Easergy MiCOM P849

Input & Output Extension Device

P849/EN M/F53

Software Version	B2
Hardware Suffix	M
Issue Date	12/2017

Technical Manual

Schneider Electric

CONTENTS

Date:	12/2017
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.
Hardware Suffix:	M
Software Version:	B2
Connection Diagrams:	10P849xx (xx = 01 to 06)

SAFETY INFORMATION

CHAPTER SI

Date:	07/2016	
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.	
Hardware Suffix:	All MiCOM Px4x products	
Software Version:	All MiCOM Px4x products	
Connection Diagrams:	P14x (P141, P142, P143 & P145): 10P141xx (xx = 01 to 02) 10P142xx (xx = 01 to 05) 10P143xx (xx = 01 to 11) 10P145xx (xx = 01 to 11) P24x (P241, P242 & P243): 10P241xx (xx = 01 to 02) 10P242xx (xx = 01) 10P243xx (xx = 01) P34x (P342, P343, P344, P345 & P391): 10P342xx (xx = 01 to 17) 10P343xx (xx = 01 to 19) 10P344xx (xx = 01 to 12) 10P345xx (xx = 01 to 07) 10P391xx (xx = 01 to 02) P445: 10P445xx (xx = 01 to 04) P44x (P442 & P444): 10P44101 (SH 1 & 2) 10P44201 (SH 1 & 2) 10P44202 (SH 1) 10P44203 (SH 1 & 2) 10P44401 (SH 1) 10P44402 (SH 1) 10P44403 (SH 1 & 2) 10P44404 (SH 1) 10P44405 (SH 1) 10P44407 (SH 1 & 2) P44y (P443 & P446): 10P44303 (SH 01 and 03) 10P44304 (SH 01 and 03) 10P44305 (SH 01 and 03) 10P44306 (SH 01 and 03) 10P44600 10P44601 (SH 1 to 2) 10P44602 (SH 1 to 2) 10P44603 (SH 1 to 2)	P54x (P543, P544, P545 & P546): 10P54302 (SH 1 to 2) 10P54303 (SH 1 to 2) 10P54400 10P54404 (SH 1 to 2) 10P54405 (SH 1 to 2) 10P54502 (SH 1 to 2) 10P54503 (SH 1 to 2) 10P54600 10P54604 (SH 1 to 2) 10P54605 (SH 1 to 2) 10P54606 (SH 1 to 2) P547: 10P54702xx (xx = 01 to 02) 10P54703xx (xx = 01 to 02) 10P54704xx (xx = 01 to 02) 10P54705xx (xx = 01 to 02) P64x (P642, P643 & P645): 10P642xx (xx = 1 to 10) 10P643xx (xx = 1 to 6) 10P645xx (xx = 1 to 9) P74x (P741, P742 & P743): 10P740xx (xx = 01 to 07) P746: 10P746xx (xx = 00 to 21) P841: 10P84100 10P84101 (SH 1 to 2) 10P84102 (SH 1 to 2) 10P84103 (SH 1 to 2) 10P84104 (SH 1 to 2) 10P84105 (SH 1 to 2) P849: 10P849xx (xx = 01 to 06)

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Notes:

1 INTRODUCTION

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

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

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

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

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

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

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

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

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

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

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

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

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

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

2 HEALTH AND SAFETY

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

People

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

Receipt, Handling, Storage and Unpacking Relays

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

Planning

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

Live and Stored Voltages

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

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

Warnings and Barricades

Everyone must observe all warning notices. This is because the incorrect use of equipment, or improper use may endanger personnel and equipment and also cause personal injury or physical damage.
Unauthorized entry should also be prevented with suitably marked fixed barricades which will notify people of any dangers and screen off work areas.

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

Electrical Isolation

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

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

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

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

Risk of Accidental Contact or Arc Flash

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

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

Temporary Protection

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

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

Restoring Power

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

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

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

Qualified Personnel

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

Qualified personnel are individuals who:

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

Documentation

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

3 SYMBOLS AND LABELS ON THE EQUIPMENT

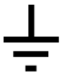
For safety reasons the following symbols and external labels, which may be used on the equipment or referred to in the equipment documentation, should be understood before the equipment is installed or commissioned.

3.1 Symbols

Caution: refer to equipment documentation

Caution: risk of electric shock

Protective Conductor (*Earth) terminal



Functional/Protective Conductor (*Earth) terminal

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

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

3.2 Labels

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

4 INSTALLING, COMMISSIONING AND SERVICING

Manual Handling

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

Many injuries are caused by:

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

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

Equipment Connections

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

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

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

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

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

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

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

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

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

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

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

Protection Class I Equipment

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

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

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

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

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

Pre-Energization Checklist

Before energizing the equipment, the following should be checked:

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

Accidental Touching of Exposed Terminals

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

Equipment Use

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

Removal of the Equipment Front Panel/Cover

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

UL and CSA/CUL Listed or Recognized Equipment

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

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

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

Equipment Operating Conditions

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

Current Transformer Circuits

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

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

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

External Resistors, including Voltage Dependent Resistors (VDRs)

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

Battery Replacement

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

Insulation and Dielectric Strength Testing

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

Insertion of Modules and PCB Cards

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

Insertion and Withdrawal of Extender Cards

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

External Test Blocks and Test Plugs

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

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

Fiber Optic Communication

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

Cleaning

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

5 DE-COMMISSIONING AND DISPOSAL

De-Commissioning

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

Disposal

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

6 TECHNICAL SPECIFICATIONS FOR SAFETY

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

6.1 Protective Fuse Rating

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

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

6.2 Protective Class

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

6.3 Installation Category

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

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

6.4 Environment

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

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

INTRODUCTION

CHAPTER 1

Date:	12/2017
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.
Hardware Suffix:	M
Software Version:	B2
Connection Diagrams:	10P849xx (xx = 01 to 06)

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Notes:

1 DOCUMENTATION STRUCTURE

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

	Description	Chapter Code
	Safety Information	**Px4x/EN SI**
	A guide to the safe handling, commissioning and testing of equipment. This provides typical information and advice which covers a range of MiCOM Px4x products. It explains how to work with equipment safely.	
1	**Introduction**	**P849/EN IT**
	A guide to the MiCOM range of relays and the documentation structure. General safety aspects of handling Electronic Equipment are discussed with particular reference to relay safety symbols. Also a general functional overview of the relay and brief application summary is given.	
2	**Technical Data**	**P849/EN TD**
	Technical data including setting ranges, accuracy limits, recommended operating conditions, ratings and performance data. Compliance with norms and international standards is quoted where appropriate.	
3	**Getting Started**	**P849/EN GS**
	A guide to the different user interfaces of the IED describing how to start using it. This chapter provides detailed information regarding the communication interfaces of the IED, including a detailed description of how to access the settings database stored within the IED.	
4	**Settings**	**P849/EN ST**
	List of all relay settings, including ranges, step sizes and defaults, together with a brief explanation of each setting.	
5	**Operation**	**P849/EN OP**
	A comprehensive and detailed functional description of all protection and non-protection functions.	
6	**Application Notes**	**P849/EN AP**
	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.	
7	**Using the PSL Editor**	**Px4x/EN SE**
	This provides a short introduction to using the PSL Editor application.	
8	**Programmable Logic**	**P849/EN PL**
	Overview of the Programmable Scheme Logic (PSL) and a description of each logical node. This chapter includes the factory default and an explanation of typical applications.	
9	**Measurements and Recording**	**P849/EN MR**
	Detailed description of the relays recording and measurements functions including the configuration of the event and disturbance recorder and measurement functions.	
10	**Product Design**	**P849/EN PD**
	Overview of the operation of the relay's hardware and software. This chapter includes information on the self-checking features and diagnostics of the relay.	
11	**Commissioning**	**P849/EN CM**
	Instructions on how to commission the relay, comprising checks on the calibration and functionality of the relay.	
12	**Test and Setting Records**	**P849/EN RC**
	This is a list of the tests made and the settings stored on the MiCOM IED.	

	Description	Chapter Code
13	**Maintenance**	**Px4x/EN MT**
	A general maintenance policy for the relay is outlined.	
14	**Troubleshooting**	**Px4x/EN TS**
	Advice on how to recognize failure modes and the recommended course of action. Includes guidance on whom within Schneider Electric to contact for advice.	
15	**SCADA Communications**	**P849/EN SC**
	This chapter provides an overview regarding the SCADA communication interfaces of the relay. Detailed protocol mappings, semantics, profiles and interoperability tables are not provided within this manual. Separate documents are available per protocol, available for download from our website.	
16	**Installation**	**Px4x/EN IN**
	Recommendations on unpacking, handling, inspection and storage of the relay. A guide to the mechanical and electrical installation of the relay is provided, incorporating earthing recommendations.	
17	**Connection Diagrams**	**P849/EN CD**
	A list of connection diagrams, which show the relevant wiring details for this relay.	
18	**Cyber Security**	**Px4x/EN CS**
	An overview of cyber security protection (to secure communication and equipment within a substation environment). Relevant cyber security standards and implementation are described too.	
19	**Dual Redundant Ethernet Board (DREB)**	**Px4x/EN REB**
	Information about how MiCOM products can be equipped with Dual Redundant Ethernet Boards (DREBs) and the different protocols which are available. Also covers how to configure and commission these types of boards.	
20	**Parallel Redundancy Protocol (PRP) Notes**	**Px4x/EN PR**
	Includes an introduction to Parallel Redundancy Protocols (PRP) and the different networks PRP can be used with. Also includes details of PRP and MiCOM functions.	
21	**High-availability Seamless Redundancy (HSR)**	**Px4x/EN HS**
	Introduction to the High-availability Seamless Redundancy (HSR); and how it is implemented on MiCOM-based products manufactured by Schneider Electric.	
22	**Version History (of Firmware and Service Manual)**	**P849/EN VH**
	This is a history of all hardware and software releases for this product.	
	Symbols and Glossary	**Px4x/EN SG**
	List of common technical terms, abbreviations and symbols found in this documentation.	

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

2 INTRODUCTION

About MiCOM Range

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

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

The components within MiCOM are:

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

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

For up-to-date information, please see:

www.schneider-electric.com

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

3 PRODUCT SCOPE

The MiCOM P849 Input and Output extension device has been designed to increase the number of possible applications. The device includes a comprehensive range of features to aid with system diagnosis and fault analysis.

3.1 Functional Overview

The device contains a wide variety of communication functions and extension facilities which are summarized below:

P849 Overview		
Input / Output (I/O) arrangements available:	**Digital inputs**	**Relay outputs**
Option A	32	16
Option B	48	24
Option C	32	30 (16 high speed & high break relays)
Option D	16	60
Option E	64	16
Option F	32	46

Features	
Function keys	10
Programmable tri-colour LEDs	18
Language:	English, French, German, Spanish, Russian or Chinese

3.1.1 Auxiliary Voltage Rating Options

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

3.1.2 Communication Protocol Options

Communication protocols	P849
K-Bus with simple password management – CSL0	Yes
MODBUS with simple password management – CSL0	Yes
DNP3.0 serial via rear RS485 with simple password management – CSL0	Yes
DNP3.0 with simple password management – CSL0	Yes
InterMiCOM + Courier Rear Port	Yes
InterMiCOM + Courier Rear Port + IRIG-B modulated	Yes
IEC 61850 Ed 1 / 2 and Courier via rear K-Bus/RS485 with simple password management – CSL0	Yes
IEC 61850 Ed 1 / 2 and CS103 via rear port RS485 with simple password management – CSL0	Yes
IEC 61850 Ed 1 / 2 and DNP3 over Ethernet and DNP3.0 via rear RS485 with simple password management – CSL0	Yes
IEC 61850 Ed 1 / 2 and Courier via rear K-Bus/RS485 with advanced Cyber Security – CSL1 – Security Administration Tool (SAT) required.	Yes
IEC 61850 Ed 1 / 2 and CS103 via rear port RS485 with advanced Cyber Security – CSL1 – Security Administration Tool (SAT) required.	Yes

Communication protocols	P849
IEC 61850 Ed 1 / 2 and DNP3 over Ethernet and DNP3.0 via rear RS485 with advanced Cyber Security – CSL1 – Security Administration Tool (SAT) required.	Yes

