a high impedance scheme, it should be noted that the external fault current contribution from the reactor is much smaller than the internal fault current. Therefore, the reactor inrush current should be used in stability calculations instead of the external fault current.

1.4 Transformer Protection

The P72x can be applied as a high impedance REF to protect the transformer windings. In a star-connected winding, particularly when the neutral is grounded through an impedance, the degree of protection is improved when a high impedance REF is applied.

The [87N] Threshold I Diff should be set such that the primary operating current is 10-60% of the winding rated current when solidly earthed and 10-25% of the minimum earth fault current for a fault at the transformer terminals when resistance earthed.

1.5 Generator/Motor Protection

The same calculation principles that apply for the three phase protection of busbars can be applied to motors and generators, although special consideration of the fault current will be required for stability calculations. For these applications, the machine contribution to an external fault should be used in the stability voltage calculation and this can be significantly lower than the maximum internal fault current that should be used in the non-linear resistor calculation. For motors the starting current or locked rotor current value is usually used in the stability calculation and this will lead to relatively small CT requirements. Often the most sensitive relay settings are used and buswire supervision is rarely applied.

2. BUSBAR CONFIGURATIONS

There are several busbar arrangements depending on the economics and flexibility of system operation. In addition to plain single and double busbar schemes, the following are some other popular arrangements. The following figures show the zone of protection of several busbar arrangements.

2.1 Single busbar

The single bus, single breaker bus arrangement is the most simple, economical and basic. It is widely used in distribution and low transmission voltages. As shown in FIGURE 1, this arrangement provides no operating flexibility. All the breakers must trip for any busbar fault.

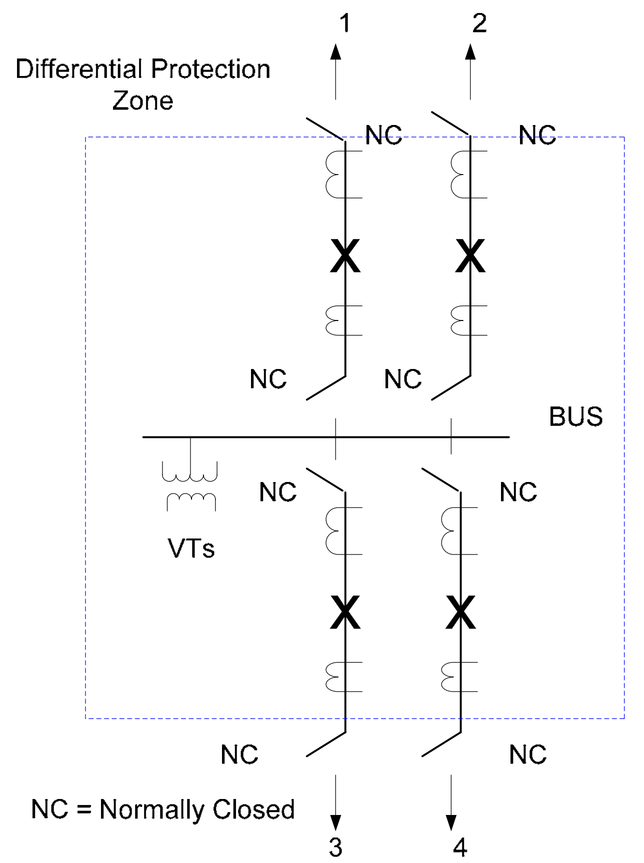


FIGURE 1: SINGLE BUSBAR ARRANGEMENT

2.2 Double busbar with transfer

With this double busbar variation, each feeder has isolators to enable switching to main or reverse/transfer bars, and an additional isolator to enable the feeder breaker to be bypassed. The reverse bar may then function also as a transfer bar and the bus coupler breaker takes over the function of the feeder breaker to free it for maintenance.

To apply discriminative busbar protection, suitable auxiliary switches are required on each isolator to select the CTs for the correct zone, and the trip circuits to the appropriate relays.

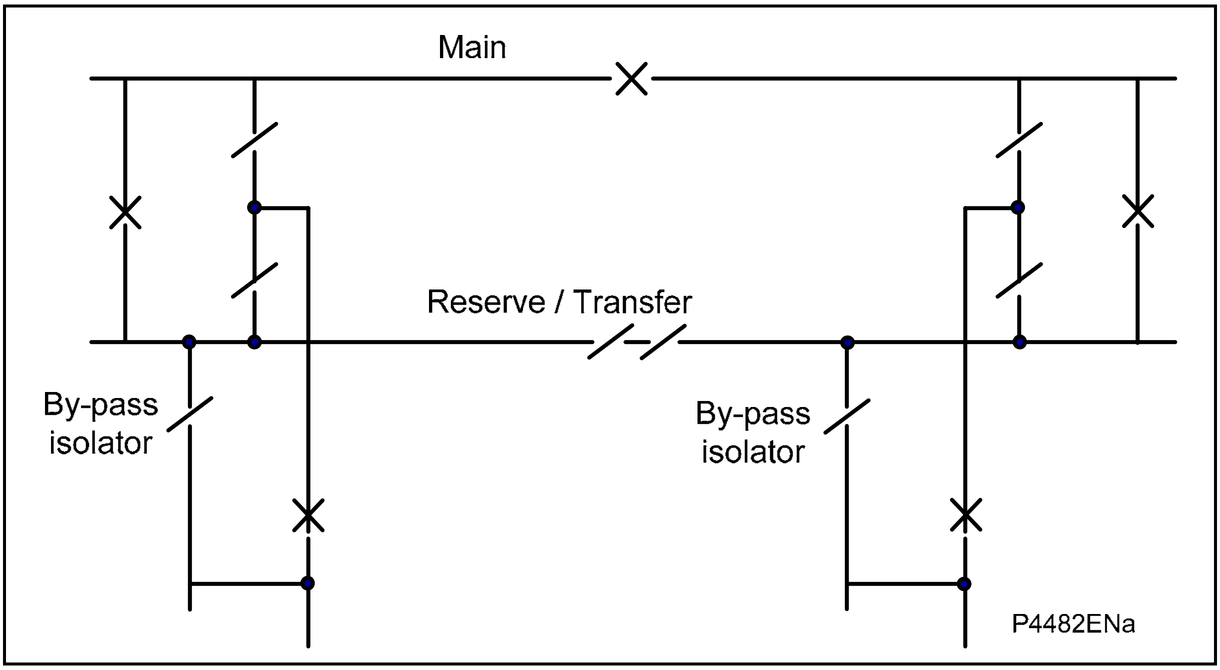


FIGURE 2: DOUBLE BUSBAR WITH TRANSFER

2.3 Triple busbar

This is a double busbar scheme with a third, transfer busbar.

Under normal conditions all bus section and bus coupler breakers are closed. During maintenance of a feeder breaker, the transfer bus is energized from the selected main or reserve bus by the transfer breaker and the feeder bypass isolator closed on the transfer bar. In this situation all bus section and bus coupler breakers remain closed. For busbar protection, isolator auxiliary switches are required.

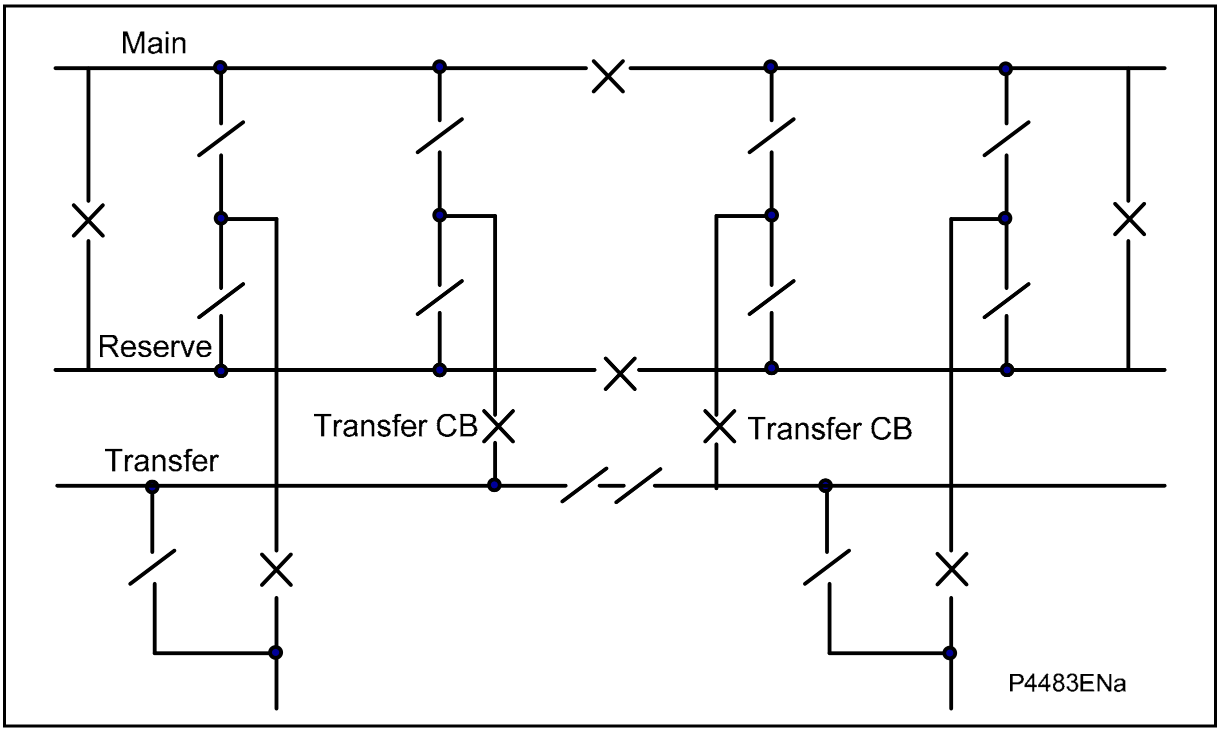


FIGURE 3: TRIPLE BUSBAR

2.4 Mesh Busbar Scheme

The mesh busbar scheme is frequently used for EHV busbar configurations. A transformer and a feeder are linked at each corner of the mesh and four circuit breakers used to complete the mesh interconnection.

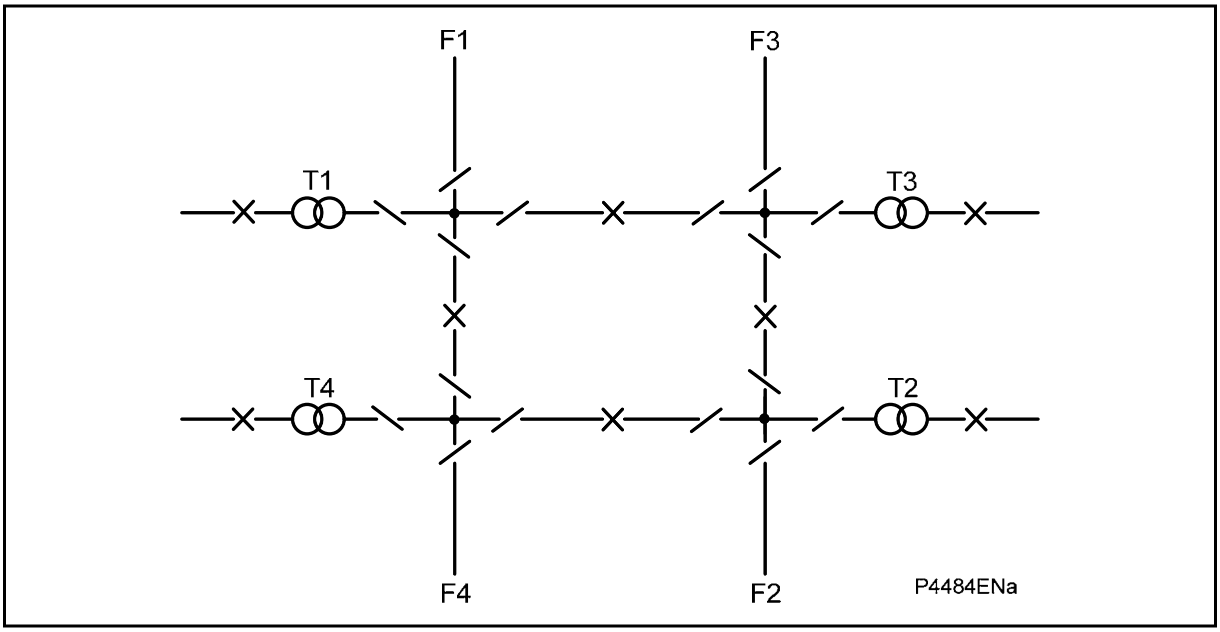


FIGURE 4: MESH BUSBAR SCHEME

The protection shown consists of a fully discriminative scheme with a relay at each corner. A fault at any corner trips the two breakers associated with that corner and also initiates any intertripping necessary to open circuit breakers at remote ends.

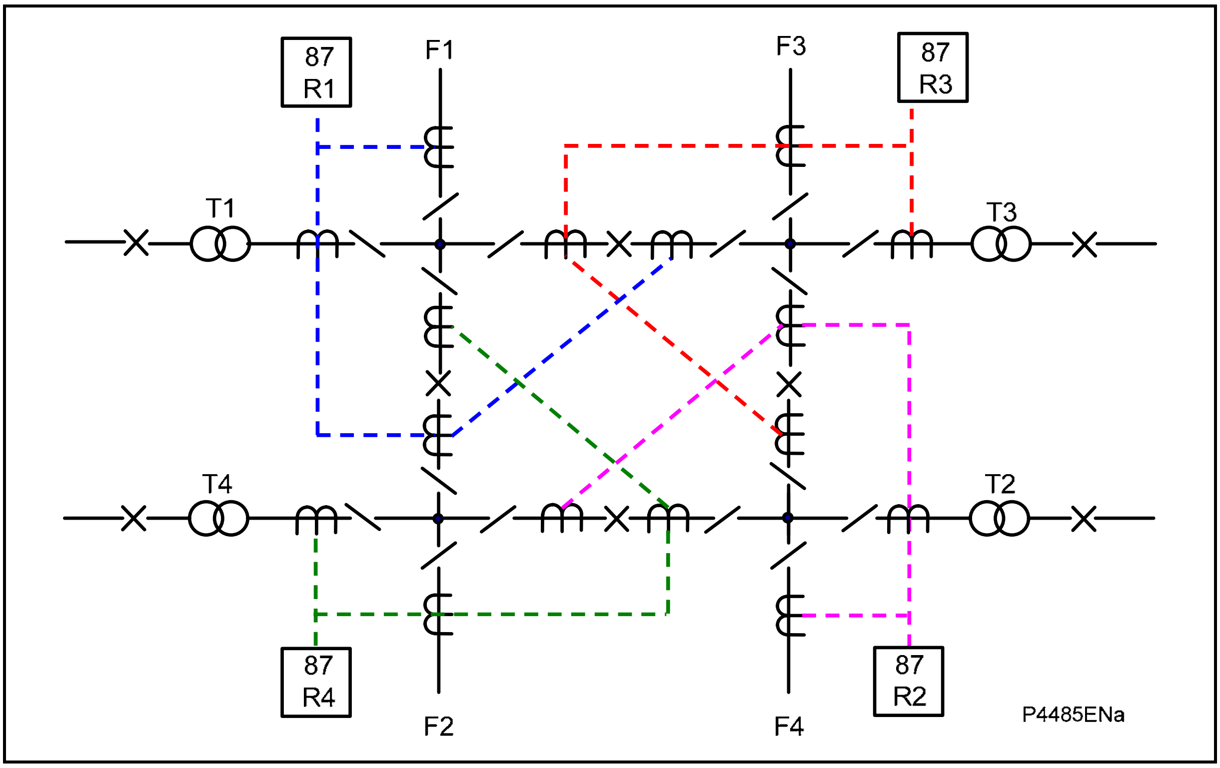


FIGURE 5: MESH BUSBAR - DIFFERENTIAL PROTECTION ZONE

2.5 One and a Half Breaker Scheme

Under normal conditions all breakers are closed. During maintenance of a feeder breaker, only that breaker would be kept open.

During maintenance of a busbar, all the breakers connected to that busbar would remain open to isolate that busbar.

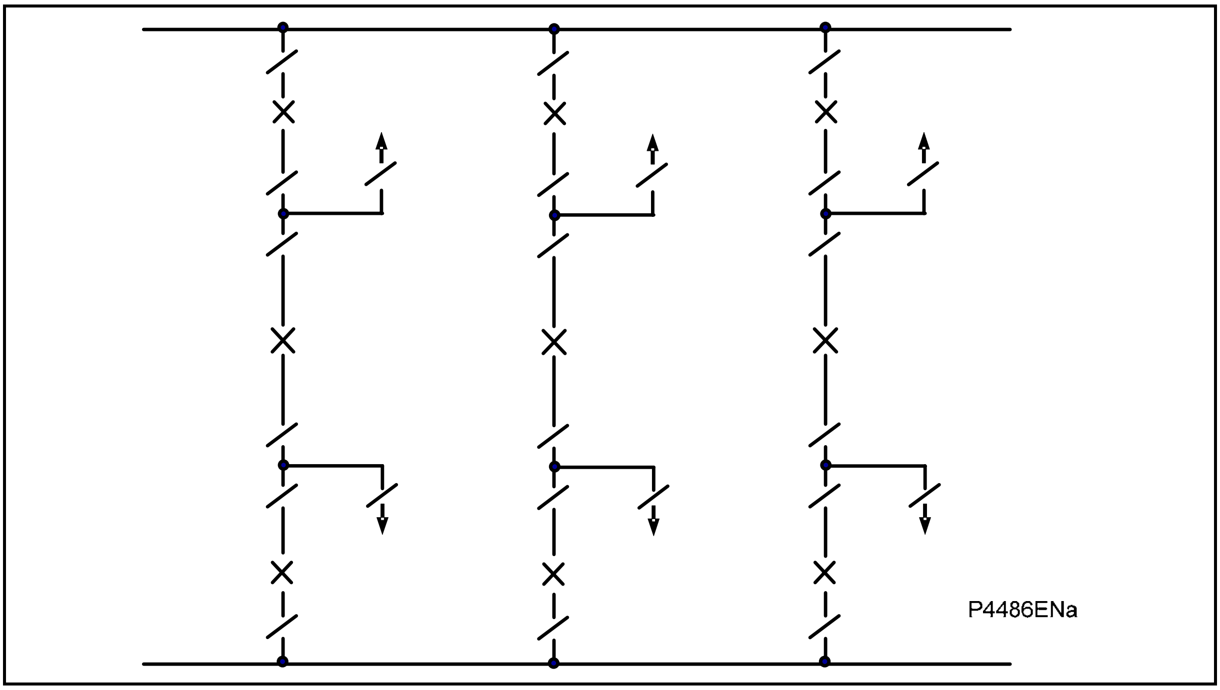


FIGURE 6: ONE AND A HALF BREAKER SCHEME

A single busbar scheme is applied to each busbar. The protection scheme does not require isolator auxiliaries for CT zone selection or in the tripping circuits. The breaker and a half scheme is popular because it is very simple and flexible in operation.

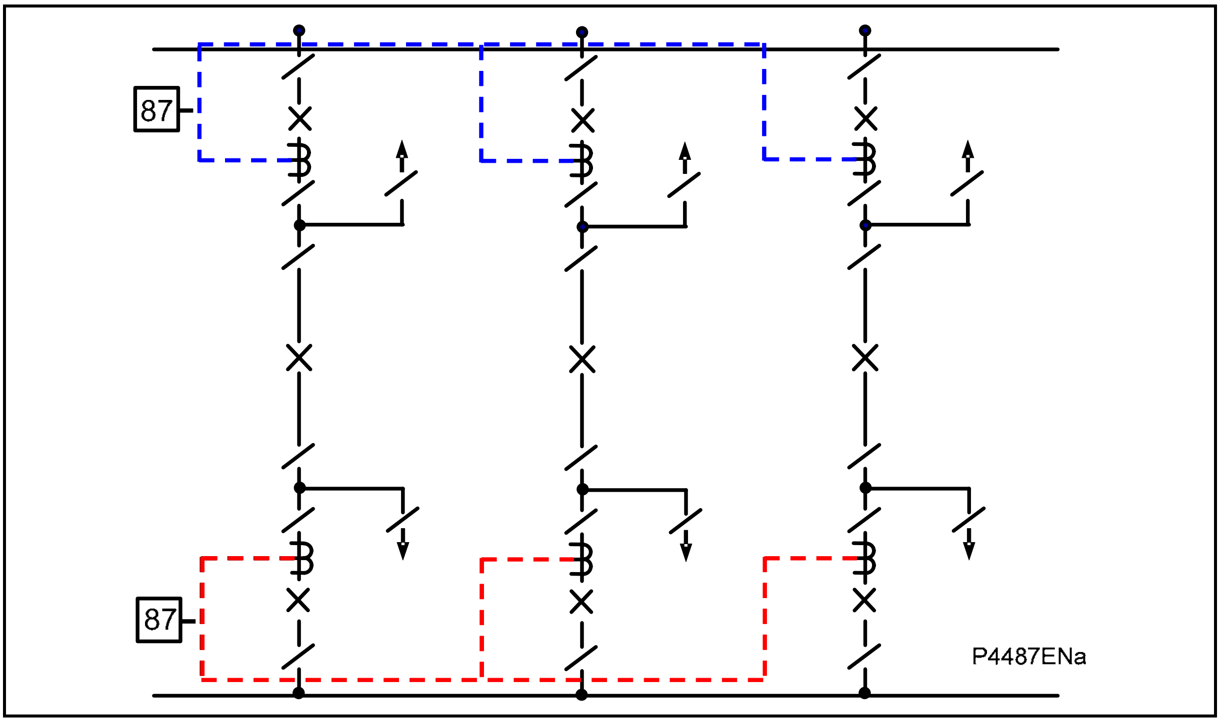


FIGURE 7: ONE AND A HALF BREAKER SCHEME – DIFFERENTIAL PROTECTION ZONE

2.6 High Impedance Differential Protection

The application of the MiCOM P72x to the protection of machines, power transformers and busbar installations is based on the high impedance differential principle. The P72x offers stability for any type of fault occurring outside the protected zone and satisfactory operation for faults within the zone.

Although the P72x only has current inputs to be used in a high impedance scheme, the Input Selection setting under CONFIGURATION/CONNECTION may be Voltage or Current. When set to Current, the **Threshold I Diff** parameter should be set. When the Input Selection is Voltage, the **Threshold V Diff** parameter should be set in addition to the **Stabilizing Resistor**. This is because the relay calculates the **Threshold I Diff** parameter as Threshold V Diff/Stabilizing Resistor.

In a high impedance differential scheme, the currents entering and leaving the protected zone are compared continuously. The CTs are also loaded with a high impedance to force the error differential current (due to CT saturation and CT errors) through the CTs instead of the current input in the P72x. Stability should be maintained during external faults with only one CT heavily saturated (this is the worst condition). In a high impedance relay the voltage setting is greater than the calculated maximum voltage that can appear across the high impedance path under the assigned maximum through fault current condition multiplied by a K factor. This K factor is indicated in the CT requirement tests results. The objective is to provide fast operation at a low fault setting on internal faults yet retain stability up to the highest possible value of short circuit current on through faults.

FIGURE 8 shows the high impedance differential principle. Current transformers on each side of the protected zone are connected in parallel which will produce a resultant current to operate a relay for internal faults only. Theoretically such a system is unaffected by through faults, but in practice the associated current transformer may not behave ideally when the current exceeds a certain value. Errors in transformation due to saturation of the current transformer cores may be sufficient to cause maloperation if special precautions are not taken. Therefore, to ensure stability for external faults the current through the relay is limited by the insertion of an external resistor in series with the relay. This resistor is known as a stabilizing resistor. The main application consideration with a high impedance scheme is stability for heavy through faults. The stability is determined by the CTs and relay settings which in turn affect the sensitivity of the scheme.

The stability limit of a busbar protection scheme is based on the maximum through fault current. In general this takes the value of the associated switchgear rating irrespective of the existing or anticipated fault levels. The differential relay and stabilizing resistor are connected across the paralleled CTs.

Consider the simple two CT differential circuit shown in FIGURE 8. During an external fault the through fault current should circulate between the current transformer secondaries. The only current that can flow through the relay circuit is that due to any difference in the current transformer outputs for the same primary current. On the other hand, if the right hand side CT fully saturates, Z_{M2} appears as a short circuit. It is considered that CT1 is not saturated and it is delivering its full current output. As a result, the current from CT1 is divided between the high impedance path (relay plus stabilizing resistor) and the saturated CT2. The current flowing through the high impedance path is as follows:

$$I_S = I\frac{(R_{CT} + 2R_L)}{(R_r + R_{ST} + R_{CT} + 2R_L)}$$

Where:

I_S = current flowing in the relay

I = current output from CT1

R_{CT} = Resistance of the current transformer secondary winding.

R_L = Resistance of a single wire from the relay to the CT.

R_r = Relay resistance, which is neglected in the P72x

R_{ST} = Stabilizing resistor

The relay is prevented from unwanted operation because most of the current will flow in the R_{CT} + $2R_L$ loop since $R_{ST} >> R_{CT} + 2R_L$.

A voltage will develop across the relay. This voltage is equal to $I_F \times (2R_L + R_{CT})$. If this voltage is greater than the setting voltage, **Threshold Vdiff**, the relay will operate. This is undesirable. Therefore, this becomes the setting criterion; the relay should be set to a voltage greater than $I_F \times (2R_L + R_{CT})$.

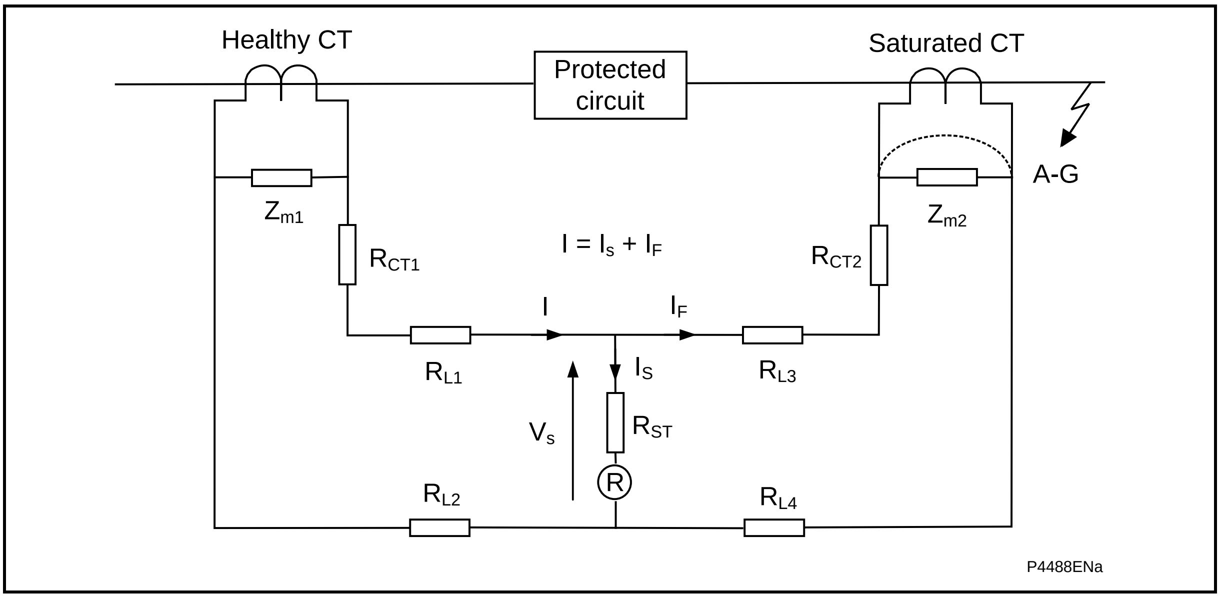


FIGURE 8: HIGH IMPEDANCE DIFFERENTIAL PRINCIPLE

The voltage applied across the high impedance path is:

$$V = I_F \times (R_{CT} + 2R_L)$$

Where:

I_F = Maximum secondary external fault current (it is assumed that $I_S << I_F$)

A stabilizing resistor R_{ST} is used in series with the relay circuit to improve the stability of the relay under external fault conditions. This resistor limits the spill current during the condition described in FIGURE 8.

V_S is the stability voltage. It depends on the relay current setting I_S and the high impedance path resistance:

$$V_S = I_S \times (R_{ST} + R_r)$$

Where:

I_S = relay current setting (corresponds to Threshold I Diff in the P72x)

V_S = stability voltage setting (corresponds to Threshold V Diff in the P72x)

R_{ST} = Stabilizing resistor

R_r = Relay resistance, which is neglected in the P72x

The general stability conditions are obtained when:

$$V_S > K \times I_F \times (R_{CT} + 2R_L)$$

Where:

K = Stability factor which is affected by the characteristic of the differential relay. In the P72x the K factor depends on which Measurement filter is selected (Fourier, Sample or Fast sample modes). In addition, K is also affected by the application; for example, high impedance busbar protection, high impedance REF, etc. K is also influenced by the ratio

V_k/V_s, where V_k is the Knee point voltage of the CT. The K factor is clearly indicated in the CT requirements section at the end of this chapter.

To obtain a high speed operation for internal faults, the Knee point voltage V_k of the CT must be significantly higher than the stability voltage V_s. A ratio of 4 or 5 would be appropriate. The operating times and K factors for $V_K/V_S \leq 16$ are indicated in the CT requirements section at the end of this chapter.

NOTE: The maximum internal fault level for the single phase CT input in the P721 and P723 must not exceed 20In.

The current transformers used in a high impedance scheme should be of equal ratio, of similar magnetizing characteristics and of low reactance construction. In cases where low reactance current transformers are not available and high reactance ones must be used, it is essential to use the reactance of the current transformer in the calculations for the voltage setting. Thus, the current transformer impedance is expressed as a complex number in the form $R_{CT} + jX_{CT}$. It is also necessary to ensure that the exciting impedance of the current transformer is large in comparison with its secondary ohmic impedance at the relay setting voltage.

Once the setting is determined, the scheme sensitivity can be calculated by considering the relay operating current reflected to the primary plus the excitation current of the CTs connected in parallel, whether carrying primary current or not.

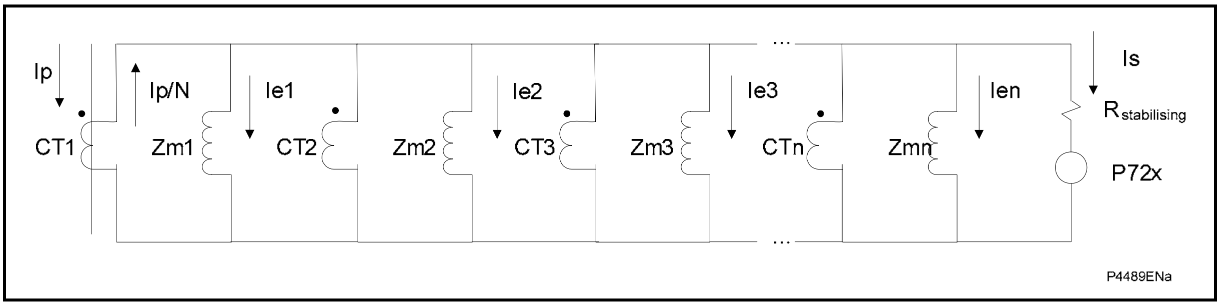


FIGURE 9: HIGH IMPEDANCE DIFFERENTIAL SCHEME SENSITIVITY

The primary operating current for the scheme can be calculated as follows:

$$I_P = N \times (I_S + nI_e)$$

Where:

I_P = Primary operating current

N = CT ratio

I_S = relay operating current at setting

I_e = excitation current at setting voltage (obtained from the CT magnetizing curve). The setting voltage is calculated as V = Is × (R_{ST} + R_r). R_{ST} is the stabilizing resistor and R_r is the relay burden which is neglected in the P72x.

N = number of CTs connected in parallel

If the relay setting voltage is high, the CT magnetizing current at the setting voltage summed for all the CTs can be significant.

In REF/BEF applications, typical setting values are chosen to provide a primary operating current, I_P, at 10 to 25% of the minimum earth fault level for a resistance earthed system. Also in REF/BEF applications, for a solidly earthed system, the typical setting provides a primary operating current of between 10 and 60 % of the winding rated current. In busbar applications it is desirable that the primary operating current does not exceed 30% of the minimum fault level. In busbar applications, it is also common to set the relay so that the primary operating current is 110 to 130% of the maximum feeder circuit loading.

As a result, I_S is calculated as follows:

$$I_S = \frac{I_P}{N} - nI_e$$

The stabilizing resistor is calculated as follows:

$$R_{ST} = \frac{V_S}{I_S} - R_r$$

R_r, the relay resistance, can be neglected in the P72x.

The standard resistors that are supplied for use in the high impedance application are wire-wound, continuously adjustable and have a continuous rating of 145 W based on Schneider Electric conjunctive testing. **These resistors should not be adjusted below 60% of their nominal ohmic value, otherwise there is a risk that the power dissipation during faults will be insufficient.**

The P79x is an integrated stabilizing resistor and varistor unit enclosed in a 20TE case that may be used in high impedance differential schemes. Three options of stabilizing resistances are provided. Each option provides four resistance values that are determined by connection. Schneider Electric has developed a spreadsheet tool to assist in determining which resistance is suitable for a given application. This tool is available on request. **When using the P79x, it is important to limit the power dissipated in the resistance once the differential (87) or the buswire supervision (95) operates. To limit the power dissipation, the contacts configured as Buswire-Short should be wired in parallel to the high impedance path (only the stabilizing resistor in the case of the P72x), as shown in FIGURE 10.** Please refer to the P79x documentation for further information.

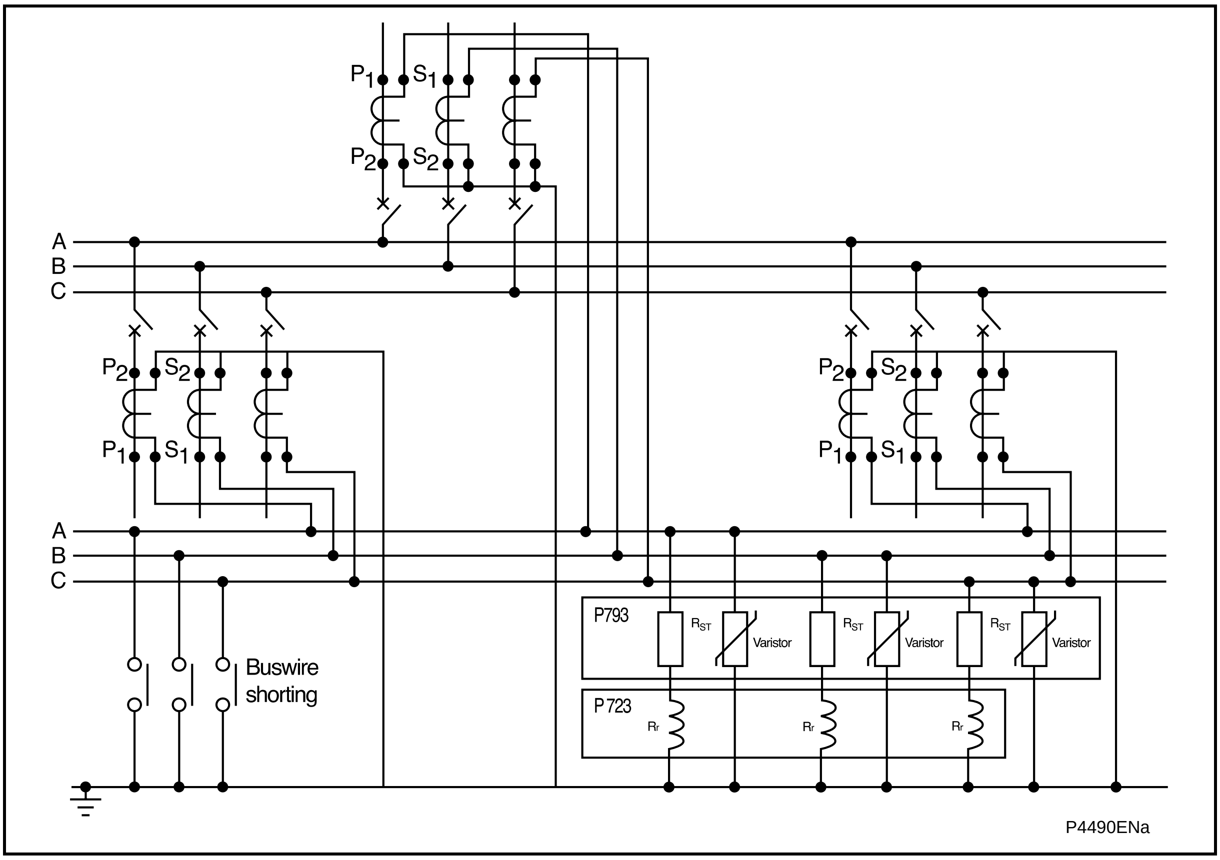


FIGURE 10: BUSWIRE-SHORT CONTACTS TO LIMIT POWER DISSIPATION WHEN USED WITH P79X

2.6.1 Use of non-linear resistors

When the maximum through fault current is limited by the protected circuit impedance, such as in the case of generator differential and power transformer restricted earth fault protection, it is generally unnecessary to use non-linear voltage limiting resistors. However, when the maximum through fault current is high, such as in busbar protection, it is more common to use a non-linear resistor across the high impedance path (relay and stabilizing resistor). Non-linear resistors 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 typically able to withstand approximately 3000 V peak.

The following formulae should be used to estimate the peak transient voltage that could be produced for an internal fault. This voltage is 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.

The internal fault level, I'_F, can be significantly higher than the external fault level, I_F, on generators where current can be fed from the supply system and the generator. Similarly the internal fault level on motors and shunt reactors will be considerably higher than the values used in the stability calculations (motor start/locked rotor and inrush currents respectively).

$$V_P = 2 \times \sqrt{2V_k\left(V_F - V_k\right)}$$

$$V_F = I'_F\left(R_{CT} + 2R_L + R_{ST} + R_r\right)$$

Where:

V_P = peak voltage developed by the CT under internal fault conditions

V_k = current transformer knee-point 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 CT to relay

R_{ST} = relay stabilizing resistor

R_r = relay ohmic impedance at setting

When the value of V_P is greater than 3000 V peak, non-linear resistors should be applied. They are effectively connected across the relay circuit, or phase to neutral of the ac buswires, and shunt the secondary current output of the current transformer from the relay circuit to prevent very high secondary voltages.

Traditionally, Schneider Electric recommends the use of non-linear resistors manufactured by Metrosil. They are externally mounted and take the form of annular discs, of 152 mm diameter and approximately 10 mm thickness. 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 is as follows:

$$I_{RMS} = 0.52\left(\frac{V_{RMS}\sqrt{2}}{C}\right)^{4}$$

Where:

VRMS = 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), the current through the nonlinear resistor at the relay voltage setting should be as low as possible but no greater than approximately 30 mA rms for 1 A CTs and approximately 100 mA rms for 5 A CTs.

2.6.1.1 Metrosil units for relays with 1 A CT

The Metrosil units with 1 A CTs have been designed to comply with the following restrictions:

- At the relay voltage setting, the Metrosil current should be less than 30 mA rms.
- 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 to be used with 1 A CTs are shown in the following table:

Relay Voltage setting	Nominal Characteristics		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	600A/S1/S256 600A/S1/S1088	600A/S3/1/S802 600A/S3/1/S1195

NOTE: Single pole Relay Metrosil Units are normally supplied without mounting brackets unless otherwise specified by the customer.

2.6.1.2 Metrosil units for relays with 5 A CT

These Metrosil units have been designed to comply with the following requirements:

- At the relay voltage setting, the Metrosil current should be less than 100 mA rms. The actual maximum currents passed by the units are shown in the following table, 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 seconds. At the higher relay settings, it is not possible to limit the fault voltage to 1500 V rms, hence higher voltages have to be tolerated (indicated by *, **, ***).

The Metrosil units normally recommended for use with 5 A CTs and single pole relays are shown in the following table:

Secondary Internal fault current	Recommended Metrosil Type			
	Relay Voltage Setting			
Amps rms 50 A	Up to 200 V rms 600A/S1/S1213 C= 540/640 35 mA rms	250 V rms 600A/S1/S1214 C= 670/800 40 mA rms	275 V rms 600A/S1/S1214 C= 670/800 50 mA rms	300 V rms 600A/S1/S1223 C= 740/870* 50 mA rms
100 A	600A/S2/P/S1217 C= 470/540 35 mA rms	600A/S2/P/S1215 C= 570/670 75 mA rms	600A/S2/P/S1215 C= 570/670 100 mA rms	600A/S2/P/S1196 C= 620/740* 100 mA rms
150 A	600A/S3/P/S1219 C= 430/500 100 mA rms	600A/S3/P/S1220 C= 520/620 100 mA rms	600A/S3/P/S1221 C= 570/670** 100 mA rms	600A/S3/P/S1222 C= 620/740*** 100 mA rms

NOTE: * 2400 V peak
** 2200 V peak
*** 2600 V peak

In some cases, single disc assemblies may be acceptable, contact Schneider Electric detailed information.
The Metrosil units used with 5 A CTs can also be used with 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.

The P79x accessory also has non-linear resistors. Two options are available, the half power non-linear resistor and the full power non-linear resistor. Schneider Electric has developed a spreadsheet tool to assist in determining which option is suitable for a given application. This tool is available on request.

When using the P79x, it is important to limit the power dissipated in the non-linear resistor once the differential (87) or the buswire supervision (95) operates. To limit the power dissipation, the contacts configured as Buswire-Short should be wired in parallel to the stabilizing resistor. Since the P72x represents a low burden, when the Buswire-Short contacts are closed, the non-linear resistors are shorted as shown in FIGURE 10**.** For further information, please refer to the P79x documentation.

2.7 Current distribution - internal and external faults

Consider the current distributions during an external fault in the single busbar diagram shown in FIGURE 11. Three feeders are connected to the busbar. The current flowing through feeder 3 is the summation of the contributions from feeders 1 and 2. To consider the worst case it is assumed that CT3 is completely saturated while CT1 and CT2 are not. Since CT3 is completely saturated, the magnetizing impedance Zm3 is zero and CT3 can produce no output. During an external fault the I1 and I2 flows through R_{CT} and R_L. Where R_{CT} is the current transformer resistive burden, R_L is the lead resistive burden and Z_{m1}, Z_{m2} and Z_{m3} are the current transformer magnetizing branch. Most of I1 + I2 will flow through CT3 and a negligible current may flow through the differential path.

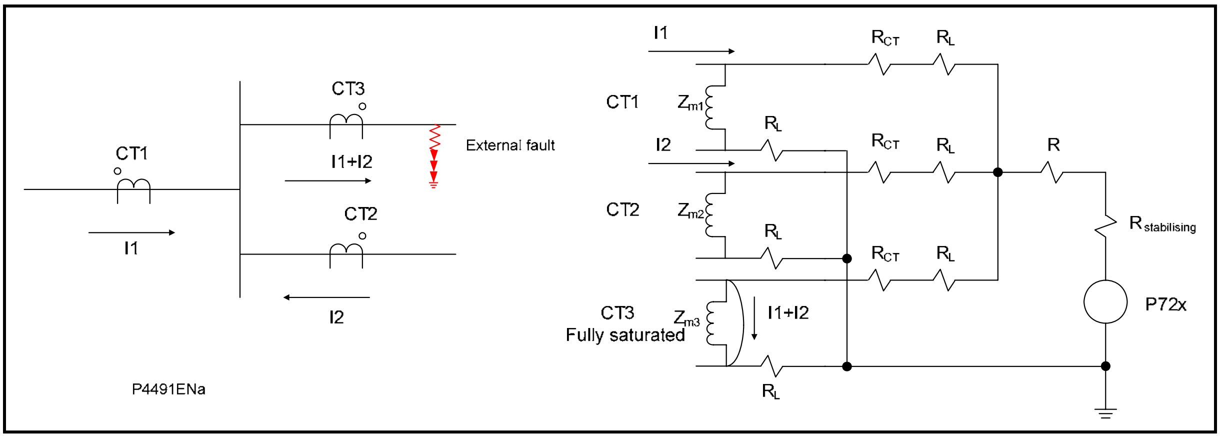


FIGURE 11: EXTERNAL FAULT – SINGLE BUSBAR

Consider the current distributions during an internal fault in the single busbar diagram shown in FIGURE 12. During an internal fault, the high impedance path (stabilizing resistor + relay burden) forces most of the secondary current through the CT magnetizing branch. The voltage developed across the magnetizing branch is very high and it is highly distorted. The peak voltage may be many times the nominal saturation voltage. This voltage is across the high impedance path; therefore enough current flows through the relay to make it trip. If the Measurement Filter is set to Fourier, the P72x would be tuned at the system frequency. Therefore, dc components and harmonics are filtered.

The resistance, R, is much smaller than the stabilizing resistor, R_{ST}; therefore, it can be neglected. Since the P72x burden is also smaller than R_{ST}, it can be neglected.

The high impedance differential scheme requires that R_{CT} + R_L is kept low. To keep R_L as low as possible, it is recommended that the junction point (physical connection of the current transformers secondaries) is as close as possible to the locations of the CTs. The current transformers secondaries should also be equidistant. The CTs should have the same ratio and should operate on the full winding.

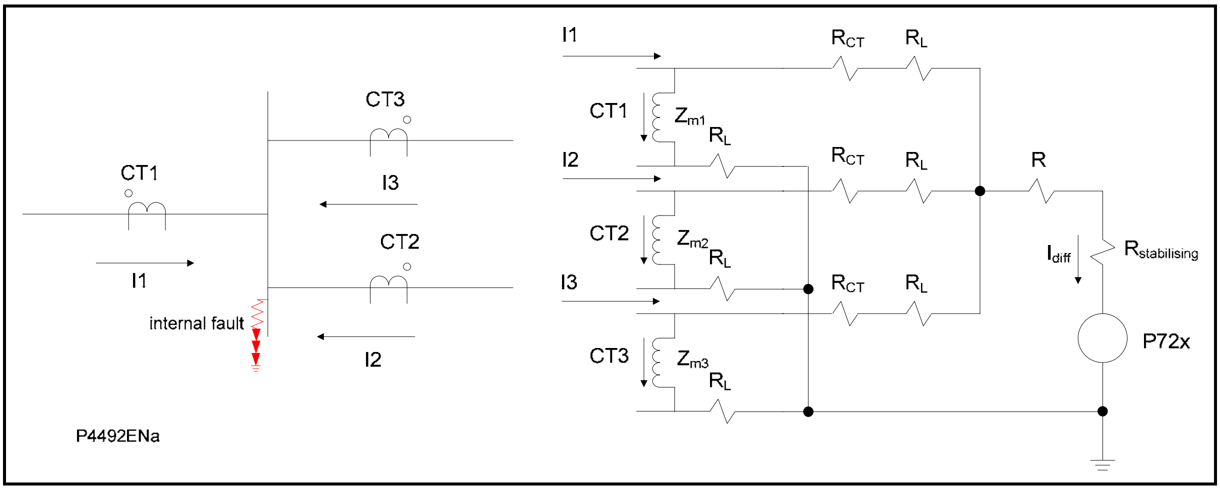


FIGURE 12: INTERNAL FAULT – SINGLE BUSBAR

The connected CTs should be grounded at only one point as shown in FIGURE 11 and FIGURE 12 to avoid improper relay operation and damage to the CT interconnections. If grounds are made at two or more locations, currents may flow in the differential circuit because of differences of potential between the grounding points, due to the flow of large ground currents during ground faults.

The correct practice is to interconnect the neutrals of all differentially connected CTs. The neutral interconnection is grounded at one point only. The grounding is for the protection of personnel, therefore the best place to make the ground is at the differential relay panel.

3. APPLYING THE MICOM P72X

To allocate the chosen protection elements (e.g. Trip [87] tDiff or Trip [87N] tDiff) to the trip relay RL1, select **AUTMAT.CTRL** > **Trip Commands**. Any elements allocated in the trip commands menu will cause RL1 to pulse for 100 ms. To latch the trip output following a protection operation, select **AUTOMAT.CTRL** > **Latch Functions** then select the appropriate protection element (e.g. Trip [87] tDiff or Trip [87N] tDiff).

The setting range of the P72x is as follows:

High impedance phase differential	Input board rating = 0.01 – 8In
Threshold I Diff	0.02 – 2 In
High impedance neutral differential	Input board rating = 0.004 – 2In
Threshold IDiff	0.01 – 1 In

3.1 Single phase applications: restricted earth fault and balanced earth fault protection

The Measurement Filter under [87N] EARTH DIFF. PROTECTION can be set to Fourier, Sample and Fast Sample mode. In general, it is recommended to set the Measurement filter to Fourier as the K factors are low and the operating times are adequate. Typically less than 40ms in REF/BEF applications at 5In and less than 18ms in busbar applications at 5In (three phase fault).

The restricted earth fault relay is a high impedance differential scheme which balances zero sequence current flowing in the transformer neutral against zero sequence current flowing in the transformer phase windings. Any unbalance for an in-zone fault results in an increasing voltage on the CT secondary and thus will activate the REF protection.

The high impedance differential technique ensures that the impedance of the circuit is sufficiently so that the differential voltage which may occur under external fault conditions is lower than the voltage required to drive setting current through the relay. This ensures stability against external fault conditions so the relay will operate only for faults occurring inside the protected zone.

This scheme is very sensitive and can then protect against low levels of fault current in resistance grounded systems where the earthing impedance and the fault voltage limit the fault current. In this application, the **Threshold IDiff** setting should be chosen to provide a primary operating current less than 30% of the minimum earth fault level.

This scheme is very sensitive so can protect against low levels of fault current in resistance grounded systems where the earthing impedance and the fault voltage limit the fault current. In this application, the **Threshold IDiff** setting should be chosen to provide a primary operating current less than 10-25% of the minimum earth fault level.

This scheme can also be used in a solidly grounded system. It provides a more sensitive protection, even though the overall differential scheme provides a protection for faults over most of the windings. In this application, the **Threshold IDiff** setting should be chosen to provide a primary operating current between 10 and 60 % of the rated current.