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

- Programmable Scheme Logic (PSL)
- Trip circuit and coil supervision (using PSL)
- Alternative setting groups
- Programmable function keys
- Control inputs
- Programmable allocation of digital inputs and outputs
- Sequence of event recording
- Disturbance recording
- Fully customizable menu texts
- Power-up diagnostics and continuous self-monitoring of relay
- Commissioning test facilities
- Real time clock/time synchronization - time synchronization possible from IRIG-B input, opto input or communications
- Simple password management:
  CSL0 - No Security Administration Tool (SAT) required
- Advanced Cyber Security:
  CSL1 - Security Administration Tool (SAT) required
- Read only mode

3.2 Ordering Options for P849

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

3.2.1 Information Required with Order

Order form	MiCOM P849										
External I/O Box	P849		0								
Vx Aux Rating:											
24 - 32 Vdc		9									
48 - 110 Vdc		2									
110 - 250 Vdc (100 - 240 Vac)		3									
In/Vn Rating:											
None			0								
Hardware Options:											
Standard : no options				1							
IRIG-B (Modulated) only				2							
Fibre Optic Converter only				3							
IRIG-B (Modulated) & Fibre Optic Converter				4							
Ethernet with 100Mbps fibre optic port				6							
2nd Rear Comms port (Courier EIA232 / EIA485 / KBUS)				7							
2nd Rear comms port (Courier EIA232 / EIA485 / KBUS) + IRIG-B (Modulated)				8							
Ethernet (100Mbit/s) plus IRIG-B (Modulated)				A							
Ethernet (100Mbit/s) plus IRIG-B (De-modulated)				B							
InterMiCOM + Courier Rear Port				E							
InterMiCOM + Courier Rear Port + IRIG-B modulated				F							
Redundant Ethernet Self-Healing Ring, 2 multi-mode ST fibre ports + IRIG-B (Modulated)				G							
Redundant Ethernet Self-Healing Ring, 2 multi-mode ST fibre ports + IRIG-B (Un-modulated)				H							
Redundant Ethernet RSTP, 2 multi-mode ST fibre ports + IRIG-B (Modulated)				J							
Redundant Ethernet RSTP, 2 multi-mode ST fibre ports + IRIG-B (Un-modulated)				K							
Redundant Ethernet Dual-Homing Star, 2 multi-mode ST fibre ports + IRIG-B (Modulated)				L							
Redundant Ethernet Dual-Homing Star, 2 multi-mode ST fibre ports + IRIG-B (Un-modulated)				M							
Redundant Ethernet Parallel Redundancy Protocol (PRP), 2 multimode ST fibre ports + IRIG-B (Modulated)				N							
Redundant Ethernet Parallel Redundancy Protocol (PRP), 2 multimode ST fibre ports + IRIG-B (Un-modulated)				P							
Redundant Ethernet (100Mbit/s) PRP or HSR and Dual IP, 2 LC ports + 1 RJ45 port + Modulated/Un-modulated IRIG-B				Q							
Redundant Ethernet (100Mbit/s) PRP or HSR and Dual IP, 3 RJ45 ports + Modulated/Un-modulated IRIG-B				R							
Ethernet (100Mbit/s), 1 RJ45 port + Modulated/Un-modulated IRIG-B				S							
Product Specific Options:											
Size 16 Case, 32 optos + 16 Relays					A						
Size 16 Case, 48 optos + 24 Relays					B						
Size 16 Case, 32 optos + 14 Relays + 16 High Break Relays					C						
Size 16 Case, 16 optos + 60 Relays					D						

Order form	MiCOM P849										
External I/O Box	**P849**		**0**								
Size 16 Case, 64 optos + 16 Relays					E						
Size 16 Case, 32 optos + 46 Relays					F						
Protocol Options:											
K-Bus K-Bus with simple password management - CSL0						1					
Modbus with simple password management - CSL0						2					
IEC 60870-5-103 [VDEW] with simple password management - CSL0						3					
DNP3.0 with simple password management - CSL0						4					
IEC 61850 Edition 1 / 2 and Courier via rear K-Bus/RS485 with simple password management - CSL0						6					
IEC 61850 Edition 1 / 2 and CS103 via rear port RS485 with simple password management - CSL0						7					
IEC 61850 Edition 1 / 2 and DNP3 over Ethernet and DNP3.0 via rear RS485 with simple password management - CSL0						B					
IEC 61850 Edition 1 / 2 and Courier via rear K-Bus/RS485 with advanced Cyber Security - CSL1 - Security Administration Tool (SAT) required						G					
IEC 61850 Edition 1 / 2 and CS103 via rear port RS485 with advanced Cyber Security - CSL1 - Security Administration Tool (SAT) required						H					
IEC 61850 Edition 1 / 2 and DNP3 over Ethernet and DNP3.0 via rear RS485 with advanced Cyber Security - CSL1 - Security Administration Tool (SAT) required						L					
Mounting Options:											
Panel Mounting							M				
Rack Mounting							N				
Language Options:											
English, French, German, Spanish								0			
English, French, German, Russian								5			
Chinese, English or French via HMI, with English or French only via Communications port								C			
Software Version Options:											
Unless specified the latest version will be delivered									**		
Customisation:											
Default										8	
Customised										9	
Design Suffix:											
Extended Phase 3 CPU											M
Extended Phase 2 CPU											K

Notes:

TECHNICAL DATA

CHAPTER 2

Date:	12/2017
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.
Hardware Suffix:	M
Software Version:	B2
Connection Diagrams:	10P849xx (xx = 01 to 06)

CONTENTS

Notes:

1 MICOM P849 INPUT & OUTPUT EXTENSION DEVICE

Input / Output (I/O)

32I/16O,
48I/24O,
32I/30O (16 high speed high break relays),
16I/60O,
64I/16O,
32I/46O.

Protocol options:

K-Bus
Modbus,
VDEW (IEC 60870-5-103)
DNP3.0
IEC61850 + Courier via rear RS485 port
IEC61850 + IEC 60870-5-103 via rear RS485 port
DNP3 over Ethernet with Courier rear port K-Bus/RS485 protocol

Hardware options:

IRIG-B input
Fibre optic converter (IEC60870-5-103)
IRIG-B input and Fibre optic converter (IEC60870-5-103)
Single Ethernet 100Mbit/s
Rear Comms + InterMiCOM
Rear Comms + IRIB-B + InterMiCOM
Single Ethernet (100Mbit/s) plus IRIG-B (Modulated)
Single Ethernet (100Mbit/s) plus IRIG-B (De-modulated)
IRIG-B (De-modulated)
InterMiCOM + Courier Rear Port *
InterMiCOM + Courier Rear Port + IRIG-B modulated *
Redundant Ethernet Self-Healing Ring, 2 multi-mode fibre ports + Modulated IRIG-B
Redundant Ethernet Self-Healing Ring, 2 multi-mode fibre ports + Un-modulated IRIG-B
Redundant Ethernet RSTP, 2 multi-mode fibre ports + Modulated IRIG-B
Redundant Ethernet RSTP, 2 multi-mode fibre ports + Un-modulated IRIG-B
Redundant Ethernet Dual-Homing Star, 2 multi-mode fibre ports + Modulated IRIG-B
Redundant Ethernet Dual-Homing Star, 2 multi-mode fibre ports + Un-modulated IRIG-B
Redundant Ethernet (100Mbit/s) PRP or HSR and Dual IP, 2 LC ports + 1 RJ45 port + Modulated/Un-modulated IRIG-B
Redundant Ethernet (100Mbit/s) PRP or HSR and Dual IP, 3 RJ45 ports + Modulated/Unmodulated IRIG-B
Ethernet (100Mbit/s), 1 RJ45 port + Modulated/Un-modulated IRIG-B

2 MECHANICAL SPECIFICATION

2.1 Design

Modular MiCOM Px40 platform relay, Size 16“ case (80TE)
Mounting is front of panel flush mounting or 19” rack mounted (order option).

2.2 Enclosure Protection

Per IEC 60529:

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

2.3 Weight

MiCOM P849: 10.5 kg

3 TERMINALS

3.1 General Input/Output Terminals

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

3.2 Case Protective Earth Connection

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

3.3 Front Port Serial PC Interface

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

3.4 Front Download/Monitor Port

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

3.5 Rear Communications Port

EIA(RS)-485 signal levels, two wire connections located on general purpose block, M4 screw.
For screened twisted pair cable, multidrop, 1000 m max.
For Courier (K-Bus), IEC-60870-5-103, MODBUS or DNP3.0 protocol (ordering option).
Isolation to SELV (Safety Extra Low Voltage) level.

3.6 Optional Second Rear Communication Port

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

3.7 Optional Rear IRIG-B Interface modulated or un-modulated

BNC socket
SELV* rated circuit.
50 ohms coaxial cable.
*: PEB = Protective equipotential bonded
*: SELV = Safety/Separated extra low voltage
Both PEB and SELV circuits are safe to touch after a single fault condition.

3.8 Optional Rear Ethernet Connection for IEC 61850 or DNP3.0

100 Base TX Communications

Interface in accordance with IEEE802.3 and IEC 61850

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

3.9 Optional Rear Redundant Ethernet Connection for IEC 61850 or DNP3.0

3.9.1 100 Base TX Communications

Interface in accordance with IEEE802.3 and IEC 61850
Isolation: 1.5 kV
Connector type: RJ45
Cable type: Screened Twisted Pair (STP)
Max. cable length: 100 m

3.9.2 100 Base FX Interface

Interface in accordance with IEEE802.3 and IEC 61850
Wavelength: 1310 nm
Fiber: multi-mode 50/125 µm or 62.5/125 µm
Connector type: LC Connector Optical Interface

Transmitter Optical Characteristics

Parameter	Sym	Min.	Typ.	Max.	Unit
Output Optical Power 62.5/125 µm, NA = 0.275 Fiber	PO	-20	-17.0	-14	dBm avg.
Output Optical Power 50/125 µm, NA = 0.20 Fiber	PO	-23.5	-20.0	-14	dBm avg.
Optical Extinction Ratio				10	dB
Output Optical Power at Logic “0” State	PO (“0”)			-45	dBm avg.

Receiver Optical Characteristics

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

4 POWER SUPPLY

4.1 Auxiliary Voltage (Vx)

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

4.2 Operating Range

(i) 19 to 38V (dc only for this variant)
(ii) 37 to 150V (dc),
(iii) 87 to 300V (dc), 80 to 265V (ac).
With a tolerable ac ripple of up to 15% for a dc supply, per EN / IEC 60255-11, EN / IEC 60255-26.

4.3 Nominal Burden

Quiescent burden:	12 W
Additions for energized binary inputs/outputs:	
Per opto input:	0.09W…(24 to 54V), 0.12W...(110/125V), 0.19W...(220/250V).
Per energized output relay:	0.13W
Per energized high break output relay:	0.73W

4.4 Power-up Time

Main Processor including User Interface and front access port < 25 s.
Ethernet Communications <120 s.

4.5 Power Supply Interruption

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

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

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

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

Note The use of a E124 extends these limits

In addition to IEC 60255-11 compliance, P746/P849 withstands:

DC Power supply voltage	DC Power supply interruption
24V	20ms
48V	20ms with Vx ordering option (ii)
110V	200ms with Vx ordering option (ii), 50ms with Vx ordering option (iii)
220V	200ms

4.6 Battery Backup

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

4.7 Field Voltage Output

Regulated 48 Vdc
Current limited at 112 mA maximum output

4.8 Digital (“Opto”) Inputs

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

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

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

Nominal pick-up and reset thresholds:

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

Recognition time:

<2 ms with long filter removed.
<12 ms with half cycle ac immunity filter on.

5 OUTPUT CONTACTS

5.1 Standard Contacts

General purpose relay outputs for signalling, tripping and alarming:

Rated voltage:	300 V	
Continuous current:	10 A	
Short-duration current:	30 A for 3 s	
Making capacity:	250A for 30 ms	
Breaking capacity:	DC:	50W resistive
	DC:	62.5W inductive (L/R = 50ms)
	AC:	2500VA resistive (cos ϕ = unity)
	AC:	2500VA inductive (cos ϕ = 0.7)
Response to command:	< 5ms	
Durability:	Loaded contact: 10000 operations minimum,	
	Unloaded contact: 100000 operations minimum.	