FIGURE 13 shows the general diagram when the P72x is used in restricted earth fault/balanced earth fault (REF/BEF) applications:

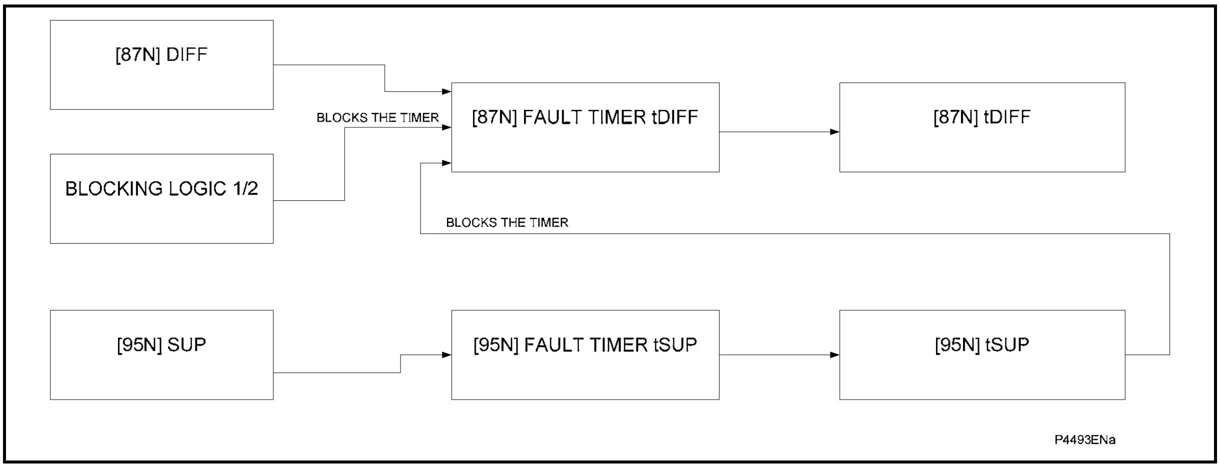


FIGURE 13: REF/BEF APPLICATIONS – P72X GENERAL DIAGRAM

FIGURE 14 to FIGURE 17 show how the P721 is implemented in REF and BEF applications using 1 A connections.

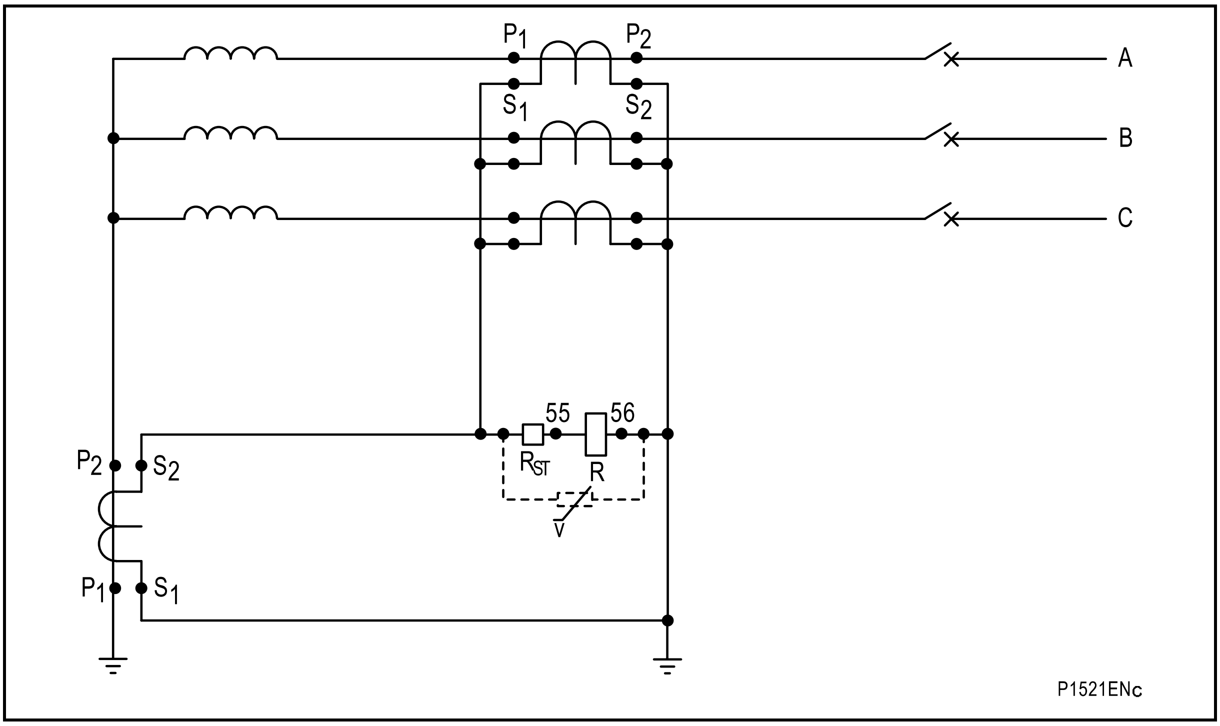


FIGURE 14: RESTRICTED EARTH FAULT PROTECTION OF A 3 PHASE, 3 WIRE SYSTEM APPLICABLE TO STAR CONNECTED GENERATORS OR POWER TRANSFORMER WINDINGS WITH NEUTRAL EARTHED AT THE GENERATOR/TRANSFORMER STARPOINT.

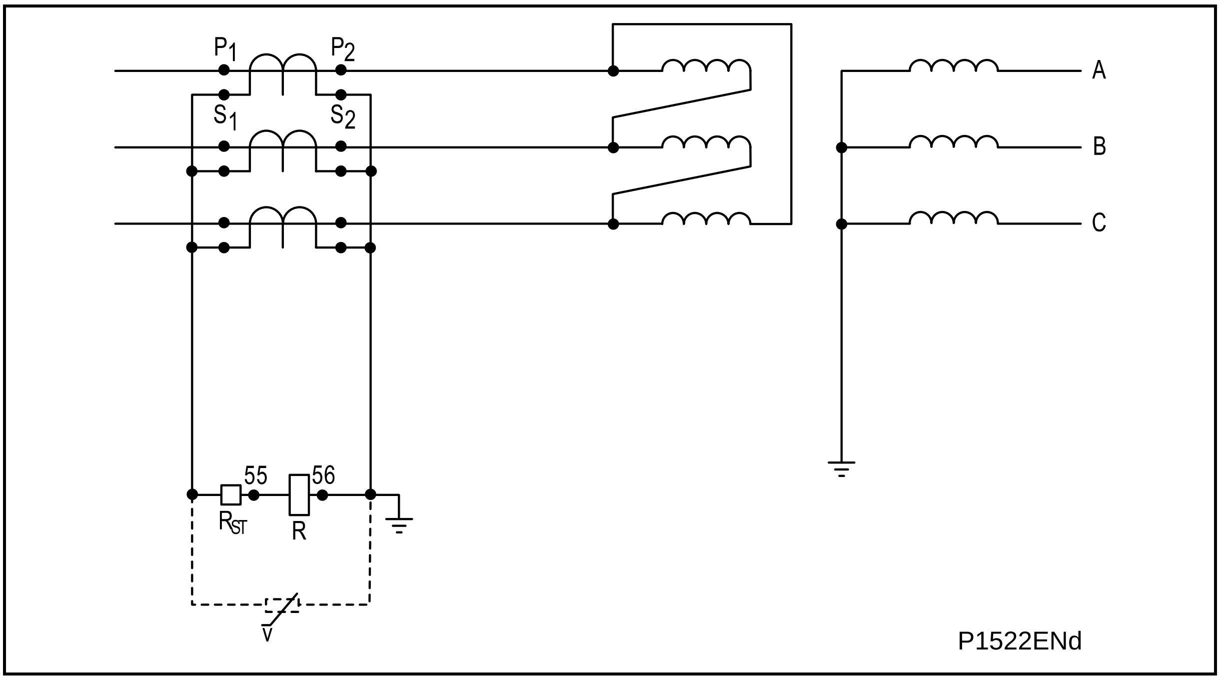


FIGURE 15: BALANCED EARTH FAULT PROTECTION FOR THE DELTA WINDING OF A POWER TRANSFORMER WITH THE SUPPLY SYSTEM EARTHED (1 A CONNECTIONS SHOWN)

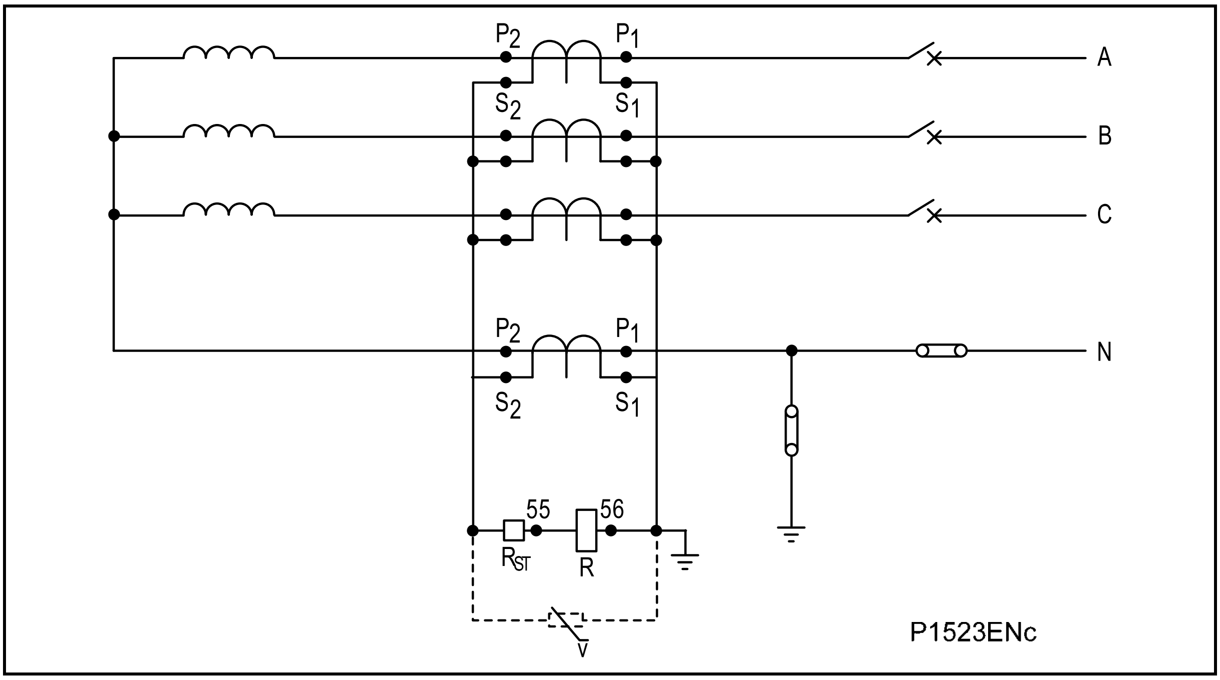


FIGURE 16: RESTRICTED EARTH FAULT PROTECTION OF A 3 PHASE, 4 WIRE SYSTEM APPLICABLE TO STAR CONNECTED GENERATORS OR POWER TRANSFORMER WINDINGS WITH NEUTRAL EARTHED AT THE SWITCHBOARD.

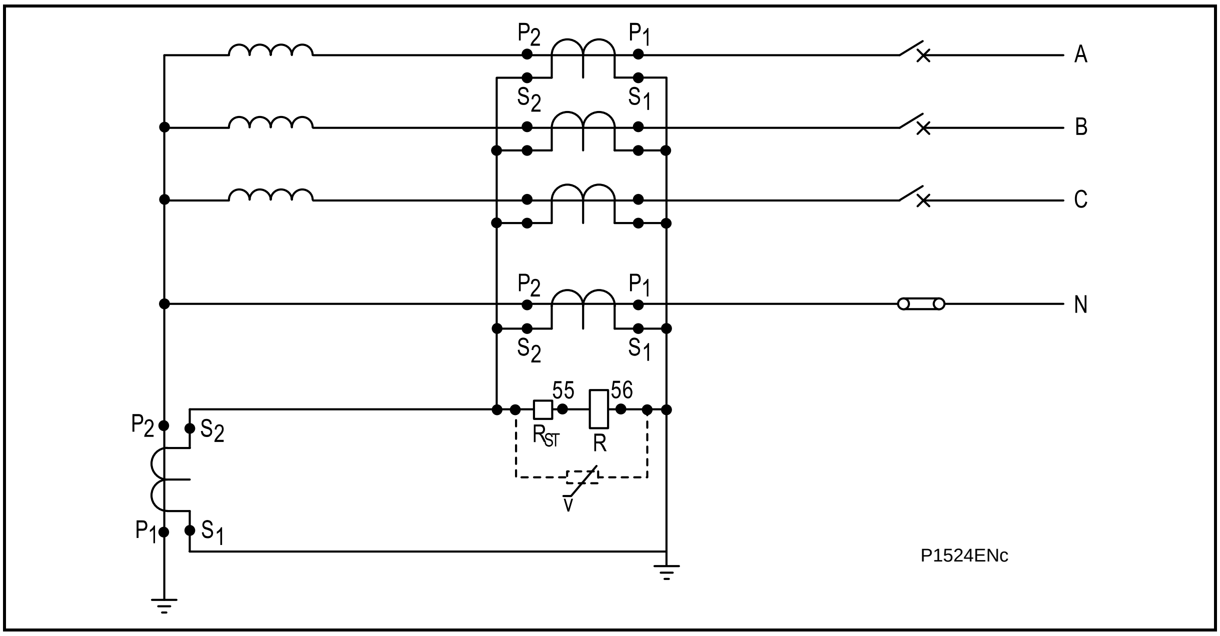


FIGURE 17: RESTRICTED EARTH FAULT PROTECTION OF A 3 PHASE, 4 WIRE SYSTEM APPLICABLE TO STAR CONNECTED GENERATORS OR POWER TRANSFORMER WINDINGS WITH NEUTRAL EARTHED AT THE GENERATOR/TRANSFORMER STARPOINT.

3.2 Three phase applications

For busbar protection, it is considered good practice by some utilities to set the minimum primary operating current in excess of the rated load such that if one of the current transformers becomes open circuit, the high impedance relay does not maloperate. Other utilities prefer to set the relay as sensitive as possible and use a second check relay connected to a separate set of current transformers to provide security against maloperation. It is desirable that the primary operating current does not exceed 30% of the prospective minimum fault current. The primary operating current should also be 110 to 130% the maximum feeder circuit loading.

For generator and motor protection, the relay is generally set as sensitive as possible to maximize fault coverage. In these applications it is important to recognize that the external fault level contribution from the generator or motor may be significantly lower than the internal fault level. The external fault level should be used for the calculation of stability voltage and resistor requirements whereas the internal fault level (that includes system contribution) should be used for non-linear resistor calculations.

FIGURE 18 shows the general diagram when the P72x is used in three phase applications:

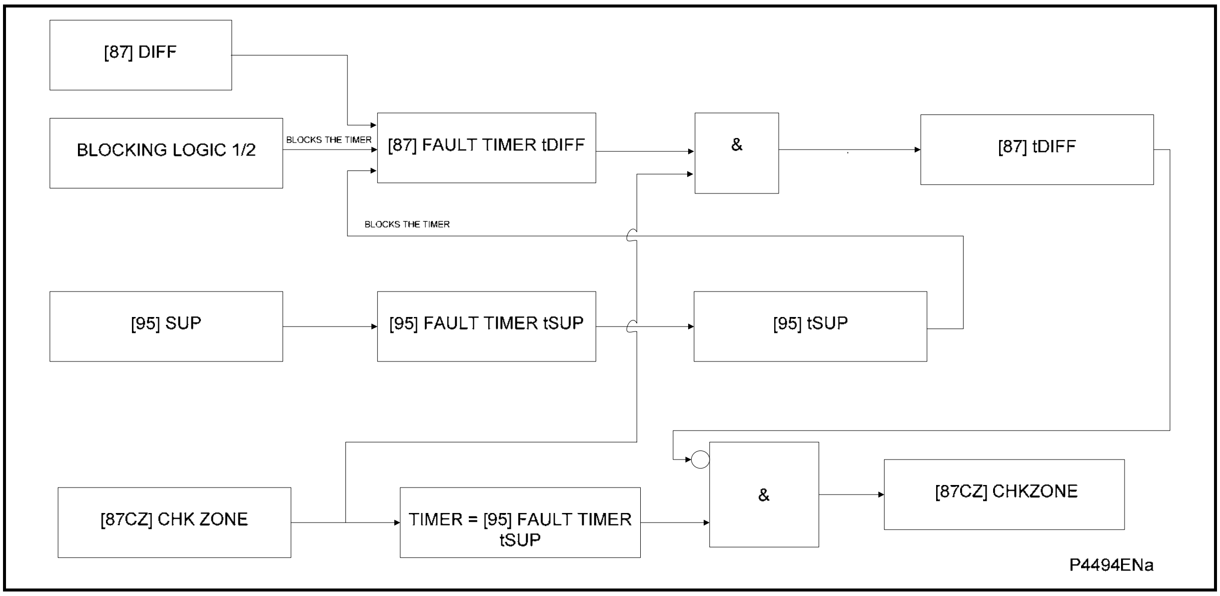


FIGURE 18: THREE PHASE APPLICATIONS – P72X GENERAL DIAGRAM

Each discriminating zone relay and the check zone relay should have a contact configured to raise an alarm whenever the time delayed supervision element is asserted.

FIGURE 19 to FIGURE 21 show how the P723 is implemented in three phase high impedance differential protection applications using a 1 A connection.

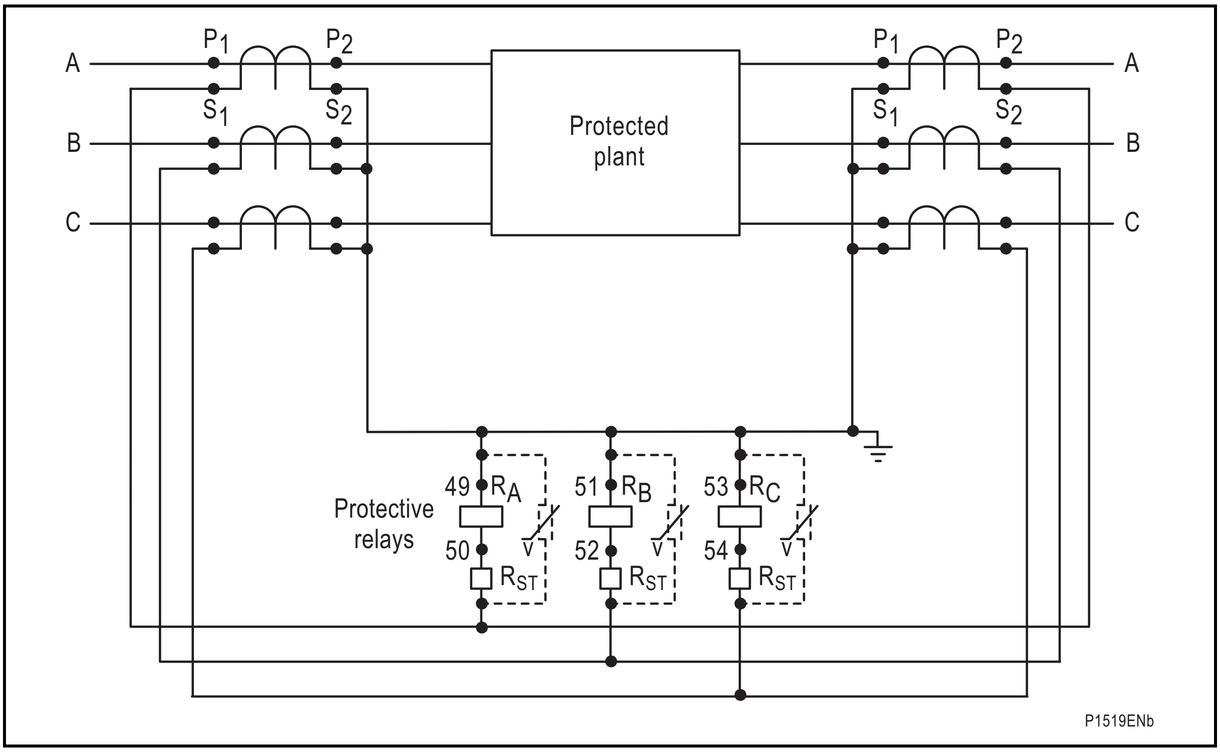


FIGURE 19: PHASE AND EARTH FAULT DIFFERENTIAL PROTECTION FOR GENERATORS, MOTORS OR REACTORS

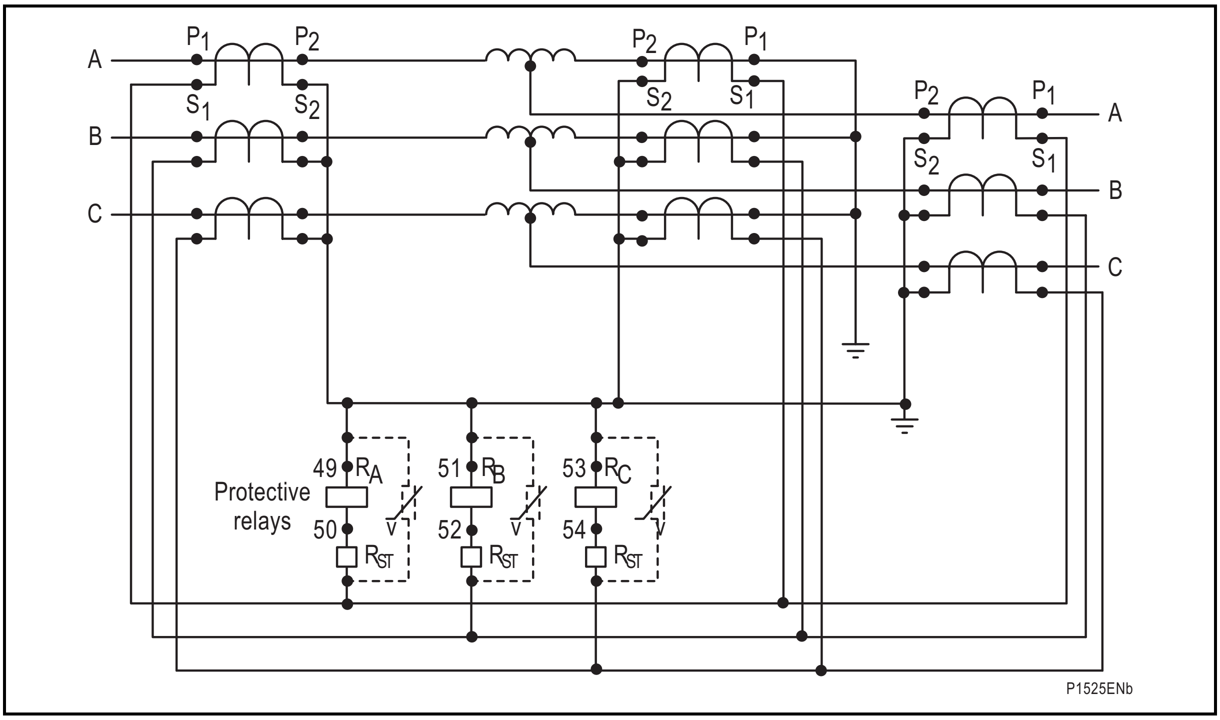


FIGURE 20: PHASE AND EARTH FAULT DIFFERENTIAL PROTECTION FOR AN AUTO-TRANSFORMER WITH CTS AT THE NEUTRAL STAR POINT

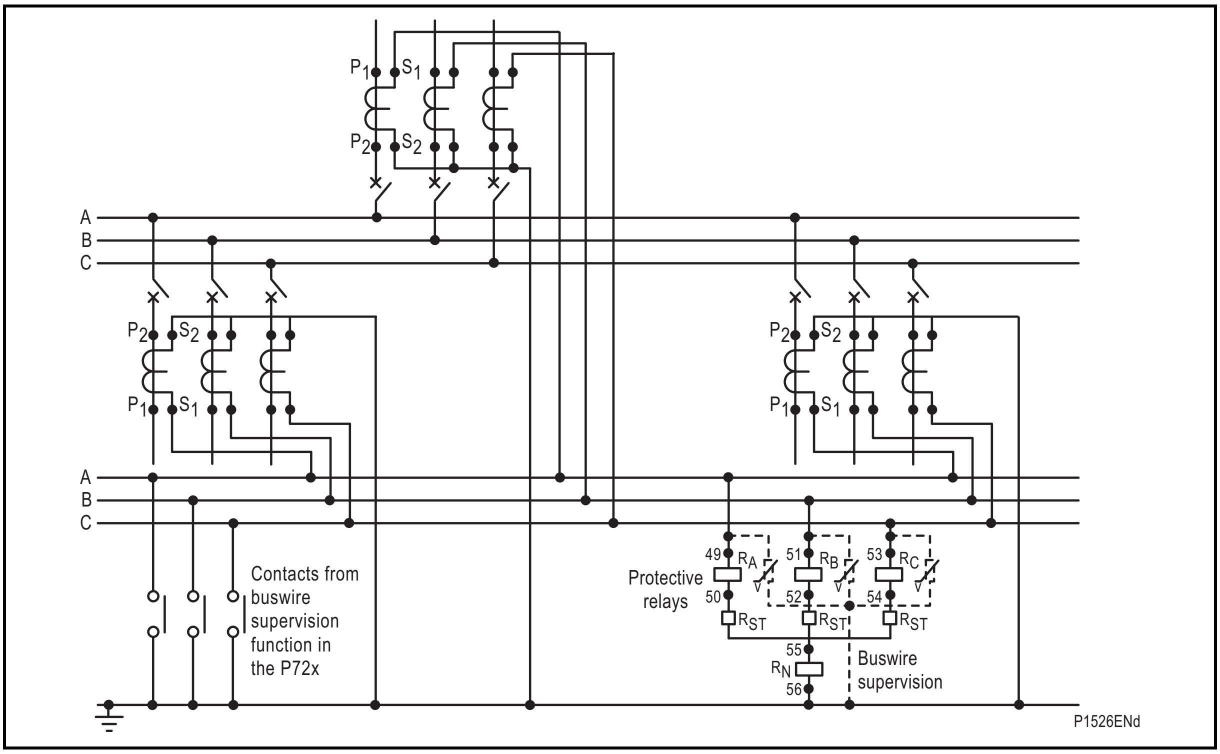


FIGURE 21: A SIMPLE, SINGLE ZONE PHASE AND EARTH FAULT BUSBAR PROTECTION SCHEME WITH BUSWIRE SUPERVISION

3.3 Buswire supervision

For a high impedance differential scheme to function correctly, the CT and secondary AC buswires must be in good condition. Any short circuit failure in these areas bypasses the differential elements, leaving the equipment (transformer, busbar etc.) unprotected. However, open circuit failures of the CTs or buswires cause a spill current to flow through the differential element and operation occurs if this current is greater than the setting.

Two methods are used to prevent nuisance tripping due to open circuit conditions:

- Duplicate differential elements (discriminating and check zones) fed from separate CTs. Tripping is only permitted when both differential elements operate. The advantage of this scheme is that the differential settings can remain very sensitive (below full load current values) but this requires a total duplication of the scheme. The P72x used to protect the discriminating zone should have an input set as [87CZ] Chk Zone. The P72x used as the Check Zone should have an output contact configured as [87N] Diff or [87] Diff. This output contact should be wired to the input [87CZ] Chk Zone in the P72x used to protect the discriminating zone. Only output contacts configured as [87N] tDiff or [87] tDiff should be configured for tripping purposes because the [87N] tDiff and [87] tDiff take into consideration the Check Zone. [87N] Diff and [87] Diff do not consider the Check Zone, as shown in FIGURE 18.
- Buswire supervision elements are provided to monitor for a continuous low level of spill current. After a time delay, this function would usually short circuit the AC buswires to ensure stability and give an alarm. The disadvantage of this scheme is that the differential elements must be set higher than the buswire supervision elements (and usually above maximum load conditions) to avoid nuisance tripping. This may create sensitivity issues. The supervision element should be time delayed to prevent spurious operation during through fault conditions.

The above two methods are usually used in conjunction with each other, although to reduce costs either scheme could be used independently. Phase segregated outputs are available from the buswire supervision so that the protection can be “stabilized” on a per phase basis by short circuiting the buswires as required. The [87N] tDiff and [87] tDiff are internally blocked by the buswire supervision elements [95N] Sup and [95] Sup.

Even though the differential protection is prevented from operating, it is important to short circuit the AC wires to prevent thermal damage to the scheme. This is especially important when using the P79x to help with energy dissipation.

When using the P721 in busbar applications (three P721 would be required), configure the buswire shorting contact as follows:

- Set one of the logic equations (in this example, equation A is being used) as:

  EQUATION A

EQUATION A.00 operator	= =
EQUATION A.00 operand	= Buswire shorting
T Operate	= 0.00 s
T Reset	= 0.00 s

- Latch equation A

  LATCH FUNCTIONS

Latch tEqu. A	= 1

- Assign tEqu.A to a normally closed contact:

OUTPUT RELAYS

tEqu.A	= 0000000000000001
Logic output relay 2	= 1

As shown in FIGURE 22, the buswire shorting is asserted when either the protection trips or the buswire supervision element is asserted.

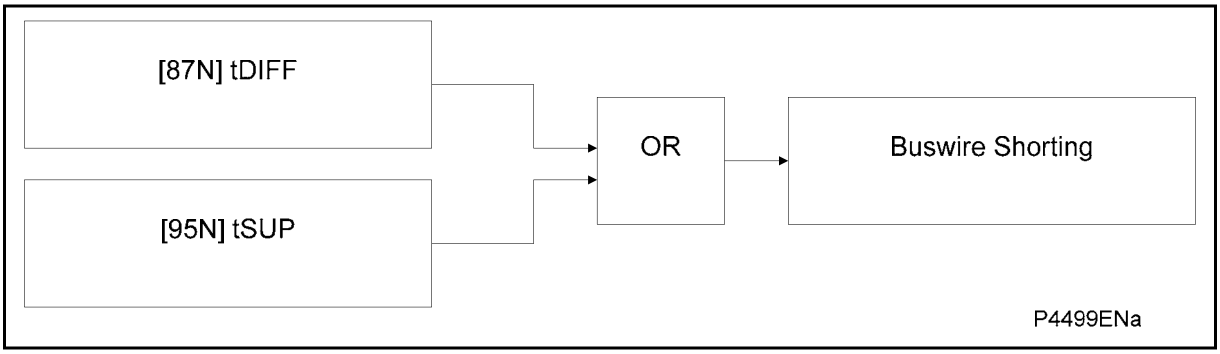


FIGURE 22: P72X – SINGLE PHASE APPLICATIONS - BUSWIRE SHORTING LOGIC

As shown in FIGURE 23, the high impedance path must be shorted under three possible situations: when the protection trips, when the protection is out of service and when the buswire supervision element is asserted. This is required to avoid unnecessary overheating of the stabilizing resistor and varistor.

As shown in FIGURE 23, RL2 is used to short the high impedance differential path. RL2 is asserted whenever the differential element trips or the buswire supervision element is asserted.

In the P721, the watchdog normally open contact may be used to energize an auxiliary relay as shown in FIGURE 23. A normally closed contact from the auxiliary relay is used to short the high impedance path when the P721 is out of service. An additional contact from the auxiliary relay is required to give an alarm to the SCADA system when the P721 is out of service.

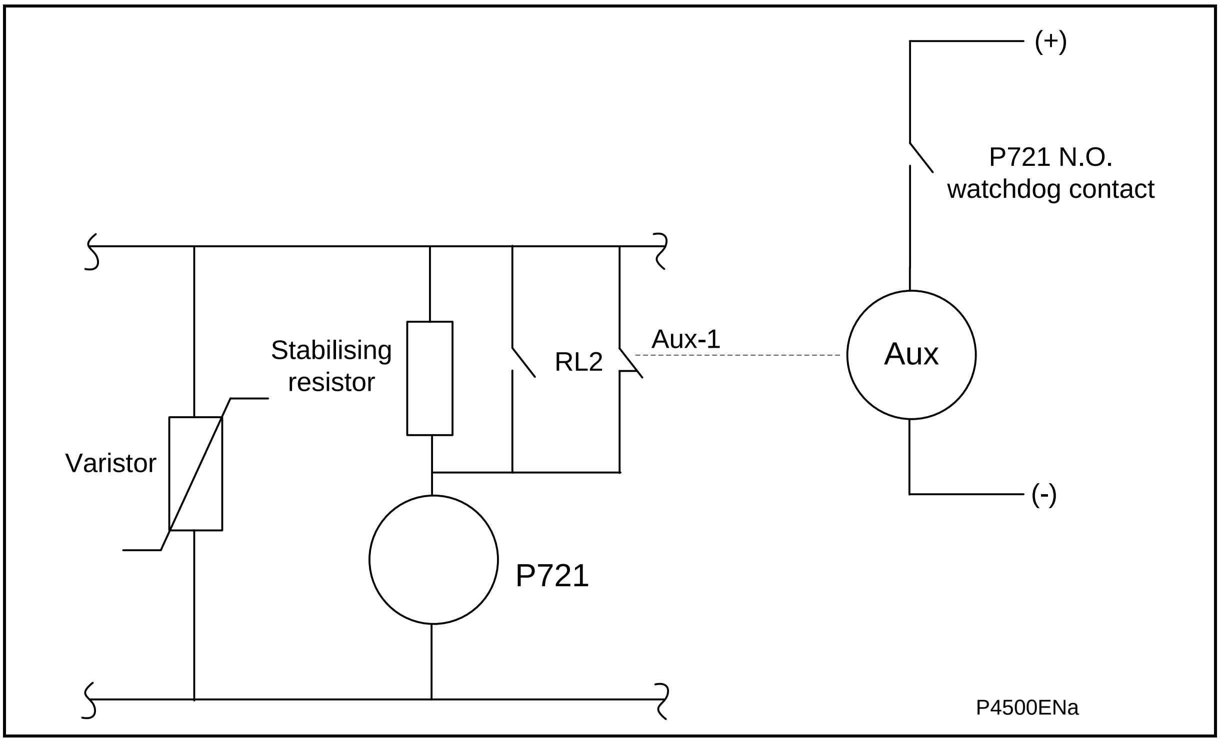


FIGURE 23: P721 – HIGH IMPEDANCE PATH SHORTED

NOTES:
1. The protection watchdog contact is normally open. It is closed when the P721 is healthy. Therefore Aux-1 is closed when the P721 is not healthy.
2. RL2 is a normally open contact. It closes when there is an ac buswire failure or the differential element is asserted.
3. If the P79x is used, refer to the P79x manual for a detailed description of this application.

When using the P723 in busbar applications, configure the buswire shorting contacts as follows:

- Set three logic equations as follows:

  EQUATION A

EQUATION A.00 operator	= =
EQUATION A.00 operand	= [95A] tSup
T Operate	= 0.00 s
T Reset	= 0.00 s

  EQUATION B

EQUATION B.00 operator	= =
EQUATION B.00 operand	= [95B] tSup
T Operate	= 0.00 s
T Reset	= 0.00 s

  EQUATION C

EQUATION C.00 operator	= =
EQUATION C.00 operand	= [95C] tSup
T Operate	= 0.00 s
T Reset	= 0.00 s

- Latch equation A

  LATCH FUNCTIONS

  Latch tEqu. A = 1

- Latch equation B

  LATCH FUNCTIONS

  Latch tEqu. B = 1

- Latch equation C

  LATCH FUNCTIONS

  Latch tEqu. C = 1

- Assign tEqu.A, tEqu.B and tEqu.C to normally open contacts:

  OUTPUT RELAYS

tEqu.A	= 0000000000000001
Logic output relay 4	= 1
tEqu.B	= 0000000000000010

Logic output relay 5	= 1
tEqu.C	= 0000000000000100
Logic output relay 6	= 1

As shown in FIGURE 24, the buswire shorting is asserted when either the protection trips or the buswire supervision element is asserted.

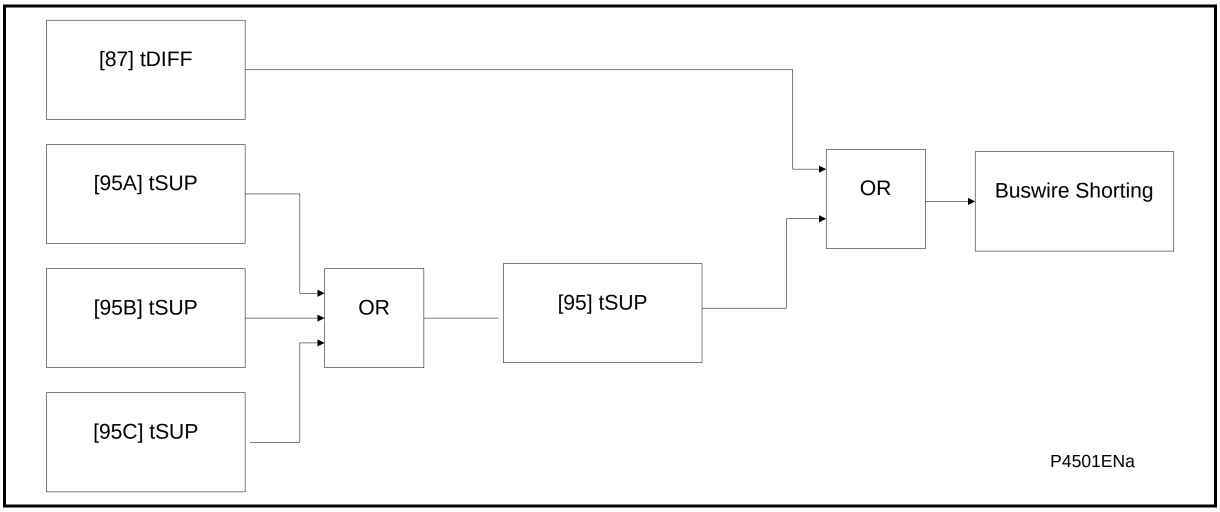


FIGURE 24: P723 – THREE PHASE APPLICATIONS - BUSWIRE SHORTING LOGIC

As shown in FIGURE 25, the high impedance path must be shorted under three possible situations: when the protection trips, when the protection is out of service and when the buswire supervision element is asserted. This is required to avoid unnecessary overheating of the stabilizing resistor and varistor.

The high impedance path must be shorted when the protection trips. This can be done using normally open contacts from the 86 relay as shown in FIGURE 25.

In the P723, the watchdog normally open contact may be used to energize an auxiliary relay as shown in FIGURE 25. The normally closed contacts from the auxiliary relay are used to short the high impedance path when the P723 is out of service. An additional contact from the auxiliary relay is required to give an alarm to the SCADA system when the P723 is out of service.

The high impedance path should also be shorted when the buswire supervision asserts. This can be done using normally open contacts configured as explained previously. This is also shown in FIGURE 25.

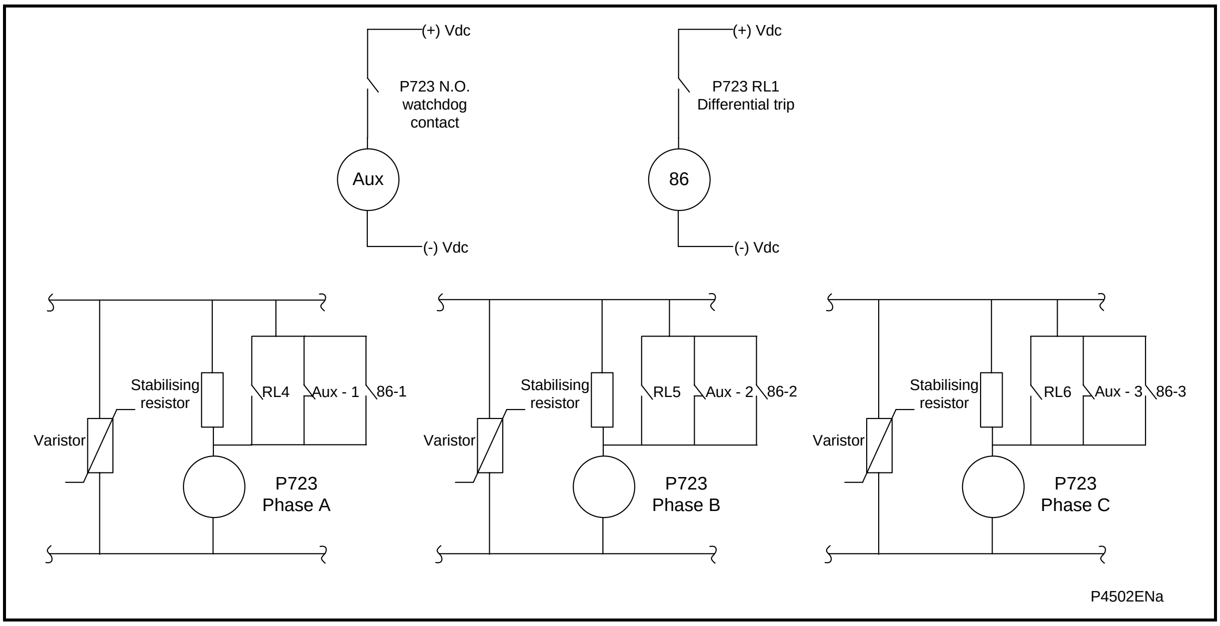


FIGURE 25: P723 – HIGH IMPEDANCE PATH SHORTED

NOTES:

1. The protection watchdog contact is normally open. It is closed when the P723 is healthy. Therefore, Aux-1, Aux-2 and Aux-3 are closed when the P723 is not healthy.
2. RL4, RL5 and RL6 are normally open contacts. They will close when there is an ac buswire failure in phases A, B and C respectively.
3. RL1 is a normally open contact. It closes when the relay trips, energizing the 86.
4. If the P79x is used, refer to the P79x manual for a detailed description of this application.

3.4 Circuit breaker failure

The P72x has one circuit breaker failure function. The current considered by the CBF function is the differential current, therefore the current flowing through a particular circuit breaker is not considered. If the CBF function in the P72x is asserted and the breaker is still closed, the 86BF associated to that particular breaker should be energized. Meanwhile the 86BF associated to the other breakers should not be energized. This is done by wiring one 52a contact in the 86BF circuit of each breaker in the high impedance scheme. Consider the single busbar scheme shown in FIGURE 26.

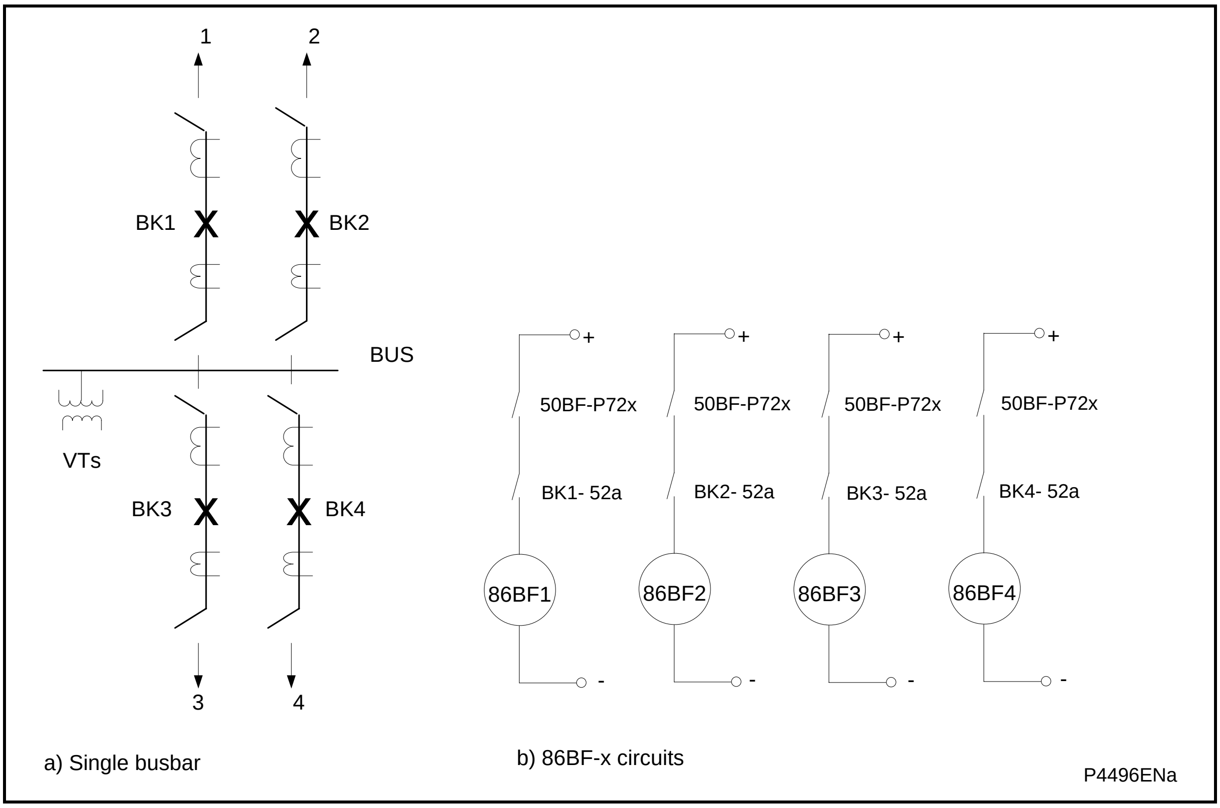


FIGURE 26: CIRCUIT BREAKER FAILURE APPLICATION

4. SETTING EXAMPLES

4.1 Restricted earth fault application

4.1.1 Example 1

FIGURE 27 shows the application of a high impedance REF to protect the LV winding of a power transformer.

In this example assume that the Input selection in the P721 is set to Voltage. Therefore, the Stabilizing Resistor N needs to be set. The P721 calculates the relay operating current using the set Voltage and Stabilizing Resistor N. Note that this current must be within the setting range of [87N] Threshold I Diff. If the calculated relay operating current is not within the range (0.01In-1In), then the warning led in the relay is asserted and the message “Inconsistent V/R ratio” is displayed.

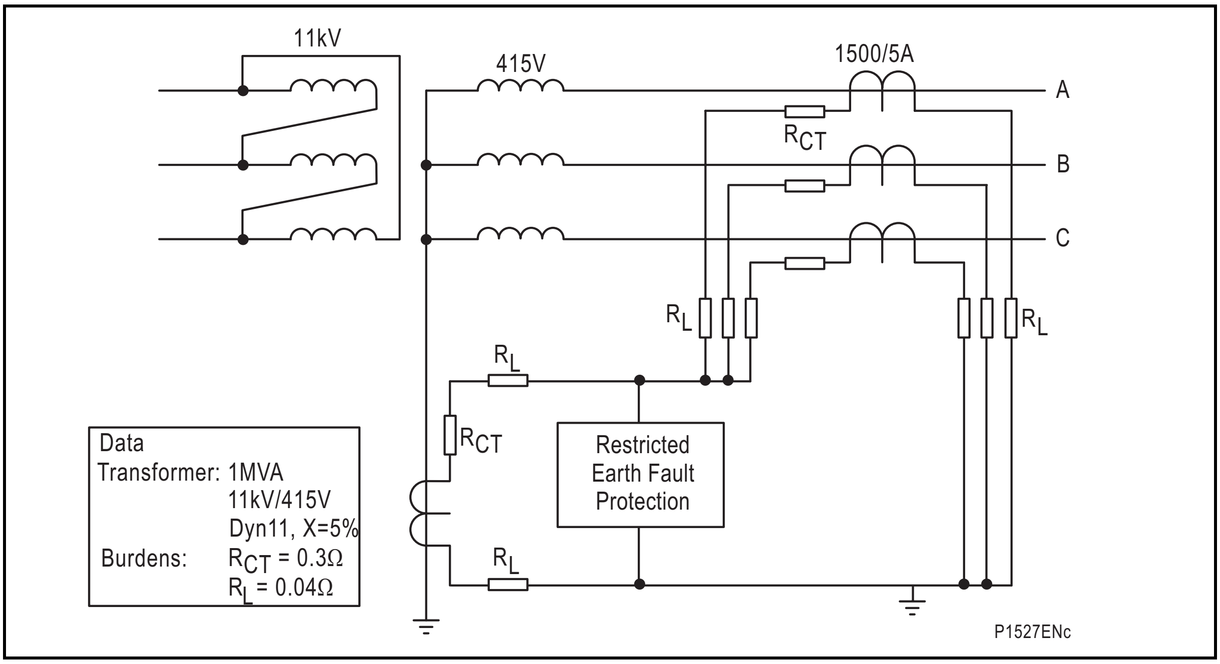


FIGURE 27: RESTRICTED EARTH FAULT PROTECTION ON A TRANSFORMER

4.1.1.1 Stability voltage calculation

The transformer full load current, I_{FLC}, is:

$$I_{FLC} = \frac{1 \times 10^6}{415 \times \sqrt{3}}$$
$$= 1391.2A$$

To calculate the stability voltage the maximum through fault level should be considered. The maximum through fault level, ignoring the source impedance, I_F, is:

$$I_F = \frac{I_{FLC}}{X_{TX}}$$
$$= \frac{1391.2A}{0.05} = 27824A$$

Required relay stability voltage, V_S, and assuming one CT saturated is:

$$V_S = KI_F\left(R_{CT} + 2R_L\right)$$

Assume that the Measurement Filter is set to Fourier. Then the graphic shown in FIGURE 28 should be used to determine the K factor and the operating time.

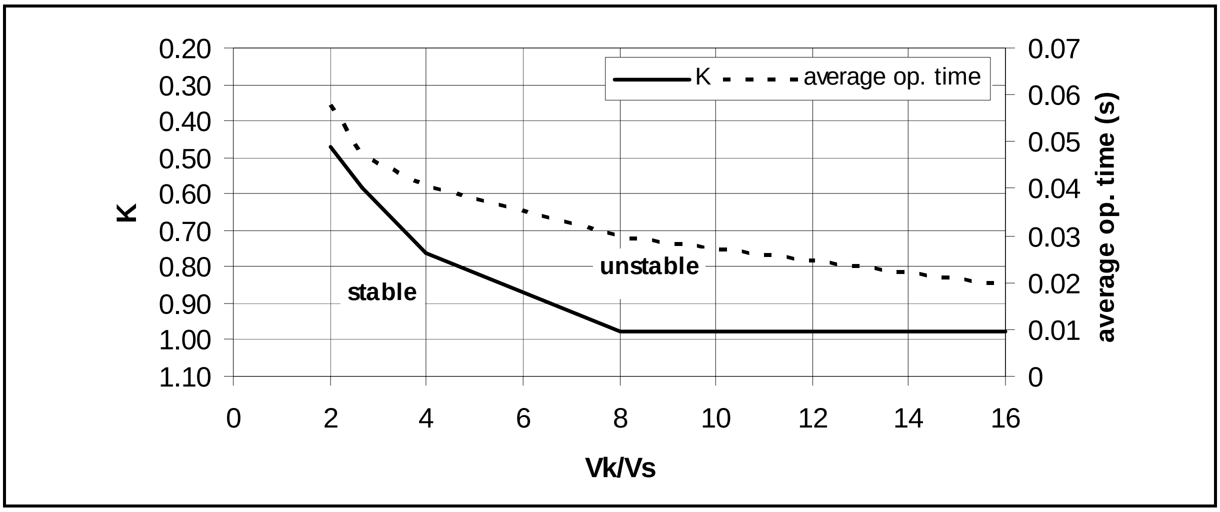


FIGURE 28: VARIATION OF K AND THE AVERAGE OPERATING TIME AS A FUNCTION OF VK/VS – REF APPLICATIONS - FOURIER MODE

Consider that an average operating time of 40 ms is appropriate, then the corresponding K factor is 0.76 approximately and Vk/Vs is 4.

$$V_S = KI_F\left(R_{CT} + 2R_L\right)$$
$$= 0.76 \times 27824\text{x}\,\frac{5}{1500}\left(0.3 + 0.08\right)$$
$$= \mathbf{26.78V}$$

The knee point voltage of the CTs should be at least 4 times Vs so that an average operating time of 40 ms is achieved.