5.2 Fast Operation and High Break Contacts

Dedicated purpose relay outputs for tripping: Uses IGBT technology

Make and Carry:	30 Amps for 3 sec, 30A @ 250V resistive
Carry:	250 Amps dc for 30ms
Continuous Carry:	10 Amps dc
Break Capacity:	10 Amps @ 250V resistive (10,000 operations)
	10 Amps @ 250V L/R=40ms
Operating time:	<200us & Reset time: 7.5ms

5.3 Watchdog Contacts

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

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

5.4 IRIG-B 12X Interface (Modulated)

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

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

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

6 ENVIRONMENTAL CONDITIONS

6.1 Ambient Temperature Range

Per IEC 60255-6: 1988

Operating temperature range:	-25°C to +55°C (or -13°F to +131°F).
Storage and transit:	-25°C to +70°C (or -13°F to +158°F).
Tested as per IEC 60068-2-1: 2007	-25°C (-13°F) storage (96 hours)
	-40°C (-40°F) operation (96 hours)
IEC 60068-2-2: 2007	+85°C (+185°F) storage (96 hours)

6.2 Ambient Humidity Range

Per IEC 60068-2-78: 2001:

56 days at 93% relative humidity and +40°C

Per IEC 60068-2-30: 2005:

Damp heat cyclic, six (12 + 12) hour cycles, 93% RH, +25 to +55°C

6.3 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.

7 TYPE TESTS

7.1 Insulation

As for IEC 60255-27: 2005 (incorporating corrigendum March 2007):
Insulation resistance > 100 MΩ at 500 Vdc
(Using only electronic/brushless insulation tester).

7.2 Creepage Distances and Clearances

Per IEC 60255-27: 2005 — Pollution degree 3
overvoltage category III
impulse test voltage 5 kV

7.3 High Voltage (Dielectric) Withstand

EIA(RS)232 ports excepted.

Per IEC 60255-27: 2005, 2 kV rms AC, 1 minute:

Between all case terminals connected together, and the case earth.
Also, between all terminals of independent circuits.
1 kV rms AC for 1 minute, across open watchdog contacts.
1 kV rms AC for 1 minute, across open contacts of changeover output relays.

Per ANSI/IEEE C37.90-1989 (reaffirmed 1994):

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

7.4 Impulse Voltage Withstand Test

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

8 ELECTROMAGNETIC COMPATIBILITY (EMC)

8.1 1 MHz Burst High Frequency Disturbance Test

As for EN 60255-22-1: 2008, Class III,

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

(EIA(RS)-232 ports excepted).

8.2 100 kHz Damped Oscillatory Test

EN 61000-4-18: 2007:	Level 3
Common mode test voltage:	2.5 kV
Differential mode test voltage:	1 kV

8.3 Immunity to Electrostatic Discharge

Per IEC 60255-22-2: 1997, Class 4,
 15kV discharge in air to user interface, display, and exposed metalwork.
Per IEC 60255-22-2: 1997, Class 3,
 8kV discharge in air to all communication ports.
 6kV point contact discharge to any part of the front of the product.

8.4 Electrical Fast Transient or Burst Requirements

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

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

8.5 Surge Withstand Capability

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

8.6 Surge Immunity Test

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

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

8.7 Immunity to Radiated Electromagnetic Energy

Per IEC 60255-22-3: 2008, Class III:

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

Per IEEE/ANSI C37.90.2: 2004:
 25MHz to 1000MHz, zero and 100% square wave modulated.
 Field strength of 35V/m.

8.8 Radiated Immunity from Digital Communications

EN61000-4-3: 2010, Level 4:
Test field strength, frequency band 800 to 960 MHz, and 1.4 to 2.0 GHz: 30 V/m,
Test using AM: 1 kHz/80%.

8.9 Radiated Immunity from Digital Radio Telephones

EN 61000-4-3: 2002: 10 V/m, 900 MHz and 1.89 GHz.

8.10 Immunity to Conducted Disturbances Induced by Radio Frequency Fields

EN 61000-4-6: 2008, Level 3, Disturbing test voltage: 10 V.

8.11 Power Frequency Magnetic Field Immunity

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

8.12 Conducted Emissions

Per EN 55022:2006:2007 and EN 60255-25:2000:
    0.15 – 0.5MHz, 79dBμV (quasi peak) 66dBμV (average)
    0.5 – 30MHz, 73dBμV (quasi peak) 60dBμV (average).

8.13 Radiated Emissions

Per EN 55022:2006+A1:2007 and EN 60255-25:2000:
30 - 230MHz, 40dBμV/m at 10m measurement distance
230 – 1GHz, 47dBμV/m at 10m measurement distance.

9 EU DIRECTIVES

9.1 EMC Compliance

2004/108/EC:
Compliance to the European Commission Directive on EMC is claimed via the Technical Construction File route. Product Specific Standards were used to establish conformity:
EN 60255-26

9.2 Product Safety

2006/95/EC:
Compliance to the European Commission Low Voltage Directive. Compliance is demonstrated by reference to generic safety standards:
EN60255-27: 2005 (incorporating corrigendum March 2007)

9.3 R&TTE Compliance

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

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

Applicable to rear communications ports.

10 MECHANICAL ROBUSTNESS

10.1 Vibration Test

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

10.2 Shock and Bump

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

10.3 Seismic Test

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

11 IRIG-B AND REAL TIME CLOCK

11.1 Modulated IRIG-B

Modulation ratio:	1/3 or 1/6
Input signal peak-peak amplitude:	200 mV to 20 V
Input impedance at 1000Hz:	6000 Ω
External clock synchronization:	Conforms to IRIG standard 200-98, format B

11.2 Un-modulated IRIG-B

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

11.3 Real Time Clock

Real time clock accuracy: < ±2 seconds/day

12 DISTURBANCE RECORDS

Accuracy

Waveshape:	Comparable with applied quantities
Duration:	±2%
Trigger position:	±2% (minimum trigger 100ms)

Reference conditions

Ambient temperature:	20°C

13 IEC 61850 ETHERNET DATA

13.1 GOOSE Performances

The follow data is the average value with 100 times test.