4.1.1.2 Primary operating current calculation

The primary operating current should be between 10 and 60 % of the winding rated current. Assuming that the relay effective setting or primary operating current for a solidly earthed power transformer is approximately 30% of the full load current, we can calculate that a setting of less than 1.391 A is required on the relay.

$$\text{relay effective setting} = 0.3 \times \frac{I_{FLC}}{CTratio}$$
$$= 0.3 \times \frac{1391.2\text{A}}{300} = 1.391\text{A}$$

4.1.1.3 Stabilising resistor calculation

Assuming that a setting of 0.5 A is selected, the stabilizing resistor R_{ST} required is:

$$R_{ST} = \frac{V_S}{[87\text{N}]\ \text{Threshold I Diff}} = \frac{26.78}{0.5} = 54.\Omega$$

If the Input selection is set to Current, the [87N] Threshold I Diff should be set to 0.1In. Since the Input selection is set to Voltage, the Stabilizing Resistor N setting should be set as 54 Ω and the [87N] Threshold V Diff as 26.8 V.

The P79x accessory may be used to provide the required stabilizing resistance. Option A may be ordered and a stabilizing resistance of 55 Ω may be used. The [87N] Threshold I Diff is kept as 0.5 A. The P79x thermal withstand should still be considered. Please refer to the P79x manual and the P79x energy limit tool to determine the P79x suitability.

To achieve an average operating time of 40 ms, Vk/Vs should be 4 as shown in FIGURE 28.

$$\text{Kneepoint Voltage, } V_K = 4V_S = 4 \times 26.78 = 108V$$

If the actual Vk is greater than 4 times Vs, the K factor increases. In this case Vs should be recalculated considering the new K factor and using equation $V_S = KI_F(R_{CT} + 2R_L)$. Note that K can reach a maximum value of 1 approximately.

4.1.1.4 Current transformers

As previously stated the effective relay setting or primary operating current is $I_P = N \times (I_S + nI_e)$. By re-arranging this equation, the excitation current for each of the current transformers at the relay stability voltage can be calculated:

$$\text{CT Magnetising current at stability voltage, } I_e \le \frac{\frac{I_P}{N} - I_S}{n} \le \frac{1.391 - 0.5}{4} \le 0.22A$$

In summary, the current transformers used for this application must have a kneepoint voltage of 108 V or higher (note that maximum Vk/Vs that should be considered is 16 and the maximum K factor is 1), with a secondary winding resistance of 0.3 Ω or lower and a magnetizing current at 26.78 V of less than 0.22 A.

4.1.1.5 Non-linear resistors

If the peak voltage developed across the relay circuit under maximum internal fault conditions exceeds 3000 V peak, a suitable non-linear resistor should be connected across the relay and stabilizing resistor to protect the insulation of the CTs, relay and interconnecting leads. To calculate the maximum fault voltage assuming no CT saturation, use the following equation:

$$V_F = I'_F(R_{CT} + 2R_L + R_{ST} + R_r) = 27824x\frac{5}{1500}(0.3 + 0.08 + 54) = 92.75 \times 54.38 = 5044V$$

Assuming that the CT is C100, the CT knee point voltage is100 V and the peak voltage can be estimated as:

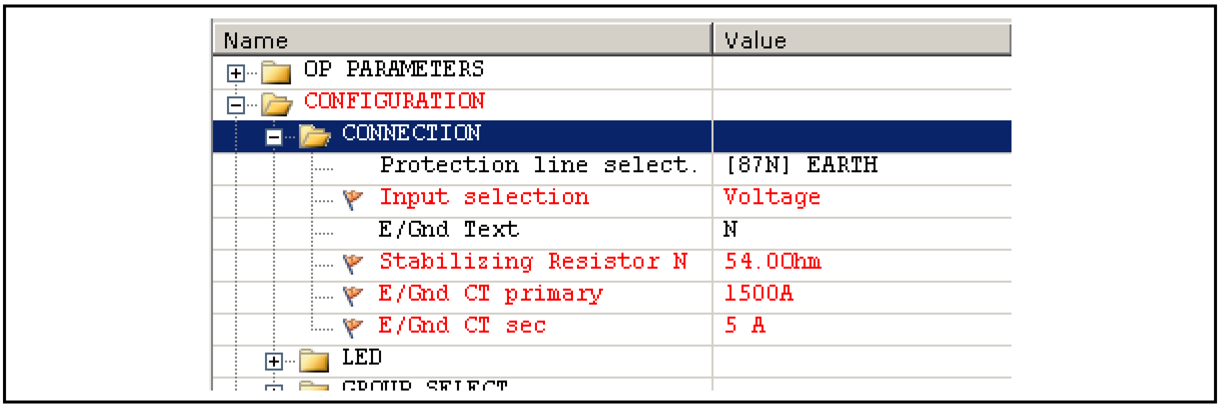
$$V_P = 2\sqrt{2V_K(V_F - V_K)} = 2\sqrt{2x100(5044 - 100)} = 1989V$$

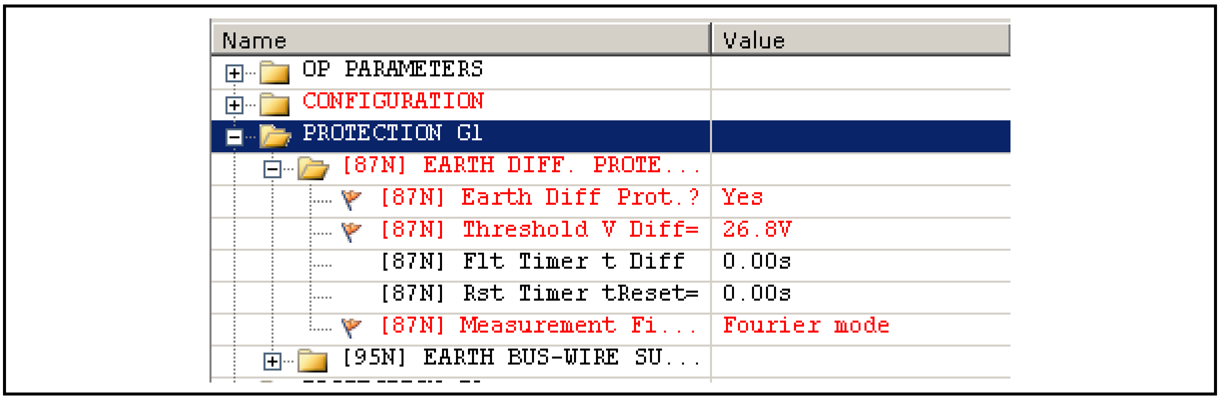
This value is below the peak voltage of 3000 V and therefore a non-linear resistor is not required.

NOTE: The kneepoint voltage value used in the above formula should be the actual voltage obtained from the CT magnetising characteristic and not a calculated value.

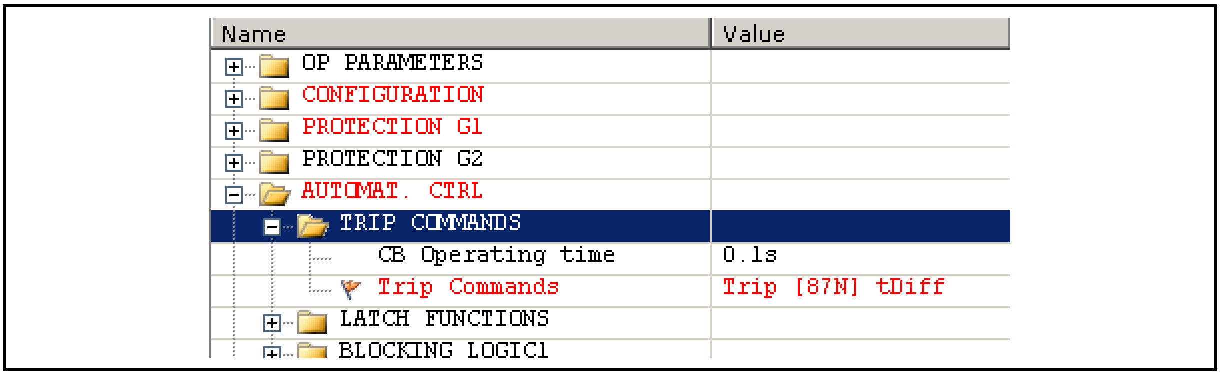
4.1.1.6 Relay settings

The P72x differential element settings are as follows:





The trip command should be configured as Trip [87N] tDiff, so that relay output 1 is asserted when the differential element operates:



4.1.2 Example 2

FIGURE 29 shows the application of a high impedance REF to protect the LV winding of a resistance earthed transformer.

In this example assume that the Input selection in the P721 is set to Current.

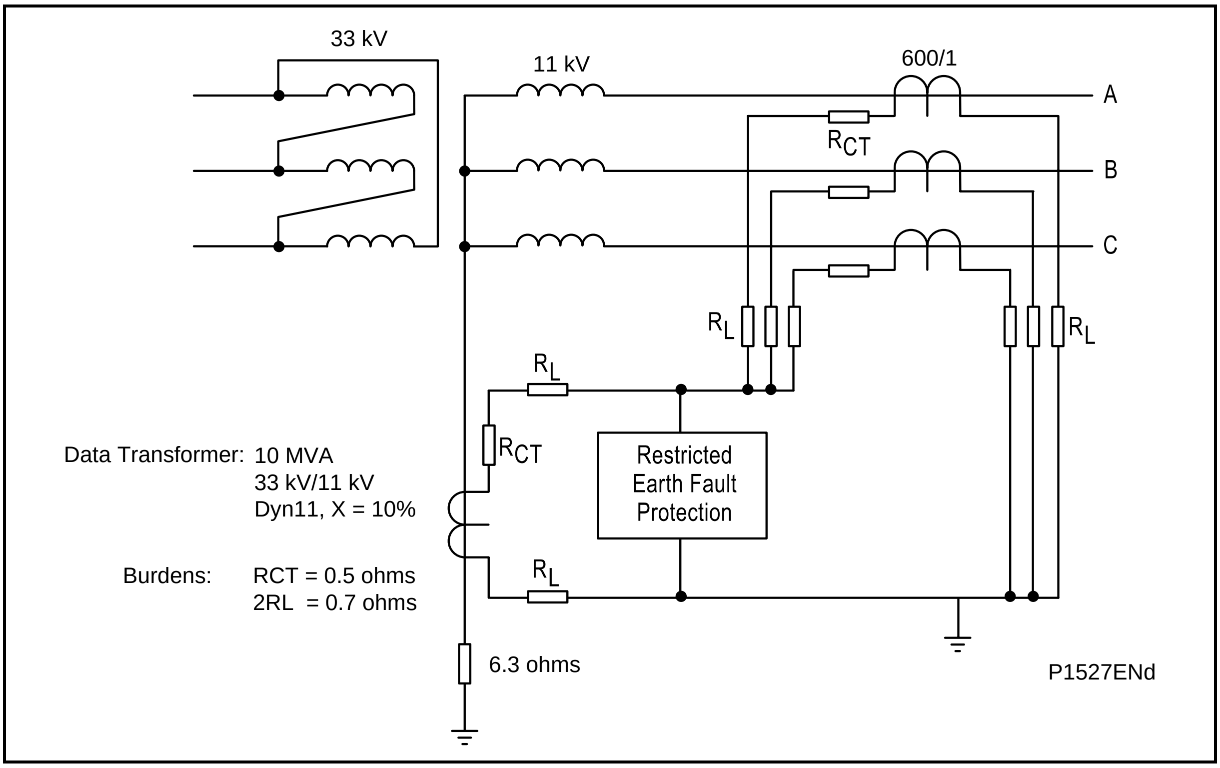


FIGURE 29: RESTRICTED EARTH FAULT PROTECTION ON A TRANSFORMER

4.1.2.1 Stability voltage calculation

The transformer full load current, I_{FLC}, is:

$$I_{FLC} = \frac{10 \times 10^6}{11 \times 10^3 \times \sqrt{3}}$$
$$= 525A$$

To calculate the stability voltage the maximum through fault level should be considered. Ignoring the source impedance the maximum through fault level, I_F, is:

$$I_F = \frac{I_{FLC}}{X_{TX}}$$
$$= \frac{525A}{0.1} = 5249A$$

Required relay stability voltage, V_S, and assuming one CT saturated is:

$$V_S = KI_F\left(R_{CT} + 2R_L\right)$$

Assume that the Measurement Filter is set to Fourier. Then the graphic shown in FIGURE 30 should be used to determine the K factor and the operating time.

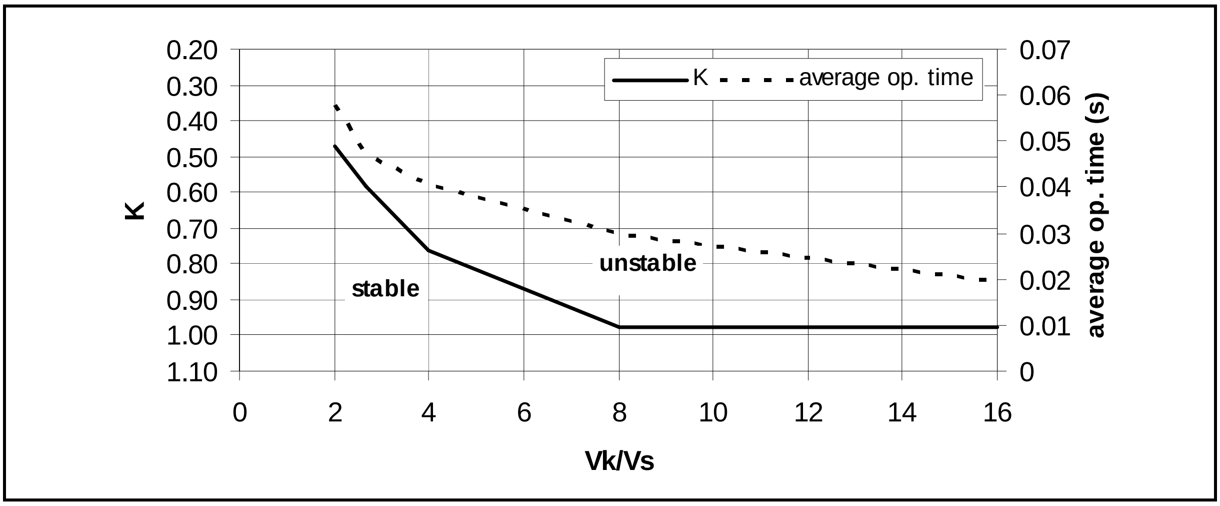


FIGURE 30: VARIATION OF K AND THE AVERAGE OPERATING TIME AS A FUNCTION OF VK/VS – REF APPLICATIONS - FOURIER MODE

Consider that an average operating time of 40 ms is appropriate, then the corresponding K factor is 0.76 approximately and Vk/Vs is 4.

$$V_S = KI_F(R_{CT} + 2R_L)$$
$$= 0.76 \times \frac{5249}{600} x(0.5 + 0.7)$$
$$= \mathbf{8V}$$

4.1.2.2 Current transformers

Assuming that the CT is 5 VA 5P20, the knee point voltage can be calculated as:

$$V_k = \frac{VA}{In} \times ALF$$
$$= \frac{5}{1} \times 20$$
$$= 100V$$

4.1.2.3 Stability voltage re-calculation

The knee point voltage of the CTs should be at least 4 times Vs so that an average operating time of 40 ms is achieved:

$$\frac{V_K}{V_S} = \frac{100}{8} = 12.5$$

Since the knee point voltage is 12.5 times Vs, the differential element requires a K factor equal to 1 approximately to remain stable during external faults as indicated in FIGURE 30. Vs and Vk/Vs should be recalculated as follows:

$$V_S = KI_F(R_{CT} + 2R_L)$$
$$= 1 \times \frac{5249}{600}(0.5 + 0.7)$$
$$= \mathbf{10.5V}$$

$$\frac{V_K}{V_S} = \frac{100}{10.5} = 9.5$$

As shown in FIGURE 30, the differential element remains stable since Vk/Vs = 9.5 and K = 1. The average operating time is 28 ms as indicated in FIGURE 30.

4.1.2.4 Primary operating current calculation

Assuming that the relay effective setting or primary operating current for a resistance earthed power transformer should not exceed 10-25% of the minimum earth fault current, we can calculate the relay effective setting as follows:

$$\begin{aligned}\text{transformer impedance} &= \text{Zpu} \times \text{Zbase}\\ &= \text{Zpu} \times \frac{\text{kV}_{\text{base}}^2 \times 1000}{\text{kVA}_{\text{base}}}\\ &= 0.1 \times \frac{(11)^2 \times 1000}{10000}\\ &= 1.21\Omega\end{aligned}$$

It is assumed that the transformer zero, positive and negative sequence impedances are equal to 1.21 Ω and that the source is strong (source impedance is negligible).

$$\text{earth fault current} = 0.25 \times \frac{11 \times 10^3 / \sqrt{3}}{(3 \times 1.21 + 6.3)} = 160\text{A}$$

4.1.2.5 Relay setting calculation

The primary operating current is $I_P = N \times (I_S + nI_e)$. According to the current transformer magnetizing characteristic, at 10.5 V the excitation current is 0.01 A. By re-arranging the equation, the relay setting can be calculated:

$$\text{Primary Effective Operating current, } I_P = N \times (I_S + nI_e)$$

$$I_S = \frac{I_P}{N} - nI_e = \frac{160}{600} - 4 \times 0.01 = 0.23\text{A}$$

If the Input selection is set to Current, then the [87N] Threshold I Diff should be set to 0.28In.

4.1.2.6 Stabilising resistor calculation

The stabilizing resistor is calculated as follows:

$$R_{ST} = \frac{V_S}{I_S} = \frac{10.5}{0.23} = 45.6.\Omega$$

For this application a 47 Ω resistor, Schneider Electric part No. ZB9016 720, can be supplied on request which can be adjusted to any value between 28.2 Ω and 47 Ω.

The P79x accessory may be used to provide the required stabilizing resistance. Option A may be ordered and a stabilizing resistance of 55 Ω may be used. The [87N] Threshold I Diff and primary operating current are recalculated as follows:

$$I_S = \frac{V_S}{R_{ST}} = \frac{10.5}{55} = 0.2\text{A}$$

$$\text{Primary Effective Operating current, } I_P = N \times (I_S + nI_e) = 600 \times (0.2 + 4 \times 0.01) = 144\text{A}$$

The P79x thermal withstand should still be considered. Please refer to the P79x manual and the P79x energy limit tool to determine the P79x suitability.

4.1.2.7 Non-linear resistor

If the peak voltage developed across the relay circuit under maximum internal fault conditions exceeds 3000 V peak, a suitable non-linear resistor should be connected across the relay and stabilizing resistor, to protect the insulation of the CTs, relay and interconnecting leads. Using the following equation we can calculate the maximum fault voltage assuming no CT saturation during the maximum internal fault:

$$
\begin{aligned}
V_F &= I'_F\left(R_{CT} + 2R_L + R_{ST} + R_r\right) \\
&= \frac{5249}{600}\left(0.5 + 0.7 + 38\right) \\
&= 343\text{V}
\end{aligned}
$$

As indicated previously, the CT knee point voltage is100 V, then the peak voltage can be estimated as:

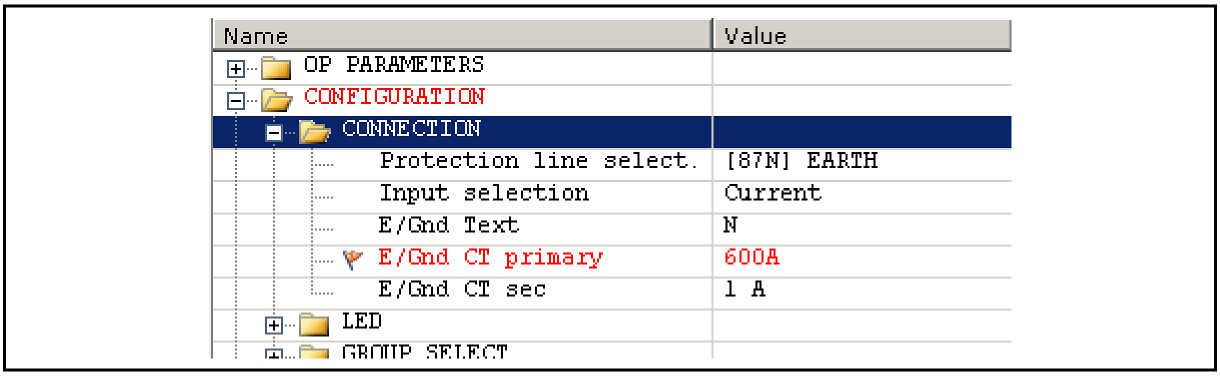
$$
\begin{aligned}
V_P &= 2\sqrt{2V_K\left(V_F - V_K\right)} \\
&= 2\sqrt{2\text{x}100(343 - 100)} \\
&= 441\text{V}
\end{aligned}
$$

This value is below the peak voltage of 3000 V and therefore a non-linear resistor is not required.

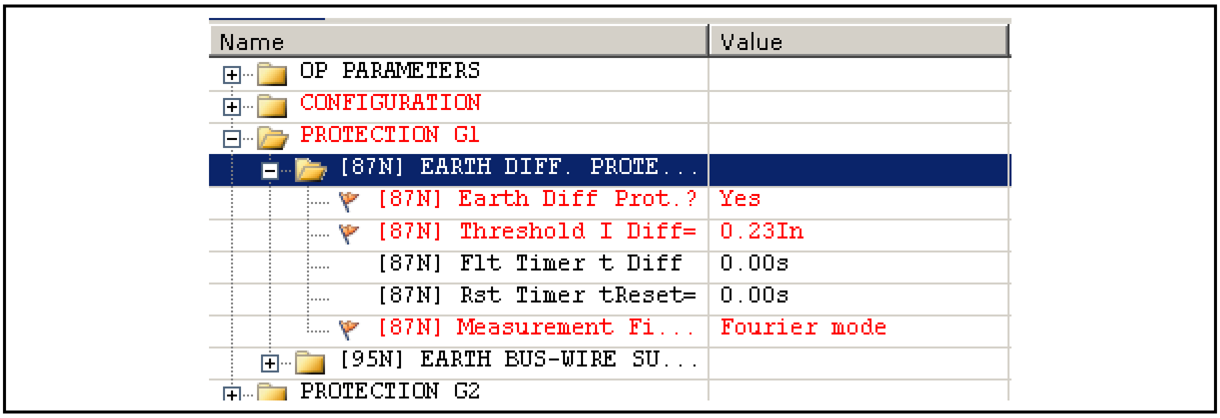
NOTE: The kneepoint voltage value used in the above formula should be the actual voltage obtained from the CT magnetising characteristic and not a calculated value.

4.1.2.8 Relay Settings

If the stabilizing resistor (Schneider Electric part No. ZB9016 720) is used, the P72x differential element settings are as follows:



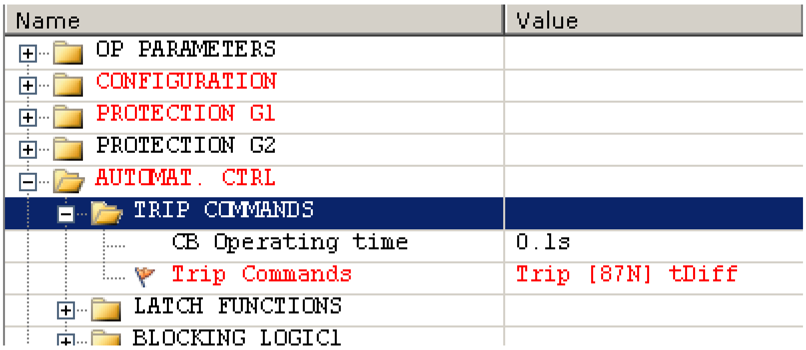
Name	Value
OP PARAMETERS	
CONFIGURATION	
CONNECTION	
Protection line select.	[87N] EARTH
Input selection	Current
E/Gnd Text	N
E/Gnd CT primary	600A
E/Gnd CT sec	1 A
LED	
GROUP SELECT	



Name	Value
OP PARAMETERS	
CONFIGURATION	
PROTECTION G1	
[87N] EARTH DIFF. PROTE...	
[87N] Earth Diff Prot.?	Yes
[87N] Threshold I Diff=	0.23In
[87N] Flt Timer t Diff	0.00s
[87N] Rst Timer tReset=	0.00s
[87N] Measurement Fi...	Fourier mode
[95N] EARTH BUS-WIRE SU...	
PROTECTION G2	

If the 55 Ω resistor available in the P79x is used, then [87N] Threshold I Diff = 0.20 In.

The trip command should be configured as Trip [87N] tDiff, so that relay output 1 is asserted when the differential element operates:



4.2 Busbar applications

FIGURE 31 shows an application of the P72x for high impedance protection of a typical 132 kV double bus generating station, consisting of two 100 MVA generators and step-up transformers, two bus-couplers and four overhead transmission lines. Each busbar is sectionalized and therefore gives a requirement for four discriminating zones and one overall check zone. Therefore, for this application five P72x relays are required. One P72x is configured as the discriminating zone for each bus bar section and one P72x is configured as the overall check zone.

Any circuit in FIGURE 31 may be transferred from one bar to the other by isolator switches. Auxiliary contacts from the isolator must transfer the current transformers between the zones. The relay trip output must also be switched to the appropriate zone. These auxiliary switches should close before the main isolator closes and should open after the main isolator opens to ensure stability during switching operation.

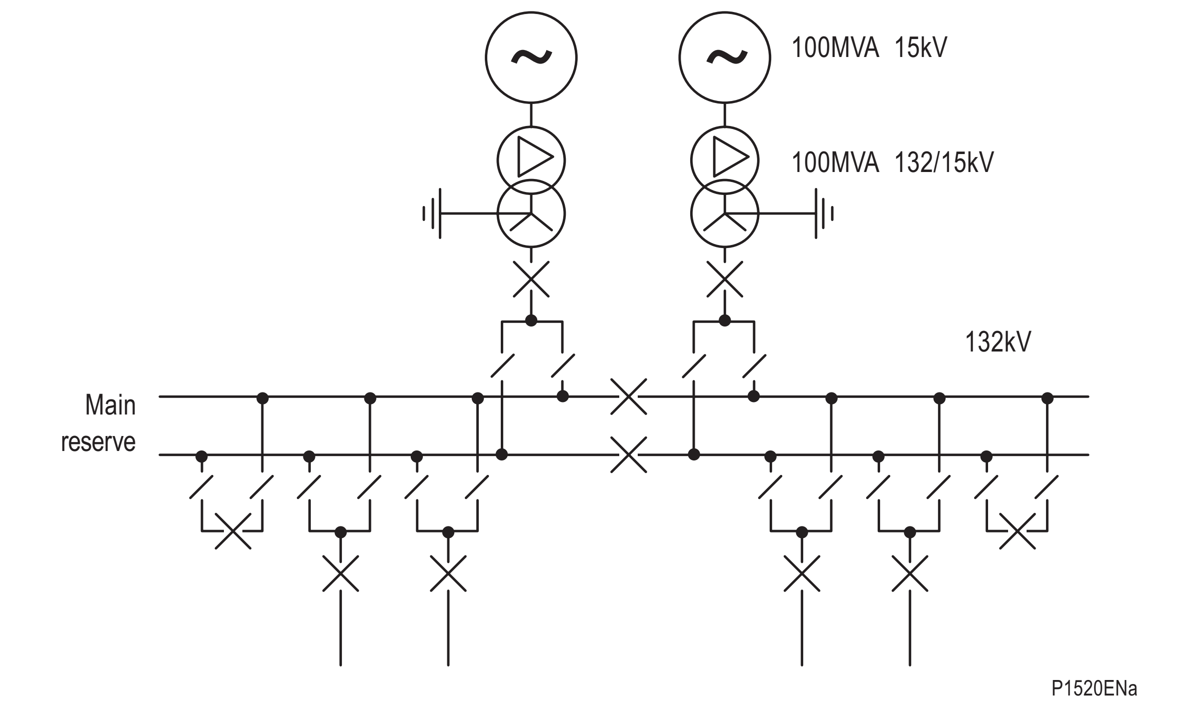


FIGURE 31: THREE PHASE AND EARTH FAULT PROTECTION OF A DOUBLE BUSBAR GENERATING STATION

FIGURE 32 shows the switching configuration for any of the feeders or transformers given in FIGURE 31: Only normally open auxiliary contacts a and b are needed in the CT secondary circuit for switching purposes.

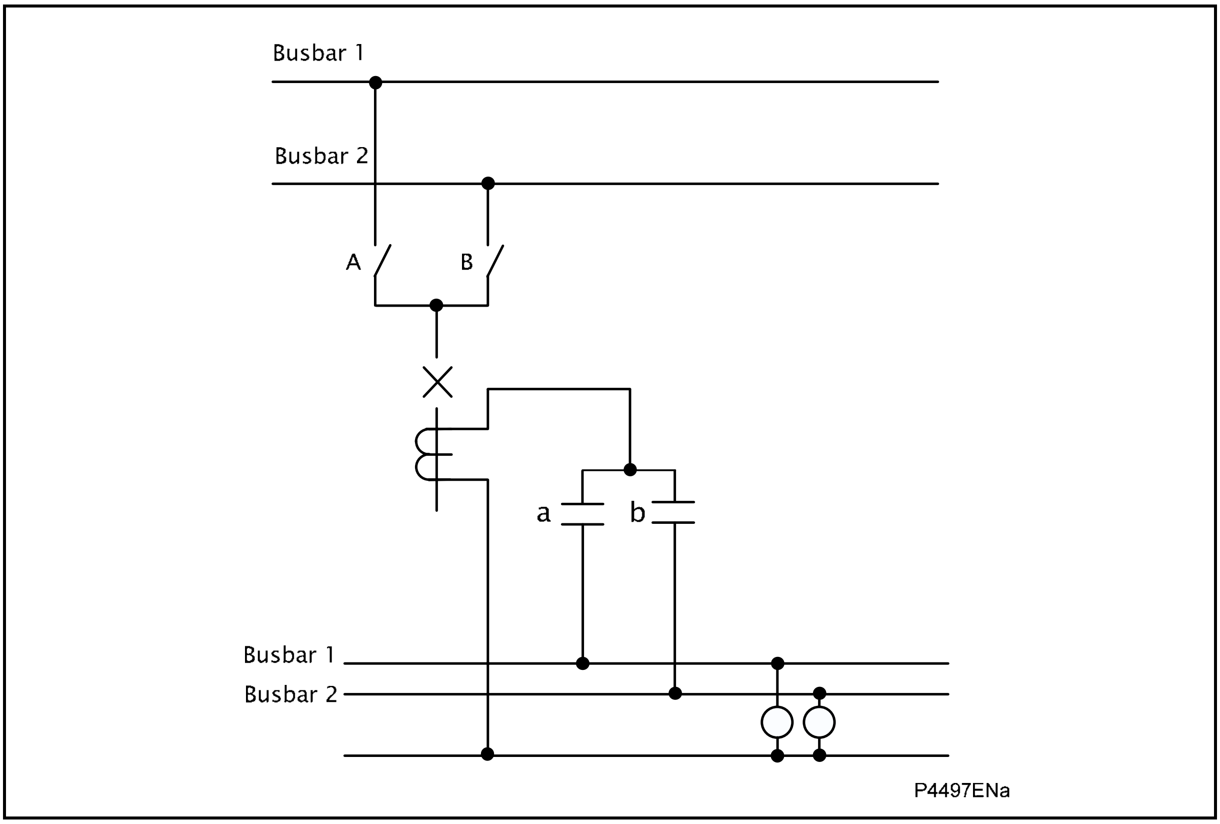


FIGURE 32: CURRENT TRANSFORMER SWITCHING CONFIGURATION

Likewise, the trip and blocking contacts from busbar 1 and busbar 2 high impedance differential schemes should be switched according to the status of the isolators. In this case normally closed and open auxiliary contacts are needed. Use normally open contacts in the trip circuit, so the trip contact from the appropriate busbar scheme is allowed to trip the breaker. In the closing circuit use normally closed contacts in parallel with the blocking contact from the 86 relay. For example, if isolator a is open and b closed, the breaker should trip due to the operation of 86-b2. The closed coil is blocked only when 86-b2 operates, because the normally closed contact b is open. If 86-b1 operates, the closing circuit path is kept uninterrupted because the normally closed contact **a** is closed.

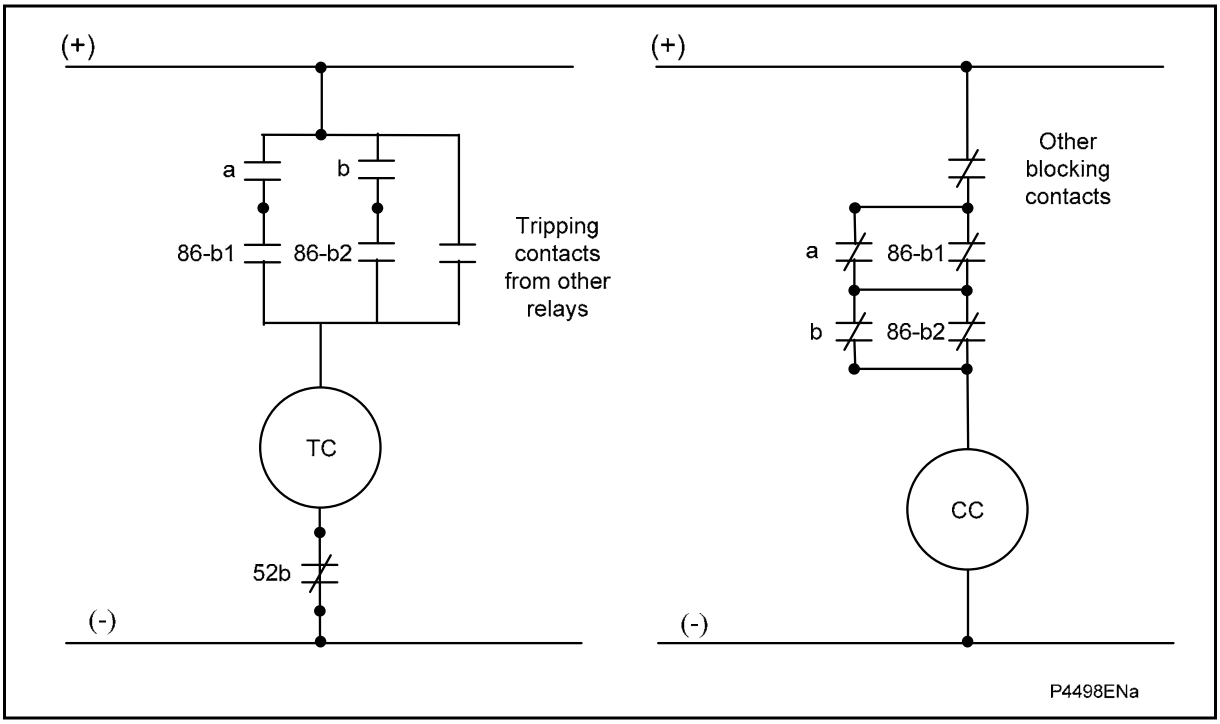


FIGURE 33: TRIP AND CLOSE CIRCUITS

For the purpose of this example it is assumed that all switchgear is rated for 3500 MVA and solidly earthed. All circuits have the same CT ratio of 500/1A with a secondary winding resistance of 0.7 Ω and the largest loop lead resistance is 2 Ω. Consider that the Input selection in the P723 is set to Current.

4.2.1 Stability voltage calculation

The stability level of the busbar protection is governed by the maximum through fault level which is assumed to be the switchgear rating. Even if the short circuit level in the system is known, it is recommended to use the switchgear rating to calculate the setting. Using the switchgear rating allows for any future expansion of the busbar:

$$\text{Maximum through fault current, } I_F = \frac{\text{Switchgear rating}}{\text{Voltage x }\sqrt{3}}$$

$$= \frac{3500\text{MVA}}{132\text{kV} \times \sqrt{3}}$$

$$= 15308\text{A}$$

Required relay stability voltage, V_S, and assuming one CT saturated is:

$$V_S = KI_F\left(R_{CT} + 2R_L\right)$$

If the Measurement Filter is set to Fourier, use FIGURE 34 to determine the K factor and the operating time.

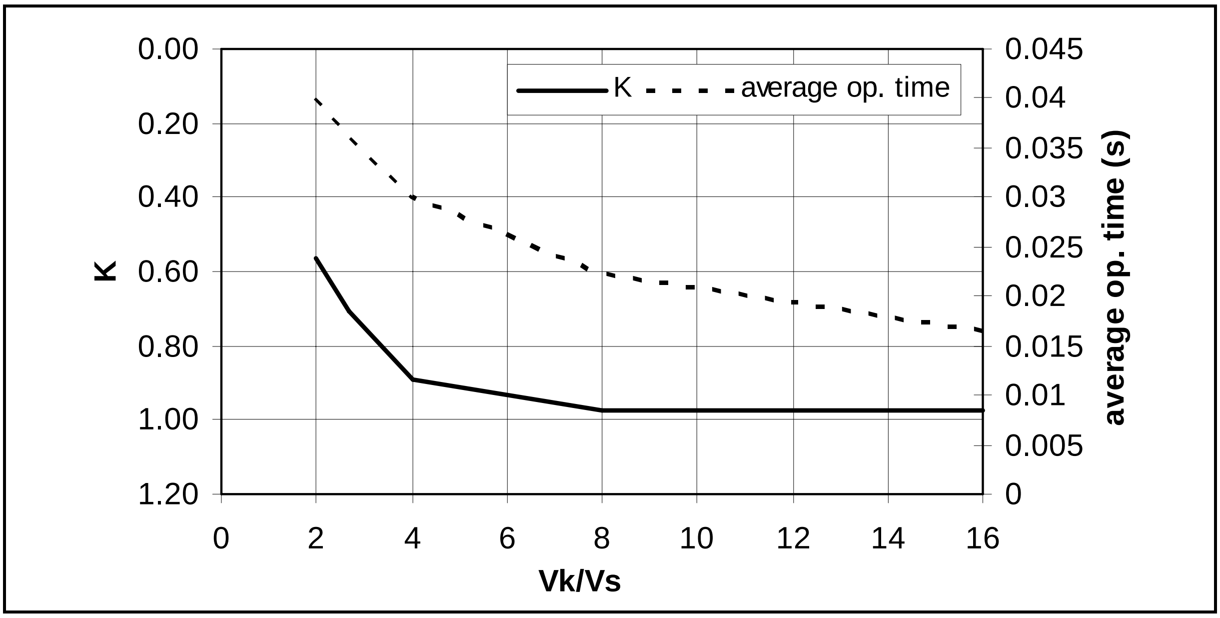


FIGURE 34: VARIATION OF K AND THE AVERAGE OPERATING TIME AS A FUNCTION OF VK/VS – BUSBAR APPLICATIONS - FOURIER MODE

Consider that an average operating time of 30 ms is appropriate, then the corresponding K factor is 0.89 approximately and Vk/Vs is 4.

$$V_S = KI_F\left(R_{CT} + 2R_L\right)$$

$$= 0.89 \times \frac{15308}{500} \times \left(0.7 + 2\right)$$

$$= 74\text{V}$$

4.2.2 Current transformers

Assuming that the CT is a 30 VA 5P20, the knee point voltage can be calculated as:

$$V_k = \frac{VA}{In} \times ALF$$
$$= \frac{30}{1} \times 20$$
$$= 600V$$

The CTs knee point voltage should be at least 4 times Vs so that an average operating time of 30 ms is achieved:

$\frac{V_K}{V_S} = \frac{600}{74} = 8.1$, since Vk/Vs = 8.1, a K factor equal to 0.89 should not used because the protection will not be stable. From FIGURE 34, If Vk/Vs = 8.1, then K is equal to 0.98. As a result, Vs and Vk/Vs should be recalculated as follows:

$$V_S = KI_F\left(R_{CT} + 2R_L\right)$$
$$= 0.98 \times \frac{15308}{500} \times (0.7 + 2)$$
$$= 81V$$

$\frac{V_K}{V_S} = \frac{600}{81} = 7.4$, from FIGURE 34 when Vk/Vs is equal to 7.4, the K factor is 0.96 approximately. Since the K factor used to recalculate Vs is higher than 0.96, the protection will be stable. Therefore, a K factor equal to 0.98 is appropriate.

4.2.3 Discriminating zone - Primary operating current

The primary operating current should be made less than 30% of the minimum fault current and more than the full load current of the largest incomer. Therefore if one of the incomer CTs becomes open circuit, the differential protection will not maloperate. It is assumed that 30% of the minimum fault current is more than the full load current of the largest circuit.

As stated before, the primary operating current should be above the full load current of the largest incomer. It is important to consider that the primary operating current should not be increased too much, because this will sacrifice some speed, and in any case, stability is maintained by the check feature.

$$\text{Full Load current, } I_{FLC} = \frac{100MVA}{132kV\sqrt{3}}$$
$$= 437.4A$$

Now if we assume that the magnetizing current taken by each CT at 81 V is 0.072 A and the relay current setting is 0.8 A, we can calculate the discriminating zone primary effective operating current as:

$$\text{Primary Effective Operating current, } I_P = \text{CT Ratio}\left(I_r + nI_e\right)$$
$$= \frac{500}{1}\left(0.8 + (5x0.072)\right)$$
$$= 580A$$
$$= 132\% \text{ of } I_{FLC}$$

Since the primary effective setting is greater than the full load current, we can say the relay setting of 0.8 A is suitable for the discriminating zone.

4.2.4 Check zone - Primary operating current calculation

For phase fault schemes, the check zone is set similarly to the discriminating zone. A set of different current transformers from those used in the discriminating zone are required. No CT switching is required, and no current transformers from the bus coupler or bus section breakers are needed.

Using the same reasoning and assumptions as already used for the discriminating zone, we can calculate for the check zone:

$$\begin{aligned}\text{Primary Effective Operating current, } I_P &= \text{CT Ratio}\left(I_r + nI_e\right)\\ &= \frac{500}{1}\left(0.8 + \left(6\text{x}0.072\right)\right)\\ &= 616\text{A}\\ &= 141\% \text{ of } I_{FLC}\end{aligned}$$

Since the primary effective setting is greater than the full load current, we can say that that relay setting of 0.8 A is suitable for the check zone.

4.2.5 Stabilizing resistor calculation

The required value of stabilizing resistor, R_{ST}, is:

$$\begin{aligned}R_{ST} &= \frac{V_S}{\text{[87] Threshold I Diff}}\\ &= \frac{81}{0.8}\\ &= 102\Omega\end{aligned}$$

For this application a 102 Ω resistor, Schneider Electric Part No. ZB9016 738, can be supplied on request which can be adjusted to any value between 90 Ω and 150 Ω. Thus a setting of 102 Ω is available.

It may be possible to use the P79x accessory with a stabilizing resistance of 82.5 Ω. Since 82.5 Ω is less than 102 Ω, the relay setting current must be modified. (The stability voltage is fixed by the requirements of the scheme). In this case the [87] Threshold Idiff is calculated as follows:

$$\begin{aligned}\text{[87] Threshold I Diff} &= \frac{V_S}{R_{ST}}\\ &= \frac{81}{82.5}\\ &= 1\text{A}\end{aligned}$$

If a 1 A setting still results in a primary operating current that does not exceed 30% of the minimum fault current and that is not lower than the full load current of the largest incomer, then the P79x accessory is adequate.

4.2.6 Non-linear resistor

If the peak voltage developed across the relay circuit under maximum internal fault conditions exceeds 3000 V peak then a suitable non-linear resistor should be connected across the relay and stabilizing resistor to protect the insulation of the CTs, relay and interconnecting leads. The maximum fault voltage assuming no CT saturation is calculated as follows:

$$
\begin{aligned}
V_F &= I_F^{'}\left(R_{CT} + 2R_L + R_{ST} + R_R\right) \\
&= 15308x\,\frac{1}{500}\left(0.7 + 2 + 102\right) \\
&= 3206V
\end{aligned}
$$

Based upon this and assuming that the CT kneepoint voltage is 300 V, we can estimate the peak voltage as:

$$
\begin{aligned}
V_P &= 2\sqrt{2V_K\left(V_F - V_K\right)} \\
&= 2\sqrt{2x600\left(3206 - 600\right)} \\
&= 3537V
\end{aligned}
$$

This value is above the peak voltage of 3000 V and therefore a non-linear resistor is required. The non-linear resistor should be chosen based on the CT secondary rating, maximum internal fault level and stability voltage. For this case the most appropriate Metrosil type is 600A/S3/I/S802. This Metrosil consists of three discs connected independently for this three phase application.

It may be possible to use the P79x accessory. Two non-linear resistors options are available and they are defined according to the transient energy withstand. Consider the P79x technical documentation and the P79x energy limit tool to determine the suitability of the P79x.

NOTE: The kneepoint voltage value used in the above formula should be the actual voltage obtained from the CT magnetising characteristic and not a calculated value.

4.2.7 Busbar supervision

The supervision element should be set to operate when the primary current is 25 A or 10% of the lowest circuit rating, whichever is greater. Assuming that 25 A is greater than 10% of the smallest circuit current we can calculate the supervision setting as:

$$
\begin{aligned}
\text{Buswire supervision setting} &= \frac{25A}{\text{CT Ratio}} \\
&= 0.05A
\end{aligned}
$$

Therefore the [95] Threshold I Sup element should be set to 0.05 A with a time delay setting, [95] Fault timer t Sup, of 3 s.

The [95] Measurement Filter should also be set to Fourier, since the [87] Measurement Filter was set to Fourier. As the output contacts are latched, set the [95] Reset Timer tReset to 0.

4.2.8 Relay Settings

The differential element (either check zone or discriminating zone) should be set as follows:

Name	Value
OP PARAMETERS	
CONFIGURATION	
CONNECTION	
Protection line select.	[87] PHASE
Input selection	Current
Phases Text	L1,L2,L3
Line CT primary	500A
Line CT sec	1 A
LED	
GROUP SELECT	

Name	Value
OP PARAMETERS	
CONFIGURATION	
PROTECTION G1	
[87] PHASE DIFF. PROTEC...	
[87] Phase diff. Pro...	Yes
[87] Threshold I Diff=	0.80In
[87] Fault Timer tdiff=	0.00s
[87] Check Zone?	Yes
[87] Reset Timer tRe...	0.00s
[87] Measurement Filter	Fourier mode
[95] PHASE BUS-WIRE SUP...	
PROTECTION G2	

The buswire supervision element should be set as follows:

Name	Value
OP PARAMETERS	
CONFIGURATION	
PROTECTION G1	
[87] PHASE DIFF. PROTEC...	
[95] PHASE BUS-WIRE SUP...	
[95] Phase Bus-Wire ...	Yes
[95] Threshold I Sup=	0.05In
[95] Fault timer t Sup=	3.00s
[95] Reset Timer tRe...	0.00s
[95] Measurement Filter	Fourier mode
PROTECTION G2	

The trip command should be configured as Trip [87] tDiff, so that relay output 1 is asserted when the differential element operates:

Name	Value
OP PARAMETERS	
CONFIGURATION	
PROTECTION G1	
PROTECTION G2	
AUTOMAT. CTRL	
TRIP COMMANDS	
CB Operating time	0.1s
Trip Commands	Trip [87] tDiff
LATCH FUNCTIONS	

4.3 Motor / generator applications

The same calculation principles that apply for the three phase protection of busbars can be applied to motors and generators, although special consideration of the fault current will be required. For these applications, the machine contribution to an external fault should be used in the stability voltage calculation and this can be significantly lower than the maximum internal fault current that should be used in the non-linear resistor calculation. For motors the starting current or locked rotor current value is usually used in the stability calculation and this will lead to relatively small CT requirements. Often the most sensitive relay settings are used and buswire supervision is rarely applied.

5. SETTING GROUP SELECTION (P721 & P723 ONLY)

MiCOM P721 and P723 relays have two setting groups associated to the protection functions named PROTECTION G1 and PROTECTION G2. Only one group is active.

Switching between the groups can be done using:

- The relay front panel interface (**CONFIGURATION** > **GROUP SELECT** > **SETTING GROUP 1** or **2**),
- A dedicated logic input (**AUTOMAT. CTRL** > **INPUT X** > **CHANGE SETTING**) where X is the chosen logic input,
- The communications port (refer to the Mapping Database for detailed information).

To avoid any false trip, the change of setting group is only carried out when no protection function is running.

If a setting group change is received during any protection or automation function, it is stored and executed after the last timer has elapsed.

The user can check which one of the active group is active looking under the OP PARAMETERS menu.

The user can also assign the active group to an output relay. Using a normally open contact, this means that:

- an open contact indicates that the active group is Group 1
- a closed contact indicates that the active group is Group 2

5.1 Change of setting group done by a digital input

The setting group can be changed by the activation of a digital input (on level).

Warning: if the digital input that has been assigned to the change of setting group operates on level (low or high), it is not possible to change the setting group by remote communication or the front panel.

5.2 Switch between active groups

When powering on the relay, the group selected (Group 1 or Group 2) corresponds to the state of the logic input. This means:

<u>A - With a Logic input configuration = 0</u>

Group 1 = logic Input is not active
Group 2 = logic Input is active

If the programmed logic input is supplied with +V, the active group will be G1.
If the programmed logic input is not supplied with +V, the active group will be G2.

<u>B - With a Logic input configuration = 1</u>

Group 1 = logic Input is not active
Group 2 = logic Input is active

If the set logic input is energized with +V, the active group will be G2.
If the set logic input is not energized with +V, the active group will be G1.

5.3 Priority

When changing parameters through the front panel, the priority is given to the user that takes local control of the relay when entering a password. Change of the setting group using a remote command is not allowed while the password is active (5 minutes).

ORIGIN OF THE ORDER	**PRIORITY LEVEL**
FRONT PANEL	MAXIMUM
LOGIC INPUT	MEDIUM
REMOTE COMMUNICATIONS	MINIMUM

6. MAINTENANCE MODE

This menu allows the user to verify the operation of the protection functions without actually sending any external command (Tripping or signaling).

The maintenance mode can be selected using a logic input, control command (rear or front port), or by front panel interface. The end of maintenance mode is done by logic input, by control command or on the front panel interface time out (5 minutes) and by turning off the power supply.