- Subscribe 1 Virtual Input and publish 1 Virtual Output: < 4ms
- Subscribe 1 Virtual Input and trigger 1 output relay: < 8ms

- Subscribe 16 Virtual Inputs and publish 16 Virtual Outputs: < 8ms
- Subscribe 16 Virtual Inputs and trigger 16 output relays: < 11ms

- Subscribe 32 Virtual Inputs and publish 32 Virtual Outputs: < 16ms
- Subscribe 32 Virtual Inputs and trigger 32 output relays: < 16ms

14 SETTINGS AND RECORDS LIST

14.1 Global Settings (System Data)

Language:	English/French/German/Spanish/Russian/Chinese (ordering option)
Frequency:	50/60 Hz

14.2 Date and Time

IRIG-B Sync:	Disabled/Enabled
Battery Alarm:	Disabled/Enabled
LocalTime Enable:	Disabled/Fixed/Flexible
LocalTime Offset:	-720 min…720 min
DST Enable:	Disabled/Enabled
DST Offset:	30 min…60 min
DST Start:	First/Second/Third/Fourth/Last
DST Start Day:	Sun/Mon/Tues/Wed/Thurs/Fri/Sat
DST Start Month:	Jan/Feb/Mar/Apr/May/Jun/Jul/Aug/Sept/Oct/Nov/Dec
DST Start Mins:	0 min…1425 min
DST End:	First/Second/Third/Fourth/Last
DST End Day:	Sun/Mon/Tues/Wed/Thurs/Fri/Sat
DST End Month:	Jan/Feb/Mar/Apr/May/Jun/Jul/Aug/Sept/Oct/Nov/Dec
DST End Mins:	0 min…1425 min
RP1 Time Zone:	UTC/Local
RP2 Time Zone:	UTC/Local
Tunnel Time Zone:	UTC/Local

14.3 Configuration

Setting Group:	Select via Menu	or	Select via Opto
Active Settings:	Group 1/2/3/4		
Setting Group 1:	Disabled/Enabled		
Setting Group 2:	Disabled/Enabled		
Setting Group 3:	Disabled/Enabled		
Setting Group 4:	Disabled/Enabled		
Input Labels:	Visible/Invisible		
Output Labels:	Visible/Invisible		
Record Control:	Visible/Invisible		
Disturb Recorder:	Visible/Invisible		
Measur't Setup:	Visible/Invisible		
Comms Setting:	Visible/Invisible		
Commission Tests:	Visible/Invisible		
Control Inputs:	Visible/Invisible		
Ctrl I/P Config:	Visible/Invisible		
Ctrl I/P Labels:	Visible/Invisible		
Direct Access:	Enabled/Disabled		
InterMiCOM:	Enabled/Disabled		
Function Key:	Visible/Invisible		
VIR Input Labels:	Disabled/Enabled		
VIR Output Labels:	Disabled/Enabled		
User Alarm Labels:	Disabled/Enabled		
RP1 Read Only:	Disabled/Enabled		
RP2 Read Only:	Disabled/Enabled		
NIC Read Only:	Disabled/Enabled		
LCD Contrast:	0…31		

14.4 Record Control

Records for the last 512 events

14.5 Disturb. Recording

Duration: Settable from 0.1 to 10.5s
Trigger Position: 0...100% (step 0.1%)
Trigger Mode: Single/Extended
32 Digital Inputs
Selected binary channel assignment from any DDB status point within the device (opto input, output contact, alarms, starts, trips, controls, logic…).
Sampling frequency: 1000Hz

14.6 Communications

14.6.1 Courier Protocol

Courier protocol:	Protocol and RP1 Card Status indicated
RP1 Address:	0 to 255 (step 1)
RP1 Inactiv timer:	1min to 30 mins (step 1min)
RP1 Physical link:	Copper/Fibre optic
RP1 Port configuration:	K-Bus/EIA485 (RS485)
RP1 comms mode:	IEC60870 FT1.2/10-Bit No Parity
RP1 Baud Rate:	9600/19200/38400 bits/s

14.6.2 IEC60870-5-103 Protocol

IEC60870-5-103 protocol:	Protocol indicated
RP1 Address:	1 to 254 (step 1)
RP1 Inactiv timer:	1min to 30 mins (step 1min)
RP1 Baud Rate:	9600/19200 bits/s
RP1 Measurement period:	1s to 60s (step 1s)
RP1 Physical link:	Copper/Fibre optic
CS103 blocking:	Disabled/Monitor blocking/Command blocking

14.6.3 MODBUS Protocol

Modbus protocol:	Protocol indicated
RP1 Address:	1 to 247 (step 1)
RP1 Inactiv timer:	1min to 30 mins (step 1min)
RP1 Baud Rate:	9600/19200/38400 bits/s
RP1 Parity:	Odd/Even/None
RP1 Physical link:	Copper/Fibre optic
Modbus IEC Time:	Standard/Reverse

14.6.4 DNP3.0 Protocol (Serial)

DNP3.0 protocol:	Protocol indicated
RP1 Address:	1 to 65519 (step 1)
RP1 Baud Rate:	1200/2400/4800/9600/19200/38400 bits/s
RP1 Parity:	Odd/Even/None
RP1 Physical link:	RS485/Fibre optic
DNP Time Sync:	Disabled/Enabled
Meas scaling:	Primary/Secondary/Normalised
Message gap:	0ms to 50ms (step 1ms)
DNP Need Time:	1min to 30mins (step 1min)
DNP Application fragment size:	100 to 2048 (step 1)
DNP Application fragment timeout:	1s to 120s (step 1s)
DNP SBO timeout:	1s to 10s (step 1s)
DNP link timeout:	0s to 120s (step 1s)

14.6.5 Ethernet Port, IEC61850 Protocol

Ethernet port, IEC61850 Protocol:	Protocol, NIC MAC address(es), Redundancy IP address, Subnet mask and Gateway address indicated
ETH tunnel timeout:	1min to 30min (step 1min)

14.6.6 Ethernet Port, DNP3.0 Protocol

Ethernet port, DNP3.0 protocol:	Protocol, NIC MAC address(es), Redundancy IP address, Subnet mask and Gateway address indicated
DNP Time Sync:	Disabled/Enabled
Meas scaling:	Primary/Secondary/Normalised
DNP need time:	1min to 30mins (step 1min)
DNP Application Fragment size:	100 to 2048 (step 1)
DNP Application fragment timeout:	1s to 120s (step 1s)
DNP SBO timeout:	1s to 10s (step 1s)
DNP Link timeout:	0s to 120s (step 1s)
ETH tunnel timeout:	1min to 30mins (step 1min)

14.7 Optional Second Rear Communication

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

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

14.8 Commission Tests

Monitor bit 1 to Monitor bit 8:
Selects DDB signals have their status visible in the Test Port Status.

Test Mode:	Disabled/Test Mode/Contacts Blocked
Test Pattern:	Configuration of which output contacts are to be energized when the contact test is applied.
Contact Test:	No Operation, Apply Test, Remove Test
Test LEDs:	No Operation, Apply Test

14.9 Opto Configuration

Opto input voltage range: 24-27V / 30-34V / 48-54V / 110-125V / 220-250V / Custom
Opto Input 1 (up to # = max. opto no. fitted)
Custom options allow independent thresholds to be set per opto, from the same range as above

15 HOTKEYS AND CONTROL INPUTS

15.1 Control Inputs Operation (Control Inputs & CTRL I/P Config menus)

Control Input Operation (Control Inputs Menu): Status of control inputs indication
Control Inputs Operation: SET/RESET/No Operation
Control Inputs Configuration (CTRL I/P config. Menu):
The control inputs can be individually assigned to the hotkeys by setting,
Control input configuration: Latched/Pulsed

16 TELEPROTECTION (INTERMICOM COMMS)

Source Address:	1…10
Received Address:	1…10
Data Rate:	600 / 1200 / 2400 / 4800 / 9600 / 19200 baud
Loopback Mode:	Disabled/Internal/External
Test Pattern:	Configuration of which InterMiCOM signals are to be energized when the loopback test is applied.
Channels statistics:	Visible/Invisible Nbr of tripping messages received Nbr blocking messages received, Number of messages received: tripping, blocking, total and incorrect, Lost messages, Elapsed time, Reset statistics: Yes/No
Channel diagnostics:	Visible/Invisible “Data carrier detect” status, Frame synchronization status, Message status, Channel status, InterMiCOM hardware status.

User defined test pattern,
Loopback status

17 INTERMICOM CONFIGURATION

IM Msg Alarm Level:	0 to 100.0% (step 1%)	
InterMiCOM Command Types:		
IM1, IM2, IM3 and IM4 Command types:		Disabled/Direct/Blocking
IM5, IM6, IM7 and IM8 Command types:		Disabled/Permissive/Direct
Fallback Mode:	Default/Latched	
Default Value:	0/1	
Frame Synchronization Time:	10ms to 1.50s (step 10ms)	

18 FUNCTION KEYS AND LABELS

18.1 Function Keys

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

18.2 Opto Input Labels

Opto Input 1 to 64 (depending on the model): Input L1 to Input L64
User-defined text string to describe the function of the particular opto input.

18.3 Outputs Labels

Relay 1 to 60 (depending on the model): Output R1 to Output R60
User-defined text string to describe the function of the particular relay output contact.

18.4 Virtual Input Labels

Virtual Input 1 to 128.
User-defined text string to describe the function of the particular virtual input.

18.5 Virtual Output Labels

Virtual Output 1 to 128.
User-defined text string to describe the function of the particular virtual output.

18.6 User Alarm Labels

User Alarm 1 to 35.
User-defined text string to describe the function of the particular self-reset user alarm or manual-reset user alarm.

18.7 Control Input Labels

Control Input 1 to Control Input 32:
User defined text string to describe the function of the particular control input.
Command text can be individually assigned to each Control input by selecting one of the following pairs:

SET/RESET
IN/OUT
ENABLED/DISABLED
ON/OFF

19 IED CONFIGURATOR (IEC61850)

GoEna:	Configuration of which GOOSE Control Blocks (GCB) are enabled (publishing)
Pub.Simul.Goose:	Configuration per GCB of whether the published GOOSE are normal or simulated
Sub.Simul.Goose:	No/Yes

20 SECURITY CONFIG

The SECURITY CONFIG column contains the main configuration settings for Security functions. This column is used to set the password attempts number and duration. When these limits expire, access to the interface is blocked until the timer has expired. This setting enables or disables port access.

Important	**The SECURITY CONFIG column is ACCESS ONLY BY AUTHORISED USERS**

Front Port:	Disabled/Enabled
Rear Port 1:	Disabled/Enabled
Rear Port 2:	Disabled/Enabled
ETH Port 1:	Disabled/Enabled
ETH Port 1/2:	Disabled/Enabled
ETH Port 2/3:	Disabled/Enabled
ETH Port 3:	Disabled/Enabled

Notes:

GETTING STARTED

CHAPTER 3

Date:	12/2017
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.
Hardware Suffix:	M
Software Version:	B2
Connection Diagrams:	10P849xx (xx = 01 to 06)

CONTENTS

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TABLES

FIGURES

1 INTRODUCTION TO THE RELAY

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

1.1 User Interfaces and Menu Structure

The settings and functions of the MiCOM P849 input & output extension device can be accessed both from the front panel keypad and LCD, and via the front and rear communication ports. Information on each of these methods is given in this section to describe how to start using the relay.