Maintenance Mode	
	YES

When this menu is activated (set to YES), the Alarm LED flashes and the alarm message **MAINTENANCE MODE** appears on the display. In this case, all the output contacts are blocked and no command can be issued to these contacts, even if a protection threshold associated to one of these output contacts has been crossed.
(If a protection threshold is crossed, all associated LEDs will be ON, even the TRIP LED, if the threshold is associated to RL1).

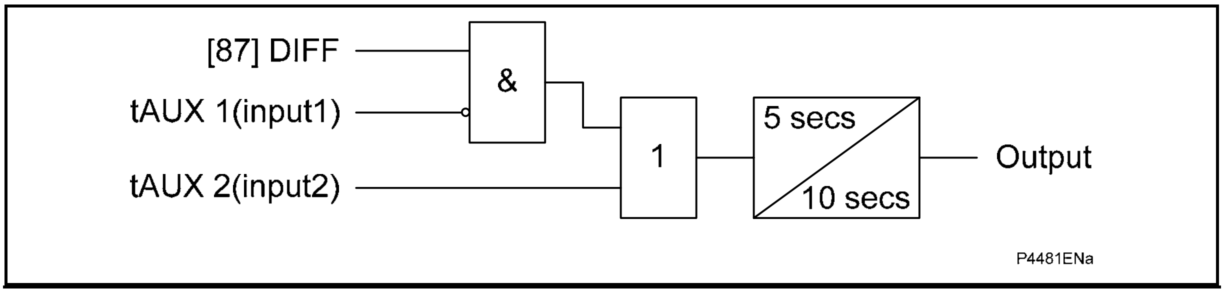
RELAYS	8765W4321
CMD	000000000

This window allows the user to verify the external wiring to the relay output contacts. To do this, the user must assign a 1 to any of the output contacts, which will close the contact, and the continuity of the wiring can be verified.

7. LOGIC EQUATIONS (P721 & P723)

The logic equations can be used to construct complex Boolean logic using the following operators: AND NOT, OR NOT, AND, OR.

An example logic implementation using Equation A is shown below:



8. REAL TIME CLOCK SYNCHRONIZATION VIA OPTO-INPUTS

In modern protective schemes it is often desirable to synchronize the relay's real time clock so that events from different relays can be placed in chronological order. This can be done using the communication interface connected to the substation control system or through an opto-input. Any of the available opto-inputs on the P72x relay can be selected for synchronization. Pulsing this input results in the real time clock snapping to the nearest minute. The recommended pulse duration is 20 ms, to be repeated no more than once per minute.

The following table shows an example of the time synchronization function and assumes a time format of hh:mm:ss.

Time of "Sync. Pulse"	Corrected Time
19:47:00.000 to 19:47:29.999	19:47:00.000
19:47:30.000 to 19:47:59.999	19:48:00.000

9. EVENT RECORDS

The relay records and time tags up to 250 events and stores them in a non-volatile (flash) memory. This allows the system operator to analyze the sequence of events that occurred in the relay after a particular power system condition, or switching sequence. When the available space is used up, the new fault automatically overwrites the oldest fault.

The relay's real time clock time tags each event with a resolution of 1 ms.

The user can view event records through the front panel interface, through the EIA (RS) 232 port, or remotely, through the rear EIA (RS) 485 port.

10. FAULT RECORDS

Each time any of the programmed thresholds are crossed, a fault record is created and stored in memory. The fault record tags up to 25 faults and stores them in non-volatile (flash) memory. This allows the system operator to identify and analyze network failures. When the available memory space is used up, the new fault automatically overwrites the oldest fault.

To view actual fault records, select **RECORD** > **Fault Record**, which can display up to 25 stored records. These are records such as fault flags and fault measurements. The time stamp in the fault record is more accurate than the corresponding time stamp in the event record. This is because events are logged some time after the actual fault record happens.

The user can view event records through the front panel interface, through the EIA (RS) 232 port, or remotely, through the rear EIA (RS) 485 port.

11. INSTANTANEOUS RECORDER

Each time any of programmed thresholds are crossed, an instantaneous record is created and displayed under **RECORDS** > **Instantaneous**.

The last five instantaneous records are displayed showing the number of faults, hour, date, origin (crossing of 87N, 95N, 87 and 95 thresholds), duration, and if the crossing of the threshold led to a trip or not.

12. DISTURBANCE RECORDER

The disturbance recorder has its own dedicated memory space. Up to 5 disturbance records of 3 seconds duration each can be stored. When the available memory space is used up, the new record automatically overwrites the oldest record.

Samples are taken 32 times per cycle.

Each disturbance record consists of analog and digital channels. The relevant CT ratios for the analog channels are also extracted to enable scaling to primary quantities. The following table shows the **RECORD** > **Disturb Record** menu.

MENU TEXT	SETTING RANGE		STEP SIZE
	MIN	MAX	
Disturb Record			
Pre-Time	100 ms	3000 ms	100 ms
Post-Time	100 ms	3000 ms	100 ms
Disturb Rec Trig	On Instantaneous	On Trip	

The total available disturbance recording time is 6.0 s (pre-trigger time plus post-trigger time).
For example, using the default settings, if the pre-trigger time time is set to 100 ms and the post–trigger time to 2.5 s, the total disturbance recording time is 2.6 s.

13. CT REQUIREMENTS

The P72x CT requirements are indicated with respect to the Measurement Filter setting and the application. The following CT requirements are for busbar and REF/BEF applications considering the three measurement filter modes.

If the Measurement Filter is set to Fourier mode, the relay is tuned to operate with the fundamental component of the differential current.

If the Measurement Filter is set to Sample mode, the relay operates when $\frac{I_{diff_{peak-peak}}}{2 \times \sqrt{2}} > \text{setting}$.

If the Measurement Filter is set to Fast sample mode, the relay operates when $I_{diff_{instantaneous}} > 2 \times \sqrt{2} \times \text{setting}$.

The general stability voltage requirement is described by $V_S \geq K \times I_F \left(2R_L + R_{CT}\right)$, which expresses the required stability voltage setting (V_S) in terms of an external fault (I_F), burden ($2R_L + R_{CT}$) and a stability factor (K).

The assumption that one CT is completely saturated for an external fault does not describe what actually happens when asymmetric CT saturation occurs. The CT that saturates only saturates during parts of each current wave form cycle. This means that the spill current waveform seen by the differential element is highly non-sinusoidal. The sensitivity of the relay element to non-sinusoidal spill waveforms for through faults is a function of the Measurement Filter setting (Fourier, Sample and Fast sample mode), its operating speed, the differential voltage or current settings (Threshold V Diff or Threshold I Diff) and the wave shapes.

The Measurement Filter and the operating speed are factors that are inherent to the relay design. Spill current wave shapes are related to the ratio of the CT kneepoint voltage (Vk) to relay circuit impedance. The stability voltage setting, $V_S = I_S R_{ST}$, is determined by the current setting and the stabilizing resistor. The stability of the high impedance differential relay during through faults is determined by the ratio V_K/V_S. Where V_K is the CT knee point voltage and V_S is the stability voltage setting.

The relationship between the ratio V_K/V_S and the required stability factor K has been found to be a general form for various relay designs that have undergone conjunctive testing by Schneider Electric. It is the absolute values of V_K/V_S and K that vary in the relationship for different relay designs. The relationship that has been found for the P72x, taking into account the application and the Measurement Filter setting, are shown in the following sections.

Once stability has been considered, the next performance factor to take into account is the operating time for internal faults. The CT kneepoint voltage, as a multiple of the protection stability voltage setting (V_K/V_S), governs the operating time of a differential relay element for heavy internal faults with transiently offset fault current waveforms. Using the operating time curves derived for the P72x, it is possible to identify the ratio V_K/V_S that is required to achieve a desired average operating speed for internal faults.

The approach with older electromechanical high impedance relays was to use a universally safe K factor of 1.0, but the older relays operated quickly with a lower Vk/Vs ratio (Vk/Vs = 2.0). With more modern relays it is desirable to identify the optimum K factor for stability, so that the required Vk/Vs ratio for stability and operating speed will not make CT kneepoint voltage requirements worse than traditional requirements.

13.1 Restricted earth fault/Balanced earth fault (REF/BEF) applications

The operating characteristics shown in FIGURE 35, FIGURE 36 and FIGURE 37 are valid when
5 ≤ X/R ≤ 120, 0.5 ≤I f ≤ 20, [87N] Threshold I Diff = 0.1In and [87] Fault timer tDiff = 0 s.

FIGURE 35 shows the CT requirements when the P72x is used in a REF/BEF application and the Measurement Mode is set to Fourier. When V_K/V_S is 4, the average operating time is 40 ms and K is approximately 0.8. The user should consider these characteristics when selecting Vk/Vs, K factor and average operating time as has been explained in the previous setting examples.

NOTE: For the P721 and the P723 (current inputs 55-56 and 47-48), the maximum internal fault level threshold (for the 0.004 to 2In range) must not exceed 20In.

FIGURE 35 shows the CT requirements when the P72x is used in a REF/BEF application and the Measurement Mode is set to Fourier. The maximum K factor is approximately 0.98. The operating time when V_K/V_S = 4 is 41 ms and K is approximately 0.76.

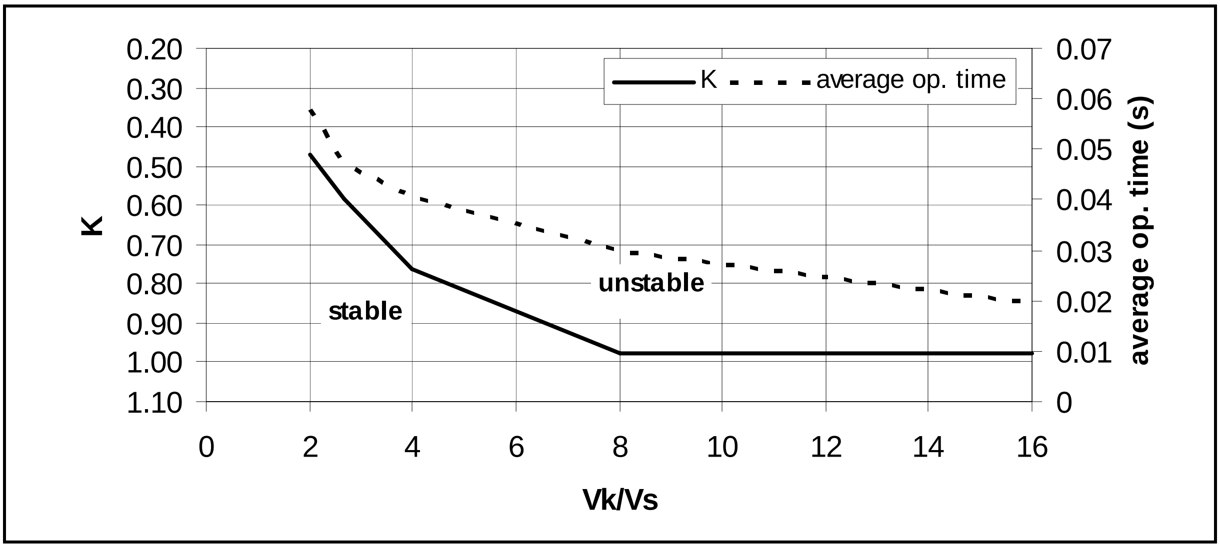


FIGURE 35: CT REQUIREMENTS- REF/BEF- FOURIER MODE

FIGURE 36 shows the CT requirements when the P72x is used in a REF/BEF application and the Measurement Mode is set to Fast Sample. The maximum K factor is approximately 0.91. The operating time when V_K/V_S = 4 is 41 ms and K is approximately 0.76.

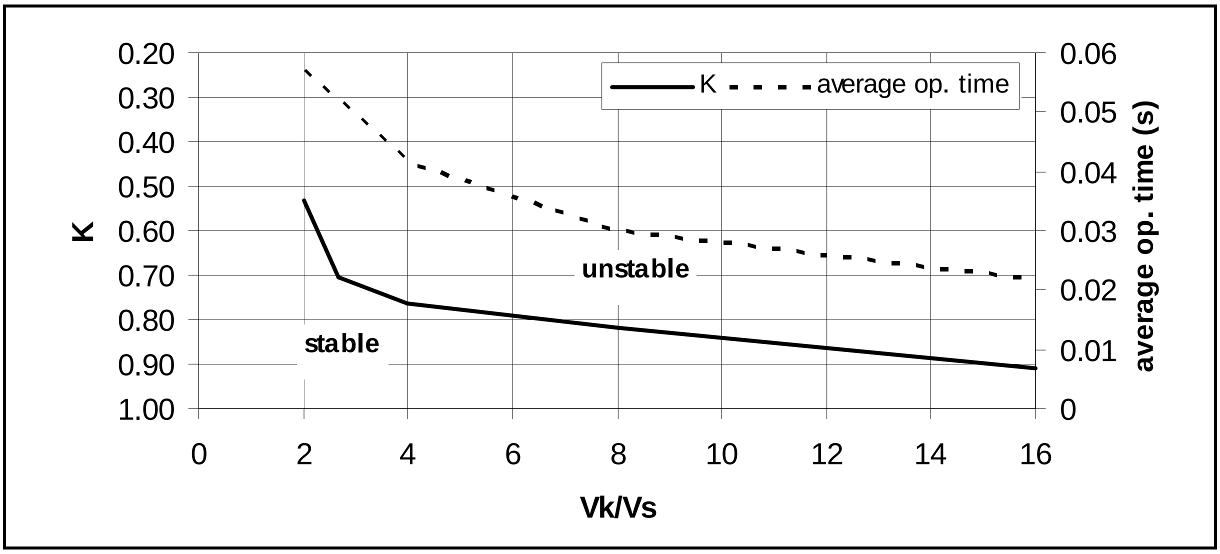


FIGURE 36: CT REQUIREMENTS- REF/BEF- FAST SAMPLE MODE

FIGURE 37 shows the CT requirements when the P72x is used in a REF/BEF application and the Measurement Mode is set to Sample. The maximum K factor is approximately 0.91. The operating time when $V_K/V_S = 4$ is 55 ms and K is approximately 0.76.

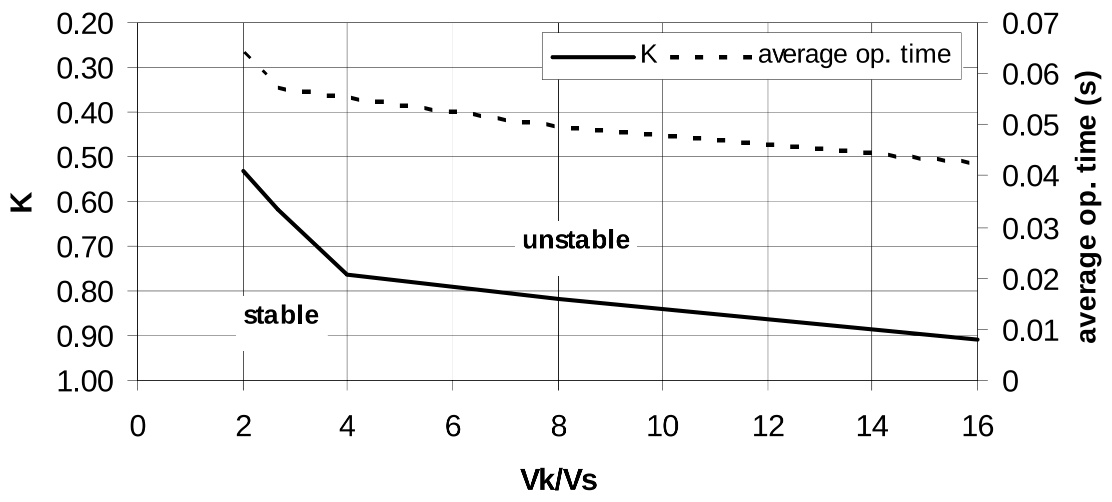


FIGURE 37: CT REQUIREMENTS- REF/BEF- SAMPLE MODE

13.2 Busbar application

The operating characteristics shown in FIGURE 38, FIGURE 39 and FIGURE 40 are valid when 5≤X/R≤ 120, 0.5≤If≤ 50 and [87N] Threshold I Diff = 0.1In.

FIGURE 38 shows the CT requirements when the P72x is used in a busbar application and the Measurement Mode is set to Fourier. The maximum K factor is approximately 0.98. When VK/VS is 4, the average operating time is 30 ms and K is approximately 0.89. The user should consider these characteristics when selecting Vk/Vs, the K factor and the average operating time as explained in the previous setting examples.

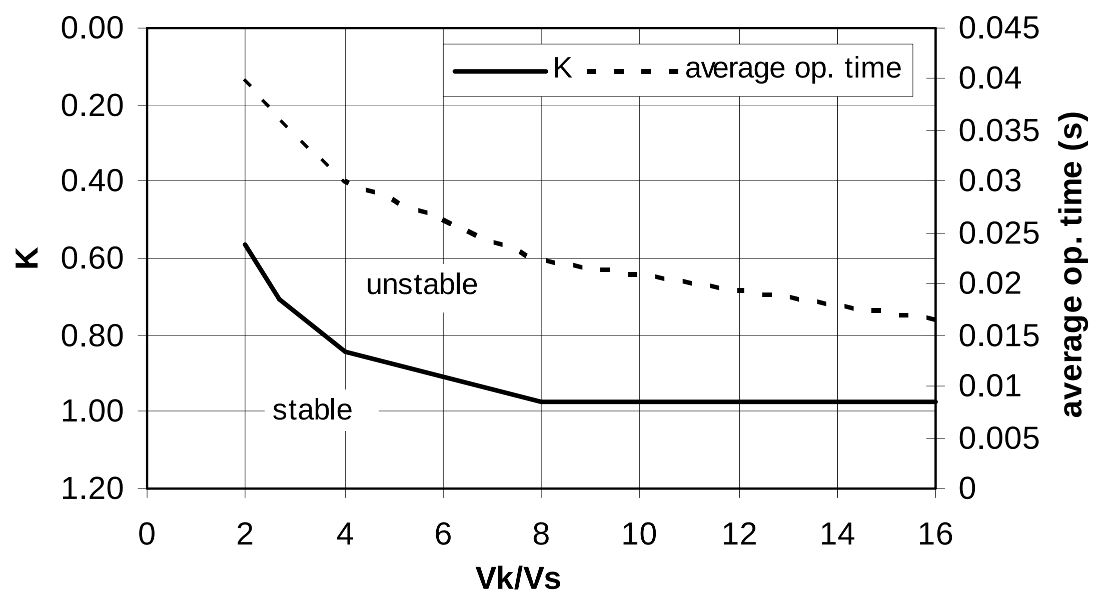


FIGURE 38: CT REQUIREMENTS- BUSBAR - FOURIER MODE

FIGURE 39 shows the CT requirements when the P72x is used in a busbar application and the Measurement Mode is set to Fast Sample. The maximum K factor is approximately 0.82. When V_K/V_S is equal to 4, the average operating time is 34 ms and K is approximately 0.80.

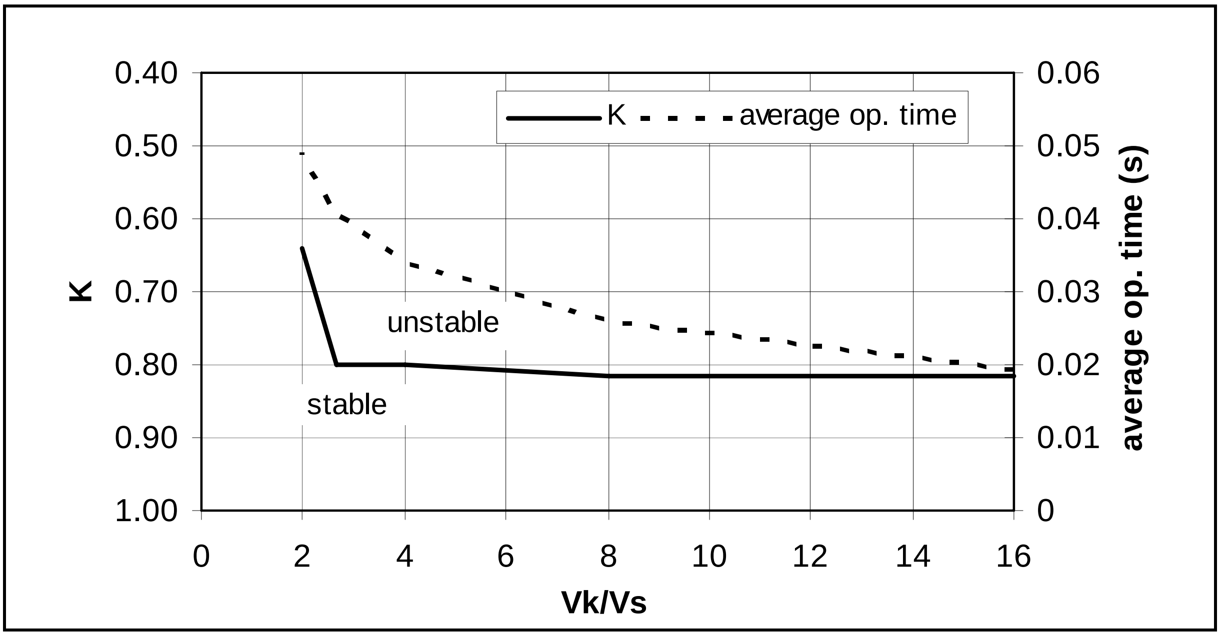


FIGURE 39: CT REQUIREMENTS- BUSBAR – FAST SAMPLE MODE

FIGURE 40 shows the CT requirements when the P72x is used in a busbar application and the Measurement Mode is set to Sample. The maximum K factor is approximately 0.82. When V_K/V_S is equal to 4, the average operating time is 53 ms and K is approximately 0.80.

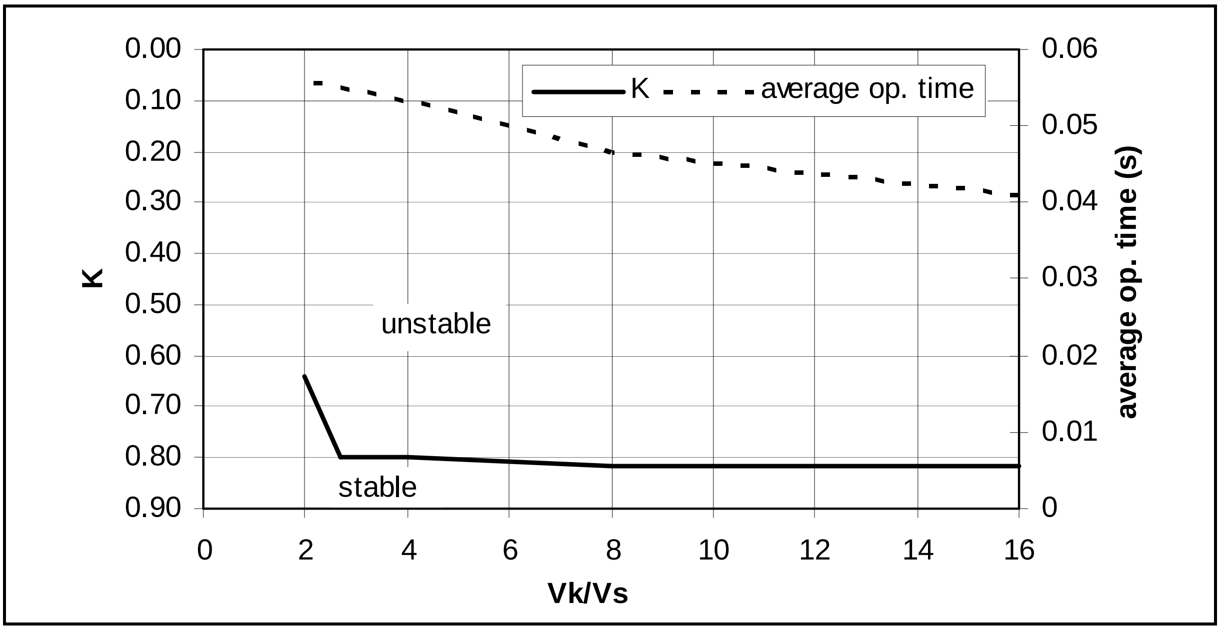


FIGURE 40: CT REQUIREMENTS- BUSBAR - SAMPLE MODE

COMMUNICATION DATABASE

BLANK PAGE

MODBUS DATABASE

MiCOM P721/P723

VERSION V11

BLANK PAGE

CONTENT

1. INTRODUCTION 5
1.1 Purpose of this document 5
2. MODBUS PROTOCOL 6
2.1 Technical characteristics of the MODBUS connection 6
2.1.1 Parameters of the MODBUS connection 6
2.2 Synchronisation of exchanges messages 6
2.3 Message validity check 6
2.4 Address of the MiCOM relays 6
2.5 MODBUS functions of the MiCOM relays 7
2.6 Presentation of the MODBUS protocol 7
2.6.1 Frame size received by the protection device (slave) 7
2.6.2 Format of frames sent by the MiCOM relays 8
2.6.3 Messages validity check 8
3. MiCOM P721 AND P723 RELAY DATABASE ORGANISATION 9
3.1 Description of the application mapping 9
3.1.1 Settings 9
3.2 Page 0h – Product information, remote signalling and measurements 9
3.3 Page 1h – General remote parameters (part 1) 12
3.4 Page 2h –Setting group 1 remote parameters 16
3.5 Page 3h – Setting group 2 remote parameters 17
3.6 Page 4h –Access in writing 17
3.7 Page 5h – Boolean equations remote parameters 18
3.8 Page 6h – General remote parameters (part 2) 22
3.9 Page 7h – Remote device status 22
3.10 Page 8h –Remote data and time 22
3.11 Pages 9h to 21h – Disturbance record data 23
3.11.1 Meaning of each value channel 24
3.11.2 Calculation formula for phase current values 24
3.11.3 Calculation formula for earth current values 24
3.11.4 Logic channels 24
3.12 Page 22h – Disturbance record index frame 24
3.13 Page 35h 25
3.14 Page 36h – Event older record data 27
3.15 Page 37h – Fault record value data 28
3.15.1 Calculation formula for phase current values 28
3.15.2 Calculation formula for earth current values 28
3.16 Page 3Eh – Fault older record data 28

3.17 Pages 38h to 3Ch – Disturbance record and channel selection 29

3.17.1 Disturbance record and channel selection (13 words) 29

3.17.2 Calculation formula for phase current values 30

3.17.3 Calculation formula for earth current values 30

3.18 Pages 3Dh – Disturbance records number available 30

4. DESCRIPTION OF THE MAPPING FORMAT 32

4.1 Disturbance record additional information 44

4.1.1 MODBUS request definition used for disturbance record 44

4.1.2 Request to know the number of disturbance records in SRAM 44

4.1.3 Service requests 44

4.1.4 Disturbance record upload request 45

4.1.5 Index frame upload request 45

4.1.6 Request to retrieve the oldest non-acknowledge event 45

4.1.7 Request to retrieve a dedicated event 45

4.1.8 Modbus request definition used to retrieve the fault records 46

4.1.9 Request to retrieve the oldest non-acknowledge fault record 46

4.1.10 Request to retrieve a dedicated fault record 46

1. INTRODUCTION

1.1 Purpose of this document

This document describes the characteristics of the different communication protocol of **MiCOM P721** and **P723** relays.

The available communication protocols on the relay are listed below:

– MODBUS,

– IEC 60870-5-103,

– DNP3

The K-BUS/Courier is not available with the P72x relays.

2. MODBUS PROTOCOL

MiCOM P721 and **P723** relays can communicate by a RS 485 link behind the unit following the MODBUS RTU protocol.

2.1 Technical characteristics of the MODBUS connection

2.1.1 Parameters of the MODBUS connection

The different parameters of the MODBUS connection are as follows:

– Isolated two-point RS485 connection (2kV 50Hz),

– MODBUS line protocol in RTU mode

Communication speed can be configured by an operator dialog in the front panel of the relay:

Baud rate (dec)
300
600
1200
2400
4800
9600
19200
38400

Transmission mode of the configured characters by operator dialog

Mode
1 start / 8 bits / 1 stop: total 10 bits
1 start / 8 bits / even parity / 1 stop: total 11 bits
1 start / 8 bits / odd parity / 1 stop: total 11 bits
1 start / 8 bits / 2 stop: total 11 bits

2.2 Synchronisation of exchanges messages

A character received after a silence (≥ 3 characters transmission time) is considered as a frame start.

2.3 Message validity check

The validation of a frame is performed with a 16-bit Cyclical Redundancy Check (CRC). Generator polynomial: $1+x^2+x^{15}+x^{16}$ = 1010 0000 0000 0001 (binary) = A001 (hexadecimal)

2.4 Address of the MiCOM relays

The address of the MiCOM relay on a same MODBUS network is situated between 1 and 255. The address 0 is reserved for the broadcast messages

2.5 MODBUS functions of the MiCOM relays

Protection device data may be read or modified by using function codes. Following are the available function codes. Function codes to read from or write into parameter cells in the protection device are described in the listed following table.

Function Nr.	Data Read	Data Write	Data Format & Type
1	X		N bits
2	X		N bits
3	X		N words
4	X		N words
5		X	1 bit
6		X	1 word
7	Fast		8 bits
8	X		Diagnostics counter
11	X		Event counter
15		X	N bits
16		X	N words

2.6 Presentation of the MODBUS protocol

Master slave protocol, all exchange understands a master query and a slave response

Frame size received from **MiCOM P721** and **P723** relays.

2.6.1 Frame size received by the protection device (slave)

Frame transmitted by the master (query):

Slave number	Function code	Information	CRC16
1 byte	1 byte	n bytes	2 bytes
0 à FFh	1 à 10h		

Slave number:

The slave number is situated between 1 and 255.

A frame transmitted with a slave number 0 is globally addressed to all pieces of equipment (broadcast frame)

Error code:

The MiCOM P72x relays manages the two following error codes:

- Code 01: the function code is not authorised or is unknown.
- Code 03: one of the following value from the data field is incorrect:
  - control of data being read,
  - control of data being written,
  - control of data address,
  - length of request for data message.

CRC16:

Value of the CRC16 calculated by the master.

NOTE: The MiCOM relay does not respond to globally broadcast frames sent out by the master.

2.6.2 Format of frames sent by the MiCOM relays

Frame sent by the MiCOM relay (response)

Slave number	Function code	Data	CRC16
1 byte	1 byte	n bytes	2 bytes
1 à FFh	1 à 10h		

Slave number:

The slave number is situated between 1 and 255.

Function code:

Processed MODBUS function (1 to 16).

Data:

Contains reply data to master query .

CRC 16:

Value of the CRC 16 calculated by the slave.

2.6.3 Messages validity check

When **MiCOM P721** and **P723** relays receive a master query, it validates the frame:

– If the CRC is false, the frame is invalid. **MiCOM 721** and **P723** relays do not reply to the query. The master must retransmit its query. Excepting a broadcast message, this is the only case of non-reply by **MiCOM P721** and **P723** relays to a master query.

– If the CRC is good but the MiCOM relay can not process the query, it sends an exception response.

Warning frame sent by the MiCOM relay (response)

Slave number	Function code	Warning code	CRC16
1 byte	1 byte	1 byte	2 bytes
1 to FFh	81h or 83h or 8Ah or 8Bh		pf ... PF

Slave number:

The slave number is situated between 1 and 255.

Function code:

The function code returned by the MiCOM relay in the warning frame is the code in which the most significant bit (b7) is forced to 1.

Warning code:

On the 8 warning codes of the MODBUS protocol, the MiCOM relay manages two of them:

- code 01: function code unauthorised or unknown.
- code 03: a value in the data field is unauthorised (incorrect data).
  - Control of pages being read
  - Control of pages being written
  - Control of addresses in pages
  - Length of request messages

CRC16:

Value of the CRC16 calculated by the slave.

3. MiCOM P721 AND P723 RELAY DATABASE ORGANISATION

3.1 Description of the application mapping

3.1.1 Settings

MiCOM P721 and P723 application mapping has 7 pages of parameters.

Parameters are organized in pages.

The characteristics are the following:

Page	Data type	Read permission	Write permission
0h	Product information, remote signalling, measurements	Through communication	
1h	General remote parameters (part 1)	X	X
2h	Setting group 1 remote parameters	X	X
3h	Setting group 2 remote parameters	X	X
4h	Remote controls	X	X
5h	Boolean equations remote parameters	X	X
6h	General remote parameters (part 2)	X	X
7h	Remote device status	Fast	
8h	Remote data and time	X	X

They are completely listed below.

3.2 Page 0h – Product information, remote signalling and measurements

Read access only

Read access only.
Legend: Reserved: Free for future use
Obsolete: Do not use (reserved for old versions)

Address	Group	Description	Values range	Step	Unit	Format	Fault Value	Range
0000	Relay Information	Device description characters 1 and 2:	"00" – "ZZ"			F10	"P7"	
0001		Device description characters 3 and 4: Device P721 Device P723	"00" – "ZZ"			F10	"21" "23"	
0002		Device description characters 5 and 6:	"00" – "ZZ"			F10	" "	
0003		Unit reference characters 1 and 2	"00" – "ZZ"			F10	"AL"	
0004		Unit reference characters 3 and 4	"00" – "ZZ"			F10	"ST"	
0005		Software version	100 – 999	1		F21		
0006		Front/rear communication	0 – 3	1		F41		
0007		Internal phase ratio		1		F1	3277	
0008		Internal earth ratio		1		F1	16350	
0009		Info General Start (only if IEC 60870-5-103 protocol)	0 – 1	1		F1		
000A – 000B		Reserved						

Address	Group	Description	Values range	Step	Unit	Format	Fault Value	Range
000C		LED Status	Binary	1		F73	8h (healthy)	
000D		Real Active Setting Group (after taking into account the protection flags)	1 – 2	1		F51		
000E		Password active ?	0 – 1	1		F24	0 (no)	
000F		Material alarm status	Binary	1		F45	0 (no warning)	
0010	Remote signalling	Logical inputs status	Binary	1		F12	0 (no input)	
0011		Logic output relay status	Binary	1		F13	10h (WD)	
0012–0013		logical inputs data signalisation	Binary	1		F20		
0014		Trip status	0 – 3	1		F22	0	
0015–0016		Reserved						
0017		Information of [87] CZ status	Binary	1		F17	0	
0018		Information of [95] SUP status	Binary	1		F17	0	
0019		Information of [87] DIFF status	Binary	1		F17	0	
001A		Information of [95N] SUP status	Binary	1		F16	0	
001B		Information of [87N] DIFF status	Binary	1		F16	0	
001C–001D		Information of general instantaneous status	Binary	1		F38	0	
001E		Information of equation status	Binary	1		F61	0	
001F		Reserved						
0020	Alarms memorised	Memorisation of [95] SUP non acknowledged alarms	Binary	1		F17	0	
0021		Memorisation of [87] DIFF non acknowledged alarms	Binary	1		F17	0	
0022		Reserved						
0023		Memorisation of [95] tSUP non acknowledged alarms	Binary	1		F17	0	
0024		Memorisation of [87] tDIFF non acknowledged alarms	Binary	1		F17	0	
0025		Reserved						
0026–0028		Memorised flag for non acknowledged alarms	Binary	1		F36	0	
0029		Number of disturbance records available	0 – 5	1		F1	0	
002A		Tripping origin	0 – 26	1		F78	0	
002B		Memorised logic output relay latched	Binary	1		F13	0	
002C–002E		Reserved						

Address	Group	Description	Values range	Step	Unit	Format	Fault Value	Range
002F	measure-ments	Frequency	4500 – 6500 9999 if out	1	10 mHz	F1	9999	
0030–0031		Phase A RMS value	0 – 600 000	1	10 mA	F18	0	
0032–0033		Phase B RMS value	0 – 600 000	1	10 mA	F18	0	
0034–0035		Phase C RMS value	0 – 600 000	1	10 mA	F18	0	
0036 – 0037		Earth RMS value	0 – 120 000	1	10 mA	F18	0	
0038 – 0039		Phase A maximum RMS value	0 – 600 000	1	10 mA	F18	0	
003A – 003B		Phase B maximum RMS value	0 – 600 000	1	10 mA	F18	0	
003C– 003D		Phase C maximum RMS value	0 – 600 000	1	10 mA	F18	0	
003E – 003F		Earth maximum RMS value	0 – 120 000	1	10 mA	F18	0	
0040– 004F		Reserved						
0050	Amplitudes for sample protection	Phase A Amplitude value of TC secondary (CAN format)			In / Add. 0007h	F1		
0051		Phase B Amplitude value of TC secondary (CAN format)			In / Add. 0007h	F1		
0052		Phase C Amplitude value of TC secondary (CAN format)			In / Add. 0007h	F1		
0053		Earth Amplitude value of TC secondary (CAN format)			In / Add. 0008h	F1		
0054	Amplitudes for fast sample protection	Phase A Amplitude value of TC secondary (CAN format)			In / Add. 0007h	F1		
0055		Phase B Amplitude value of TC secondary (CAN format)			In / Add. 0007h	F1		
0056		Phase C Amplitude value of TC secondary (CAN format)			In / Add. 0007h	F1		
0057		Earth Amplitude value of TC secondary (CAN format)			In / Add. 0008h	F1		
0058	Amplitudes for Fourier protection	Phase A Amplitude value of TC secondary (CAN format)			In / Add. 0007h	F1		
0059		Phase B Amplitude value of TC secondary (CAN format)			In / Add. 0007h	F1		
005A		Phase C Amplitude value of TC secondary (CAN format)			In / Add. 0007h	F1		
005B		Earth Amplitude value of TC secondary (CAN format)			In / Add. 0008h	F1		
005C– 00DF		Reserved						

Address	Group	Description	Values range	Step	Unit	Format	Fault Value	Range
00E0–00EF	HMI screen	Copy of the HMI screen	ASCII code			16 x F10		
00F0–00FF		Reserved						

3.3 Page 1h – General remote parameters (part 1)

Read and write access

Address	Group	Description	Values range	Step	Unit	Format	Fault Value	Range
0100	Remote settings	Address of front port	1 – 255	1		F1	1	
0101		HMI language	0 – 13			F63		
0102		Password characters 1 and 2	"00" – "ZZ"			F10	AA	
0103		Password characters 3 and 4	"00" – "ZZ"			F10	AA	
0104		Frequency	50 – 60	10	Hz	F1	50	
0105	Display	Phases label	0-2			F26	0	
0106		Earth label	0-2			F26	0	
0107–0109		reserved						
010A		User reference characters 1 and 2	"00" – "ZZ"			F10	AL	
010B		User reference characters 3 and 4	"00" – "ZZ"			F10	ST	
010C		Reserved						
010D	Logical input	Configuration of logical inputs active	Binary	1		F11	FFFFh	
010E		Reserved						
010F		AC/DC voltage Type applied to the logical inputs	0 – 1	1		F50	0 (DC)	
0110–011F		Reserved						
0120	Connection	Primary phase CT value	1 – 50000	1	A	F1	1000	
0121		Secondary phase CT value	1 – 5	4	A	F1	1	
0122		Primary earth CT value	1 – 50000	1	A	F1	1000	
0123		Secondary earth CT value	1 – 5	4	A	F1	1	
0124		Differential protection type	0 – 1	1		F79	0 (Earth)	
0125		Analogue input unit mode	0 – 1	1		F75	0 (Amp.)	
0126		Stabilizing Resistor Phase A	300 – 40000	1	Ohm/10	F1	300	
0127		Stabilizing Resistor Phase B	300 – 40000	1	Ohm/10	F1	300	
0128		Stabilizing Resistor Phase C	300 – 40000	1	Ohm/10	F1	300	
0129		Stabilizing Resistor Earth	300 – 40000	1	Ohm/10	F1	300	
012A–012B		Reserved						
012C	Output relays	Local maintenance mode ?	0 – 1	1		F24	0 (no)	
012D		Relays latching	Binary	1		F14	0 (no conf.)	
012E		Fail safe and inversion relays	Binary	1		F60	0 (no conf.)	
012F		Reserved						

Address	Group	Description	Values range	Step	Unit	Format	Fault Value	Range
0130	Rear port communi-cation	Baud rate	0 – 7	1		F4	6 (19200 Bd)	
0131		Parity	0 – 2	1		F5	0 (without)	
0132		Data bits	0 – 1	1		F28	1 (8 bits)	
0133		Stop bit	0 – 1	1		F29	0 (1 bit)	
0134		Communication available ?	0 – 1	1		F24	1 (yes)	
0135		Date Format	0 – 1	1		F48	0 (Private)	
0136		Reserved						
0137		Address of rear port: Modbus ~~Courier~~ IEC870-5-103 DNP3	 1 – 255 1 – 255 1 – 255 1 – 59999				 1 255 1 1	
0138		IEC870-5-103 only : Spontaneous event enabling	0 - 2	1		F80	2 (All)	
0139		IEC870-5-103 only : Commands blocking	0 - 1	1		F24	0	
013A		IEC870-5-103 only : Signals & measurements blocking	0 - 1	1		F24	0	
013B		IEC870-5-103 only : measurements enabling	0 - 3	1		F81	3 (ASDU 3.4 & 9)	
013C–013F		Reserved					0	
0140	Config. setting group	Setting group	1 – 2	1		F51	1 (Group 1)	
0141		Configuration of change of group selection	0 – 1	1		F47	0 (Menu)	
0142		Reserved						
0143	Conf. alarms	Validation of instantaneous alarms auto reset ?	0 – 1	1		F24	0 (no)	
0144		Configuration of alarm reset on fault ?	0 – 1	1		F24	0 (no)	
0145		Inhibition of alarms	Binary	1		F59	0Ch (tAux3 & tAux4)	
0146–014F		Reserved						
0150 – 0153	Conf. LED	LED 5	Binary	1		F19	0 (no conf.)	
0154–0157		LED 6	Binary	1		F19	0 (no conf.)	
0158–015B		LED 7	Binary	1		F19	0 (no conf.)	
015C–015F		LED 8	Binary	1		F19	0 (no conf.)	
0160–0161	Logical input allocation	Logical input 1	Binary	1		F20	0 (no conf.)	
0162–0163		Reserved						
0164–0165		Logical input 2	Binary	1		F20	0 (no conf.)	
0166–0167		Reserved						

Address	Group	Description	Values range	Step	Unit	Format	Fault Value	Range
0168–0169		Logical input 3	Binary	1		F20	0 (no conf.)	
016A–016B		Reserved						
016C–016D		Logical input 4	Binary	1		F20	0 (no conf.)	
016 –016F		Reserved						
0170–0171		Logical input 5	Binary	1		F20	0 (no conf.)	
0172 – 0173		reserved						
0174 – 017B		reserved						
017C		Auxiliary input 1 timer	0 – 20000	1	10 ms	F1	0	
017D		Auxiliary input 2 timer	0 – 20000	1	10 ms	F1	0	
017E		Auxiliary input 3 timer	0 – 20000	1	10 ms	F1	0	
017F		Auxiliary input 4 timer	0 – 20000	1	10 ms	F1	0	
0180	Output relay allocation	Trip	Binary	1		F14	0 (no conf.)	
0181		[87] DIFF	Binary	1		F14	0 (no conf.)	
0182		[87] tDIFF	Binary	1		F14	0 (no conf.)	
0183		[87CZ] check zone	Binary	1		F14	0 (no conf.)	
0184		Buswire shorting	Binary	1		F14	0 (no conf.)	
0185		reserved						
0186		[95] SUP	Binary	1		F14	0 (no conf.)	
0187		[95] tSUP	Binary	1		F14	0 (no conf.)	
0188		[95A] tSUP	Binary	1		F14	0 (no conf.)	
0189		[95B] tSUP	Binary	1		F14	0 (no conf.)	
018A		[95C] tSUP	Binary	1		F14	0 (no conf.)	
018B–018D		reserved						
018E		[87N] DIFF	Binary	1		F14	0 (no conf.)	
018F		[87N] tDIFF	Binary	1		F14	0 (no conf.)	
0190		[95N] SUP	Binary	1		F14	0 (no conf.)	
0191		[95N] tSUP	Binary	1		F14	0 (no conf.)	
0192–0193		reserved						
0194		tAux 1	Binary	1		F14	0 (no conf.)	
0195		tAux 2	Binary	1		F14	0 (no conf.)	
0196		tAux 3	Binary	1		F14	0 (no conf.)	
0197		tAux 4	Binary	1		F14	0 (no conf.)	

Address	Group	Description	Values range	Step	Unit	Format	Fault Value	Range
0198		tEquation A	Binary	1		F14	0 (no conf.)	
0199		tEquation B	Binary	1		F14	0 (no conf.)	
019A		tEquation C	Binary	1		F14	0 (no conf.)	
019B		tEquation D	Binary	1		F14	0 (no conf.)	
019C		tEquation E	Binary	1		F14	0 (no conf.)	
019D		tEquation F	Binary	1		F14	0 (no conf.)	
019E		tEquation G	Binary	1		F14	0 (no conf.)	
019F		tEquation H	Binary	1		F14	0 (no conf.)	
01A0		Logical input 1 (energized)	Binary	1		F14	0 (no conf.)	
01A1		Logical input 2 (energized)	Binary	1		F14	0 (no conf.)	
01A2		Logical input 3 (energized)	Binary	1		F14	0 (no conf.)	
01A3		Logical input 4 (energized)	Binary	1		F14	0 (no conf.)	
01A4		Logical input 5 (energized)	Binary	1		F14	0 (no conf.)	
01A5–01A6		Reserved						
01A7		CB failure (50BF)	Binary	1		F14	0 (no conf.)	
01A8		Active setting group 2	Binary	1		F14	0 (no conf.)	
01A9		Control trip (from communication)	Binary	1		F14	0 (no conf.)	
01AA–01AD		Reserved						
01AE	Automatism	Reserved						
01AF		CB Operating time	10 – 500	1	10 ms	F1	10	
01B0–01B1		Trip command	Binary	1		F6	0 (no conf.)	
01B2–01B3		Trip function latching	Binary	1		F6	0 (no conf.)	
01B4–01B5	Blocking logic	Blocking logic 1	Binary	1		F8	0 (no conf.)	
01B6–01B7		Blocking logic 2	Binary	1		F8	0 (no conf.)	
01B8–01BF		Reserved						
01C0	Default record	Default number to be displayed	1 – 25	1		F1	25 (newest)	
01C1		Instantaneous fault number to be displayed	1 – 5	1		F1	5 (newest)	
01C2–01C4		Reserved						
01C5	Disturbance record	Pre-time	10 – 300	1	10 ms	F1	100	
01C6		Post-time	10 – 300	1	10 ms	F1	200	
01C7		Disturbance starting condition	0 – 1	1		F32	0 (inst.)	

Address	Group	Description	Values range	Step	Unit	Format	Fault Value	Range
01C8–01CF		Reserved						
01D0	CB failure [50BF]	CB failure function ?	0 - 1	1		F24	0 (no)	
01D1		Idiff< CB failure	1 – 100	1	In/100	F1	10	
01D2		tBF	3 – 1000	1	10 ms	F1	10	
01D3		Vdiff< CB failure	5 – 2000	10	100 mV	F1	50	
01D4–01DF		Reserved						
01E0	Equation timer	Equation A rising tempo	0 – 60000	1	10 ms	F1	0	
01E1		Equation A falling tempo	0 – 60000	1	10 ms	F1	0	
01E2		Equation B rising tempo	0 – 60000	1	10 ms	F1	0	
01E3		Equation B falling tempo	0 – 60000	1	10 ms	F1	0	
01E4		Equation C rising tempo	0 – 60000	1	10 ms	F1	0	
01E5		Equation C falling tempo	0 – 60000	1	10 ms	F1	0	
01E6		Equation D rising tempo	0 – 60000	1	10 ms	F1	0	
01E7		Equation D falling tempo	0 – 60000	1	10 ms	F1	0	
01E8		Equation E rising tempo	0 – 60000	1	10 ms	F1	0	
01E9		Equation E falling tempo	0 – 60000	1	10 ms	F1	0	
01EA		Equation F rising tempo	0 – 60000	1	10 ms	F1	0	
01EB		Equation F falling tempo	0 – 60000	1	10 ms	F1	0	
01EC		Equation G rising tempo	0 – 60000	1	10 ms	F1	0	
01ED		Equation G falling tempo	0 – 60000	1	10 ms	F1	0	
01EE		Equation H rising tempo	0 – 60000	1	10 ms	F1	0	
01EF		Equation H falling tempo	0 – 60000	1	10 ms	F1	0	
01F0 – 01FF		Reserved						

3.4 Page 2h –Setting group 1 remote parameters

Access in reading and in writing

Address	Group	Description	Values range	Step	Unit	Format	Fault Value	Range
0200	[87] ph. differential	[87] DIFF function ?	0 – 1	1		F24	0 (No)	
0201		[87] Current IDIFF Threshold	2 – 200	1	In/100	F1	200	
0202		[87] Voltage VDIFF Threshold	10 – 4000	10	100 mV	F1	4000	
0203		[87] tDIFF timer value	0 – 200	1	10 ms	F1	0	
0204		[87] tRESET timer value	0 – 60000	1	10 ms	F1	0	
0205		[87] Filter of analog input protection	1, 3, 4	1		F74	1 (Sample mode)	
0206		[87] Check zone permission ?	0 – 1	1		F24	0 (No)	
0207–021F		Reserved						
0220	[95] Buswire supervision	[95] SUP function ?	0 – 1	1		F24	0 (No)	
0221		[95] Current ISUP Threshold	2– 200	1	In/100	F1	200	
0222		[95] Voltage VSUP Threshold	10 – 4000	10	100 mV	F1	4000	
0223		[95] tSUP timer value	50 – 300	1	10 ms	F1	300	
0224		[95] tRESET timer value	0 – 60000	1	10 ms	F1	0	

Address	Group	Description	Values range	Step	Unit	Format	Fault Value	Range
0225		[95] Filter of analog input protection	1, 3, 4	1		F74	1 (Sample mode)	
0226–023F		Reserved						
0240	[87N] E/gnd differential	[87N] DIFF function ?	0 – 1	1		F24	0 (No)	
0241		[87N] Current IDIFF Threshold	1 – 100	1	In/100	F1	100	
0242		[87N] Voltage VDIFF Threshold	5 – 2000	10	100 mV	F1	2000	
0243		[87N] tDIFF timer value	0 – 200	1	10 ms	F1	0	
0244		[87N] tRESET timer value	0 – 60000	1	10 ms	F1	0	
0245		[87N] Filter of analog input protection	1, 3, 4	1		F74	1 (Sample mode)	
0246–025F		Reserved						
0260	[95N] Buswire supervision	[95N] SUP function ?Function	0 – 1	1		F24	0 (No)	
0261		[95N] Current ISUP Threshold	1 – 100	1	In/100	F1	100	
0262		[95N] Voltage VSUP Threshold	5 – 2000	10	100 mV	F1	2000	
0263		[95N] tSUP timer value	50 – 300	1	10 ms	F1	300	
0264		[95N] tRESET timer value	0 – 60000	1	10 ms	F1	0	
0265		[95N] Filter of analog input protection	1, 3, 4	1		F74	1 (Sample mode)	
0266–027F		Reserved						

3.5 Page 3h – Setting group 2 remote parameters

Access in reading and in writing

The same as page 2H except addresses are 03XX instead of 02XX.

3.6 Page 4h –Access in writing

Address	Group	Description	Values range	Step	Unit	Format	Fault Value	Range
0400–0401	Remote control	Protection remote control	Binary	1		F9	0	
0402–0403		Reserved						
0404		Output relay remote control in maintenance mode	Binary	1		F13	0	
0405		Keyboard remote control	Binary	1		F76	0	
0406–040F		Reserved						

3.7 Page 5h – Boolean equations remote parameters

Read and write access.

Address (hex)	Group	Description	Values range	Step	Unit	Format	Def. Value
0500	Bool Equations	Equation A.00 operator	0 – 1	1		F70	0
0501		Equation A.00 operand	0 – 24	1		F72	0
0502		Equation A.01 operator	0 – 3	1		F71	0
0503		Equation A.01 operand	0 – 24	1		F72	0
0504		Equation A.02 operator	0 – 3	1		F71	0
0505		Equation A.02 operand	0 – 24	1		F72	0
0506		Equation A.03 operator	0 – 3	1		F71	0
0507		Equation A.03 operand	0 – 24	1		F72	0
0508		Equation A.04 operator	0 – 3	1		F71	0
0509		Equation A.04 operand	0 – 24	1		F72	0
050A		Equation A.05 operator	0 – 3	1		F71	0
050B		Equation A.05 operand	0 – 24	1		F72	0
050C		Equation A.06 operator	0 – 3	1		F71	0
050D		Equation A.06 operand	0 – 24	1		F72	0
050E		Equation A.07 operator	0 – 3	1		F71	0
050F		Equation A.07 operand	0 – 24	1		F72	0
0510		Equation A.08 operator	0 – 3	1		F71	0
0511		Equation A.08 operand	0 – 24	1		F72	0
0512		Equation A.09 operator	0 – 3	1		F71	0
0513		Equation A.09 operand	0 – 24	1		F72	0
0514		Equation A.10 operator	0 – 3	1		F71	0
0515		Equation A.10 operand	0 – 24	1		F72	0
0516		Equation A.11 operator	0 – 3	1		F71	0
0517		Equation A.11 operand	0 – 24	1		F72	0
0518		Equation A.12 operator	0 – 3	1		F71	0
0519		Equation A.12 operand	0 – 24	1		F72	0
051A		Equation A.13 operator	0 – 3	1		F71	0
051B		Equation A.13 operand	0 – 24	1		F72	0
051C		Equation A.14 operator	0 – 3	1		F71	0
051D		Equation A.14 operand	0 – 24	1		F72	0
051E		Equation A.15 operator	0 – 3	1		F71	0
051F		Equation A.15 operand	0 – 24	1		F72	0
0520		Equation B.00 operator	0 – 1	1		F70	0
0521		Equation B.00 operand	0 – 24	1		F72	0
0522		Equation B.01 operator	0 – 3	1		F71	0
0523		Equation B.01 operand	0 – 24	1		F72	0
0524		Equation B.02 operator	0 – 3	1		F71	0
0525		Equation B.02 operand	0 – 24	1		F72	0
0526		Equation B.03 operator	0 – 3	1		F71	0
0527		Equation B.03 operand	0 – 24	1		F72	0
0528		Equation B.04 operator	0 – 3	1		F71	0
0529		Equation B.04 operand	0 – 24	1		F72	0
052A		Equation B.05 operator	0 – 3	1		F71	0
052B		Equation B.05 operand	0 – 24	1		F72	0
052C		Equation B.06 operator	0 – 3	1		F71	0
052D		Equation B.06 operand	0 – 24	1		F72	0
052E		Equation B.07 operator	0 – 3	1		F71	0
052F		Equation B.07 operand	0 – 24	1		F72	0
0530		Equation B.08 operator	0 – 3	1		F71	0
0531		Equation B.08 operand	0 – 24	1		F72	0
0532		Equation B.09 operator	0 – 3	1		F71	0
0533		Equation B.09 operand	0 – 24	1		F72	0
0534		Equation B.10 operator	0 – 3	1		F71	0
0535		Equation B.10 operand	0 – 24	1		F72	0
0536		Equation B.11 operator	0 – 3	1		F71	0

Address (hex)	Group	Description	Values range	Step	Unit	Format	Def. Value
0537		Equation B.11 operand	0 – 24	1		F72	0
0538		Equation B.12 operator	0 – 3	1		F71	0
0539		Equation B.12 operand	0 – 24	1		F72	0
053A		Equation B.13 operator	0 – 3	1		F71	0
053B		Equation B.13 operand	0 – 24	1		F72	0
053C		Equation B.14 operator	0 – 3	1		F71	0
053D		Equation B.14 operand	0 – 24	1		F72	0
053E		Equation B.15 operator	0 – 3	1		F71	0
053F		Equation B.15 operand	0 – 24	1		F72	0
0540		Equation C.00 operator	0 – 1	1		F70	0
0541		Equation C.00 operand	0 – 24	1		F72	0
0542		Equation C.01 operator	0 – 3	1		F71	0
0543		Equation C.01 operand	0 – 24	1		F72	0
0544		Equation C.02 operator	0 – 3	1		F71	0
0545		Equation C.02 operand	0 – 24	1		F72	0
0546		Equation C.03 operator	0 – 3	1		F71	0
0547		Equation C.03 operand	0 – 24	1		F72	0
0548		Equation C.04 operator	0 – 3	1		F71	0
0549		Equation C.04 operand	0 – 24	1		F72	0
054A		Equation C.05 operator	0 – 3	1		F71	0
054B		Equation C.05 operand	0 – 24	1		F72	0
054C		Equation C.06 operator	0 – 3	1		F71	0
054D		Equation C.06 operand	0 – 24	1		F72	0
054E		Equation C.07 operator	0 – 3	1		F71	0
054F		Equation C.07 operand	0 – 24	1		F72	0
0550		Equation C.08 operator	0 – 3	1		F71	0
0551		Equation C.08 operand	0 – 24	1		F72	0
0552		Equation C.09 operator	0 – 3	1		F71	0
0553		Equation C.09 operand	0 – 24	1		F72	0
0554		Equation C.10 operator	0 – 3	1		F71	0
0555		Equation C.10 operand	0 – 24	1		F72	0
0556		Equation C.11 operator	0 – 3	1		F71	0
0557		Equation C.11 operand	0 – 24	1		F72	0
0558		Equation C.12 operator	0 – 3	1		F71	0
0559		Equation C.12 operand	0 – 24	1		F72	0
055A		Equation C.13 operator	0 – 3	1		F71	0
055B		Equation C.13 operand	0 – 24	1		F72	0
055C		Equation C.14 operator	0 – 3	1		F71	0
055D		Equation C.14 operand	0 – 24	1		F72	0
055E		Equation C.15 operator	0 – 3	1		F71	0
055F		Equation C.15 operand	0 – 24	1		F72	0
0560		Equation D.00 operator	0 – 1	1		F70	0
0561		Equation D.00 operand	0 – 24	1		F72	0
0562		Equation D.01 operator	0 – 3	1		F71	0
0563		Equation D.01 operand	0 – 24	1		F72	0
0564		Equation D.02 operator	0 – 3	1		F71	0
0565		Equation D.02 operand	0 – 24	1		F72	0
0566		Equation D.03 operator	0 – 3	1		F71	0
0567		Equation D.03 operand	0 – 24	1		F72	0
0568		Equation D.04 operator	0 – 3	1		F71	0
0569		Equation D.04 operand	0 – 24	1		F72	0
056A		Equation D.05 operator	0 – 3	1		F71	0
056B		Equation D.05 operand	0 – 24	1		F72	0
056C		Equation D.06 operator	0 – 3	1		F71	0
056D		Equation D.06 operand	0 – 24	1		F72	0
056E		Equation D.07 operator	0 – 3	1		F71	0
056F		Equation D.07 operand	0 – 24	1		F72	0
0570		Equation D.08 operator	0 – 3	1		F71	0
0571		Equation D.08 operand	0 – 24	1		F72	0

Address (hex)	Group	Description	Values range	Step	Unit	Format	Def. Value
0572		Equation D.09 operator	0 – 3	1		F71	0
0573		Equation D.09 operand	0 – 24	1		F72	0
0574		Equation D.10 operator	0 – 3	1		F71	0
0575		Equation D.10 operand	0 – 24	1		F72	0
0576		Equation D.11 operator	0 – 3	1		F71	0
0577		Equation D.11 operand	0 – 24	1		F72	0
0578		Equation D.12 operator	0 – 3	1		F71	0
0579		Equation D.12 operand	0 – 24	1		F72	0
057A		Equation D.13 operator	0 – 3	1		F71	0
057B		Equation D.13 operand	0 – 24	1		F72	0
057C		Equation D.14 operator	0 – 3	1		F71	0
057D		Equation D.14 operand	0 – 24	1		F72	0
057E		Equation D.15 operator	0 – 3	1		F71	0
057F		Equation D.15 operand	0 – 24	1		F72	0
0580		Equation E.00 operator	0 – 1	1		F70	0
0581		Equation E.00 operand	0 – 24	1		F72	0
0582		Equation E.01 operator	0 – 3	1		F71	0
0583		Equation E.01 operand	0 – 24	1		F72	0
0584		Equation E.02 operator	0 – 3	1		F71	0
0585		Equation E.02 operand	0 – 24	1		F72	0
0586		Equation E.03 operator	0 – 3	1		F71	0
0587		Equation E.03 operand	0 – 24	1		F72	0
0588		Equation E.04 operator	0 – 3	1		F71	0
0589		Equation E.04 operand	0 – 24	1		F72	0
058A		Equation E.05 operator	0 – 3	1		F71	0
058B		Equation E.05 operand	0 – 24	1		F72	0
058C		Equation E.06 operator	0 – 3	1		F71	0
058D		Equation E.06 operand	0 – 24	1		F72	0
058E		Equation E.07 operator	0 – 3	1		F71	0
058F		Equation E.07 operand	0 – 24	1		F72	0
0590		Equation E.08 operator	0 – 3	1		F71	0
0591		Equation E.08 operand	0 – 24	1		F72	0
0592		Equation E.09 operator	0 – 3	1		F71	0
0593		Equation E.09 operand	0 – 24	1		F72	0
0594		Equation E.10 operator	0 – 3	1		F71	0
0595		Equation E.10 operand	0 – 24	1		F72	0
0596		Equation E.11 operator	0 – 3	1		F71	0
0597		Equation E.11 operand	0 – 24	1		F72	0
0598		Equation E.12 operator	0 – 3	1		F71	0
0599		Equation E.12 operand	0 – 24	1		F72	0
059A		Equation E.13 operator	0 – 3	1		F71	0
059B		Equation E.13 operand	0 – 24	1		F72	0
059C		Equation E.14 operator	0 – 3	1		F71	0
059D		Equation E.14 operand	0 – 24	1		F72	0
059E		Equation E.15 operator	0 – 3	1		F71	0
059F		Equation E.15 operand	0 – 24	1		F72	0
05A0		Equation F.00 operator	0 – 1	1		F70	0
05A1		Equation F.00 operand	0 – 24	1		F72	0
05A2		Equation F.01 operator	0 – 3	1		F71	0
05A3		Equation F.01 operand	0 – 24	1		F72	0
05A4		Equation F.02 operator	0 – 3	1		F71	0
05A5		Equation F.02 operand	0 – 24	1		F72	0
05A6		Equation F.03 operator	0 – 3	1		F71	0
05A7		Equation F.03 operand	0 – 24	1		F72	0
05A8		Equation F.04 operator	0 – 3	1		F71	0
05A9		Equation F.04 operand	0 – 24	1		F72	0
05AA		Equation F.05 operator	0 – 3	1		F71	0
05AB		Equation F.05 operand	0 – 24	1		F72	0
05AC		Equation F.06 operator	0 – 3	1		F71	0

Address (hex)	Group	Description	Values range	Step	Unit	Format	Def. Value
05AD		Equation F.06 operand	0 – 24	1		F72	0
05AE		Equation F.07 operator	0 – 3	1		F71	0
05AF		Equation F.07 operand	0 – 24	1		F72	0
05B0		Equation F.08 operator	0 – 3	1		F71	0
05B1		Equation F.08 operand	0 – 24	1		F72	0
05B2		Equation F.09 operator	0 – 3	1		F71	0
05B3		Equation F.09 operand	0 – 24	1		F72	0
05B4		Equation F.10 operator	0 – 3	1		F71	0
05B5		Equation F.10 operand	0 – 24	1		F72	0
05B6		Equation F.11 operator	0 – 3	1		F71	0
05B7		Equation F.11 operand	0 – 24	1		F72	0
05B8		Equation F.12 operator	0 – 3	1		F71	0
05B9		Equation F.12 operand	0 – 24	1		F72	0
05BA		Equation F.13 operator	0 – 3	1		F71	0
05BB		Equation F.13 operand	0 – 24	1		F72	0
05BC		Equation F.14 operator	0 – 3	1		F71	0
05BD		Equation F.14 operand	0 – 24	1		F72	0
05BE		Equation F.15 operator	0 – 3	1		F71	0
05BF		Equation F.15 operand	0 – 24	1		F72	0
05C0		Equation G.00 operator	0 – 1	1		F70	0
05C1		Equation G.00 operand	0 – 24	1		F72	0
05C2		Equation G.01 operator	0 – 3	1		F71	0
05C3		Equation G.01 operand	0 – 24	1		F72	0
05C4		Equation G.02 operator	0 – 3	1		F71	0
05C5		Equation G.02 operand	0 – 24	1		F72	0
05C6		Equation G.03 operator	0 – 3	1		F71	0
05C7		Equation G.03 operand	0 – 24	1		F72	0
05C8		Equation G.04 operator	0 – 3	1		F71	0
05C9		Equation G.04 operand	0 – 24	1		F72	0
05CA		Equation G.05 operator	0 – 3	1		F71	0
05CB		Equation G.05 operand	0 – 24	1		F72	0
05CC		Equation G.06 operator	0 – 3	1		F71	0
05CD		Equation G.06 operand	0 – 24	1		F72	0
05CE		Equation G.07 operator	0 – 3	1		F71	0
05CF		Equation G.07 operand	0 – 24	1		F72	0
05D0		Equation G.08 operator	0 – 3	1		F71	0
05D1		Equation G.08 operand	0 – 24	1		F72	0
05D2		Equation G.09 operator	0 – 3	1		F71	0
05D3		Equation G.09 operand	0 – 24	1		F72	0
05D4		Equation G.10 operator	0 – 3	1		F71	0
05D5		Equation G.10 operand	0 – 24	1		F72	0
05D6		Equation G.11 operator	0 – 3	1		F71	0
05D7		Equation G.11 operand	0 – 24	1		F72	0
05D8		Equation G.12 operator	0 – 3	1		F71	0
05D9		Equation G.12 operand	0 – 24	1		F72	0
05DA		Equation G.13 operator	0 – 3	1		F71	0
05DB		Equation G.13 operand	0 – 24	1		F72	0
05DC		Equation G.14 operator	0 – 3	1		F71	0
05DD		Equation G.14 operand	0 – 24	1		F72	0
05DE		Equation G.15 operator	0 – 3	1		F71	0
05DF		Equation G.15 operand	0 – 24	1		F72	0
05E0		Equation H.00 operator	0 – 1	1		F70	0
05E1		Equation H.00 operand	0 – 24	1		F72	0
05E2		Equation H.01 operator	0 – 3	1		F71	0
05E3		Equation H.01 operand	0 – 24	1		F72	0
05E4		Equation H.02 operator	0 – 3	1		F71	0
05E5		Equation H.02 operand	0 – 24	1		F72	0
05E6		Equation H.03 operator	0 – 3	1		F71	0
05E7		Equation H.03 operand	0 – 24	1		F72	0

Address (hex)	Group	Description	Values range	Step	Unit	Format	Def. Value
05E8		Equation H.04 operator	0 – 3	1		F71	0
05E9		Equation H.04 operand	0 – 24	1		F72	0
05EA		Equation H.05 operator	0 – 3	1		F71	0
05EB		Equation H.05 operand	0 – 24	1		F72	0
05EC		Equation H.06 operator	0 – 3	1		F71	0
05ED		Equation H.06 operand	0 – 24	1		F72	0
05EE		Equation H.07 operator	0 – 3	1		F71	0
05EF		Equation H.07 operand	0 – 24	1		F72	0
05F0		Equation H.08 operator	0 – 3	1		F71	0
05F1		Equation H.08 operand	0 – 24	1		F72	0
05F2		Equation H.09 operator	0 – 3	1		F71	0
05F3		Equation H.09 operand	0 – 24	1		F72	0
05F4		Equation H.10 operator	0 – 3	1		F71	0
05F5		Equation H.10 operand	0 – 24	1		F72	0
05F6		Equation H.11 operator	0 – 3	1		F71	0
05F7		Equation H.11 operand	0 – 24	1		F72	0
05F8		Equation H.12 operator	0 – 3	1		F71	0
05F9		Equation H.12 operand	0 – 24	1		F72	0
05FA		Equation H.13 operator	0 – 3	1		F71	0
05FB		Equation H.13 operand	0 – 24	1		F72	0
05FC		Equation H.14 operator	0 – 3	1		F71	0
05FD		Equation H.14 operand	0 – 24	1		F72	0
05FE		Equation H.15 operator	0 – 3	1		F71	0
05FF		Equation H.15 operand	0 – 24	1		F72	0

3.8 Page 6h – General remote parameters (part 2)

Read and write access

Address	Group	Description	Values range	Step	Unit	Format	Fault Value
0600 – 06FF		Reserved					

3.9 Page 7h – Remote device status

Access in quick reading only (MODBUS 07 function)

Address	Group	Description	Values range	Step	Unit	Format	Fault Value
0700		Device status		1	-	F23	1

3.10 Page 8h –Remote data and time

Read and write access

Time synchronisation: access in writing for n words (function 16). The time synchronisation format is based on 8 bits (4 words).

If date Format (0135h) is private date then format is:

Address	Group	Description	Values range	Step	Unit	Format	Fault Value
0800	Date	Year	1994-2093	1	Year	F1	1994
0801		Month	1 -12	1	Month	F1 MSB	1
		Day	1 – 31	1	Days	F1 lsb	1
0802		Hour	0 – 23	1	Hours	F1 MSB	0
		Minute	0 – 59	1	mn	F1 lsb	0
0803		Milliseconds	0 – 59999	1	ms	F1	0

Else format is (Inverted IEC 870-5-4 CP56Time2a):

Address	Group	Description	Values range	Step	Unit	Format	Fault Value
0800	Date	Year : 1994 – 1999 2000 – 2093	00 – 99 : 94 – 99 00 – 93	1	Year	F1	94
0801		Month	1 -12	1	Month	F1 MSB	1
		Day of the week : Monday – Sunday	1 – 7	1	Days	F1 lsb bit 5-7	1
		Day of the month	1 – 31	1	Days	F1 lsb bit 0-4	1
0802		Season : Summer – Winter	0 – 1	1	Season	F1 MSB bit 7	0
		Hour	0 – 23	1	Hours	F1 MSB bit 0-4	0
		Date validity : Valid – Invalid	0 – 1	1		F1 lsb bit 7	0
		Minute	0 – 59	1	mn	F1 lsb bit 0-6	0
0803		Milliseconds	0 – 59999	1	ms	F1	0

3.11 Pages 9h to 21h – Disturbance record data

Disturbance record data (25 pages). Access in words writing (**function 03**)

Each disturbance mapping page contain 250 words.

Addresses (hex)	Contents
0900 to 09FA	250 disturbance data words
0A00 to 0AFA	250 disturbance data words
0B00 to 0BFA	250 disturbance data words
0C00 to 0CFA	250 disturbance data words
0D00 to 0DFA	250 disturbance data words
0E00 to 0EFA	250 disturbance data words
0F00 to 0FFA	250 disturbance data words
1000 to 10FA	250 disturbance data words
1100 to 11FA	250 disturbance data words
1200 to 12FA	250 disturbance data words
1300 to 13FA	250 disturbance data words
1400 to 14FA	250 disturbance data words
1500 to 15FA	250 disturbance data words
1600 to 16FA	250 disturbance data words
1700 to 17FA	250 disturbance data words
1800 to 18FA	250 disturbance data words
1900 to 19FA	250 disturbance data words
1A00 to 1AFA	250 disturbance data words
1B00 to 1BFA	250 disturbance data words
1C00 to 1CFA	250 disturbance data words
1D00 to 1DFA	250 disturbance data words
1E00 to 1EFA	250 disturbance data words
1F00 to 1FFA	250 disturbance data words
2000 to 20FA	250 disturbance data words
2100 to 21FA	250 disturbance data words

NOTE: The disturbance data pages contain values of one channel from one given disturbance record.

3.11.1 Meaning of each value channel

- IA, IB, IC and I_O channels:

The value is an signed 16 bits word equivalent to the ADC value

3.11.2 Calculation formula for phase current values

Line phase current value (primary value) = phase sampled value x phase primary CT / phase internal CT ratio (mapping address 0007 = 800) x √2

3.11.3 Calculation formula for earth current values

Line earth current value (primary value) = earth sampled value (e.g. word 10 or 14) x earth primary CT / earth internal CT ratio (mapping address 0008h) x √2

3.11.4 Logic channels

Logic channel	MODBUS & DNP 3.0	IEC 61870-5-103
Bit 0	Trip relay (RL1)	Earth Starting
Bit 1	Output relay 2	General Starting
Bit 2	Output relay 3	CB Fail
Bit 3	Output relay 4	General Trip
Bit 4	Watch-dog relay	[95] tSUP
Bit 5	Output relay 5	[87] tDIFF
Bit 6	Output relay 6	Reserved
Bit 7	Output relay 7	[95N] tSUP
Bit 8	Output relay 8	[87N] tDIFF
Bit 9	Reserved	Reserved
Bit 10	Logic input 1	Logic input 1
Bit 11	Logic input 2	Logic input 2
Bit 12	Logic input 3	Logic input 3
Bit 13	Logic input 4	Logic input 4
Bit 14	Logic input 5	Logic input 5
Bit 15	Reserved	Reserved

3.12 Page 22h – Disturbance record index frame

Disturbance record index frame (7 to 9 Words)

Access in word reading (**function 03**)

Addresses	Contents
2200h	Disturbance data index frame

Disturbance record index frame

Word	Contents
n° 1	Disturbance record number
n° 2	Disturbance record finish date (second)
n° 3	Disturbance record finish date (second)
n° 4	Disturbance record finish date (millisecond)
n° 5	Disturbance record finish date (millisecond)
n° 6	Disturbance record starting condition: 1: tripping command (RL1) 2: instantaneous 3: remote command 4: logic input
n° 7	Frequency at the post-time beginning
n° 8	(=0) Optional
n° 9	(=0) Optional

3.13 Page 35h

Addresses 3500h to 354Ah.

Addresses (hex)	Contents
3500	Event records 1
3501	Event records 2
…	…
354A	Event records 250

Event record data (9 words)

Word n° 1: Event code

Word n° 2: MODBUS associated value

Word n° 3: MODBUS address

Word n° 4:

Words n° 5 & 6 if data format is private:

Event date (second) number of seconds since 01/01/94

Words n° 7 & 8 if data format is private:

Event date (millisecond)

Words N°5, 6, 7, 8, if data format is Inverted IEC 870-5-4 CP56Time2a:

See format page 8h

Word n° 9: Acknowledge
0=event non acknowledged
1= event acknowledged

Code	Meaning of the event	Type	MODBUS address	COURIER Cell
00	No event			
01				
02	Remote control tripping	F9 Ctrl 1		
03	Disturbance recording start	F82		
04	Trip output unlatched	F9 Ctrl 1		
05	Setting change	Address		
06				
07	Maintenance Mode	F45 ↑↓	Yes	
08	Output relay remote word in maintenance mode	F13		
09	[95] SUP	F17 ↑↓	Yes	
10	[87] DIFF	F17 ↑↓	Yes	
11				
12	[95N] SUP	F16 ↑↓	Yes	
13	[87N] DIFF	F16 ↑↓	Yes	
14				
15				
16				
17	[95] tSUP	F17 ↑↓	Yes	
18	[87] tDIFF	F17 ↑↓	Yes	
19				
20	[95N] tSUP	F16 ↑↓	Yes	
21	[87N] tDIFF	F16 ↑↓	Yes	

Code	Meaning of the event	Type	MODBUS address	COURIER Cell
22				
23				
24				
25	tAux 1	F38 word 1↑↓	Yes	
26	tAux 2	F38 word 1 ↑↓	Yes	
27	CB Failure (50BF)	F38 word 1 ↑↓	Yes	
28				
29				
30	Blocking logic 1	F20 word 1 ↑↓	Yes	
31	Blocking logic 2	F20 word 1 ↑↓	Yes	
32	Setting group change	1 or 2		
33				
34				
35	Output relays unlatched (Logical input)	F20 word 1 ↑↓		
36				
37				
38	Change of logical input state	F12 ↑↓		
39				
40				
41	[87] tDIFF fault (tripping)	F13		
42				
43				
44	[87N] tDIFF fault (tripping)	F13		
45				
46				
47				
48	tAux 1 fault (tripping)	F13		
49	tAux 2 fault (tripping)	F13		
50	Output relays command	F13		
51	Front panel single alarm acknowledge.			
52	Front panel all alarms acknowledge			
53	Remote single alarm acknowledge			
54	Remote all alarms acknowledge			
55	Major material alarm	F45 ↑↓	Yes	
56	Minor material alarm	F45 ↑↓	Yes	
57				
58				
59				
60				
61				
62				
63				
64				
65				
66				
67				
68	General Start (IEC 60870-5-103)	F24 ↑↓		
69				
70				
71	Auxiliary output relays latched	F13	Yes	
72				
73				
74				
75				
76				
77	Local Mode (IEC 60870-5-103)	F24 ↑↓		

Code	Meaning of the event	Type	MODBUS address	COURIER Cell
78	Trip output relay latched	F22 ↑↓		
79	tAux 3	F38 word 1 ↑↓	Yes	
80	tAux 3 fault (tripping)	F13		
81	tAux 4	F38 word 1 ↑↓	Yes	
82	tAux 4 fault (tripping)	F13		
83				
84				
85				
86				
87				
88				
89				
90				
91				
92				
93	Local Mode	F20 word 2 ↑↓		
94	Reset alarms & LED (IEC 60870-5-103)			
95				
96				
97	Synchronization > 10 s	F23		
98				
99	tEquation A	F61 ↑↓	Yes	
100	tEquation B	F61 ↑↓	Yes	
101	tEquation C	F61 ↑↓	Yes	
102	tEquation D	F61 ↑↓	Yes	
103	tEquation E	F61 ↑↓	Yes	
104	tEquation F	F61 ↑↓	Yes	
105	tEquation G	F61 ↑↓	Yes	
106	tEquation H	F61 ↑↓	Yes	
107	tEquation A fault (tripping)	F13		
108	tEquation B fault (tripping)	F13		
109	tEquation C fault (tripping)	F13		
110	tEquation D fault (tripping)	F13		
111	tEquation E fault (tripping)	F13		
112	tEquation F fault (tripping)	F13		
113	tEquation G fault (tripping)	F13		
114	tEquation H fault (tripping)	F13		
115	t[87CZ] check zone	F17 ↑↓	Yes	
116	Buswire shorting	F36 word 1 ↑↓	Yes	
117	Signals & measurements blocking (IEC 60870-5-103)	F24 ↑↓		
118	Commands blocking (IEC 60870-5-103)	F24 ↑↓		

NOTA: The double arrow ↑ ↓ means the event is generated on event occurrence (↑) and on event disappearance (↓).
On event occurrence, the corresponding bit of the associated format is set to « 1 ».
On event disappearance, the corresponding bit of the associated format is set to « 0 ».

3.14 Page 36h – Event older record data

Access in word reading (**function 03**)

Addresses	Contents
3600h	Most older event data

3.15 Page 37h – Fault record value data

Access in word reading (**function 03**)

Addresses	Contents
3700h	Fault value record n°1
3701h	Fault value record n°2
3702h	Fault value record n°3
…	…
3718h	Fault value record n°25

Each record is made up of 15 words:

Word Nr.	Contents
1	Fault number
PRIVATE FORMAT: 2 & 3	Fault date (number of seconds since 01/01/94)
PRIVATE FORMAT: 4 & 5	Fault date (milli-seconds)
IEC FORMAT: 2 to 5	Fault date (see format of time synchronisation, address 0800h)
6	Fault date (season) 0= winter 1= summer 2= undefined
7	Active setting group during the fault (1 or 2)
8	Phase/earth fault origin (format F77)
9	Fault recording starting origin (format F78)
10	Fault value
11	Phase A current value (nominal value)
12	Phase B current value (nominal value)
13	Phase C current value (nominal value)
14	Earth current value (nominal value)
15	Acknowledgement: 0 = fault not acknowledged 1 = fault acknowledged

3.15.1 Calculation formula for phase current values

Line phase current value (primary value) = phase sampled value (e.g. word 10, 11, 12 or 13) x phase primary CT / phase internal CT ratio (mapping address 0007 = 800)

3.15.2 Calculation formula for earth current values

Line earth current value (primary value) = earth sampled value (e.g. word 10 or 14) * earth primary CT ratio / earth internal CT ratio (mapping address 0008h).

3.16 Page 3Eh – Fault older record data

Access in word reading (**function 03**)

Addresses	Contents
3E00h	Most older Fault record

3.17 Pages 38h to 3Ch – Disturbance record and channel selection

Selection of the disturbance record and channel (11 to 13 words are uploaded for each address reading)

Access in word reading (**function 03**)

Address	Disturbance record number	Format
3800h	1	IA
3801h	1	IB
3802h	1	IC
3803h	1	IE
3804h	1	Frequency
3805h	1	Logic input and outputs
3900h	2	IA
3901h	2	IB
3902h	2	IC
3903h	2	IE
3904h	2	Frequency
3905h	2	Logic input and outputs
3A00h	3	IA
3A01h	3	IB
3A02h	3	IC
3A03h	3	IE
3A04h	3	Frequency
3A05h	3	Logic input and outputs
3B00h	4	IA
3B01h	4	IB
3B02h	4	IC
3B03h	4	IE
3B04h	4	Frequency
3B05h	4	Logic input and outputs
3C00h	5	IA
3C01h	5	IB
3C02h	5	IC
3C03h	5	IE
3C04h	5	Frequency
3C05h	5	Logic input and outputs

3.17.1 Disturbance record and channel selection (13 words)

Word n° 1: Number of samples included in the mapping

Word n° 2: Sample number in pre-time

Word n° 3: Sample number in post-time

Word n° 4: Phase primary CT ratio

Word n° 5: Phase secondary CT ratio

Word n° 6: Earth primary CT ratio

Word n° 7: Earth secondary CT ratio

Word n° 8: Phase internal CT ratio

Word n° 9: Earth internal CT ratio

Word n° 10: Mapping last page number

Word n° 11: Number of words in the mapping last page

Word n° 12: Coefficient of samples conversion (=1) (Optional)

Word n° 13: Reference of samples conversion (=1) (Optional)

3.17.2 Calculation formula for phase current values

Line phase current value (primary value) = phase sampled value (e.g. address 3800h, 3801h or 3802h) x phase primary CT x (1 / phase internal CT ratio*) x $\sqrt{2}$

(*) Mapping address 0007h

3.17.3 Calculation formula for earth current values

Line earth current value (primary value) = earth sampled value (e.g. address 3803h) x earth primary CT x (1 / earth internal CT ratio*) x $\sqrt{2}$

(*) Mapping address 0008h

3.18 Pages 3Dh – Disturbance records number available

Number of disturbance records available

Access in word reading (**function 03**)

Addresses	Contents
3D00h	Number of disturbance records available

Word n° 1: Number of disturbance records available

Word n° 2: Oldest disturbance record number (n)

Words n° 3 & 4: Oldest disturbance record date (second)

Words n° 5 & 6: Oldest disturbance record date (millisecond)

Word n° 7: Disturbance record starting origin
1= trip relay (RL1)
2= instantaneous threshold
3= remote command
4= logic input

Word n° 8: Acknowledge

Word n° 9: Number of Previous Disturbance record (n+1)

Words n° 10 & 11: Previous disturbance record date (second)

Words n° 12 & 13: Previous disturbance record date (millisecond)

Word n° 14: Disturbance record starting origin
1= trip relay (RL1)
2= instantaneous threshold
3= remote command
4= logic input

Word n° 15: Acknowledge

Word n° 16: Number of Previous Disturbance record (n+2)

Words n° 17 & 18: Previous disturbance record date (second)

Words n° 19 & 20: Previous disturbance record date (millisecond)

Word n° 21: Disturbance record starting origin
1= trip relay (RL1)
2= instantaneous threshold
3= remote command
4= logic input

Word n° 22: Acknowledge

Word n° 23: Number of Previous Disturbance record (n+3)

Words n° 24 & 25: Previous disturbance record date (second)

Words n° 26 & 27:	Previous disturbance record date (millisecond)
Word n° 28:	Disturbance record starting origin 1= trip relay (RL1) 2= instantaneous threshold 3= remote command 4= logic input
Word n° 29:	Acknowledge
Word n° 30:	Number of Previous Disturbance record (n+4)
Words n° 31 & 32:	Previous disturbance record date (second)
Words n° 33 & 34:	Previous disturbance record date (millisecond)
Word n° 35:	Disturbance record starting origin 1= trip relay (RL1) 2= instantaneous threshold 3= remote command 4= logic input
Word n° 36:	Acknowledge

4. DESCRIPTION OF THE MAPPING FORMAT

CODE	DESCRIPTION
F1	Unsigned integer – numerical data: 0 to 65535
F2	Signed integer – numerical data: -32768 to 32767
F3	Reserved
F4	Unsigned integer: MODBUS speed 0: 300 bd 1: 600 bd 2: 1200 bd 3: 2400 bd 4: 4800 bd 5: 9600 bd 6: 19200 bd 7: 38400 bd
F5	Unsigned integer: parity 0: without 1: even 2: odd
F6	Unsigned integer: Tripping configuration and latching Word 1: bit 0: bit 1: [87] tDIFF bit 2: bit 3: bit 4: [87N] tDIFF bit 5: bit 6: bit 7: bit 8: bit 9: tAux 1 bit 10: tAux 2 bit 11: bit 12: bit 13: tAux 3 bit 14: tAux 4 bit 15: Word 2: bit 0 (bit 16): bit 1 (bit 17): Control trip bit 2 (bit 18): tEquation A bit 3 (bit 19): tEquation B bit 4 (bit 20): tEquation C bit 5 (bit 21): tEquation D bit 6 (bit 22): tEquation E bit 7 (bit 23): tEquation F bit 8 (bit 24): tEquation G bit 9 (bit 25): tEquation H bit 10 (bit 26): bit 11 (bit 27): bit 12 (bit 28): bit 13 (bit 39): bit 14 (bit 30): bit 15 (bit 31):
F7	Reserved

CODE	DESCRIPTION
F8a	Unsigned integer: Blocking logic (based on F6) Word 1: bit 0: bit 1: [87] tDIFF bit 2: bit 3: bit 4: [87N] tDIFF bit 5: bit 6: bit 7: bit 8: bit 9: tAux 1 bit 10: tAux 2 bit 11: bit 12: bit 13: tAux 3 bit 14: tAux 4 bit 15: Word 2: bit 0 (bit 16): bit 1 (bit 17): bit 2 (bit 18): bit 3 (bit 19): bit 4 (bit 20): bit 5 (bit 21): bit 6 (bit 22): bit 7 (bit 23): bit 8 (bit 24): bit 9 (bit 25): bit 10 (bit 26): bit 11 (bit 27): bit 12 (bit 28): bit 13 (bit 39): bit 14 (bit 30): bit 15 (bit 31):
F9	Unsigned 2 word: Protection remote control Word 1: bit 0: Output tripping and auxiliary contact delatched bit 1: 1st alarm acknowledgement bit 2: All alarms acknowledgement bit 3: Remote control tripping bit 4: bit 5: Setting group change bit 6: bit 7: Max & average RMS value reset bit 8: Disturbance record remote start bit 9: Mode Maintenance remote start bit 10: bit 11: bit 12: Local manual acknowledgement bit 13: Oldest event record acknowledgement bit 14: Oldest fault record acknowledgement bit 15: Statistic alarm acknowledgement Word 2: bit 0 (bit 16): bit 1 (bit 17): Output tripping contact delatched bit 2 (bit 18): Acknowledgement of the oldest disturbance record bit 3 (bit 19): Mode Maintenance remote stop bit 4 (bit 20): bit 5 (bit 21): bit 6 (bit 22): All LED and alarms reset bit 7 (bit 23):

CODE	DESCRIPTION
	bit 8 (bit 24): bit 9 (bit 25): bit 10 (bit 26): bit 11 (bit 27): bit 12 (bit 28): bit 13 (bit 39): bit 14 (bit 30): All records suppres. (alarms, events, faults, inst., stat. and dist.) bit 15 (bit 31):
F10	2 characters ASCII 32 –127 = ASCII character1 32 – 127 = ASCII character 2
F11	Unsigned integer: Configuration of logical inputs active bit 0: logical input number 1 bit 1: logical input number 2 bit 2: logical input number 3 bit 3: logical input number 4 bit 4: logical input number 5 bit 5: bit 6: bit 7: bit 8: bit 9: bit 10: bit 11: bit 12: bit 13: bit 14: bit 15: bit value = 0, input is active if de-energized bit value = 1, input is active if energized
F12	Unsigned integer: Logical input status bit 0: logical input number 1 bit 1: logical input number 2 bit 2: logical input number 3 bit 3: logical input number 4 bit 4: logical input number 5 bit 5: bit 6: bit 7: bit 8: bit 9: bit 10: bit 11: bit 12: bit 13: bit 14: bit 15: bit value = 0, input is de-energized bit value = 1, input is energized

CODE	DESCRIPTION
F13	Unsigned integer: Logic outputs relay bit 0: logic output number RL1 (tripping) bit 1: logic output number RL2 bit 2: logic output number RL3 bit 3: logic output number RL4 bit 4: logic output number RL0 (watchdog) bit 5: logic output number RL5 bit 6: logic output number RL6 bit 7: logic output number RL7 bit 8: logic output number RL8 bit 9: bit 10: bit 11: bit 12: bit 13: bit 14: bit 15:
F14	Unsigned integer: Output relay allocation bit 0: Logic output relay 2 bit 1: Logic output relay 3 bit 2: Logic output relay 4 bit 3: Logic output relay 5 bit 4: Logic output relay 6 bit 5: Logic output relay 7 bit 6: Logic output relay 8 bit 7: bit 8: bit 9: bit 10: bit 11: bit 12: bit 13: bit 14: bit 15:
F15	Reserved
F16	Unsigned integer: threshold earth information status bit 0: information of earth threshold exceeded bit 1: reserved bit 2: reserved bit 3: reserved bit 4: reserved bit 5: Instantaneous information diff bit 6: Temporized information tdiff bit 7: bit 8: bit 9: bit 10: bit 11: bit 12: bit 13: bit 14: bit 15:

CODE	DESCRIPTION
F17	Unsigned integer: threshold phase information status bit 0: information of phase threshold exceeded bit 1: Instantaneous line A bit 2: Instantaneous line B bit 3: Instantaneous line C bit 4: reserved bit 5: Instantaneous information diff bit 6: Temporized information tdiff bit 7: bit 8: bit 9: bit 10: bit 11: bit 12: bit 13: bit 14: bit 15:
F18	Long integer
F19	Unsigned 3 words: Configuration LED Word 1: bit 0: [95] SUP bit 1: [95] tSUP bit 2: [87] DIFF bit 3: [87] tDIFF bit 4: bit 5: bit 6: [95N] SUP bit 7: [95N] tSUP bit 8: [87N] DIFF bit 9: [87N] tDIFF bit 10: bit 11: bit 12: [95A] tSUP bit 13: [95B] tSUP bit 14: [95C] tSUP bit 15: CB failure (50BF) Word 2: bit 0 (bit 16): Logical input 1 (energized) bit 1 (bit 17): Logical input 2 (energized) bit 2 (bit 18): Logical input 3 (energized) bit 3 (bit 19): Logical input 4 (energized) bit 4 (bit 20): Logical input 5 (energized) bit 5 (bit 21): bit 6 (bit 22): bit 7 (bit 23): tAux 1 bit 8 (bit 24): tAux 2 bit 9 (bit 25): bit 10 (bit 26): bit 11 (bit 27): tAux 3 bit 12 (bit 28): tAux 4 bit 13 (bit 29): [87CZ] check zone bit 14 (bit 30): Buswire shorting bit 15 (bit 31): Word 3: bit 0 (bit 32): tEquation A bit 1 (bit 33): tEquation B bit 2 (bit 34): tEquation C bit 3 (bit 35): tEquation D bit 4 (bit 36): tEquation E bit 5 (bit 37): tEquation F bit 6 (bit 38): tEquation G bit 7 (bit 39): tEquation H bit 8 (bit 40):

CODE	DESCRIPTION
	bit 9 (bit 41): bit 10 (bit 42): bit 11 (bit 43): bit 12 (bit 44): bit 13 (bit 45): bit 14 (bit 46): bit 15 (bit 47): Word 4: Not used
F20	Unsigned long: logical input settings and signalization Word 1: bit 0: bit 1: bit 2: Unlatch output relays bit 3: bit 4: bit 5: bit 6: Auxiliary input 1 bit 7: Auxiliary input 2 bit 8: Blocking logic 1 bit 9: Blocking logic 2 bit 10: Start disturbance bit 11: bit 12: Setting group 2 selection bit 13: bit 14: bit 15: Word 2: bit 0 (bit 16): bit 1 (bit 17): Reset of all alarms bit 2 (bit 18): Maintenance mode bit 3 (bit 19): Auxiliary input 3 bit 4 (bit 20): Auxiliary input 4 bit 5 (bit 21): bit 6 (bit 22): Local mode bit 7 (bit 23): Synchronization bit 8 (bit 24): [87CZ] check zone bit 9 (bit 25): bit 10 (bit 26): bit 11 (bit 27): bit 12 (bit 28): bit 13 (bit 29): bit 14 (bit 30): bit 15 (bit 31):
F21	Unsigned integer: software version 100: Version 10.A 101: Version 10.B 110: Version 11.A …
F22	Unsigned integer: Trip status bit 0: Trip output relay RL1 latched bit 1: Memorization of trip information bit 2 to bit 15: free
F23	Unsigned integer 8 bits: Device status bit 0: Device status bit 1: Minor material alarm bit 2: Presence of non-acknowledged event record bit 3: Synchronisation state bit 4: Presence of non-acknowledged disturbance record bit 5: Presence of non-acknowledged fault record bit 6: bit 7:

CODE	DESCRIPTION
F24	Unsigned integer: Status of the relay functions 0: Disabled / No 1: Enabled / Yes
F25	Reserved
F26	Phases and Earth identifier Phase1 Phase2 Phase3 0 : "L1" "L2" "L3" 1 : " A" " B" " C" 2: " R" " S" " T" Earth 0 : " N" 1 : " o" 2: " E"
F27	Reserved
F28	Unsigned integer: Rear port communication data bits 0: 7 data bits 1: 8 data bits
F29	Unsigned integer: Rear port communication stop bits 0: 1 stop bit 1: 2 stop bits
F30	Unsigned integer: Rear port communication available 0: Communication non-available 1: Communication available
F31	Reserved
F32	Unsigned integer: 0: Disturbance record start condition on INSTANTANEOUS 1: Disturbance record start condition on TRIPPING
F33	Reserved
F34	Reserved
F35	Reserved
F36	Unsigned 3 words: Memorised flags of non acknowledged alarms Word 1 bit 0: [95N] SUP bit 1: [95N] tSUP bit 2: [87N] DIFF bit 3: [87N] tDIFF bit 4: bit 5: bit 6: [87CZ] check zone bit 7: Buswire shorting bit 8: bit 9: CB failure (50BF) bit 10: bit 11: bit 12: bit 13: tAux 1 bit 14: tAux 2 bit 15: Word 2 bit 0 (bit 16): bit 1 (bit 17): bit 2 (bit 18): bit 3 (bit 19): bit 4 (bit 20): bit 5 (bit 21): tAux 3 bit 6 (bit 22): tAux 4 bit 7 (bit 23): bit 8 (bit 24): bit 9 (bit 25): bit 10 (bit 26): bit 11 (bit 27): bit 12 (bit 28):

CODE	DESCRIPTION
	bit 13 (bit 29): bit 14 (bit 30): bit 15 (bit 31): Word 3 bit 0 (bit 32): tEquation A bit 1 (bit 33): tEquation B bit 2 (bit 34): tEquation C bit 3 (bit 35): tEquation D bit 4 (bit 36): tEquation E bit 5 (bit 37): tEquation F bit 6 (bit 38): tEquation G bit 7 (bit 39): tEquation H bit 8 (bit 40): bit 9 (bit 42): bit 10 (bit 43): bit 11 (bit 44): bit 12 (bit 45): bit 13 (bit 46): bit 14 (bit 47):
F37	Reserved
F38	Unsigned 2 words: Information of general status Word 1: bit 0: Pole earth opening bit 1: CB failure (50BF) bit 2: Pole phase A opening bit 3: Pole phase B opening bit 4: Pole phase C opening bit 5: bit 6: tAux 1 bit 7: tAux 2 bit 8: bit 9: CB failure delay started (start tBF) bit 10: bit 11: bit 12: tAux 3 bit 13: tAux 4 bit 14: Buswires shorting bit 15: Word 2: bit 0 (bit 16): bit 1 (bit 17): bit 2 (bit 18): bit 3 (bit 19): bit 4 (bit 20): bit 5 (bit 21): bit 6 (bit 22): bit 7 (bit 23): bit 8 (bit 24): bit 9 (bit 25): bit 10 (bit 26): bit 11 (bit 27): bit 12 (bit 28): bit 13 (bit 29): bit 14 (bit 30): bit 15 (bit 31):
F39	Reserved
F40	Reserved
F41	Unsigned integer: Front/rear communication 0: Front and rear MODBUS communication 1: Front MODBUS and rear Courier communication 2: Front MODBUS and rear IEC 60870-5-103 communication 3: Front MODBUS and rear DNP3 communication

CODE	DESCRIPTION
F42	Reserved
F43	Reserved
F44	Reserved
F45	Unsigned integer: Material alarm status bit 0: Watch-Dog operating * bit 1: Communication failure bit 2: Program data failure * bit 3: Analogue input failure * bit 4: Datation failure bit 5: Calibration data failure * bit 6: Record data failure bit 7: bit 8: Maintenance Mode bit 9: Default settings alarm * bit 10: Inconsistent setting * bit 11: bit 12: bit 13: bit 14: bit 15: * Major alarm
F46	Reserved
F47	Unsigned integer: Setting group change configuration 0: setting group change either by communication, or of the relay front (MENU) 1: setting group change on logical input state (LEVEL) of digital input.
F48	Unsigned integer: Communication date format 0: Private Format Date 1: IEC Format Date
F50	Unsigned integer: AC/DC voltage Type applied to the logical inputs 0: Direct current (DC) voltage 1: Alternative current (AC) voltage
F51	Unsigned integer: Setting group 1: Setting group 1 2: Setting group 2
F52	Reserved
F53	Reserved
F54	Reserved
F55	Reserved
F56	Unsigned integer : IEC870-5-103 messages option for non-standard protections 0 : Public messages 1 : Private messages.
F57	Reserved
F58	Reserved
F59	Unsigned integer : Inhibition of alarms bit 0: Alarm tAux1 inhibited bit 1: Alarm tAux2 inhibited bit 2: Alarm tAux3 inhibited bit 3: Alarm tAux4 inhibited bit 4: bit 5: bit 6: bit 7: bit 8: bit 9: bit 10: bit 11: bit 12: bit 13: bit 14: bit 15:

CODE	DESCRIPTION
F60	Unsigned integer : Fail safe and inversion relays bit 0 : Fail safe logic output number RL1 (tripping) bit 1 : Fail safe logic output number RL2 bit 2 : Inversion logic output number RL3 bit 3 : Inversion logic output number RL4 bit 4 : Inversion logic output number RL5 bit 5 : Inversion logic output number RL6 bit 6 : Inversion logic output number RL7 bit 7 : Inversion logic output number RL8 bit 8: bit 9: bit 10: bit 11: bit 12: bit 13: bit 14: bit 15: bit value = 0 : relay normally de-energized. bit value = 1 : relay normally energized.
F61	Unsigned integer : Information of equation status bit 0 : tEquation A bit 1 : tEquation B bit 2 : tEquation C bit 3 : tEquation D bit 4 : Temporisation A, B,… or H active bit 5 : tEquation E bit 6 : tEquation F bit 7 : tEquation G bit 8 : tEquation H bit 9 : bit 10 : bit 11 : bit 12 : bit 13 : bit 14 : bit 15:
F62	Reserved
F63	Unsigned integer: HMI language * 00 – French 01 – English 02 – Spanish 03 – German 04 – Italian 05 – Russian 06 – Polish 07 – Portuguese 08 – Dutch 09 – American 10 – Czech 11 – Hungarian 12 – Greek 13 – Chinese Other – Language by default (product code) * The list of available language depends of the release.
F64	Reserved
F65	Reserved
F66	Reserved
F67	Reserved
F68	Reserved
F69	Reserved

CODE	DESCRIPTION
F70	Unsigned integer: 1st operator for Boolean equations 0 : NULL 1 : NOT
F71	Unsigned integer: Other than 1st operator for Boolean equations 0 : OR 1 : OR NOT 2 : AND 3 : AND NOT
F72	Unsigned integer: Operand for Boolean equations 0: NULL 1: [95] SUP 2: [95] tSUP 3: [95A] tSUP 4: [95B] tSUP 5: [95C] tSUP 6: [87] DIFF 7: [87] tDIFF 8: [95N] SUP 9: [95N] tSUP 10: [87N] DIFF 11: [87N] tDIFF 12: [87CZ] check zone 13: Buswire shorting 14: tAux 1 15: tAux 2 16: tAux 3 17: tAux 4 18: Logic input 1 (energized) 19: Logic input 2 (energized) 20: Logic input 3 (energized) 21: Logic input 4 (energized) 22: Logic input 5 (energized) 23: Active setting group 2 24: CB Failure
F73	Unsigned integer: LED status (bit = 0 if LED inactive) bit 0: Trip LED bit 1: Alarm LED bit 2: Warning LED bit 3: Healthy LED (always active) bit 4: LED 5 bit 5: LED 6 bit 6: LED 7 bit 7: LED 8 bit 8: bit 9: bit 10: bit 11: bit 12: bit 13: bit 14: bit 15:
F74	Unsigned integer: Filter of analogue input protection correspondence : 1: Sample mode only 3: Sample mode + Fast sample mode 4: Fourier mode (said differently: bit 0 is for Samples mode, bit 1 is for Fast samples mode, bit 2 is for Fourier mode)
F75	Unsigned integer: Diff. threshold unit mode 0: Current set (A) / Ampere 1: Voltage set (V) / Volt

CODE	DESCRIPTION
F76	Unsigned integer: Keyboard remote control word. Only one bit simultaneously. The bit active simulate a pressure on the key. bit 0: CLEAR key bit 1: ALARM key bit 2: UP key bit 3: RIGHT key bit 4: ENTER key bit 5: DOWN key bit 6: LEFT key bit 7: bit 8: bit 9: bit 10: bit 11: bit 12: bit 13: bit 14: bit 15: Dialog re-init (factory test reserved)
F77	Unsigned integer: Phase/earth fault origin. 0: none 1: phase A 2: phase B 3: phase C 4: phases A-B 5: phases A-C 6: phases B-C 7: phases A-B-C 8: earth
F78	Unsigned integer: Fault recording starting origin (Trip origin). 0: none 1: Remote Control trip 2: 3: 4: [87] tDIFF 5: 6: 7: [87N] tDIFF 8: 9: 10: 11: tAux1 12: tAux2 13: 14: 15: tAux3 16: tAux4 17: 18: 19: tEquation A 20: tEquation B 21: tEquation C 22: tEquation D 23: tEquation E 24: tEquation F 25: tEquation G 26: tEquation H
F79	Unsigned integer: Differential protection type 0: Earth protection 1: Three-phase protection
F80	Unsigned integer: Spontaneous event enabling for IEC870-5-103 communication 0 : None 1 : IEC only 2 : All (IEC + Private)

CODE	DESCRIPTION
F81	Unsigned integer: Measurements transmission enabling for IEC870-5-103 communication 0 : None 1 : ASDU3.4 only 2: ASDU 9 only 3 : ASDU3.4 + ASDU 9
F82	Unsigned integer: Source of the disturbance recording start. 0 : None 1 : On trip protection 2: On instantaneous protection 3 : On communication order 4 : On logic input order 5 : No disturbance

4.1 Disturbance record additional information

4.1.1 MODBUS request definition used for disturbance record

To upload a disturbance record, the following requests must be done in the exact given order:

1. (optional): Send a request to know the number of disturbance records available in SRAM.
2. (compulsory): Send a request with the record number and the channel number.
3. (compulsory): Send one or several requests to upload the disturbance record data. It depends of the number of samples.
4. (compulsory): Send a request to upload the index frame.

4.1.2 Request to know the number of disturbance records in SRAM

Slave number	Function code	Word address	Word number	CRC
xx	03h	3Dh 00	00 24h	xx xx

This request may be answered an error message with the error code:

EVT_NOK(OF): No record available

NOTA: If there is less than 5 records available, the answer will contains zero in the non-used words.

4.1.3 Service requests

This request must be send before uploading the disturbance record channel samples. It allows to know the record number and the channel number to upload. It allows also to know the number of samples in the channel.

Slave number	Function code	Word address	Word number	CRC
xx	03h	Refer to mapping	00 0Bh	xx xx

This request may be answered an error message with two different error codes:

CODE_DEF_RAM(02): SRAM failure

CODE_EVT_NOK(03): No disturbance record available in SRAM

4.1.4 Disturbance record upload request

Slave number	Function code	Word address	Word number	CRC
xx	03h	22h to 00	01 to 7Dh	xx xx

This request may be answered an error message with two different error codes:

CODE_DEP_DATA(04): The required disturbance data number is greater than the memorised number.

CODE_SERV_NOK(05): The service request for disturbance record and channel number has not been send.

4.1.5 Index frame upload request

Slave number	Function code	Word address	Word number	CRC
xx	03h	22h 00	00 07h	xx xx

This request may be answered an error message with an error code:

CODE_SERV_NOK(05): The service request for disturbance record and channel number has not been send.

Two ways can be followed to retrieve an event record:

– Send a request to retrieve the oldest non-acknowledge event.

– Send a request to retrieve a dedicated event.

4.1.6 Request to retrieve the oldest non-acknowledge event

Slave number	Function code	Word address	Word number	CRC
xx	03h	36h 00	00 09h	xx xx

This event request may be answered an error message with the error code:

EVT_EN_COURS_ECRIT (5): An event is being written into the saved RAM.

NOTE: On event retrieval, two possibilities exist regarding the event record acknowledgement:
a) Automatic event record acknowledgement on event retrieval.
b) Non automatic event record acknowledgement on event retrieval.

a) <u>Automatic event record acknowledgement on event retrieval:</u>

The bit12 of the remote order frame (format F9 – mapping address 0400h) shall be set to 0. On event retrieval, this event record is acknowledged.

b) <u>Non automatic event record acknowledgement on event retrieval:</u>

The bit12 of the remote order frame (format F9 – mapping address 0400h) shall be set to 1. On event retrieval, this event record is not acknowledged.

To acknowledge this event, an other remote order shall be sent to the relay. The bit 13 of this frame (format F9 – mapping address 0400h) shall be set to 1.

4.1.7 Request to retrieve a dedicated event

Slave number	Function code	Word address	Word number	CRC
xx	03h	Refer to mapping	00 09h	xx xx

This event request may be answered an error message with the error code:

EVT_EN_COURS_ECRIT (5): An event is being written into the saved RAM.

NOTA: This event retrieval does not acknowledge this event.

4.1.8 Modbus request definition used to retrieve the fault records

Two ways can be followed to retrieve a fault record:

Send a request to retrieve the oldest non-acknowledge fault record.

Send a request to retrieve a dedicated fault record.

4.1.9 Request to retrieve the oldest non-acknowledge fault record

Slave number	Function code	Word address	Word number	CRC
xx	03h	3Eh 00	00 0Fh	xx xx

NOTA: On fault retrieval, two possibilities exist regarding the fault record acknowledgement:
a) Automatic fault record acknowledgement on event retrieval.
b) Non automatic fault record acknowledgement on event retrieval.

a) Automatic fault record acknowledgement on fault retrieval:

The bit12 of the remote order frame (format F9 – mapping address 0400h) shall be set to 0. On fault retrieval, this fault record is acknowledged.

b) Non automatic fault record acknowledgement on fault retrieval:

The bit12 of the remote order frame (format F9 – mapping address 0400h) shall be set to 1. On fault retrieval, this fault record is not acknowledged.

To acknowledge this fault, an other remote order shall be sent to the relay. The bit 14 of this frame (format F9 – mapping address 0400h) shall be set to 1.

4.1.10 Request to retrieve a dedicated fault record

Slave number	Function code	Word address	Word number	CRC
xx	03h	Refer to mapping	00 0Fh	xx xx

NOTA: This fault value retrieval does not acknowledge this fault record.

IEC 60870-5-103 DATABASE

MiCOM P721/P723

VERSION V11

BLANK PAGE

CONTENTS

1. IEC60870-5-103 INTERFACE 51

1.1 Physical connection and link layer 51
1.2 Link layer 51
1.3 Message validity check 52
1.4 IEC870-5-103 address 52
1.5 Initialisation 52
1.6 Time synchronisation 52
1.7 Spontaneous events 52
1.8 General interrogation 52
1.9 Cyclic measurements 53
1.10 Commands 53
1.11 Disturbance records 53
1.12 Blocking of monitor direction 53

2. APPENDIX 1 54

2.1 Spontaneous messages managed by MiCOM P72x 54
2.2 List of data contained in General Interrogation 57
2.3 Processed Commands 59
2.4 Relay re initialization 60
2.5 Cyclic Messages (Class 2 – measurements) 60
2.6 IEC870-5-103 messages for Disturbance record extraction 61

BLANK PAGE

5. IEC60870-5-103 INTERFACE

The IEC60870-5-103 interface is a master/slave interface with the relay as the slave device. This protocol is based on the VDEW communication protocol. The relay conforms to compatibility level 2, compatibility level 3 is not supported.

The following IEC60870-5-103 facilities are supported by this interface:

- Initialisation (Reset)
- Time Synchronisation
- Event Record Extraction
- Disturbance Record Extraction
- General Interrogation
- Cyclic Measurements
- General Commands

5.1 Physical connection and link layer

Connection is available for IEC60870-5-103 through the rear RS485 port. It is possible to select both the relay address and baud rate using the front panel interface. Following a change, a reset command is required to re-establish communications.

The parameters of the communication are the following:

- Even Parity,
- 8 Data bits,
- 1 stop bit,
- Communication speed can be set in the front panel of the relay:

Baud rate (dec)
300
600
1200
2400
4800
9600
19200
38400

- Isolated two-point RS485 connection (2kV 50Hz),
- Asynchronous transmission.

To connect the relay after a parameter, speed, parity or address modification, a reset command is required.

5.2 Link layer

IEC870-5-103 frame conforms with IEC 870-5-FT1.2 standards. In addition, Special commands are added in accordance with IEC870-5-103 standard.

5.3 Message validity check

The validation of a frame is performed with a 16-bit Cyclical Redundancy Check (CRC). Generator polynomial: $1+x^2+x^{15}+x^{16}$ = 1010 0000 0000 0001 (binary) = A001 (hexadecimal)

5.4 IEC870-5-103 address

A slave address is defined in the range 1-254.

The address “255” is a standard address, frames with 255 are received by all slave devices.

5.5 Initialisation

Whenever the relay has been powered up, or if the communication parameters have been changed a reset command is required to initialise the communications. The relay will respond to either of the two reset commands (Reset CU or Reset FCB), the difference being that the Reset CU will clear any unsent messages in the relay’s transmit buffer.

The relay will respond to the reset command with an identification message ASDU 5, the Cause Of Transmission COT of this response will be either Reset CU or Reset FCB depending on the nature of the reset command. The following information will be contained in the data section of this ASDU:

Manufacturer Name: **Schneider Electric**

The Software Identification Section will contain the first four characters of the relay model number to identify the type of relay, e.g. P723.

In addition to the above identification message, if the relay has been powered up it will also produce a power up event.

5.6 Time synchronisation

The relay time and date can be set using the time synchronisation feature of the IEC60870-5-103 protocol. The relay will correct for the transmission delay as specified in IEC60870-5-103. If the time synchronisation message is sent as a send/confirm message then the relay will respond with a confirm. Whether the time synchronisation message is sent as a send confirm or a broadcast (send/no reply) message, a time synchronisation message will be returned as Class 1 data.

5.7 Spontaneous events

The events created by the relay will be passed using the standard function type/information numbers to the IEC60870-5-103 master station. Private codes are not used, thus any events that cannot be passed using the standardised messages will not be sent.

Events are categorised using the following information:

- Common Address
- Function Type
- Information number
- Cause of Transmission (to caracterise event origin).

APPENDIX 1 contains a complete listing of all events produced by the relay.

5.8 General interrogation

The GI request can be used to read the status of the relay, the function numbers, information numbers and common address offsets that will be returned during the GI cycle are indicated in APPENDIX 1.

5.9 Cyclic measurements

The relay will produce measured values using ASDU 9 and ASDU 3.4 on a cyclical basis, this can be read from the relay using a Class 2 poll.

It should be noted that the measurands transmitted by the relay are sent as a proportion of 2.4 times the rated value of the analogue value. The selection of either 1.2 or 2.4 for a particular value is indicated in APPENDIX 1.

5.10 Commands

A list of the supported commands is contained in APPENDIX 1. The relay will respond to other commands with an ASDU 1, with a cause of transmission (COT) of negative acknowledgement of a command. If the relay takes in account the command, it will answer with an ASDU 1, with a cause of transmission (COT) of positive acknowledgement.

A blocking command (Control directioncan be introduced using a communication parameter.

5.11 Disturbance records

The disturbance records stored by the relay cannot be extracted using the mechanism defined in the IEC60870-5-103 standard. A list of the analog channels and tags (logic signals) for record extraction is indicated in APPENDIX 1.

5.12 Blocking of monitor direction

The relay does not support a facility to block messages in the Monitor direction.IEC 60870-5-103 DATABASES

6. APPENDIX 1

6.1 Spontaneous messages managed by MiCOM P72x

These messages include a sub-assembly of events which are generated on the relay, because some generated events are not registered in VDEW. They are the most priority messages.

An event is always generated on the rising edge of the information.

Some events can be generated on the rising or lowering edge.

In the list below, events only generated on rising edge will be tagged with a '*'.

Two types of ASDU can be generated for events: ASDU 1 (time-tagged message) or ASDU 2 (time-tagged message with relative time).

The following list of processed events is the list **with the private messages option active**, for all Overcurrent protection functions, with the associated FUNCTION Type, INFORMATION NUMBER, ASDU TYPE, CAUSE OF TRANSMISSION and COMMON ADDRESS OF ASDU (The corresponding numbers with **private messages option inactive** are given just below).

FUN <208>: Function type in Public range for High-impedance Differential Protections (compatible).

FUN <210>: Function type in Private range (Reserved for High-impedance Differential Protections).

Status indications in monitor direction		Availability
LEDs reset:	FUN<208>;INF <19>; TYP <1>; COT<1>;<ADDR>,*	
Local parameter Setting active:	FUN<208>;INF <22>; TYP <1>; COT<1>,<ADDR>↑↓	
Monitor direction blocked:	FUN<208>;INF <20>; TYP <1>; COT<1>,<ADDR>↑↓	
Command direction blocked:	FUN<210>;INF <151>; TYP <1>; COT<1>,<ADDR>↑↓	
Setting Group number 1 active:	FUN<208>;INF <23>; TYP <1>; COT<1>,<ADDR>↑↓	
Setting Group number 2 active:	FUN<208>;INF <24>; TYP <1>; COT<1>,<ADDR>↑↓	
Auxiliary input 1:	FUN<208>;INF <27>; TYP <1>; COT<1>,<ADDR>↑↓	
Auxiliary input 2:	FUN<208>;INF <28>; TYP <1>; COT<1>,<ADDR>↑↓	
Auxiliary input 3:	FUN<208>;INF <29>; TYP <1>; COT<1>,<ADDR>↑↓	
Auxiliary input 4:	FUN<208>;INF <30>; TYP <1>; COT<1>,<ADDR>↑↓	
Group Warning (Minor hardware alarm):	FUN<208>;INF <46>; TYP <1>; COT<1>,<ADDR>↑↓	
Group Alarm (Major hardware alarm):	FUN<208>;INF <47>; TYP <1>; COT<1>,<ADDR>↑↓	

Status indications in monitor direction		Availability
Logical input 1:	FUN<210>;INF <160>; TYP <1>; COT<1>,<ADDR>↑↓	
Logical input 2:	FUN<210>;INF <161>; TYP <1>; COT<1>,<ADDR>↑↓	
Logical input 3:	FUN<210>;INF <162>; TYP <1>; COT<1>,<ADDR>↑↓	
Logical input 4:	FUN<210>;INF <163>; TYP <1>; COT<1>,<ADDR>↑↓	
Logical input 5:	FUN<210>;INF <164>; TYP <1>; COT<1>,<ADDR>↑↓	
Logical output 1:	FUN<210>;INF <176>; TYP <1>; COT<1>,<ADDR>↑↓	
Logical output 2:	FUN<210>;INF <177>; TYP <1>; COT<1>,<ADDR>↑↓	
Logical output 3:	FUN<210>;INF <178>; TYP <1>; COT<1>,<ADDR>↑↓	
Logical output 4:	FUN<210>;INF <179>; TYP <1>; COT<1>,<ADDR>↑↓	
Logical output 5 (Watch-dog):	FUN<210>;INF <180>; TYP <1>; COT<1>,<ADDR>↑↓	
Logical output 6:	FUN<210>;INF <181>; TYP <1>; COT<1>,<ADDR>↑↓	
Logical output 7:	FUN<210>;INF <182>; TYP <1>; COT<1>,<ADDR>↑↓	
Logical output 8:	FUN<210>;INF <183>; TYP <1>; COT<1>,<ADDR>↑↓	
Logical output 9:	FUN<210>;INF <184>; TYP <1>; COT<1>,<ADDR>↑↓	
Logical blocking 1:	FUN<210>;INF <30>; TYP <1>; COT<1>,<ADDR>↑↓	
Logical blocking 2:	FUN<210>;INF <31>; TYP <1>; COT<1>,<ADDR>↑↓	
Local mode active:	FUN<210>;INF <40>; TYP <1>; COT<1>,<ADDR>↑↓	
Time Synchronisation:	FUN<210>;INF <226>; TYP <1>; COT<1>; <ADDR>,*	

NOTE: The double arrow ↑↓ means that the event generated on event occurrence and another event is generated on event disappearing.

Supervision Indications in monitor direction		**Availability**
Start / pick-up [95] Diff>:	FUN<210>;INF <9>; TYP <2>; COT<1>,<ADDR>↑↓	
Start / pick-up [87] Diff>>:	FUN<210>;INF <10>; TYP <2>; COT<1>,<ADDR>↑↓	
Start / pick-up [95N] Diff>:	FUN<210>;INF <12>; TYP <2>; COT<1>,<ADDR>↑↓	
Start / pick-up [87N] Diff>>:	FUN<210>;INF <13>; TYP <2>; COT<1>,<ADDR>↑↓	
Start / pick-up Check Zone:	FUN<210>;INF <24>; TYP <2>; COT<1>,<ADDR>↑↓	
Start / pick-up Bus Wire Shorting:	FUN<210>;INF <26>; TYP <2>; COT<1>,<ADDR>↑↓	
General Trip:	FUN<208>;INF <68>; TYP <2>; COT<1>,<ADDR>,*	
General Start / pick-up:	FUN<208>;INF <84>; TYP <2>; COT<1>,<ADDR>↑↓	
Breaker failure:	FUN<208>;INF <85>; TYP <2>; COT<1>,<ADDR>,*	
Trip [95] Diff>:	FUN<210>;INF <17>; TYP <2>; COT<1>,<ADDR>,*	
Trip [95A] Diff>:	FUN<210>;INF <42>; TYP <2>; COT<1>,<ADDR>,*	
Trip [95B] Diff>:	FUN<210>;INF <43>; TYP <2>; COT<1>,<ADDR>,*	
Trip [95C] Diff>:	FUN<210>;INF <44>; TYP <2>; COT<1>,<ADDR>,*	
Trip [87] Diff>>:	FUN<210>;INF <18>; TYP <2>; COT<1>,<ADDR>,*	
Trip [95N] Diff>:	FUN<210>;INF <20>; TYP <2>; COT<1>,<ADDR>,*	
Trip [87N] Diff>>:	FUN<210>;INF <21>; TYP <2>; COT<1>,<ADDR>,*	
Trip Equation A:	FUN<210>;INF <144>; TYP <2>;COT<1>,<ADDR>,↑↓	
Trip Equation B:	FUN<210>;INF <145>; TYP <2>;COT<1>,<ADDR>,↑↓	
Trip Equation C:	FUN<210>;INF <146>; TYP <2>;COT<1>,<ADDR>,↑↓	
Trip Equation D:	FUN<210>;INF <147>; TYP <2>;COT<1>,<ADDR>,↑↓	
Trip Equation E:	FUN<210>;INF <196>; TYP <2>;COT<1>,<ADDR>,↑↓	
Trip Equation F:	FUN<210>;INF <197>; TYP <2>;COT<1>,<ADDR>,↑↓	

Supervision Indications in monitor direction		Availability
Trip Equation G:	FUN<210>;INF <198>; TYP <2>;COT<1>,<ADDR>,↑↓	
Trip Equation H:	FUN<210>;INF <199>; TYP <2>;COT<1>,<ADDR>,↑↓	

NOTE: The double arrow ↑↓ means that the event generated on event occurrence and another event is generated on event disappearing.

Auto-recloser Indications (monitor direction)		Availability
Trip TC:	FUN<210>;INF <1>; TYP <1>; COT<1>,<ADDR>↑↓	

NOTE: The double arrow ↑↓ means that the event generated on event occurrence and another event is generated on event disappearing.

6.2 List of data contained in General Interrogation

It is given in the answer to the General Interrogation (GI).

Relay state information are Class 1 data, they are systematically sent to the master station, during a General Interrogation.

The list of processed data, following a General Interrogation, is given below: it is a sub-assembly of the spontaneous message list, so like spontaneous messages, these data are generated on rising and lowering edge.

Status indications (monitor direction):

Status Indications (monitor direction):

Status Indications (monitor direction)		Availability
Local parameter Setting active:	FUN<208>;INF <22>; TYP <1>; COT<9>,<ADDR>	
Monitor direction blocked:	FUN<208>;INF <20>; TYP <1>; COT<9>,<ADDR>	
Setting Group number 1 active:	FUN<208>;INF <23>; TYP <1>; COT<9>,<ADDR>	
Setting Group number 2 active:	FUN<208>;INF <24>; TYP <1>; COT<9>,<ADDR>	
Auxiliary input 1:	FUN<208>;INF <27>; TYP <1>; COT<9>,<ADDR>	
Auxiliary input 2:	FUN<208>;INF <28>; TYP <1>; COT<9>,<ADDR>	
Auxiliary input 3:	FUN<208>;INF <29>; TYP <1>; COT<9>,<ADDR>	
Auxiliary input 4:	FUN<208>;INF <30>; TYP <1>; COT<9>,<ADDR>	

Status Indications (monitor direction)		Availability
Group Warning (Minor hardware alarm):	FUN<208>;INF <46>; TYP <1>; COT<9>,<ADDR>	
Group Alarm (Major hardware alarm):	FUN<208>;INF <47>; TYP <1>; COT<9>,<ADDR>	
General Start / pick-up:	FUN<208>;INF <84>; TYP <2>; COT<9>,<ADDR>	
Command direction blocked:	FUN<210>;INF <151>; TYP <1>; COT<9>,<ADDR>	
Maintenance mode trig:	FUN<210>;INF <7>; TYP <1>; COT<9>,<ADDR>	

Fault Indications in monitor direction		Availability
Start / pick-up [95] Diff>:	FUN<210>;INF <9>; TYP <2>; COT<9>,<ADDR>	
Start / pick-up [87] Diff>>:	FUN<210>;INF <10>; TYP <2>; COT<9>,<ADDR>	
Start / pick-up [95N] Diff >:	FUN<210>;INF <12>; TYP <2>; COT<9>,<ADDR>	
Start / pick-up [87N] Diff>>:	FUN<210>;INF <13>; TYP <2>; COT<9>,<ADDR>	
Start / pick-up Check Zone:	FUN<210>;INF <24>; TYP <2>; COT<9>,<ADDR>	
Start / pick-up Bus Wire Shorting:	FUN<210>;INF <26>; TYP <2>; COT<9>,<ADDR>	

Status Indications in monitor direction		Availability
Logical input 1:	FUN<210>;INF <160>; TYP <1>; COT<9>,<ADDR>	
Logical input 2:	FUN<210>;INF <161>; TYP <1>; COT<9>,<ADDR>	
Logical input 3:	FUN<210>;INF <162>; TYP <1>; COT<9>,<ADDR>	
Logical input 4:	FUN<210>;INF <163>; TYP <1>; COT<9>,<ADDR>	
Logical input 5:	FUN<210>;INF <164>; TYP <1>; COT<9>,<ADDR>	
Logical output 1:	FUN<210>;INF <176>; TYP <1>; COT<9>,<ADDR>	
Logical output 2:	FUN<210>;INF <177>; TYP <1>; COT<9>,<ADDR>	
Logical output 3:	FUN<210>;INF <178>; TYP <1>; COT<9>,<ADDR>	

Status Indications in monitor direction		Availability
Logical output 4:	FUN<210>;INF <179>; TYP <1>; COT<9>,<ADDR>	
Logical output 5 (Watch-dog):	FUN<210>;INF <180>; TYP <1>; COT<9>,<ADDR>	
Logical output 6:	FUN<210>;INF <181>; TYP <1>; COT<9>,<ADDR>	
Logical output 7:	FUN<210>;INF <182>; TYP <1>; COT<9>,<ADDR>	
Logical output 8:	FUN<210>;INF <183>; TYP <1>; COT<9>,<ADDR>	
Logical output 9:	FUN<210>;INF <184>; TYP <1>; COT<9>,<ADDR>	

6.3 Processed Commands

System Commands		Availability
Synchronization Command (ASDU 6)	FUN<255>,INF <0>; TYP <6>;COT<8>	

This command can be sent to a specific relay, or global. The time sent by master is the time of the first bit of the frame. The relay synchronizes with this time, corrected by the frame transmission delay. After updating its time, the relay send back an acknowledge to the master, by giving its new current time. This acknowledge message will be an event of ASDU 6 type.

– General Interrogation Initialization command (ASDU 7):

This command starts the relay interrogation:

– The relay then sends a list of data containing the relay state (see list described above).

– The GI command contains a scan number which will be included in the answers of the GI cycle generated by the GI command.

If a data has just changed before extracted by the GI, the new state is sent to the master station.

When an event is generated during the GI cycle, the event is sent in priority, and the GI cycle is temporarily interrupted. The end of the GI consists in sending an ASDU 8 to the master station.

If, during a General Interrogation cycle, another GI Initialization command is received, the precedent answer is stopped, and the new GI cycle started.

General Commands (ASDU 20) (Control Direction)		Availability
LEDs Reset: This command acknowledge all alarms on Front Panel on MiCOM P72x products:	FUN<208>;INF<19>, TYP<20>, COT <20>,<ADDR>	
Setting group number 1:	FUN<208>;INF<23>, TYP<20>, COT <20>,<ADDR>	
Setting group number 2:	FUN<208>;INF<24>, TYP<20>, COT <20>,<ADDR>	

General Commands (ASDU 20) (Control Direction)		Availability
Trip TC:	FUN<210>;INF <1>; TYP <20>; COT<20>,<ADDR>	
Disturbance trig:	FUN<210>;INF <3>; TYP <20>; COT<20>,<ADDR>	
Maintenance mode trig:	FUN<210>;INF <7>; TYP <20>; COT<20>,<ADDR>	

After executing one of these commands, the relay sends an acknowledge message, which contains the result of command execution.

If a state change is the consequence of the command, it must be sent in a ASDU 1 with COT 12 (remote operation).

If the relay receive another command message from the master station before sending the acknowledge message, it will be discarded.

Commands which are not processed by the relay are rejected with a negative acknowledge message.

6.4 Relay re initialization

<u>In case of relay re initialization, the relay send to the master station:</u>

		Availability
A message indicating relay start/restart:	(FUN<208>;INF <5>; TYP <5> COT <5>)	
or a message indicating Reset CU:	(FUN<208>;INF <5>; TYP <3> COT <4>)	
or a message indicating Reset FCB :	(FUN<208>;INF <5>; TYP <2> COT <3>)	

Each identification message of the relay (ASDU 5) contains the manufacturer name in 8 ASCII characters and 2 free bytes containing: « 721 » or « 723 »,in decimal format, then 2 free bytes containing the software version number in decimal (for ex. : 112 corresponds to "11.C").

6.5 Cyclic Messages (Class 2 – measurements)

Only measurands can be stored in these messages.

The measurands values are stored in lower levels of communication, before polling by master station.

Measurands I1,I2,I3,V1,V2,V3, P, Q	FUN<208>;INF <148>; TYP <9>; COT<2>,<ADDR>	

Several of the fields in the ASDU 9 are not used (Voltage and Power values), so they are set to 0: Only RMS Ia, Ib, Ic values and frequency are stored (with a rate such as: 2,4 * nominal value = 4096).

Measurands In, Ven	FUN<208>;INF <147>; TYP <3>; COT<2>,<ADDR>	

The second ASDU is ASDU3.4 (STRUCT<2>), which contains in first position In earth current value in rated format (with a rate such as: 2,4 * nominal value = 4096). Ven value does not exist, so the second position value in ASDU3.4 is set to « unused ».

6.6 IEC870-5-103 messages for Disturbance record extraction

The disturbance extraction procedure with IEC870-5-103 in MICOM Px2x relays is in conformance with IEC870-5-103 standard definition.
The maximum disturbance record number stored in a P721 and P723 is 5.

The disturbance record mapping is the following:

– 4 analog channels:

- Channel 1: Ia current (Phase L1).
- Channel 2: Ib current (Phase L2).
- Channel 3: Ic current (Phase L3).
- Channel 4: IN current (Earth).

– 12 Identifiers of tags transmitted in ASDU 29 (logical informations):

- Tag number 1: General start: FUN <208> INF <84>
- Tag number 2: CB Failure: FUN <208> INF <85>
- Tag number 3: General Trip: FUN <208> INF <68>
- Tag number 4: [95] Diff>: FUN <210> INF <17>
- Tag number 5: [87] Diff>>: FUN <210> INF <18>
- Tag number 6 [95N] Diff>: FUN <210> INF <20>
- Tag number 7 [87N] Diff>>: FUN <210> INF <21>
- Tag number 8 Log input 1: FUN <210> INF <160>
- Tag number 9 Log input 2: FUN <210> INF <161>
- Tag number 10 Log input 3: FUN <210> INF <162>
- Tag number 11 Log input 4: FUN <210> INF <163>
- Tag number 12 Log input 5: FUN <210> INF <164>

BLANK PAGE

DNP 3.0 DATABASE

MiCOM P721/P723
VERSION V11

BLANK PAGE

CONTENTS

1. INTRODUCTION 67

1.1 Purpose of this document 67

1.2 DNP V3.00 device Profile 67

1.3 Implementation Table 70

1.4 Point List 72

1.4.1 Binary Input Points 72

1.4.2 Binary Output Status Points and Control Relay Output Blocks 74

1.4.3 Counters 75

1.4.4 Analog Inputs 76

BLANK PAGE

1. INTRODUCTION

1.1 Purpose of this document

The purpose of this document is to describe the specific implementation of the **D**istributed **N**etwork **P**rotocol (DNP) 3.0 within P72x MiCOM relays.

P72x uses the Triangle MicroWorks, Inc. DNP 3.0 Slave Source Code Library Version 2.18.

This document, in conjunction with the DNP 3.0 Basic 4 Document Set, and the DNP Subset Definitions Document, provides complete information on how to communicate with P72x via the DNP 3.0 protocol.

This implementation of DNP 3.0 is fully compliant with DNP 3.0 Subset Definition Level 2, contains many Subset Level 3 features, and contains some functionality even beyond Subset Level 3.

1.2 DNP V3.00 device Profile

The following table provides a “Device Profile Document” in the standard format defined in the DNP 3.0 Subset Definitions Document. While it is referred to in the DNP 3.0 Subset Definitions as a “Document,” it is only a component of a total interoperability guide. This table, in combination with the following should provide a complete interoperability/configuration guide for P72x:

- the Implementation Table provided in Section 1.3 (beginning on page 70),
- the Point List Tables provided in Section 1.4 (beginning on page 72),
- and a description of configuration methods and user-interface in Sections

DNP V3.00

DEVICE PROFILE DOCUMENT

(ALSO SEE THE IMPLEMENTATION TABLE IN SECTION 1.3, BEGINNING ON PAGE 70).

Vendor Name: **Schneider Electric**

Device Name: **SERIAL 20 Platform using the Triangle MicroWorks, Inc. DNP 3.0 Slave Source Code Library, Version 2.18.**

Highest DNP Level Supported:	Device Function:
For Requests: **Level 2** For Responses: **Level 2**	☒ Master ☐ **Slave**

Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the attached table):

For static (non-change-event) object requests, request qualifier codes 00 and 01 (start-stop), 07 and 08 (limited quantity), and 17 and 28 (index) are supported in addition to request qualifier code 06 (no range – or all points).
Static object requests received with qualifiers 00, 01, 06, 07, or 08, will be responded with qualifiers 00 or 01. Static object requests received with qualifiers 17 or 28 will be responded with qualifiers 17 or 28.
For change-event object requests, qualifiers 17 or 28 are always responded.
16-bit and 32-bit Analog Change Events with Time may be requested.
The read function code for Object 50 (Time and Date), variation 1, is supported.

Maximum Data Link Frame Size (octets):	Maximum Application Fragment Size (octets):
Transmitted: **292** Received **292**	Transmitted: **2048** Received: **2048**
Maximum Data Link Re-tries: ☒ None ☐ **Fixed at 2** ☒ Configurable	Maximum Application Layer Re-tries: ☐ **None** ☒ Configurable

Requires Data Link Layer Confirmation:

☐ **Never**
☐ Always
☐ Sometimes
☐ Configurable

Requires Application Layer Confirmation:

☐ Never
☐ Always
☐ **When reporting Event Data**
☐ **When sending multi-fragment responses**
☐ Sometimes
☐ Configurable

Timeouts while waiting for:

Data Link Confirm:	☐	None	☐**Fixed (100 ms)**	Variable	Configurable.
Complete Appl. Fragment:	☐	**None**	Fixed at ____	Variable	Configurable
Application Confirm:	☐	None	☐**Fixed (1s)**	Variable	Configurable
Complete Appl. Response:	☐	**None**	Fixed at ____	Variable	Configurable

Others:

Binary input change scanning period: 5ms
Analog input change scanning period: 1s

DNP V3.00

DEVICE PROFILE DOCUMENT

(ALSO SEE THE IMPLEMENTATION TABLE IN SECTION 1.3, BEGINNING ON PAGE 70).

Sends/Executes Control Operations:

WRITE Binary Outputs	☐ **Never**	☐ Always	☐ Sometimes	☐ Configurable
SELECT/OPERATE	☐ Never	☐ **Always**	☐ Sometimes	☐ Configurable
DIRECT OPERATE	☐ Never	☐ **Always**	☐ Sometimes	☐ Configurable
DIRECT OPERATE – NO ACK	☐ Never	☐ **Always**	☐ Sometimes	☐ Configurable
Count > 1	☐ **Never**	☐ Always	☐ Sometimes	☐ Configurable
Pulse On	☐ Never	☐ **Always**	☐ Sometimes	☐ Configurable
Pulse Off	☐ **Never**	☐ Always	☐ Sometimes	☐ Configurable
Latch On	☐ **Never**	☐ Always	☐ Sometimes	☐ Configurable
Latch Off	☐ **Never**	☐ Always	☐ Sometimes	☐ Configurable
Queue	☐ **Never**	☐ Always	☐ Sometimes	☐ Configurable
Clear Queue	☐ **Never**	☐ Always	☐ Sometimes	☐ Configurable

Reports Binary Input Change Events when no specific variation requested:

- ☐ Never
- ☐ **Only time-tagged for P721 and P723**
- ☐ Only non-time-tagged
- ☐ Configurable

Reports time-tagged Binary Input Change Events when no specific variation requested:

- ☐ Never
- ☐ **Binary Input Change With Time for P721 and P723**
- ☐ Binary Input Change With Relative Time
- ☐ Configurable (attach explanation)

Sends Unsolicited Responses:

- ☐ **Never**
- ☐ Configurable
- ☐ Only certain objects
- ☐ Sometimes (attach explanation)
- ☐ ENABLE/DISABLE UNSOLICITED Function codes supported

Sends Static Data in Unsolicited Responses:

- ☐ **Never**
- ☐ When Device Restarts
- ☐ When Status Flags Change

No other options are permitted.

Default Counter Object/Variation:

- ☐ No Counters Reported
- ☐ Configurable
- ☐ **Default Object: 20**
- ☐ **Default Variation: 5**
- ☐ Point-by-point list attached

Counters Roll Over at:

- ☐ No Counters Reported
- ☐ Configurable (attach explanation)
- ☐ **16 Bits**
- ☐ **32 Bits**
- ☐ Other Value: _____
- ☐ **Point-by-point list attached**

Sends Multi-Fragment Responses:

- ☐ **Yes**
- ☐ No

1.3 Implementation Table

The following table identifies the variations, function codes, and qualifiers supported by the P72x in both request messages and in response messages.

For static (non-change-event) objects, requests sent with qualifiers 00, 01, 06, 07, or 08, will be responded with qualifiers 00 or 01. Static object requests sent with qualifiers 17 or 28 will be responded with qualifiers 17 or 28. For change-event objects, qualifiers 17 or 28 are always responded.

In the table below the text shaded as Subset Level 3 indicates Subset Level 3 functionality

(beyond Subset Level 2), and text shaded as beyond Subset Level 3 Indicates functionality

beyond Subset Level 3.

OBJECT			REQUEST (Library will parse)		RESPONSE (Library will respond with)	
Object Number	Variation Number	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes (dec)	Qualifier Codes (hex)
1	0	Binary Input (Variation 0 is used to request default variation)	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)		
1	1 (default – see note 1)	Binary Input	1 (read) 22	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index – see note 2)
1	2	Binary Input with Status	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index	129 (response)	00, 01 (start-stop) 17, 28 (index – see note 2)
2	0	Binary Input Change (Variation 0 is used to request default variation)	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
2	1(default – see note1)	Binary Input Change without Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
2	2 (default – see note 1)	Binary Input Change with Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
10	0	Binary Output Status (Variation 0 is used to request default variation)	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)		
10	2 (default – see note 1)	Binary Output Status	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index – see note 2)
12	1	Control Relay Output Block	3 (select) 4 (operate) 5 (direct op) 6 (dir. op, noack)	00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)	129 (response)	echo of request
20	0	Binary Counter (Variation 0 is used to request default variation)	1 (read) 7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz. cl. Noack)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)		
20	1	32-Bit Binary Counter	1 (read) 7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz. cl. Noack)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index – see note 2)
20	2	16-Bit Binary Counter	1 (read) 7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz. cl. Noack)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index – see note 2)
20	5	32-Bit Binary Counter without Flag	1 (read) 7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz. cl. Noack)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index – see note 2)
20	6	16-Bit Binary Counter without Flag	1 (read) 7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz. cl. Noack)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index – see note 2)

OBJECT			REQUEST (Library will parse)		RESPONSE (Library will respond with)	
Object Number	Variation Number	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes (dec)	Qualifier Codes (hex)
21	0	Frozen Counter (Variation 0 is used to request default variation)	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)		
21	1	32-Bit Frozen Counter	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index – see note 2)
21	2	16-Bit Frozen Counter	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index – see note 2)
21	9	32-Bit Frozen Counter without Flag	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index – see note 2)
21	10	16-Bit Frozen Counter without Flag	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index – see note 2)
30	0	Analog Input (Variation 0 is used to request default variation)	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)		
30	1 (default – see note 1	32-Bit Analog Input	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index – see note 2)
30	2	16-Bit Analog Input	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index – see note 2)
30	3	32-Bit Analog Input without Flag	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index – see note 2)
30	4	16-Bit Analog Input without Flag	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index – see note 2)
32	0	Analog Change Event (Variation 0 is used to request default variation)	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
32	1 (default – see note 1)	32-Bit Analog Change Event without Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
32	2	16-Bit Analog Change Event without Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
32	3	32-Bit Analog Change Event with Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
32	4	16-Bit Analog Change Event with Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
50	0	Time and Date	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index – see note 2)
50	1 (default – see note 1)	Time and Date	1 (read) 2 (write)	00, 01 (start-stop) 06 (no range, or all) 07 (limited qty=1) 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index – see note 2)
52	2	Time Delay Fine			129 (response)	07 (limited qty) (qty = 1)
60	0	Class 0, 1, 2, and 3 Data	1 (read)	06 (no range, or all)		
60	1	Class 0 Data	1 (read)	06 (no range, or all)	129	17,28
60	2	Class 1 Data	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129	17,28
60	3	Class 2 Data	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129	17,28
60	4	Class 3 Data	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129	17,28
80	1	Internal Indications	2 (write)	00 (start-stop) (index must =7)		
		No Object (function code only) –See Note 3	13 (cold restart)			
		No Object (function code only)	14 (warm restart)			
		No Object (function code only)	23 (delay meas.)			

Note 1: A Default variation refers to the variation responded when variation 0 is requested and/or in class 0, 1, 2, or 3 scans.

Note 2: For static (non-change-event) objects, qualifiers 17 or 28 are only responded when a request is sent with qualifiers 17 or 28, respectively. Otherwise, static object requests sent with qualifiers 00, 01, 06, 07, or 08, will be responded with qualifiers 00 or 01. (For change-event objects, qualifiers 17 or 28 are always responded.)

Note 3: For P72x, a cold restart is implemented as a warm restart – the executable is not restarted, but the DNP process is restarted.

1.4 Point List

The tables in the following sections identify all the individual data points provided by this implementation of DNP 3.0. uses the database protection.

1.4.1 Binary Input Points

Every Binary Input Status points are included in class 0 polls, because they are included in one of classes 1, 2 or 3.

Binary Input Points
Static (Steady-State) Object Number: **1**
Change Event Object Number: **2**
Request Function Codes supported: **1 (read)**
Static Variation reported when variation 0 requested: **1 (Binary Input without status)**
Change Event Variation reported when variation 0 requested:
2 (Binary Input Change with Time) for P721 and P723

P72x Point Index	P721 Presence	P723 Presence	Name/Description	init val.	Change Event Class (1, 2, 3 or none)
0	X	X	Output relay 1 (trip)	0	1
1	X	X	Output relay 2	0	2
2	X	X	Output relay 3	0	2
3	X	X	Output relay 4	0	2
4	X	X	Output relay 0 (watch dog)	0	2
5		X	Output relay 5	0	2
6		X	Output relay 6	0	2
7		X	Output relay 7	0	2
8		X	Output relay 8	0	2
9	X	X	Opto isolator 1	0	2
10	X	X	Opto isolator 2	0	2
11		X	Opto isolator 3	0	2
12		X	Opto isolator 4	0	2
13		X	Opto isolator 5	0	2
14		X	[95] diff> start	0	1
15		X	[95] tdiff> trip	0	1
16		X	[87] diff>> start	0	1
17		X	[87] tdiff>> trip	0	1
18	X	X	[95N] diff> start	0	1
19	X	X	[95N] tdiff> trip	0	1
20	X	X	[87N] diff>> start	0	1
21	X	X	[87N] tdiff>> trip	0	1
22	X	X	[87CZ] check zone	0	1
23	X	X	Buswire shorting	0	1
24	X	X	tAux1	0	1
25	X	X	tAux2	0	1
26	X	X	tAux3	0	1
27	X	X	tAux4	0	1
28	X	X	Blocking Logic 1	0	1

Binary Input Points
Static (Steady-State) Object Number: **1**
Change Event Object Number: **2**
Request Function Codes supported: **1 (read)**
Static Variation reported when variation 0 requested: **1 (Binary Input without status)**
Change Event Variation reported when variation 0 requested:
2 (Binary Input Change with Time) for P721 and P723

P72x Point Index	P721 Presence	P723 Presence	Name/Description	init val.	Change Event Class (1, 2, 3 or none)
29	X	X	Blocking Logic 2	0	1
30	X	X	De latching by a logic input	0	1
31	X	X	De latching of the Tripping output relay by remote order	0	1
32	X	X	Tripping order by remote order	0	1
33		X	CB Failure (50BF)	0	1
34	X	X	tEquation A	0	1
35	X	X	tEquation B	0	1
36	X	X	tEquation C	0	1
37	X	X	tEquation D	0	1
38	X	X	tEquation E	0	1
39	X	X	tEquation F	0	1
40	X	X	tEquation G	0	1
41	X	X	tEquation H	0	1
42	X	X	Shifting to maintenance mode	0	1
43	X	X	Major material Alarms	0	1
44	X	X	Minor material Alarms	0	1
45	X	X	Latching of Relay	0	2
46		X	[95] tdiff> trip alarm (latched)	0	3
47		X	[87] tdiff>> trip alarm (latched)	0	3
48	X	X	[95N] tdiff> trip alarm (latched)	0	3
49	X	X	[87N] tdiff>> trip alarm (latched)	0	3
50	X	X	[87CZ] check zone alarm (latched)	0	3
51	X	X	Buswire shorting alarm (latched)	0	3
52	X	X	tAux1 alarm (latched)	0	3
53	X	X	tAux2 alarm (latched)	0	3
54	X	X	tAux3 alarm (latched)	0	3
55	X	X	tAux4 alarm (latched)	0	3
56		X	CB Failure alarm (50BF) (latched)	0	3
57	X	X	tEquation A (latched)	0	3
58	X	X	tEquation B (latched)	0	3
59	X	X	tEquation C (latched)	0	3
60	X	X	tEquation D (latched)	0	3
61	X	X	tEquation E (latched)	0	3
62	X	X	tEquation F (latched)	0	3
63	X	X	tEquation G (latched)	0	3
64	X	X	tEquation H (latched)	0	3

1.4.2 Binary Output Status Points and Control Relay Output Blocks

The following table lists both the Binary Output Status Points (Object 10) and the Control Relay Output Blocks (Object 12). Binary Output Status points are not included in class 0 polls.

Binary Output Status Points
Object Number: **10**
Request Function Codes supported: **1 (read)**
Default Variation reported when variation 0 requested: **2 (Binary Output Status)**
Control Relay Output Blocks
Object Number: **12**
Request Function Codes supported: **3 (select), 4 (operate), 5 (direct operate), 6 (direct operate, noack)**

P72x Point Index	P721 presence	P723 presence	Name/Description	Initial Status Value	Supported Control Relay Output Block Fields
0	X	X	De Latch of relays	0	Unpaired Pulse On, Paired Trip/Pulse On, Paired Close/Pulse On
1	X	X	Acknowledgement of the 1st alarm	0	Unpaired Pulse On, Paired Trip/Pulse On, Paired Close/Pulse On
2	X	X	Acknowledgement of all the alarms	0	Unpaired Pulse On, Paired Trip/Pulse On, Paired Close/Pulse On
3	X	X	Remote control Tripping	0	Unpaired Pulse On, Paired Trip/Pulse On,
4	X	X	Change of Active Group	0	Unpaired Pulse On, Paired Trip/Pulse On, Paired Close/Pulse On
5		X	maximum RMS values reset	0	Unpaired Pulse On, Paired Trip/Pulse On, Paired Close/Pulse On
6	X	X	Disturbance remote start	0	Unpaired Pulse On, Paired Trip/Pulse On, Paired Close/Pulse On
7	X	X	Maintenance mode enabling	0	Unpaired Pulse On, Paired Trip/Pulse On, Paired Close/Pulse On
8	X	X	Maintenance mode disabling	0	Unpaired Pulse On, Paired Trip/Pulse On, Paired Close/Pulse On

1.4.3 Counters

The following table lists both Binary Counters (Object 20) and Frozen Counters (Object 21). When a freeze function is performed on a Binary Counter point, the frozen value is available in the corresponding Frozen Counter point.

Binary Counters and Frozen Counters are not included in class 0 polls.

P721 does not support binary Counters and Frozen Counters.

Binary Counters
Static (Steady-State) Object Number: **20**
Change Event Object Number: not supported
Request Function Codes supported: **1 (read), 7 (freeze), 8 (freeze noack)**
9 (freeze and clear), 10 (freeze and clear, noack)
Static Variation reported when variation 0 requested: **5 (32-Bit Binary Counter without Flag**
Change Event Variation reported when variation 0 requested: none-not supported

Frozen Counters
Static (Steady-State) Object Number: **21**
Change Event Object Number: not supported
Request Function Codes supported: **1 (read)**
Static Variation reported when variation 0 requested: **9 (32-Bit Frozen Binary without Flag)**
Change Event Variation reported when variation 0 requested: none-not supported

P723 Point Index		Name/Description	Data type
0		Max RMS current phase A (A/100)	D1
1		Max RMS current phase B (A/100)	D1
2		Max RMS current phase C (A/100)	D1

1.4.4 Analog Inputs

The following table lists Analog Inputs (Object 30). It is important to note that 16-bit and 32-bit variations of Analog Inputs, Analog Output Control Blocks, and Analog Output Statuses are transmitted through DNP as signed numbers. Even for analog input points that are not valid as negative values, the maximum positive representation is 32767. For each point, the "Scaling and Units" column indicates the value of a transmitted 32767. This also implies the value of a transmitted –32767. The entry in the column *does not* imply a valid value for the point.

Always indicating the representation of 32767 in the tables below is a consistent method for representing scale, applicable to all scaling possibilities.

The "Default Deadband," and the "Default Change Event Assigned Class" columns are used to represent the absolute amount by which the point must change before an analog change event will be generated, and once generated in which class poll (1, 2, 3) will the change event be reported. Only the default values for these columns are documented here because the values may change in operation due to either local (user-interface) or remote (through DNP) control.

Every Analog Inputs points are included in class 0 polls, because they are included in one of classes 1, 2 or 3.

Analog Inputs
Static (Steady-State) Object Number: **30**
Change Event Object Number: **32**
Request Function Codes supported: **1 (read)**
Static Variation reported when variation 0 requested: **1 (32-Bit Analog Input)**
Change Event Variation reported when variation 0 requested: **1 (32-Bit Analog Change Event w/o Time)**
Change Event Scan Rate: **The scan rate for analog input change events is fixed at 1s**

P72x Point Index	P721 presence	P723 presence	Name/Description	Initial Value	Scaling and Units (representation of 32767 – see above)	Valid Range	Change Event Dead-band	Initial Change Event Class (1, 2, 3 or none)
0	X	X	Active Group	1	32767	1 à 2	1	1
1		X	Magnitude IA	0	10 In	0 to 10 In	0.4 %In	3
2		X	Magnitude IB	0	10 In	0 to 10 In	0.4 %In	3
3		X	Magnitude IC	0	10 In	0 to 10 In	0.4 %In	3
4	X	X	Magnitude IN	0	2 IEn	0 to 2 IEn	0.08 % IEn	3
5		X	rms IA	0A	327.67A	0 to 10000000 A/100	2%	3
6		X	rms IB	0A	327.67A	0 to 10000000 A/100	2%	3
7		X	rms IC	0A	327.67A	0 to 10000000 A/100	2%	3
8	X	X	rms IN	0A	327.67A	0 to 10000000 A/100	2%	3
9	X	X	Frequency	0	327,67 Hz	45Hz to 65 Hz and 99.99Hz = = ERROR	1Hz	3
10	X	X	Fault number	0	32767	0 to 65535	1	2
11	X	X	group	0	32767	1 to 2	each new fault	2
12	X	X	Fault phase	0	32767	0 to 8 (F1)	each new fault	2
13	X	X	Fault origin	0	32767	0 to 26 (F2)	each new fault	2

Analog Inputs
Static (Steady-State) Object Number: **30**
Change Event Object Number: **32**
Request Function Codes supported: **1 (read)**
Static Variation reported when variation 0 requested: **1 (32-Bit Analog Input)**
Change Event Variation reported when variation 0 requested: **1 (32-Bit Analog Change Event w/o Time)**
Change Event Scan Rate: **The scan rate for analog input change events is fixed at 1s**

P72x Point Index	P721 presence	P723 presence	Name/Description	Initial Value	Scaling and Units (representation of 32767 – see above)	Valid Range	Change Event Dead-band	Initial Change Event Class (1, 2, 3 or none)
14	X	X	Fault magnitude	0	10 In	0 to 10 In	each new fault	2
15		X	Fault magnitude IA	0	10 In	0 to 10 In	each new fault	2
16		X	Fault magnitude IB	0	10 In	0 to 10 In	each new fault	2
17		X	Fault magnitude IC	0	10 In	0 to 10 In	each new fault	2
18	X	X	Fault magnitude IN	0	2 IEn	0 to 2 IEn	each new fault	2

Format:

F1:
0: None, 1: Phase A, 2: Phase B, 3: Phase C, 4: Phase AB, 5: Phase AC, 6: Phase BC, 7: Phase A B C, 8: Earth.

F2:
0: Null, 1: Remote trip, 2: … (See format F78 in MODBUS conception document).

BLANK PAGE

COMMISSIONING AND MAINTENANCE GUIDE

CONTENTS

1.	**REQUIREMENTS PRIOR TO COMMISSIONING**	**3**
2.	**COMMISSIONING TEST ENVIRONMENT**	**4**
2.1	**Important notes**	**4**
2.1.1	Injection test sets	4
2.1.2	Additional commissioning test equipment	4
2.1.3	Communication	4
2.2	**Commissioning test sheets**	**4**
3.	**PRODUCT VERIFICATION TESTS**	**5**
3.1	**Allocation of terminals**	**5**
3.2	**Electrostatic discharge (ESD)**	**5**
3.3	**Visual inspection**	**5**
3.4	**Earthing**	**5**
3.5	**Current transformers (CTs)**	**5**
3.6	**Auxiliary supply**	**6**
3.7	**Logic inputs**	**6**
3.8	**Logic outputs**	**7**
3.9	**RS 485 rear communication**	**7**
4.	**SETTING CHECK**	**8**
4.1	**Settings**	**8**
4.2	**Measurements**	**8**
4.2.1	MiCOM P721	8
4.2.2	MiCOM P723	8
4.3	**Phase differential proteciton ([87] Threshold I Diff])**	**9**
4.3.1	Test wiring diagram	9
4.3.2	MiCOM settings	11
4.3.3	[87] Threshold I Diff with Fourier mode	11
4.3.4	[87] Threshold I Diff with Sample mode	12
4.3.5	[87] Threshold I Diff with Fast mode	12
4.4	**Earth differential protection ([87N] Threshold I Diff)**	**13**
4.4.1	Test wiring diagram	13
4.4.2	MiCOM settings	14
4.4.3	[87N] Threshold I Diff with Fourier mode	15
4.4.4	[87N] Threshold I Diff with Sample mode	15
4.4.5	[87N] Threshold I Diff with Fast mode	16

4.5 Phase bus wire supervision ([95] Phase Bus-Wire Sup) 16

4.5.1 Test wiring diagram 16

4.5.2 MiCOM settings 16

4.5.3 [95] Threshold I Sup with Fourier mode 17

4.5.4 [95] Threshold I Sup with Sample mode 17

4.5.5 [95] Threshold I Sup with Fast mode 18

4.6 Earth bus wire supervision ([95N] Earth Bus-Wire Sup) 19

4.7 REF/BEF Primary Injection Tests 19

4.7.1 Correct set up check 19

4.8 Busbar Primary Injection Tests 21

4.9 Final checks 23

5. MAINTENANCE 24

5.1 Equipment failure 24

5.1.1 Minor fault 24

5.1.2 Major fault 24

5.1.3 Hardware and software faults 25

5.2 Method of repair 25

5.2.1 Replacing the active part 25

5.2.2 Replacing the complete relay 25

5.3 Problem solving 26

5.3.1 Password lost or not accepted 26

5.3.2 Communication 26

1. REQUIREMENTS PRIOR TO COMMISSIONING

The MiCOM P72x relays are fully numerical in their design, implementing all protection and non-protection functions in software. The MiCOM relays use a high degree of self-checking and, in the unlikely event of a failure, will give an alarm. As a result of this, the commissioning tests do not need to be as extensive as with non-numerical relays (static or electromechanical).

To commission MiCOM relays, it is only necessary to verify that the hardware is functioning correctly and that the application-specific software settings have been applied to the MiCOM 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 the appropriate setting software MiCOM S1 (preferred method)
- From the front panel user interface.

REMINDER: It is not possible to download new setting software while the programming mode is active.

To confirm that the product is operating correctly once the application-specific settings have been applied, a test should be performed on a single protection element.

Unless previously agreed to the contrary, the customer will be responsible for determining the application-specific settings to be applied to the MiCOM relays and for testing of any scheme logic applied by external wiring.

Blank commissioning test sheets and commissioning setting record sheets are provided in the *Commissioning Test and Record Sheets* (RS) chapter.

BEFORE CARRYING OUT ANY WORK ON THE EQUIPMENT, THE USER SHOULD BE FAMILIAR WITH THE CONTENTS OF THE SAFETY GUIDE SFTY/4LM/G11 OR LATER ISSUE, OR THE SAFETY AND TECHNICAL DATA SECTION OF THE TECHNICAL MANUAL AND ALSO THE RATINGS ON THE EQUIPMENT RATING LABEL.

2. COMMISSIONING TEST ENVIRONMENT

2.1 Important notes

All commissioning tests of **MiCOM P721** and **P723** relays are carried out by injecting currents to the secondary of the earth and/or phase CTs using the appropriate injection test sets provided for this purpose.

2.1.1 Injection test sets

For convenience (weight, space, transportation), a single-phase injection test set is more suitable for commissioning and can perform all commissioning tests for the MiCOM P72x relay.

The following descriptions indicate how to conduct the commissioning tests with a single-phase injection test set.

However, for certain commissioning tests, the three-phase wiring diagrams are easier to understand and in this case the description is also given in three-phase format.

<u>Single-phase injection test set</u>

1 current (0 to 50 A), timer (precision 1 ms).

<u>Three-phase injection test set</u>

3 currents (0 to 50 A), timer (precision 1 ms).

2.1.2 Additional commissioning test equipment

- 1 multimeter (precision 1%),
- 1 connecting terminal to measure the currents exceeding 10 A (precision 2%),
- Test plugs and wires to carry out injections to the CT's secondary (dimensions according to the currents injected).

2.1.3 Communication

For all commissioning tests, the records can be downloaded using the RS232 front communication port in the P72x.

According to each RS 485 communication protocol (MODBUS, Courier, IEC 60870-5-103, DNP3.0).

2.2 Commissioning test sheets

Blank commissioning test sheets are provided in the *Commissioning Test and Record Sheets* (RS) chapter.

The Commissioning test sheets enable you to log:

- The name of the relay, station and circuit
- The characteristics of the MiCOM P72x relay
- The various settings
- The results of the protection and automation checks
- The result of the test records after commissioning.

3. PRODUCT VERIFICATION TESTS

BEFORE CARRYING OUT ANY WORK ON THE EQUIPMENT, THE USER SHOULD BE FAMILIAR WITH THE CONTENTS OF THE SAFETY GUIDE SFTY/4LM/E11 OR LATER ISSUE, OR THE SAFETY AND TECHNICAL DATA SECTIONS OF THE TECHNICAL MANUAL AND ALSO THE RATINGS ON THE EQUIPMENT RATING LABEL.

3.1 Allocation of terminals

Consult the appropriate wiring diagrams in the *Connection Diagrams* (CO) chapter while observing the various polarities and ground/earth connections.

3.2 Electrostatic discharge (ESD)

The case of the P72x protects it from electrostatic discharge. Do not remove the front panel unnecessarily.

A person's normal movements can generate high electrostatic voltages which can cause serious damage to electronic components. The damage is not always immediately apparent but can reduce reliability.

For further details see the chapter *Handling Installation and Case Dimensions* (IN).

3.3 Visual inspection

Carefully examine the relay to see if there has been any possible deterioration following installation.

Check the external wiring corresponds to the appropriate relay diagram or the assembly diagram. The reference number of the relay diagram is on a label under the upper flap of the front panel.

When the relay is withdrawn from its case, use a continuity tester to check if the current short-circuits (phases and earth CTs) between the terminals indicated on the wiring diagram are closed.

3.4 Earthing

Check if the earth connection of the case situated above the rear terminal block is used to connect the relay to a local earth bar. With several relays present, make sure that the copper earth bar is properly installed for solidly connecting the earthing terminals of each case.

3.5 Current transformers (CTs)

WARNING: NEVER OPEN CIRCUIT THE SECONDARY CIRCUIT OF A CURRENT TRANSFORMER SINCE THE HIGH VOLTAGE PRODUCED MAY BE LETHAL AND COULD DAMAGE INSULATION.

3.6 Auxiliary supply

Check the value of the auxiliary supply voltage (terminals 33 and 34). The value measured shall be between 0.8 and 1.2 times the dc nominal auxiliary supply voltage, or 0.8 and 1.1 times the ac nominal auxiliary supply voltage indicated on the MiCOM P72x.

Uaux range (Volts)	Uaux nominal zone (Volts)	Maximum peak value (Volts)
24 - 60 Vdc	19 - 72 Vdc	80
48 - 250 Vdc/48 - 240 Vac	38 - 300 Vdc/38 - 264 Vac	336
24 - 250 Vdc/24 - 240 Vac	19 - 300 Vdc/19 - 264 Vac	336

3.7 Logic inputs

This test checks that all the opto-isolated inputs are functioning correctly. The P723 relays have 5 opto-isolated inputs whereas the P721 relays have 2 opto-isolated inputs.

The opto inputs should be energized one at a time. The status of the input can be viewed using the menu **OP. PARAMETERS** > **Input Status**. 1 indicates an energized input and 0 indicates a de-energized input. When each logic input is energized, one of the characters on the bottom line of the menu display changes to the value shown in the following table to indicate the new state of the inputs.

Input	MiCOM P72x models	OP. PARAMETERS/Inputs Status cell value
Opto input 1 22-24 Terminals	P721, P723	00001
Opto input 2 26-28 Terminals	P721, P723	00010
Opto input 3 17-19 Terminals	P723	00100
Opto input 4 21-23 Terminals	P723	01000
Opto input 5 25-27 Terminals	P723	10000

3.8 Logic outputs

This test checks that all outputs are functioning correctly. The P723 has 8 outputs whereas the P721 has 4 outputs.

The Watchdog normally-closed contact is in terminals 35-36 and the Watchdog normally-open contact is in terminals 35-37.

RL1 and RL2 are change-over relays (2-4-6, 8-10-12).

RL3 to RL4 are normally open relays (14-16, 18-20).

RL5 to RL8 are normally open relays (1-3, 5-7, 11-9, 15-13).

Each output contact may have its own independent power supply (refer to wiring schemes).

To view the status of the outputs, use the menu **OP. PARAMETERS** > **Relay Status**. 1 indicates a closed output relay and 0 indicates an open output relay. When each output relay is closed, one of the corresponding characters on the bottom line of the menu display changes to the value shown in the following table to indicate the new state of the output.

OUTPUT	MiCOM P72x models	OP. PARAMETERS > RelayStatus cell value
RL 1 2-4-6 Terminals	P721, P723	00000001
RL 2 8-10-12 Terminals	P721, P723	00000010
RL 3 14-16 Terminals	P721, P723	00000100
RL 4 18-20 Terminals	P721, P723	00001000
RL 5 1-3 Terminals	P723	00010000
RL 6 5-7 Terminals	P723	00100000
RL 7 11-9 Terminals	P723	01000000
RL 8 15-13 Terminals	P723	10000000

3.9 RS 485 rear communication

This test should only be performed where the relay is to be accessed from a remote location and will vary depending on the communication protocol being used (refer to the label under the upper flap).

The test is not intended to verify the operation of the complete system from the relay to the remote location, just the relay's rear communication port and any protocol converter necessary.

Connect a laptop PC to the RS485 rear port (for instance via an ACKSYS for Courier communication) and check the communication.

4. SETTING CHECK

The setting checks ensure that all of the application-specific relay settings for the particular installation have been correctly applied to the relay.

Transfer the setting file to the relay using a laptop PC running the appropriate software through the RS232 front port (all MiCOM P72x models) or the RS485 rear port (all MiCOM models). This method is preferred because it is much faster. If the setting software is not used, enter the settings manually using the relay front panel interface.

Commissioning consists of the following points:

- Configuration of the settings
- Validation of the measurements
- Validation of the thresholds and associated timers.

4.1 Settings

Enter the settings on the commissioning test sheets.

4.2 Measurements

The **MiCOM P721** measures the earth differential current (true rms), the maximum earth differential current, and the frequency.

The **MiCOM P723** measures the phase or earth differential currents (true rms), the maximum phase or earth differential currents (true rms), and the frequency.

The **MiCOM P723** measures earth differential current when the **Connection** setting is **Earth**. It measures phase differential currents when the **Connection** setting is **Phase**.

**WARNING: MiCOM P721 AND P723 RELAYS HAVE 1 AND 5 AMP CURRENT INPUTS.
CHECK THAT THE INJECTED CURRENT IS COMPATIBLE WITH THE SELECTED RANGE.**

4.2.1 MiCOM P721

- Note the selected CT ratio.
- Energize the **MiCOM P721** relay.
- Apply current to input terminals 55-56 or 47-48 and verify the INDiff value on the LCD.
- Carry forward the results to the Commissioning test sheets (Injected current and relay current displayed)

4.2.2 MiCOM P723

- Note the selected phase and earth CTs ratio.
- Energize the **MiCOM P723** relay.
- Apply current to inputs 55-56 or 47-48. Verify the INDiff values on the LCD.
- Apply current to inputs 49-50 or 41-42, 51-52 or 43-44 and 53-54 or 45-46 and verify the IDiff values on the LCD.
- Enter the results on the Commissioning test sheets (Injected current and relay current displayed).

4.3 Phase differential proteciton ([87] Threshold I Diff])

Set the Trip [87] tDiff to the Trip Commands. Note that [87] tDiff is affected by the timer, any blocking logic, the bus wire supervision and the check zone. On the other hand, [87] Diff is instantaneous and it is not affected by any blocking logic, the bus wire supervision or the check zone. To monitor the [87] Diff operation, assign it to any of the relay outputs available (Rl2 to Rl8). The logic scheme of the three-phase high impedance differential protection is shown in Figure 1:

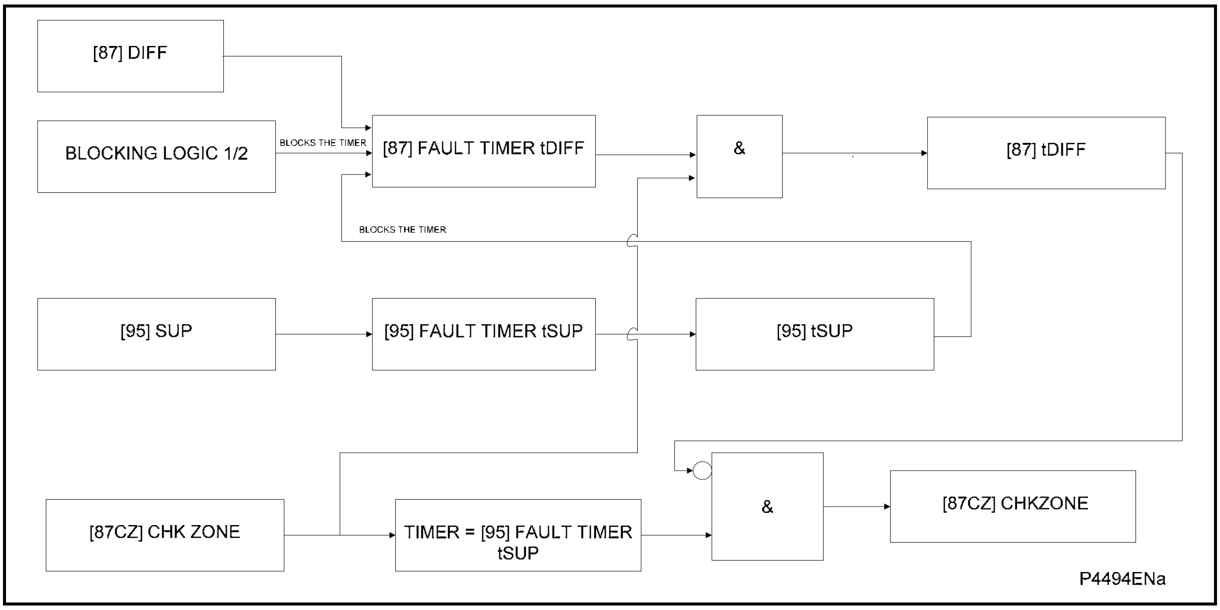


FIGURE 1: [87] I DIFF LOGIC

4.3.1 Test wiring diagram

The test wiring diagram shown in Figure 2 makes it possible to conduct tests related to the [87] Threshold I Diff.

The diagram describes current injection onto the 5 Amp phase current inputs (terminals 41-42, 43-44, 45-46), as well as current injection onto the 1 Amp phase current inputs (terminals 49-50, 51-52, 53-54).

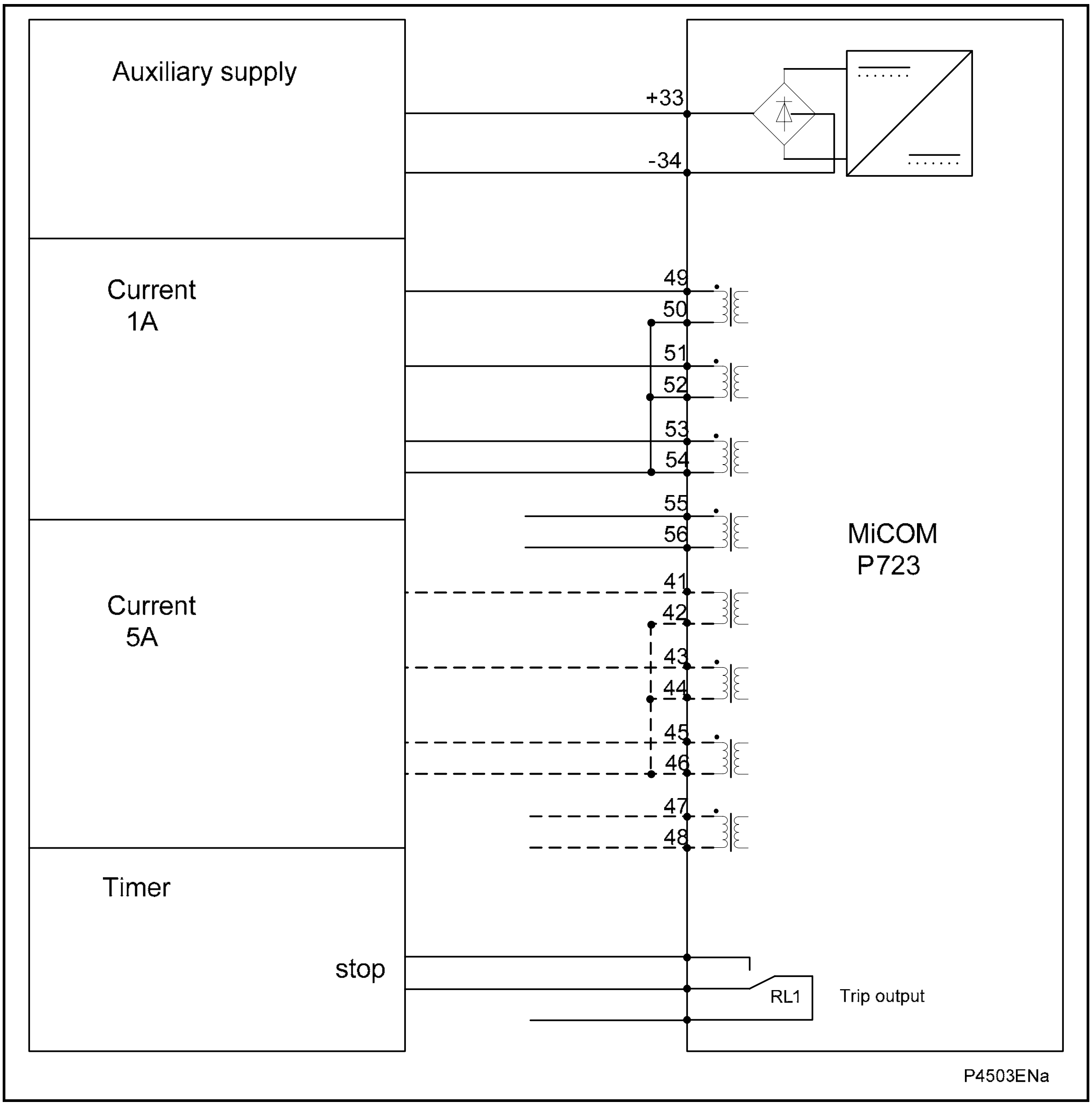


FIGURE 2: I DIFF TESTS WIRING

4.3.2 MiCOM settings

4.3.2.1 MiCOM P723 Settings

Note that the setting cell Protection line select under Configuration/Connection should be set as Phase.

Protection Menu

[87] PHASE DIFF. PROTECTION	
[87] Phase diff. Prot.	YES
[87] Threshold I Diff	2.00 In
[87] Fault Timer t diff	0.00 s
[87] Check Zone?	No
[87] Measurement Filter	Fourier, Sample, Fast sample modes
[87] Reset Timer tReset	0.00 s

AUTOMAT. CTRL/Trip commands Menu

TRIP [87] tDiff	YES

4.3.3 [87] Threshold I Diff with Fourier mode

The Fourier mode is based on the module of the fundamental of the differential current. If $\text{Idiff} > \text{[87] Threshold I Diff}$, the relay trips.

Values to be recorded:

[87] Threshold I Diff for each phase

Time delay tDiff> for each phase.

[87] Threshold I Diff check:

If the time delay [87] Fault Timer tdiff is short, gradually increase the injection current up to the value of the [87] Threshold I Diff.

If the time delay [87] Fault Timer tdiff is long, inject 0.95 x [87] Threshold I Diff and check that there is no tripping. Then inject 1.1 x [87] Threshold I Diff and check the trip.

Gradually decrease the injected current and record the value of the drop out.

Checks:

Alarm message on the LCD.

Alarm LED flashes.

Trip LED on

[87] tDiff LED on (if programmed).

Trip output closes.

[87] tDiff output closes (if programmed).

[87] Fault Timer tdiff check:

Apply a current onto phase A and measure the time delay [87] tDiff by pre-setting the current above the [87] Threshold I Diff (I injected > 2 x [87] Threshold I Diff). Repeat the same test for phases B and C.

4.3.4 [87] Threshold I Diff with Sample mode

The sample mode compares the peak-to-peak value of the differential current divided by $2 \times \sqrt{2}$ against the [87] Threshold I Diff.

If $\frac{\mathrm{Idiff}_{\mathrm{peak-peak}}}{2 \times \sqrt{2}} > [87]\ \mathrm{Threshold\ I\,Diff}$, then the relay trips.

Values to be recorded:

[87] Threshold I Diff for each phase

Time delay tDiff> for each phase.

[87] Threshold I Diff check:

If the time delay [87] Fault Timer tdiff is short, gradually increase the injection current up to the value of the [87] Threshold I Diff.

If the time delay [87] Fault Timer tdiff is long, inject 0.95 x [87] Threshold I Diff and check that there is no tripping. Then inject 1.1 x [87] Threshold I Diff and check the trip.

Gradually decrease the injected current and record the value of the drop out.

Checks:

Alarm message on the LCD.

Alarm LED flashes.

Trip LED on

[87] tDiff LED on (if programmed).

Trip output closes.

[87] tDiff output closes (if programmed).

[87] Fault Timer tdiff check:

Apply a current onto phase A and measure the time delay [87] tDiff by presetting the current above the [87] Threshold I Diff (I injected > 2 x [87] Threshold I Diff). Repeat the same test for phases B and C.

4.3.5 [87] Threshold I Diff with Fast mode

The Fast mode detects a number of samples above the threshold during one AC half cycle. The Fast mode threshold is $2 \times \sqrt{2} \times$ [87] Threshold I Diff. If four consecutive samples are above $2 \times \sqrt{2} \times$ [87] Threshold I Diff, then the relay trips.

Values to be recorded:

[87] Threshold I Diff for each phase

Time delay tDiff> for each phase.

[87] Threshold I Diff check:

If the time delay [87] Fault Timer tdiff is short, gradually increase the injection current up to the value of $2 \times \sqrt{2} \times$ [87] Threshold I Diff.

If the time delay [87] Fault Timer tdiff is long, inject $0.95 \times 2 \times \sqrt{2} \times$ [87] Threshold I Diff and check that there is no tripping. Then inject $1.1 \times 2 \times \sqrt{2} \times$ [87] Threshold I Diff and check the trip.

Gradually decrease the injected current and record the value of the drop out.

Checks:

Alarm message on the LCD.

Alarm LED flashes.

Trip LED on

[87] tDiff LED on (if programmed).

Trip output closes.

[87] tDiff output closes (if programmed).

[87] Fault Timer tdiff check:

Apply a current onto phase A and measure the time delay [87] tDiff by presetting the current above the 2 × √2 × [87] Threshold I Diff (I injected > 2 × 2 × √2 ×

[87] Threshold I Diff). Repeat the same test for phases B and C.

4.4 Earth differential protection ([87N] Threshold I Diff)

Set the Trip [87N] tDiff to the Trip Commands. Note that [87N] tDiff is affected by the timer, the bus wire supervision and any blocking logic. On the other hand, [87N] Diff is instantaneous and it is not affected by any blocking logic or the bus wire supervision. To monitor the [87N] Diff operation, assign it to any of the relay outputs available (RL2 to RL8). The logic scheme of the single-phase high impedance differential protection is shown in Figure 3.

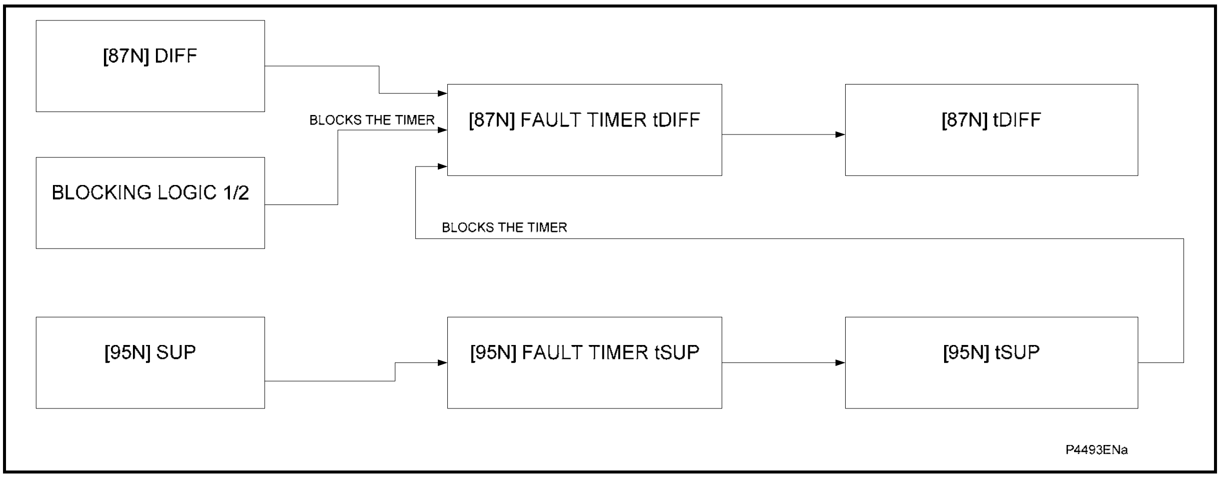


FIGURE 3: [87N] I DIFF LOGIC

4.4.1 Test wiring diagram

The test wiring diagram shown in Figure 4 makes it possible to conduct tests related to the [87N] Threshold I Diff.

The diagram describes current injection onto the 5 Amp phase current inputs (terminals 47-48), as well as current injection onto the 1 Amp phase inputs (terminals 55-56).

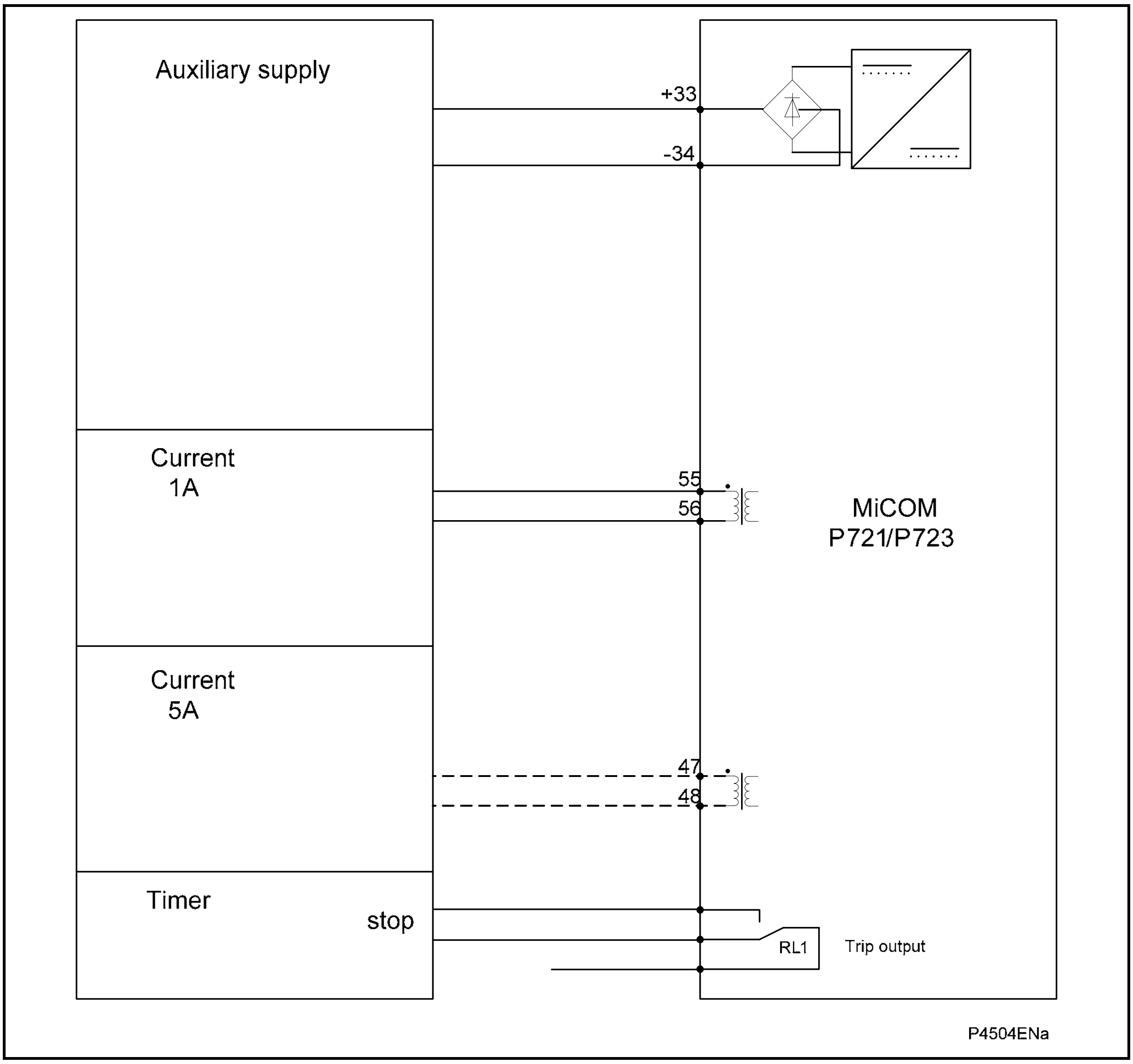


FIGURE 4: [87N] I DIFF TESTS WIRING

4.4.2 MiCOM settings

4.4.2.1 MiCOM P721 and P723 settings

Protection Menu

In the P723 setting file, the cell Description under **Op Parameters** can be set as either P721 or P723. If it is set as P723, then setting cell Protection line select under Configuration/Connection may be set as either [87N] Earth or [87] Phase. If the cell Description is set to P721, then setting cell Protection line select under Configuration/Connection can only be set as [87N] Earth.

[87N] EARTH DIFF. PROTECTION	
[87N] Earth Diff Prot.	Yes
[87N] Threshold I Diff	1.00 In
[87N] Flt Timer t Diff	0.00 s
[87N] Measurement Filter	Fourier, Sample, Fast sample modes
[87N] Rst Timer tReset	0.00 s

AUTOMAT. CTRL/Trip commands Menu

TRIP [87N] tDiff	YES

4.4.3 [87N] Threshold I Diff with Fourier mode

The Fourier mode is based on the differential current fundamental module. If $\text{Idiff} > [87]\ \text{Threshold I Diff}$, then the relay trips.

Values to be recorded:

[87N] Threshold I Diff

Time delay tDiff>

[87] Threshold I Diff check:

If the time delay [87N] Flt Timer tdiff is short, gradually increase the injection current up to the value of the [87N] Threshold I Diff.

If the time delay [87N] Flt Timer tdiff is long, inject 0.95 x [87N] Threshold I Diff and check that there is no tripping. Then inject 1.1 x [87N] Threshold I Diff and check the trip.

Gradually decrease the injected current and record the value of the drop out.

Checks:

Alarm message on the LCD.

Alarm LED flashes.

Trip LED on

[87N] tDiff LED on (if programmed).

Trip output closes.

[87N] tDiff output closes (if programmed).

[87N] Flt Timer tdiff check:

Apply a current onto the single phase CT input and measure the time delay [87N] tDiff by pre-setting the current above the [87N] Threshold I Diff (I injected > 2 x [87N] Threshold I Diff).

4.4.4 [87N] Threshold I Diff with Sample mode

The sample mode compares the peak-to-peak value of the differential current divided by $2 \times \sqrt{2}$ against the [87N] Threshold I Diff. If $\frac{\text{Idiff}_{\text{peak}-\text{peak}}}{2 \times \sqrt{2}} > [87\text{N}]\ \text{Threshold I Diff}$, then the relay trips.

Values to be recorded:

[87N] Threshold I Diff

Time delay tDiff>

[87] Threshold I Diff check:

If the time delay [87N] Flt Timer tdiff is short, gradually increase the injection current up to the value of the [87N] Threshold I Diff.

If the time delay [87N] Flt Timer tdiff is long, inject 0.95 x [87N] Threshold I Diff and check that there is no tripping. Then inject 1.1 x [87N] Threshold I Diff and check the trip.

Gradually decrease the injected current and record the value of the drop out.

Checks:

Alarm message on the LCD.

Alarm LED flashes.

Trip LED on

[87N] tDiff LED on (if programmed).

Trip output closes.

[87N] tDiff output closes (if programmed).

[87N] Fault Timer tdiff check:

Apply a current onto the single phase CT input and measure the time delay [87N] tDiff by pre-setting the current above the [87N] Threshold I Diff (I injected > 2 x [87N] Threshold I Diff).

4.4.5 [87N] Threshold I Diff with Fast mode

The Fast mode detects a number of samples above the threshold during one AC half cycle. The Fast mode threshold is $2 \times \sqrt{2} \times$ [87N] Threshold I Diff. If four consecutive samples are above $2 \times \sqrt{2} \times$ [87N] Threshold I Diff, then the relay trips.

Values to be recorded:

[87N] Threshold I Diff

Time delay tDiff>

[87N] Threshold I Diff check:

If the time delay [87N] Flt Timer tdiff is short, gradually increase the injection current up to the value of $2 \times \sqrt{2} \times$ [87N] Threshold I Diff.

If the time delay [87N] Fault Timer tdiff is long, inject $0.95 \times 2 \times \sqrt{2} \times$ [87N] Threshold I Diff and check that there is no tripping. Then inject $1.1 \times 2 \times \sqrt{2} \times$ [87N] Threshold I Diff and check the trip.

Gradually decrease the injected current and record the value of the drop out.

Checks:

Alarm message on the LCD.

Alarm LED flashes.

Trip LED on

[87N] tDiff LED on (if programmed).

Trip output closes.

[87N] tDiff output closes (if programmed).

[87N] Fault Timer tdiff check:

Apply a current onto the single phase CT and measure the time delay [87N] tDiff by pre-setting the current above the $2 \times \sqrt{2} \times$ [87N] Threshold I Diff (I injected > $2 \times 2 \times \sqrt{2} \times$ [87N] Threshold I Diff).

4.5 Phase bus wire supervision ([95] Phase Bus-Wire Sup)

4.5.1 Test wiring diagram

The same test wiring diagram shown in section 4.3.1 can be used.

4.5.2 MiCOM settings

4.5.2.1 MiCOM P723 Settings

Note that the setting cell Protection line select under Configuration/Connection should be set as [87] Phase.

Protection Menu

[95] PHASE BUS-WIRE SUPERV	
[95] Phase Bus-Wire Sup	YES
[95] Threshold I Sup	2.00 In
[95] Fault timer t Sup	3.00 s
[95] Measurement Filter	Fourier, Sample, Fast sample modes
[95] Reset Timer tReset	0.00 s

AUTOMAT. CTRL/Output Relays

Assign [95A] tSup A, [95B] tSup B, [95C] tSup C and [95] Sup to any of the outputs relays (RL2-RL8) to monitor the status of the bus wire supervision function.

4.5.3 [95] Threshold I Sup with Fourier mode

The Fourier mode is based on the module of the fundamental of the differential current.

Values to be recorded:

[95] Threshold I Sup for each phase

Time delay tSup for each phase.

[95] Threshold I Sup check:

If the time delay [95] Fault Timer t Sup is short, gradually increase the injected current up to the value of the [95] Threshold I Sup and verify that [95] Sup is asserted. Keep injecting the current and after the timer elapses verify that [95] tSup is also asserted.

If the time delay [95] Fault Timer t Sup is long, inject 0.95 x [95] Threshold I Sup and check that [95] Sup is not asserted. Then inject 1.1 x [95] Threshold I Sup and check [95] Sup is asserted. Keep injecting the later current and after the timer elapses verify that [95] tSup is also asserted.

Gradually decrease the injected current and record the value of the drop out.

Checks:

Alarm message on the LCD.

Alarm LED flashes.

[95] tSup LED on (if programmed).

Trip output does not close (If $[95]\ \text{Threshold I Sup} < \text{Idiff} < [87]\ \text{Threshold I Diff}$ and the [95] Fault timer t Sup has elapsed).

[95A] tSup A output closes (if programmed).

[95B] tSup B output closes (if programmed).

[95C] tSup C output closes (if programmed).

[95] Fault Timer t Sup check:

Apply a current onto phase A and measure the time delay [95A] tSup A by presetting the current above the [95] Threshold I Sup (2 x [95] Threshold I Diff < I injected < [87] Threshold I Diff). Repeat the same test for phases B and C using [95B] tSup B and [95C] tSup C respectively.

4.5.4 [95] Threshold I Sup with Sample mode

The sample mode compares the peak to peak value of the differential current divided by $2 \times \sqrt{2}$ against the [95] Threshold I Sup.

Values to be recorded:

[95] Threshold I Sup for each phase

Time delay tSup for each phase.

[95] Threshold I Sup check:

If the time delay [95] Fault Timer t Sup is short, gradually increase the injected current to [95] Threshold I Sup and verify that [95] Sup is asserted. Keep injecting the current and after the timer elapses verify that [95] tSup is also asserted.

If the time delay [95] Fault Timer t Sup is long, inject 0.95 × [95] Threshold I Sup and check that [95] Sup is not asserted. Then inject 1.1 × [95] Threshold I Sup and check that [95] Sup is asserted. Keep injecting the later current and after the timer elapses verify that [95] tSup is also asserted.

Gradually decrease the injected current and record the value of the drop out.

Checks:

Alarm message on the LCD.

Alarm LED flashes.

[95] tSup LED on (if programmed).

Trip output does not close

(If $[95]\ \text{Threshold}\ \text{I}\,\text{Sup} < \frac{\text{Idiff}_{\text{peak}-\text{peak}}}{2 \times \sqrt{2}} < [87]\ \text{Threshold}\ \text{I}\,\text{Diff}$ and the [95] Fault timer t Sup has elapsed).

[95A] tSup A output closes (if programmed).

[95B] tSup B output closes (if programmed).

[95C] tSup C output closes (if programmed).

[95] Fault Timer tSup check:

Apply a current onto one of the phases and measure the time delay [95] tSup by presetting the current above the [95] Threshold I Sup (2 x [95] Threshold I Sup < I injected < [87] Threshold I Diff) and verify that [95] Sup is asserted. Keep injecting the current and after the timer elapses verify that [95] tSup is also asserted. Repeat the same test for phases B and C using [95B] tSup B and [95C] tSup C respectively.

4.5.5 [95] Threshold I Sup with Fast mode

The Fast mode detects a number of samples above the threshold during one AC half cycle. The Fast mode threshold is 2 × √2 × [95] Threshold I Sup.

Values to be recorded:

[95] Threshold I Sup for each phase

Time delay tSup for each phase.

[95] Threshold I Sup check:

If the time delay [95] Fault Timer tSup is short, gradually increase the injection current up to the value of 2 × √2 × [95] Threshold I Sup and verify that [95] Sup is asserted. Keep injecting the current and after the timer elapses verify that [95] tSup is also asserted.

If the time delay [95] Fault Timer tSup is long, inject 0.95 x 2 × √2 × [95] Threshold I Sup and check that [95] Sup is not asserted. Then inject 1.1 x 2 × √2 × [95] Threshold I Sup and check that [95] Sup is asserted. Keep injecting the later current and after the timer elapses verify that [95] tSup is also asserted.

Gradually decrease the injected current and record the value of the drop out.

Checks:

Alarm message on the LCD.

Alarm LED flashes.

[95] tSup LED on (if programmed).

Trip output does not close

(If $2 \times \sqrt{2} \times [95]\ \text{Threshold I Sup} < \text{Idiff} < 2 \times \sqrt{2} \times [87]\ \text{Threshold I Diff}$ and the [95] Fault timer t Sup has elapsed).

[95A] tSup A output closes (if programmed).

[95B] tSup B output closes (if programmed).

[95C] tSup C output closes (if programmed).

[95] Fault Timer tdiff check:

Apply a current onto phase A and measure the time delay [95A] tDiff A by pre-setting the current above the 2 × √2 × [95] Threshold I Sup (2 × 2 × √2 × [95] Threshold I Sup < I injected < 2 × √2 × [87] Threshold I Diff). Repeat the same test for phases B and C using [95B] tSup B and [95C] tSup C respectively.

4.6 Earth bus wire supervision ([95N] Earth Bus-Wire Sup)

Three P721 relays are required to use the P721 in three phase applications. In this case, the [95N] Earth Bus-wire Sup should be tested the same way as the [95] Phase Bus-wire Sup in the P723. [95N] Sup and [95N] tSup should be verified. Check section 4.5 for further test details.

4.7 REF/BEF Primary Injection Tests

Primary injection tests will be used to check that the current transformers for the high impedance differential scheme are correctly connected.

4.7.1 Correct set up check

Before commencing any primary injection tests it is essential to ensure that the circuit is dead, isolated from the remainder of the system and that only those earth connections associated with the primary injection test equipment are in position.

The stability of the scheme can be checked by injecting through the neutral current transformer and each phase current transformer in turn. This test is required when the P72x is used in a high impedance REF.

Figure 7 shows the connections for the P721 and P723 when the relays are used in a high impedance differential scheme.

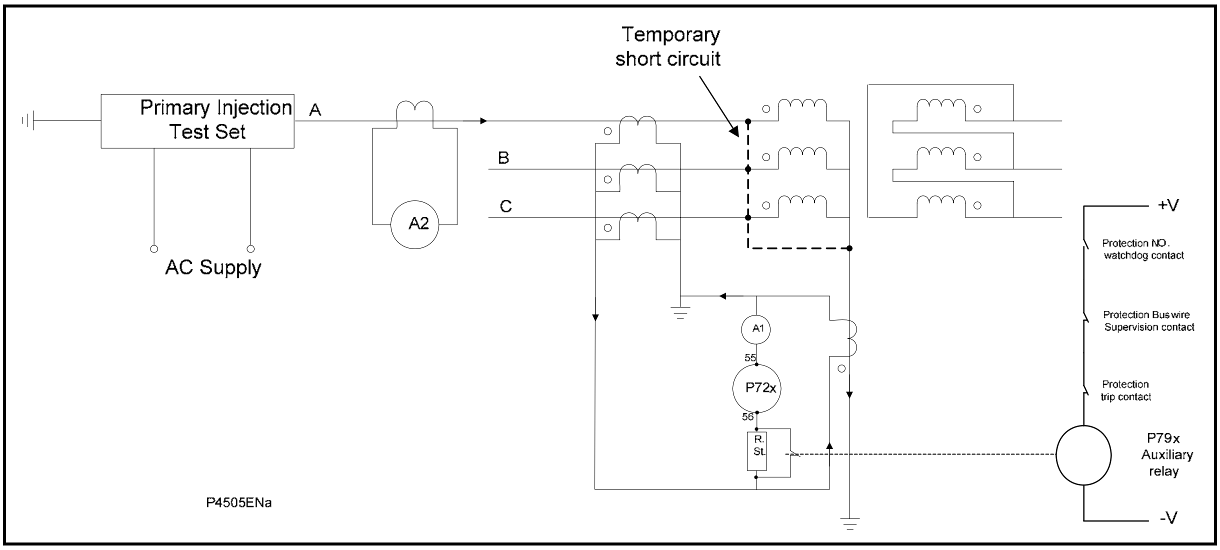


FIGURE 5: REF - PRIMARY INJECTION - STABILITY TEST SET UP

During the stability test, it is necessary to measure the spill current in the relay circuit, therefore the stabilizing resistor should be shorted out. The current should be increased up to as near full load as possible and the current flowing through ammeter A1 noted. If the connections are correct, this current would be very low, only a few milliamps. A high reading, (twice the injected current, referred through the current transformer ratio) indicates that one of the current transformer connections is reversed. This test should be repeated for the B-phase CT and neutral CT, and then for the C-phase CT and neutral CT.

The sensitivity of the protection can be checked by injecting with the single phase test set through each of the main current transformers in turn. This is shown in Figure 6. While carrying out this test it is advisable to measure the voltage across the relay coil and stabilizing resistance, and so to check the approximate voltage developed by the main current transformer to cause relay operation. During this test the P79x auxiliary relay should be kept energized, thus the stabilizing resistor is not short circuited.

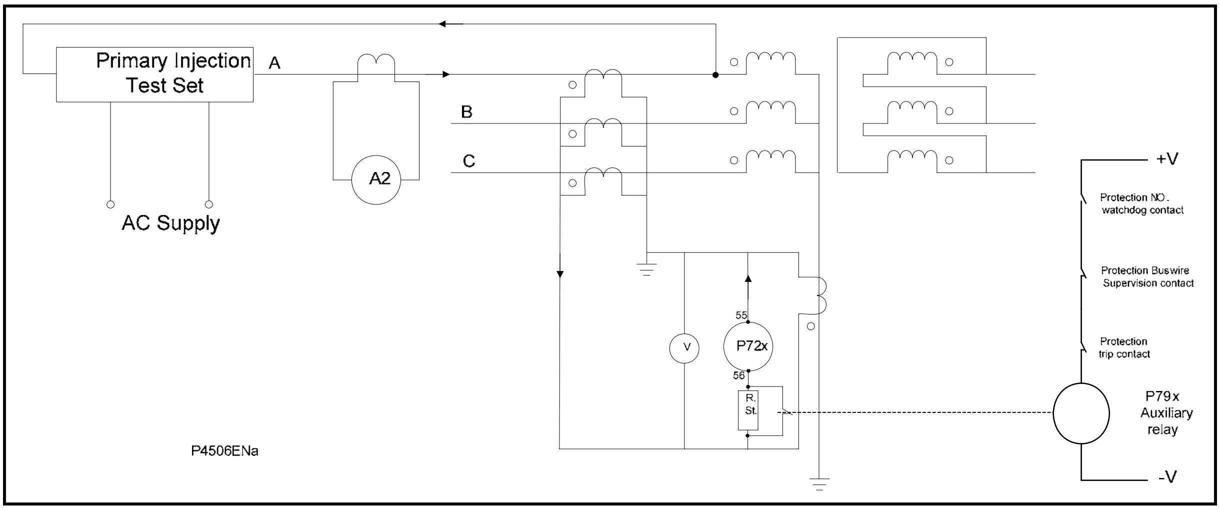


FIGURE 6: REF/BEF - PRIMARY INJECTION - SENSITIVITY TEST SET UP

4.8 Busbar Primary Injection Tests

First choose any of the CTs as the reference CT. The polarity and ratio of the reference CT should be checked first. Afterwards the polarity and ratio of the other CTs in the high impedance differential busbar scheme should be verified against the reference CT.

As shown in Figure 7, primary current should be injected through the reference CT to verify the CT ratio. It is important to short circuit the stabilizing resistor since it may not be rated to continuously withstand the injected current. Since the P723 has a low burden, the varistor is effectively short circuited when the stabilizing resistor is short circuited. If the P79x is de-energized, the stabilizing resistor and varistor will be short circuited.

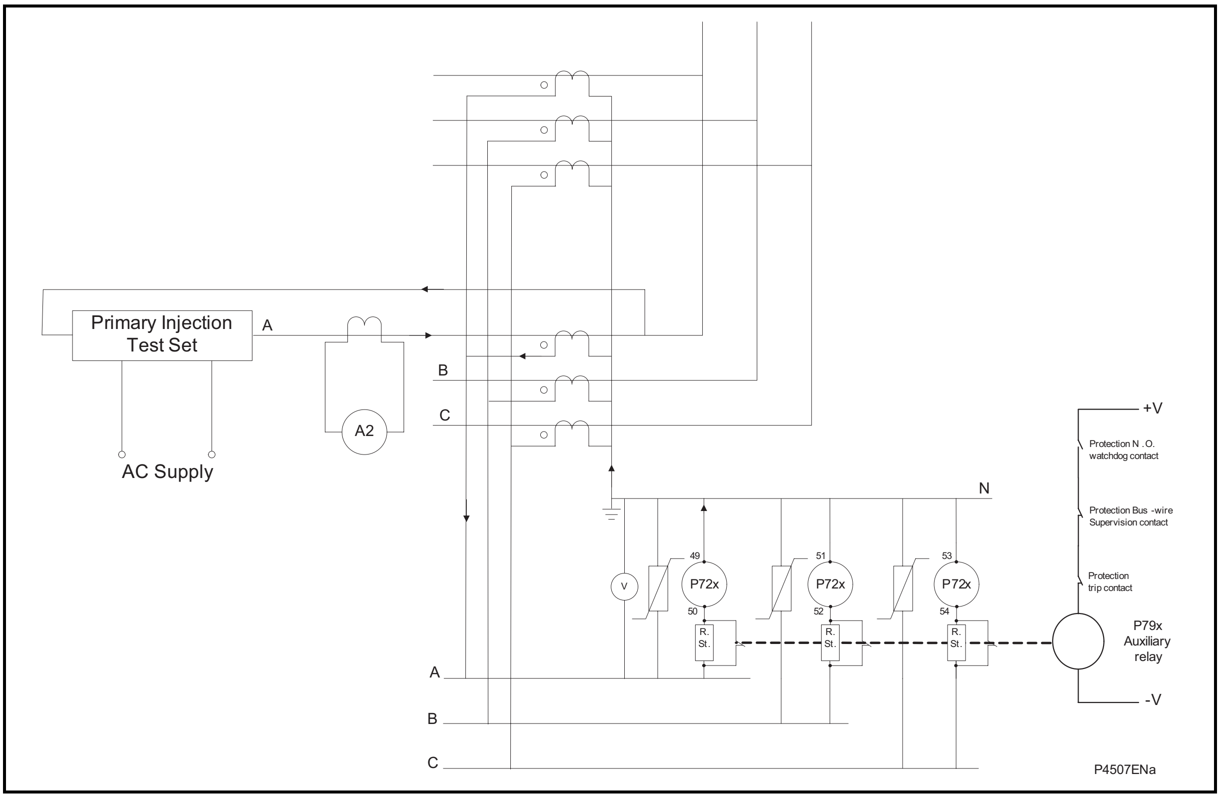


FIGURE 7: BUSBAR APPLICATION - PRIMARY INJECTION – RATIO CHECK OF REFERENCE CT

The ratio of A2 to A1 should approximate closely to the actual CT ratio.

To check the polarity of reference current transformers, current injection should be carried out through the primaries of two current transformers in the group as shown in Figure 8. During this test keep the P79x de-energized so that the stabilizing resistor and the varistor are kept short circuited. The polarity is correct if the reading on A1 is a few milliamperes. Phases A and B can be tested first and then phases B and C. If the current transformers are switched between main and reserve bus wires by isolator auxiliary switches, it is recommended to perform the tests with the busbar isolators in both positions.

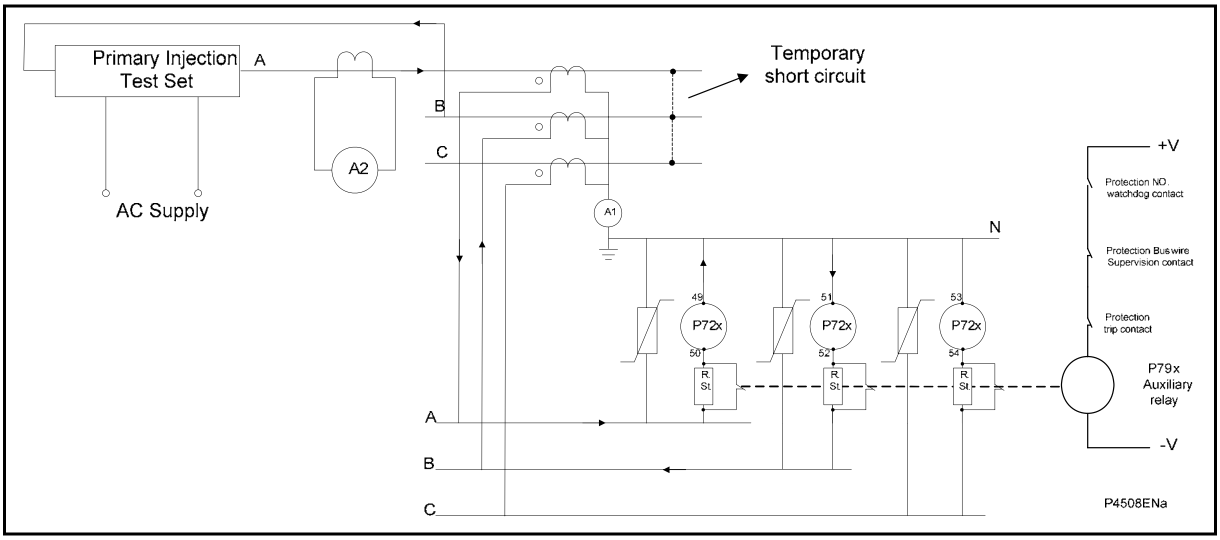


FIGURE 8: BUSBAR APPLICATION - PRIMARY INJECTION – POLARITY CHECK OF REFERENCE CT

The current transformers of each other circuit should be checked against the reference CT. This is done by injecting primary current through the reference and each of the remaining circuits. The P79x should be kept de-energized to effectively short circuit the high impedance differential scheme. As shown in Figure 9, primary current is injected into one pair of phases of the reference circuit with a temporary three phase short circuit applied in the test circuit. The ratio of the reading on ammeter A2 to A3 should closely approximate to the current transformer ratio. If the polarity is correct, then only a few milliamperes may be read on A1. To verify the ratio and polarity of all current transformers, primary injection should be performed between A and B and then between B and C phases.

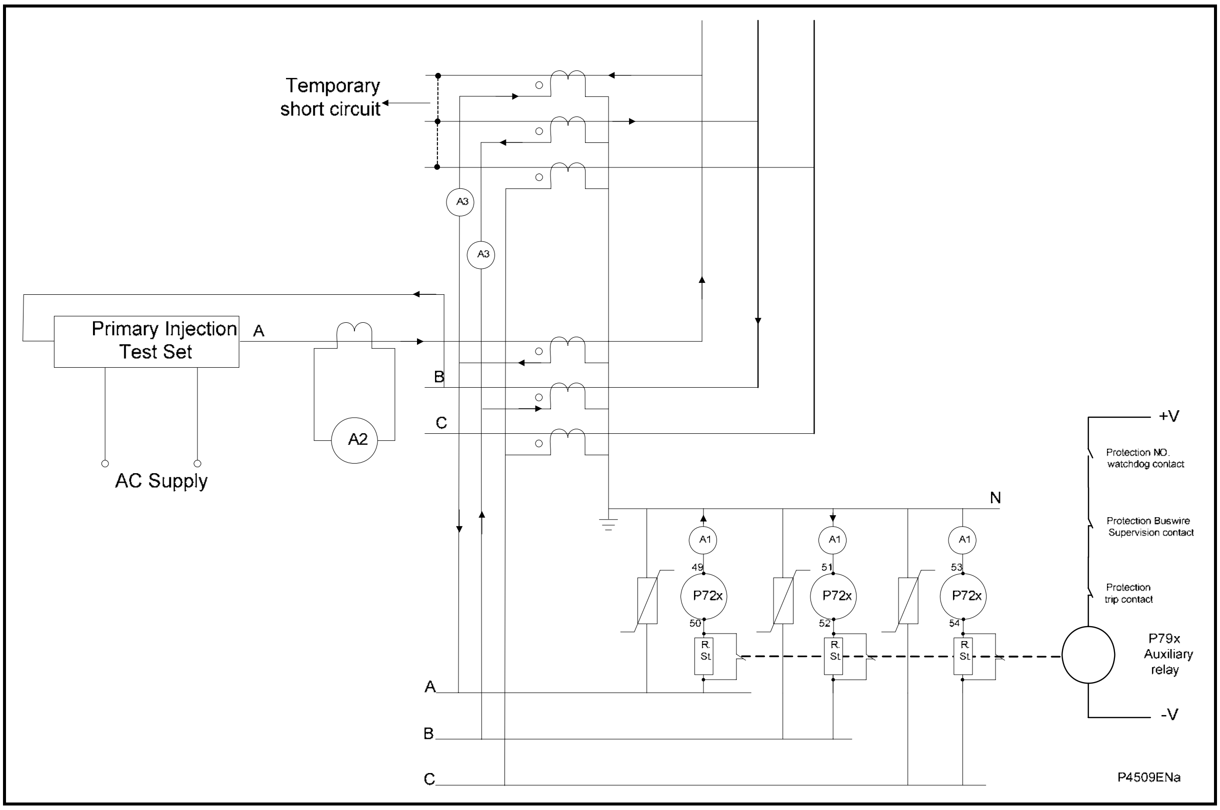


FIGURE 9: BUSBAR APPLICATION - PRIMARY INJECTION – INTER-GROUP RATIO AND POLARITY CHECK

The sensitivity of the scheme should also be tested by injecting primary current into one of the current transformers only. The current required to operate the P72x with the maximum number of current transformers in idle shunt should be measured. Since the supervision relay has a low setting it should be left inoperative while performing the sensitivity test. To verify that the correct value of stabilizing resistor is used, a voltmeter should be used to measure the voltage across the P72x and the stabilizing resistor. The voltage reading should be noted when the P72x operates, and this voltage should be very close to the Vs (stability voltage). The sensitivity test should be performed for each discriminating zone and for the overall check zone. The primary operating current should be very close to the effective relay setting or primary operating current calculated. Figure 10 shows the sensitivity test connections. During this test the P79x auxiliary relay should be kept energized, thus the stabilizing resistor is not short circuited.

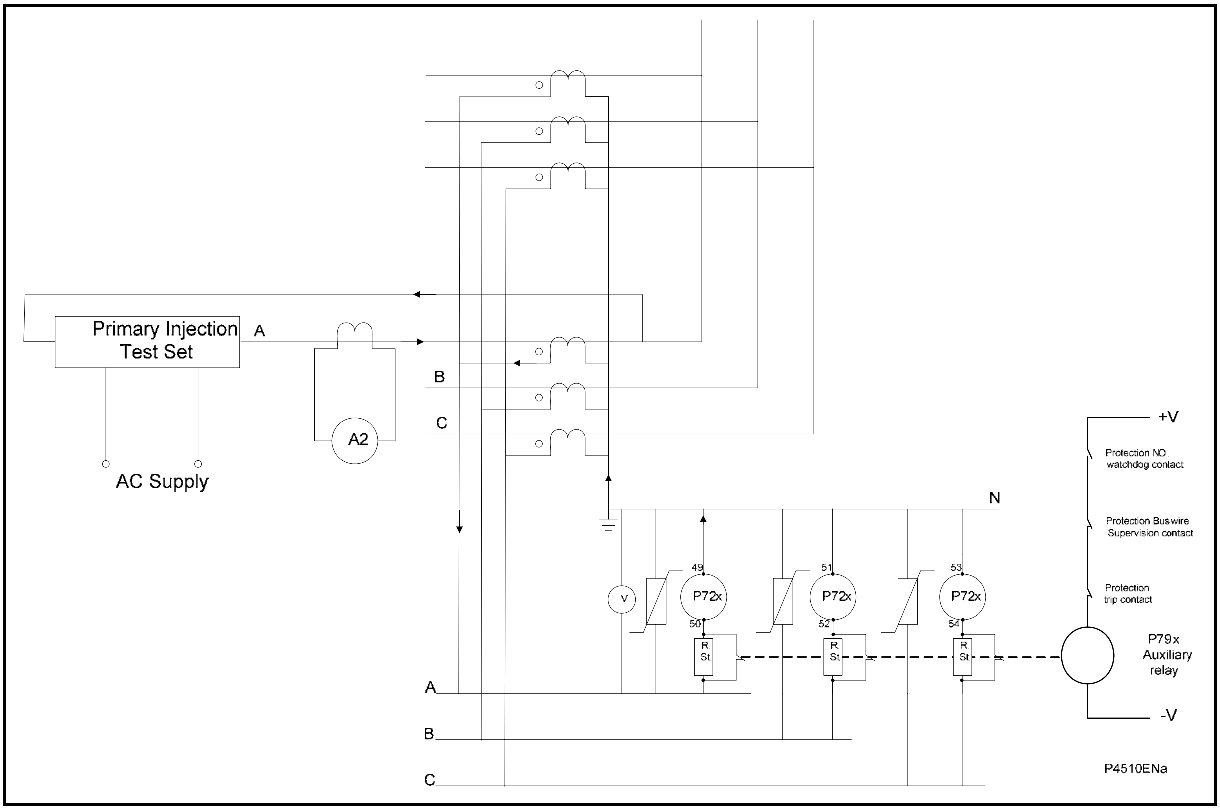


FIGURE 10: BUSBAR APPLICATION - PRIMARY INJECTION – SENSITIVITY TEST

4.9 Final checks

The tests are now complete. Remove all test or temporary shorting leads, etc.. If it is necessary to disconnect any of the external wiring from the relay to perform the wiring verification tests, ensure that all connections are replace in accordance with the relevant external connection or scheme diagram.

If a MMLG test block is installed, remove the MMLB01 test plug and replace the MMLG cover so that the protection is put into service.

Ensure that all event, fault and disturbance records, alarms and LEDs have been reset before leaving the relay.

5. MAINTENANCE

5.1 Equipment failure

The **MiCOM P723 and P721** are fully digital and self-diagnosing. As soon as an internal fault is detected, depending on its type (minor or major), an alarm message is displayed as a priority on the front panel LCD before the fault LED is illuminated (fixed or flashing) and the watchdog relay is closed (if the fault is a major one).

The watchdog facility provides two output relay contacts, one normally open and one normally closed that are driven by the processor board. These are provided to give an indication that the relay is in a healthy state.

An equipment failure (major or minor) cannot be acknowledged on the front panel (using the dedicated tactile button keypad). Only the disappearance of the cause will acknowledge the fault and hence reset the fault LED.

All tests are performed while the relay boots. Background software tasks, except for volatile memory tests, are performed only when the relay boots and on any setting changes.

5.1.1 Minor fault

A communication failure is regarded by the **MiCOM P721** and **P723** relays as a minor fault. If the communication is at fault, the **MiCOM P721** and **P723** protection and automation modules are not affected. The MiCOM relay is fully operational. The watchdog relay is energized (35-36 contact open and 36-37 contact closed).

Message:

"COMM.ERROR": Communication fault

Cause:

Hardware or software failure of the communication module

Action:

Withdraw the active part and return it to the factory for repair.

Alternative: If communication is not used, disable communication in the COMMUNICATION menu (Communication ? = No).

5.1.2 Major fault

In **MiCOM P721** and **P723** relays, major faults are all software and hardware failures except for communication faults. As soon as this type of failure is detected, the watchdog (WD) is de-energized (35-36 contact closed and 36-37 contact open) and all operations are stopped (protection, automation, communication).

5.1.3 Hardware and software faults

Messages:

"DEFAULT SETTING": Indication that the relay is running the default setting

"SETTING ERROR": Failure in the setting

" CALIBRATION ERROR.": Calibration zone failure

"CT ERROR": Analogue channel failure

Cause:

Hardware or software failure

Action:

Restart the protection software (refer § 5.3).
If the software fault still remains after restart, withdraw the active part and return the module to the factory for repair.

5.2 Method of repair

5.2.1 Replacing the active part

BEFORE CARRYING OUT ANY WORK ON THE EQUIPMENT, THE USER SHOULD BE FAMILIAR WITH THE CONTENTS OF THE SAFETY GUIDE SFTY/4LM/E11 OR LATER ISSUE, OR THE SAFETY AND TECHNICAL DATA SECTIONS OF THE TECHNICAL MANUAL AND ALSO THE RATINGS ON THE EQUIPMENT RATING LABEL.

The case and the rear terminals blocks have been designed to facilitate removal of the MiCOM P72x relay should replacement or repair become necessary without disconnect the scheme wiring.

NOTE: The MiCOM range of relays have integral current transformer shorting switches which will close when the active part is removed from the case.

Remove the upper and lower flap without exerting excessive force. Remove the external screws. Under the upper flap, turn the extractor with a 3 mm screwdriver and extract the active part of the relay by pulling from the upper and lower notches on the front panel of the MiCOM relay.

To reinstall the repaired or replacement relay follow the above instructions in reverse, ensuring that no modification has been made to the scheme wiring.

On completion of any operations which require the relay to be removed from its case, verify that the four fixing screws are fitted at the corners of the front panel under the flaps. These screws secure the chassis (removable part) to the relay case, ensuring good seating and contact.

5.2.2 Replacing the complete relay

To remove the complete relay (active part and case) the entire wiring must be removed from the rear connector.

Before working at the rear of the relay, isolate all current supplies to the MiCOM relay and ensure that the relay is no longer powered.

WARNING: NEVER OPEN THE SECONDARY CIRCUIT OF A CURRENT TRANSFORMER SINCE THE HIGH VOLTAGE PRODUCED MAY BE LETHAL AND COULD DAMAGE THE INSULATION.

Remove all wiring (communication, logic inputs, outputs, auxiliary voltage, current inputs). Disconnect the relay earth connection from the rear of the relay.

Remove the screws used to fasten the relay to the panel, rack, etc.. These are the screws with the larger diameter heads that are accessible when the upper and lower flaps are installed.

Carefully withdraw the relay from the panel or rack because it will be heavy due to the internal transformers.

To reinstall the repaired or replacement relay, follow the above instructions in reverse, ensuring that each terminal block is relocated in the correct position and that the case earth and communication are replaced.

Once reinstallation is complete the relay should be recommissioned.

5.3 Problem solving

5.3.1 Password lost or not accepted

Problem:

Password lost or not accepted

Cause:

MiCOM P721 and **P723** relays are supplied with the password set to ***AAAA.*** This password can be changed by the user (refer OP PARAMETERS menu).

Action:

There is an additional unique recovery password associated with the relay which can be supplied by the factory or service agent, if given details of its serial number (under the upper flap of the front panel). With this serial number, contact your Schneider Electric local dealer or Customer Contact Center (http://www.schneider-electric.com/CCC).

5.3.2 Communication

5.3.2.1 Values measured locally and remotely.

Problem:

The measurements noted remotely and locally (via RS485 communication) differ.

Cause:

The values accessible on the front face via the Measurement menu are refreshed every second. Those fed back via RS485 communication and accessible by the Schneider Electric's Setting software generally have skeletal refreshing frequencies. If the refreshing frequency of the supervision software differs from that of **MiCOM P721** and **P723** relays (1s), there may be a difference between indicated values.

Action:

Adjust the frequency for refreshing the measurements of the supervision software or of the setting software to 1 second.

5.3.2.2 MiCOM relay no longer responds

Problem:

No response from **MiCOM P721** and **P723** relays when asked by the supervision software without any communication fault message.

Cause:

Mainly, this type of problem is linked to an error in the **MiCOM P721** and **P723** communication parameters.

Action:

Check **MiCOM P721** and **P723** communication parameters (data rate, parity, etc.) are in accordance with the supervision settings.

Check **MiCOM P721** and **P723** network address.

Check that this address is not used by another device connected on the same LAN.

Check that the other devices on the same LAN answer to supervision requests.

5.3.2.3 A remote command is not taken in account

Problem:

The communication between the relay and the PC is correct, but the relay does not accept any remote command or file downloading.

Cause:

Generally this is due to the fact that the relay is in a programming situation, therefore the password is active.

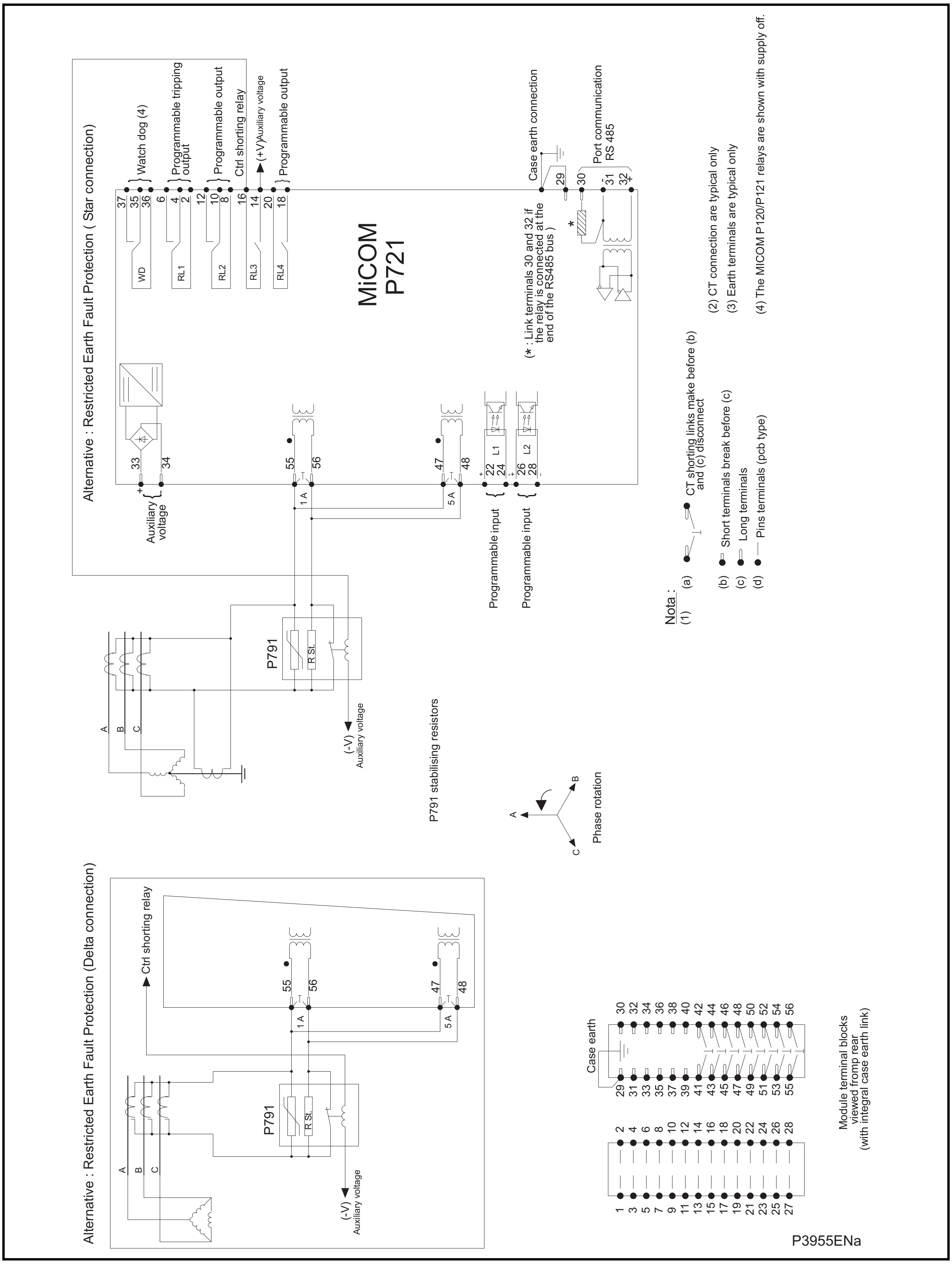
Action:

Check that the relay password has not been active for the last 5 minutes.

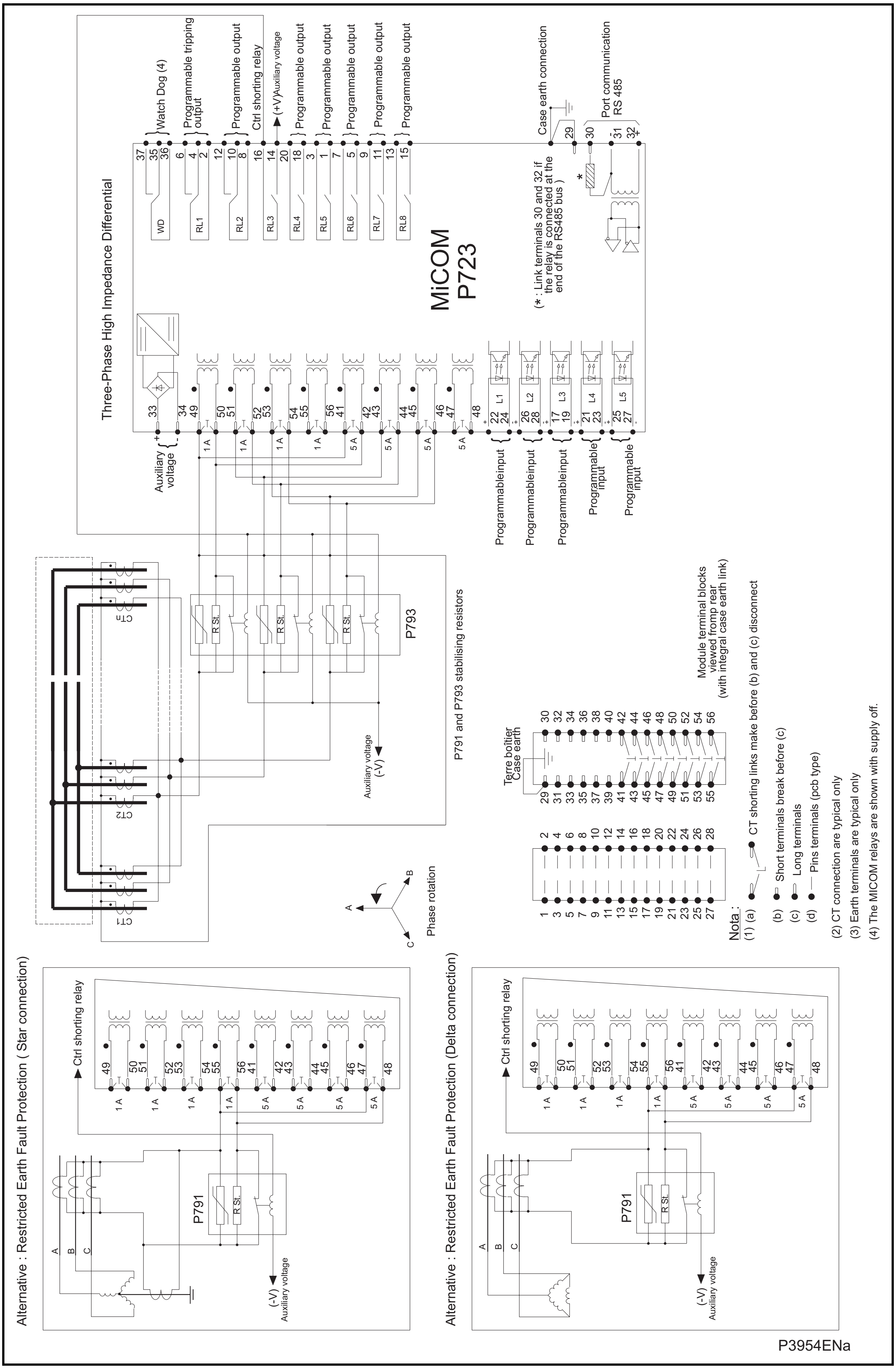
BLANK PAGE

CONNECTION DIAGRAMS

BEFORE CARRYING OUT ANY WORK ON THE EQUIPMENT, THE USER SHOULD BE FAMILIAR WITH THE CONTENTS OF THE SAFETY GUIDE SFTY/4LM/E11 OR LATER ISSUE, OR THE SAFETY AND TECHNICAL DATA SECTION OF THE TECHNICAL MANUAL AND ALSO THE RATINGS ON THE EQUIPMENT RATING LABEL."



SCHEME REPRESENTING MiCOM RELAY OFF



SCHEME REPRESENTING MiCOM RELAY OFF

COMMISSIONING TEST & RECORD SHEETS

CONTENTS

1.	**COMMISSIONING TEST SHEETS**	**3**
1.1	**Relay identification**	**3**
1.2	**Commissioning test record**	**3**
2.	**COMMISSIONING SETTING RECORD SHEETS**	**6**
2.1	**OP PARAMETERS Menu**	**6**
2.2	**CONFIGURATION Menu**	**6**
2.2.1	Connection menu	6
2.2.2	LEDs 5 to 8 configuration	7
2.2.3	Group select configuration	7
2.2.4	Alarms configuration	8
2.2.5	Inputs configuration	8
2.2.6	Relays maintenance	8
2.3	**COMMUNICATION Menu**	**9**
2.4	**PROTECTION G1 Menu**	**10**
2.4.1	[87N] Earth differential protection	10
2.4.2	[95N] Earth bus-wire supervision	10
2.4.3	[87] Phase differential protection (P723 only)	10
2.4.4	[95] Phase bus-wire supervision (P723 only)	11
2.5	**PROTECTION G2 Menu**	**11**
2.5.1	[87N] Earth differential protection	11
2.5.2	[95N] Earth bus-wire supervision	11
2.5.3	[87] Phase differential protection (P723 only)	12
2.5.4	[95] Phase bus-wire supervision (P723 only)	12
2.6	**AUTOMAT.CTRL Menu**	**13**
2.6.1	TRIP Command allocation	13
2.6.2	Latch function allocation	13
2.6.3	Blocking Logic 1 function allocation	14
2.6.4	Blocking Logic 1 function allocation	14
2.6.5	OUTPUT RELAYS allocation	14
2.6.6	LATCH OUTPUT RELAYS allocation	15
2.6.7	LOGIC INPUT allocation	16
2.6.8	CIRCUIT BREAKER FAILURE	16
2.6.9	LOGIC EQUATIONS	17
2.7	**RECORDING Menu**	**21**
2.7.1	FAULT RECORD Record	21
2.7.2	INSTANTANEOUS Record	21
2.7.3	DISTURBANCE RECORD	21

BLANK PAGE

1. COMMISSIONING TEST SHEETS

BEFORE CARRYING OUT ANY WORK ON THE EQUIPMENT, THE USER SHOULD BE FAMILIAR WITH THE CONTENTS OF THE SAFETY GUIDE SFTY/4LM/D11 OR LATER ISSUE, OR THE SAFETY AND TECHNICAL DATA SECTION OF THE TECHNICAL MANUAL AND ALSO THE RATINGS ON THE EQUIPMENT RATING LABEL.

1.1 Relay identification

Commissioning date : ____________________

Engineer : ____________________

Substation : ____________________

Circuit : ____________________

Network nominal frequency: ____________________

MiCOM Overcurrent relay model : ❑ **P721** ❑ **P723**

Serial number :

Rated current In :

Auxiliary voltage Uaux :

Communication protocol :

Language :

1.2 Commissioning test record

(put a cross after each checked stage)

Serial number check ?	☐
All current transformer shorting switches closed ?	☐
Wiring checked against diagram (if available) ?	☐
Case earth installed ?	☐
Test block connections checked (if installed) ?	☐
Insulation tested ?	☐

Auxiliary supply control

Auxiliary voltage to relay		☐
Auxiliary voltage value	________________	Vdc/Va
Watchdog contacts		
With auxiliary supply off	Terminals 35 and 36	☐
With auxiliary supply on	Terminals 36 and 37	☐

Measurements

	Applied value	**Relay value**
PHASE CT INPUT		
Phase A current	________________ A	________________A
Phase B current	________________ A	________________A
Phase C current	________________ A	________________A
EARTH CT INPUT		
Earth current	________________ A	________________A

Phase protection test

	Theoretical value	**Relay value**
Threshold I Diff	________________ A	
I Diff Threshold		________________A
I Diff drop Threshold		________________A
Timer		
Fault Timer tdiff at 2*I Diff	______________ ms	________________A
Fault Timer tdiff at 10*I Diff	______________ ms	________________A
Reset Timer tReset at 2*I Diff	______________ ms	________________A
Reset Timer tReset at 10*I Diff	______________ ms	________________A
Check Zone	________________ A	
Reset Timer tReset	______________ ms	________________A

Earth protection test

	Theoretical value	Relay value
Threshold Earth Diff	________________ A	
I Diff Threshold		________________A
I Diff drop Threshold		________________A
Timer		
Fault Timer tdiff at 2*I Diff	________________ ms	________________A
Fault Timer tdiff at 10*I Diff	________________ ms	________________A
Reset Timer tReset at 2*I Diff	________________ ms	________________A
Reset Timer tReset at 10*I Diff	________________ ms	________________A

Commissioning Engineer Date

____________________________ ________________

2. COMMISSIONING SETTING RECORD SHEETS

2.1 OP PARAMETERS Menu

Password : ______________________

Reference : ______________________

Software version : ______________________

Frequency : ❑ 50 Hz ❑ 60 Hz

2.2 CONFIGURATION Menu

2.2.1 Connection menu

Protection line select	❑ Earth	❑ Phase
Input Selection	❑ Current	❑ Voltage

If protection Line = Earth				
E/Gnd Text	❑ N	❑ E	❑ G	
Line CT Primary	Ω			
E/Gnd CT Primary	Primary earth CT ratio			
E/Gnd CT Secondary	Secondary earth CT ratio		❑ 1 A	❑ 5 A

If protection Line = Phase				
Phase A Text	❑ A	❑ L1	❑ R	
Phase B Text	❑ B	❑ L2	❑ S	
Phase C Text	❑ C	❑ L3	❑ T	
Stabiliz resist L1 (A, R)	Ω			
Stabiliz resist L2 (B, S)	Ω			
Stabiliz resist L3 (C, T)	Ω			
Line CT Primary	Primary phase CT ratio			
Line CT Secondary	Secondary phase CT ratio		❑ 1 A	❑ 5 A

2.2.2 LEDs 5 to 8 configuration

• = available with this model.

Functions	P721	P723	LED 5	LED 6	LED 7	LED 8
			Yes	Yes	Yes	Yes
[87] Diff		•	❑	❑	❑	❑
[87N] Diff	•	•	❑	❑	❑	❑
[87] tDiff		•	❑	❑	❑	❑
[87N] tDiff	•	•	❑	❑	❑	❑
[87CZ] Check zone		•	❑	❑	❑	❑
[95] Sup		•	❑	❑	❑	❑
[95N] Sup		•	❑	❑	❑	❑
[95] tSup		•	❑	❑	❑	❑
[95N] tSup	•	•	❑	❑	❑	❑
[95A] tSupA		•	❑	❑	❑	❑
[95B] tSupB		•	❑	❑	❑	❑
[95C] tSupC		•	❑	❑	❑	❑
Input 1	•	•	❑	❑	❑	❑
Input 2	•	•	❑	❑	❑	❑
Input 3		•	❑	❑	❑	❑
Input 4		•	❑	❑	❑	❑
Input 5		•	❑	❑	❑	❑
tAux 1	•	•	❑	❑	❑	❑
tAux 2	•	•	❑	❑	❑	❑
tAux 3		•	❑	❑	❑	❑
tAux 4		•	❑	❑	❑	❑
tEqu.A	•	•	❑	❑	❑	❑
tEqu.B	•	•	❑	❑	❑	❑
tEqu.C	•	•	❑	❑	❑	❑
tEqu.D	•	•	❑	❑	❑	❑
tEqu.E	•	•	❑	❑	❑	❑
tEqu.F	•	•	❑	❑	❑	❑
tEqu.G	•	•	❑	❑	❑	❑
tEqu.H	•	•	❑	❑	❑	❑

2.2.3 Group select configuration

Change group input	❑ Menu	❑ Input
Setting group	❑ 1	❑ 2

2.2.4 Alarms configuration

Inst. Self Reset?	❑ YES	❑ NO
Reset Led on fault	❑ YES	❑ NO
Alarm tAux1	❑ YES	❑ NO
Alarm tAux2	❑ YES	❑ NO
Alarm tAux3 (P723 only)	❑ YES	❑ NO
Alarm tAux4 (P723 only)	❑ YES	❑ NO
Alarm tAux5 (P723 only)	❑ YES	❑ NO

2.2.5 Inputs configuration

Inputs (P721 only)		2 ❑		1 ❑	
Inputs (P723 only)	5 ❑	4 ❑	3 ❑	2 ❑	1 ❑
Voltage input DC	❑ DC			❑ AC	

2.2.6 Relays maintenance

					← ❑ P721 →				
		← ❑ P723 →							
Fail Safe Relay		8	7	6	5	4	3	2	1
Maintenance Mode	❑ YES				❑ NO				

					← ❑ P721 →				
	← ❑ P723 →								
Relays CMD	8	7	6	5	W	4	3	2	1

2.3 COMMUNICATION Menu

NOTE: Menu content depends on the communication protocol.

Communication ?	❑ YES	❑ NO	
Rear Comm. Address			
Baud Rate	❑ 300 bds	❑ 600 bds	
	❑ 1.200 bds	❑ 2.400 bds	
	❑ 4.800 bds	❑ 9.600 bds	
	❑ 19.200 bds	❑ 38 400 bds	
Parity	❑ Odd	❑ Even	❑ None
Data bits	❑ 7	❑ 8	
Stop bits	❑ 1	❑ 2	
Spont. Event.	❑ All	❑ IEC only	❑ None
Command blocking	❑ YES	❑ NO	
Signal Blocking	❑ YES	❑ NO	
Measure Enabling	❑ ASDU 3.4&9	❑ ASDU 9	
	❑ ASDU 3.4	❑ None	
Front Comm. Address			
Date Format	❑ Private	❑ IEC	

2.4 PROTECTION G1 Menu

2.4.1 [87N] Earth differential protection

[87N] Earth Diff protection?	❑ Yes		❑ No:
[87N] Threshold I diff=	In		
[87N] Threshold V diff=	V		
[87N] Flt Timer t Diff	s		
[87N] Flt Timer t Reset	s		
[87N] Measure Filter	❑ Sample mode	❑ Fast sample mode	❑ Fourier mode

2.4.2 [95N] Earth bus-wire supervision

[95N] Earth bus-wire sup?	❑ Yes		❑ No:
[95N] Threshold I Sup=	In		
[95N] Threshold V Sup=	V		
[95N] Flt Timer t Sup	s		
[95N] Flt Timer t Reset	s		
[95N] Measure Filter	❑ Sample mode	❑ Fast sample mode	❑ Fourier mode

2.4.3 [87] Phase differential protection (P723 only)

[87] Phase Diff prot?	❑ Yes		❑ No:
[87] Threshold I diff=	In		
[87] Threshold V diff=	V		
[87] Flt Timer t Diff	s		
[87] Check zone?	❑ Yes		❑ No:
[87] Rst Timer t Reset	s		
[87] Measure Filter	❑ Sample mode	❑ Fast sample mode	❑ Fourier mode

2.4.4 [95] Phase bus-wire supervision (P723 only)

[95] Phase bus-wire sup?	❑ Yes		❑ No:
[95] Threshold I Sup=	In		
[95] Threshold V Sup=	V		
[95] Flt Timer t Sup	s		
[95] Flt Timer t Reset	s		
[95] Measure Filter	❑ Sample mode	❑ Fast sample mode	❑ Fourier mode

2.5 PROTECTION G2 Menu

2.5.1 [87N] Earth differential protection

[87N] Earth Diff protection?	❑ Yes		❑ No:
[87N] Threshold I diff=	In		
[87N] Threshold V diff=	V		
[87N] Flt Timer t Diff	s		
[87N] Flt Timer t Reset	s		
[87N] Measure Filter	❑ Sample mode	❑ Fast sample mode	❑ Fourier mode

2.5.2 [95N] Earth bus-wire supervision

[95N] Earth bus-wire sup?	❑ Yes		❑ No:
[95N] Threshold I Sup=	In		
[95N] Threshold V Sup=	V		
[95N] Flt Timer t Sup	s		
[95N] Flt Timer t Reset	s		
[95N] Measure Filter	❑ Sample mode	❑ Fast sample mode	❑ Fourier mode

2.5.3 [87] Phase differential protection (P723 only)

[87] Phase Diff prot?	❑ Yes		❑ No:
[87] Threshold I diff=	In		
[87] Threshold V diff=	V		
[87] Flt Timer t Diff	s		
[87] Check zone?	❑ Yes		❑ No:
[87] Rst Timer t Reset	s		
[87] Measure Filter	❑ Sample mode	❑ Fast sample mode	❑ Fourier mode

2.5.4 [95] Phase bus-wire supervision (P723 only)

[95] Phase bus-wire sup?	❑ Yes		❑ No:
[95] Threshold I Sup=	In		
[95] Threshold V Sup=	V		
[95] Flt Timer t Sup	s		
[95] Flt Timer t Reset	s		
[95] Measure Filter	❑ Sample mode	❑ Fast sample mode	❑ Fourier mode

2.6 AUTOMAT.CTRL Menu

2.6.1 TRIP Command allocation

Function	P721	P723
	Yes	Yes
Trip [87] tDiff		❑
Trip [87N] tDiff	❑	❑
Trip tAux 1	❑	❑
Trip tAux 2	❑	❑
Trip tAux 3	❑	❑
Trip tAux 4		❑
Control Trip		❑
Trip Equ A	❑	❑
Trip Equ B	❑	❑
Trip Equ C	❑	❑
Trip Equ D	❑	❑
Trip Equ E	❑	❑
Trip Equ F	❑	❑
Trip Equ G	❑	❑
Trip Equ H	❑	❑

2.6.2 Latch function allocation

Function	P721	P723
	YES	YES
Latch [87N] tDiff	❑	❑
Latch [87] tDiff		❑
Latch t Aux 1	❑	❑
Latch t Aux 2	❑	❑
Latch t Aux 3		❑
Latch t Aux 4		❑
Latch Control Trip	❑	❑
Latch tEqu.A	❑	❑
Latch tEqu.B	❑	❑
Latch tEqu.C	❑	❑
Latch tEqu.D	❑	❑
Latch tEqu.E	❑	❑
Latch tEqu.F	❑	❑
Latch tEqu.G	❑	❑
Latch tEqu.H	❑	❑

2.6.3 Blocking Logic 1 function allocation

Function	P721	P723
	Yes	Yes
[87N] tDiff	❑	❑
[87] tDiff		❑
tAux 1	❑	❑
tAux 2	❑	❑
tAux 3		❑
tAux 4		❑

2.6.4 Blocking Logic 1 function allocation

Function	P721	P723
	Yes	Yes
[87N] tDiff	❑	❑
[87] tDiff		❑
tAux 1	❑	❑
tAux 2	❑	❑
tAux 3		❑
tAux 4		❑

2.6.5 OUTPUT RELAYS allocation

			← P721 →						
			← P723 →						
Function	P721	P723	RL2	RL3	RL4	RL5	RL6	RL7	RL8
			Yes	Yes	Yes	Yes	Yes	Yes	Yes
[87N] Diff	•	•	❑	❑	❑	❑	❑	❑	❑
[87N] tDiff	•	•	❑	❑	❑	❑	❑	❑	❑
[87] Diff		•	❑	❑	❑	❑	❑	❑	❑
[87] tDiff		•	❑	❑	❑	❑	❑	❑	❑
[87CZ] ChkZone		•	❑	❑	❑	❑	❑	❑	❑
[95N] Sup	•	•	❑	❑	❑	❑	❑	❑	❑
[95N] tSup	•	•	❑	❑	❑	❑	❑	❑	❑
[95] Sup		•	❑	❑	❑	❑	❑	❑	❑
[95] tSup		•	❑	❑	❑	❑	❑	❑	❑
Buswire Short	•	•	❑	❑	❑	❑	❑	❑	❑
[95A] tSup A		•	❑	❑	❑	❑	❑	❑	❑
[95B] tSup B		•	❑	❑	❑	❑	❑	❑	❑
[95C] tSup C		•	❑	❑	❑	❑	❑	❑	❑

			← P721 →						
			← P723 →						
Function	**P721**	**P723**	**RL2**	**RL3**	**RL4**	**RL5**	**RL6**	**RL7**	**RL8**
			Yes	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
CB Fail	•	•	❑	❑	❑	❑	❑	❑	❑
t Aux 1	•	•	❑	❑	❑	❑	❑	❑	❑
t Aux 2	•	•	❑	❑	❑	❑	❑	❑	❑
t Aux 3		•	❑	❑	❑	❑	❑	❑	❑
t Aux 4		•	❑	❑	❑	❑	❑	❑	❑
Active group	•	•	❑	❑	❑	❑	❑	❑	❑
Control trip	•	•	❑	❑	❑	❑	❑	❑	❑
Input1	•	•	❑	❑	❑	❑	❑	❑	❑
Input2	•	•	❑	❑	❑	❑	❑	❑	❑
Input3		•	❑	❑	❑	❑	❑	❑	❑
Input4		•	❑	❑	❑	❑	❑	❑	❑
Input5		•	❑	❑	❑	❑	❑	❑	❑
tEqu. A	•	•	❑	❑	❑	❑	❑	❑	❑
tEqu. B	•	•	❑	❑	❑	❑	❑	❑	❑
tEqu. C	•	•	❑	❑	❑	❑	❑	❑	❑
tEqu D	•	•	❑	❑	❑	❑	❑	❑	❑
tEqu E	•	•	❑	❑	❑	❑	❑	❑	❑
tEqu. F	•	•	❑	❑	❑	❑	❑	❑	❑
tEqu. G	•	•	❑	❑	❑	❑	❑	❑	❑
tEqu. H	•	•	❑	❑	❑	❑	❑	❑	❑

2.6.6 LATCH OUTPUT RELAYS allocation

Output 2	❑ YES	❑ NO
Output 3	❑ YES	❑ NO
Output 4	❑ YES	❑ NO
Output 5 (P723)	❑ YES	❑ NO
Output 6 (P723)	❑ YES	❑ NO
Output 7 (P723)	❑ YES	❑ NO
Output 8 (P723)	❑ YES	❑ NO

2.6.7 LOGIC INPUT allocation

2.6.7.1 Inputs

Function	P120	P123	Inputs				
			1	2	3	4	5
Unlatch	•	•	❑	❑	❑	❑	❑
Aux 1	•	•	❑	❑	❑	❑	❑
Aux 2	•	•	❑	❑	❑	❑	❑
Aux 3		•	❑	❑	❑	❑	❑
Aux 4		•	❑	❑	❑	❑	❑
Block Logic 2	•	•	❑	❑	❑	❑	❑
Start Disturb	•	•	❑	❑	❑	❑	❑
Start Block Logic 1	•	•	❑	❑	❑	❑	❑
Start Block Logic 2	•	•	❑	❑	❑	❑	❑
Change setting	•	•	❑	❑	❑	❑	❑
Reset Leds	•	•	❑	❑	❑	❑	❑
Maint. Mode	•	•	❑	❑	❑	❑	❑
Local Mode	•	•	❑	❑	❑	❑	❑
Synchro	•	•	❑	❑	❑	❑	❑
[87CZ] Chk Zone		•	❑	❑	❑	❑	❑

2.6.7.2 tAux

Aux 1 : Time tAux 1	s
Aux 2 : Time tAux 2	s
Aux 3 : Time tAux 3 (P723)	s
Aux 5 : Time tAux 4 (P723)	s

2.6.8 CIRCUIT BREAKER FAILURE

CB Fail ?	❑ YES	❑ NO
t Diff < =	In	
V Diff < =	V	
CB Fail Time tBF	ms	

2.6.9 LOGIC EQUATIONS

Equ. A	Boolean	Logic
A.00	❑ = / ❑ = NOT	
A.01	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
A.02	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
A.03	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
A.04	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
A.05	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
A.06	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
A.07	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
A.08	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
A.09	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
A.10	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
A.11	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
A.12	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
A.13	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
A.14	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
A.15	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
T Operate	ms	
T Reset	ms	

Equ B	Boolean	Logic
B.00	❑ = / ❑ = NOT	
B.01	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
B.02	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
B.03	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
B.04	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
B.05	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
B.06	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
B.07	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
B.08	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
B.09	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
B.10	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
B.11	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
B.12	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
B.13	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
B.14	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
B.15	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
T Operate	ms	
T Reset	ms	

Equ. C	Boolean	Logic
C.00	❑ = / ❑ = NOT	
C.01	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
C.02	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
C.03	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
C.04	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
C.05	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
C.06	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
C.07	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
C.08	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
C.09	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
C.10	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
C.11	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
C.12	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
C.13	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
C.14	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
C.15	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
T Operate	ms	
T Reset	ms	

Equ. D	Boolean	Logic
D.00	❑ = / ❑ = NOT	
D.01	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
D.02	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
D.03	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
D.04	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
D.05	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
D.06	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
D.07	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
D.08	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
D.09	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
D.10	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
D.11	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
D.12	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
D.13	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
D.14	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
D.15	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
T Operate	ms	
T Reset	ms	

Equ. E	Boolean	Logic
E.00	❑ = / ❑ = NOT	
E.01	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
E.02	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
E.03	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
E.04	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
E.05	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
E.06	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
E.07	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
E.08	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
E.09	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
E.10	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
E.11	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
E.12	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
E.13	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
E.14	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
E.15	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
T Operate	ms	
T Reset	ms	

Equ. F	Boolean	Logic
F.00	❑ = / ❑ = NOT	
F.01	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
F.02	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
F.03	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
F.04	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
F.05	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
F.06	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
F.07	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
F.08	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
F.09	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
F.10	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
F.11	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
F.12	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
F.13	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
F.14	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
F.15	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
T Operate	ms	
T Reset	ms	

Equ. G	Boolean	Logic
G.00	❑ = / ❑ = NOT	
G.01	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
G.02	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
G.03	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
G.04	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
G.05	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
G.06	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
G.07	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
G.08	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
G.09	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
G.10	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
G.11	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
G.12	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
G.13	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
G.14	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
G.15	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
T Operate	ms	
T Reset	ms	

Equ. H	Boolean	Logic
H.00	❑ = / ❑ = NOT	
H.01	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
H.02	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
H.03	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
H.04	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
H.05	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
H.06	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
H.07	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
H.08	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
H.09	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
H.10	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
H.11	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
H.12	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
H.13	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
H.14	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
H.15	❑ OR / ❑ = OR NOT / ❑ AND / ❑ = AND NOT	
T Operate	ms	
T Reset	ms	

2.7 RECORDING Menu

2.7.1 FAULT RECORD Record

Fault Record	
Fault Time	: :
Fault date	/ /
Active Set Group	❑ 1 ❑ 2
Faulted phase	❑ None ❑ Phase A ❑ Phase B ❑ Phase C ❑ Earth
Threshold	
Fault Magnitude	A
IA Diff R.M.S	A
IB Diff R.M.S	A
IC Diff R.M.S	A
IN Diff R.M.S	A

2.7.2 INSTANTANEOUS Record

Number	❑ 1 ❑ 2 ❑ 3 ❑ 4 ❑ 5	
Hour	: : :	
Date	/ /	
Origin		
Length	s	
Trip	❑ YES	❑ NO

2.7.3 DISTURBANCE RECORD

Pre-time	ms	
Post-time	ms	
Disturb Rec Trig	❑ ON INST.	❑ ON TRIP

BLANK PAGE

HARDWARE VERSION HISTORY AND COMPATIBILITY

CONTENTS

1. MiCOM P721 3

2. MiCOM P723 4

BLANK PAGE

1. MiCOM P721

Relay Type P721				
Software Version	Date of Issue	Full Description of Changes	S1 Compati-bility	Backward Compatibility with previous hardware
V11.B	03/2009	V11.B software the first software for the P721 hardware (first issue)	V2.14 V3.0	HARD 5
V11.D	12/2011	New Schneider Electric Brand	V3.4	HARD 5
V12.B	03/2016	1. "Fast mode" is the default setting to provide fastest fault detection and clearance 2. "Shorted Buswire" alarm is customer settable	V3.4	HARD 5

2. MiCOM P723

Relay Type P723				
Software Version	Date of Issue	Full Description of Changes	S1 Compati-bility	Backward Compatibility with previous hardware
V11.B	03/2009	V11.B software is the first software for the P723 hardware (first issue)	V2.14 V3.0	HARD 5
V11.D	12/2011	New Schneider Electric Brand	V3.4	HARD 5
V12.B	03/2016	1. "Fast mode" is the default setting to provide fastest fault detection and clearance 2. "Shorted Buswire" alarm is customer settable	V3.4	HARD 5