1.2 Front Panel

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

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

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

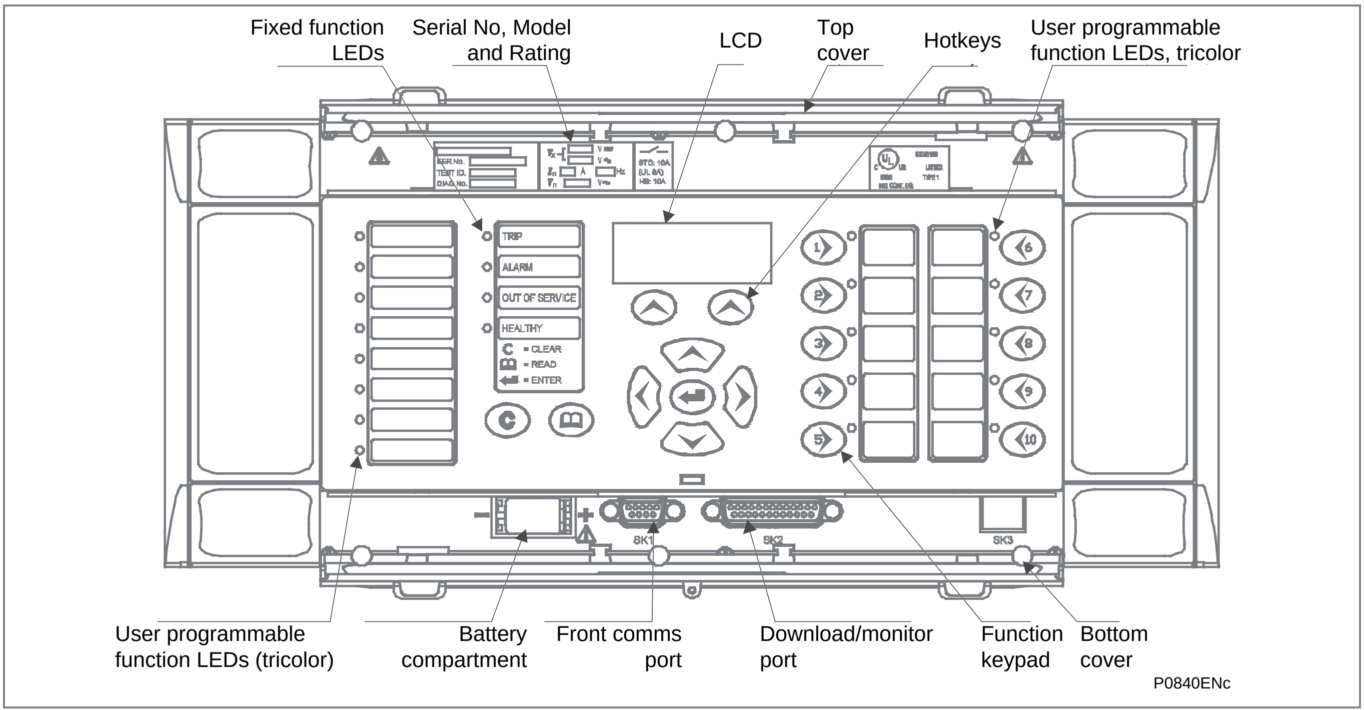


Figure 1 - MiCOM P849 - front view

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

- A 16-character by 3-line alphanumeric Liquid Crystal Display (LCD).
- A 9-key keypad with 4 arrow keys (, , and), an enter key (), a clear key (), a read key (), 2 hot keys ().
- 12 LEDs; 4 fixed function LEDs on the left hand side of the front panel and 8 programmable function LEDs on the right hand side.

Function Key Functionality:

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

Under the top hinged cover:

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

Under the bottom hinged cover:

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

1.2.1 LED Indications

1.2.1.1 Fixed Function

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

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

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

1.2.1.2 Programmable LEDs

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

- Function key 1: GOOSE testing mode – When ON VIPs will not drive outputs. (toggled mode. The yellow LED lit when ON)

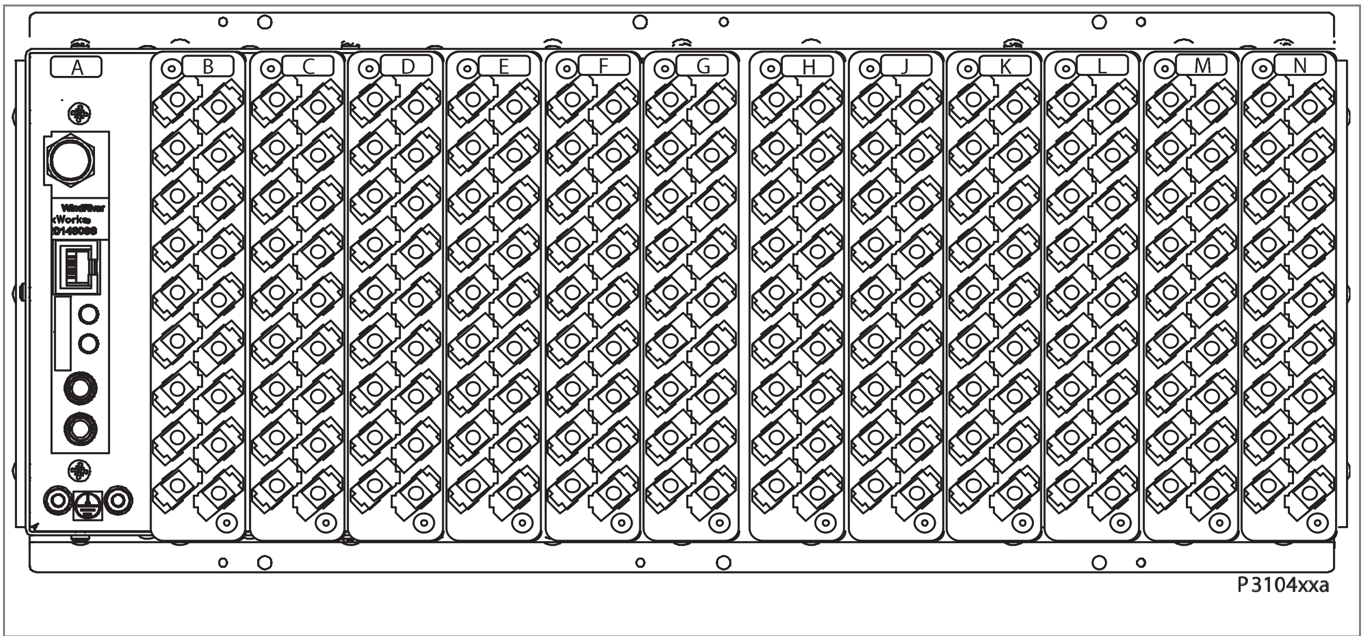
- Function key 6: send testing VOP message if in testing mode (toggled mode. The yellow LED lit when sending)
- Function key 10: Trigger disturbance record

The other Function keys are not assigned in the default configuration.

1.3 Rear Panel

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

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



A –	IRIG B / Ethernet / COMMS	H –	Relay \ Opto \ high break
B –	Opto	J –	Relay \ Opto \ high break
C –	Opto	K –	Relay \ Opto \ high break
D –	Opto	L –	Relay board
E –	Relay \ Opto	M –	Relay board
F –	Relay \ Opto	N	Power supply board
G –	Relay \ Opto \ high break		

Figure 2 – MiCOM P849 – rear view 80TE

1.4 Connection and Power-Up

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

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

Table 1 - Nominal and Operative ranges for dc and ac

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

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

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

2 USER INTERFACES AND SETTINGS OPTIONS

The relay has these user interfaces:

- The front panel user interface via the LCD and keypad
- The front port which supports Courier communication
- The rear port which supports these protocols:
    - Courier
    - MODBUS
    - IEC 60870-5-103
    - DNP3
- The optional Ethernet port which supports IEC 61850 and/or DNPoE

The measurement information and relay settings that can be accessed from the different interfaces are shown in this table:

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

Table 2 - Measurement information and relay settings

3 MENU STRUCTURE

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

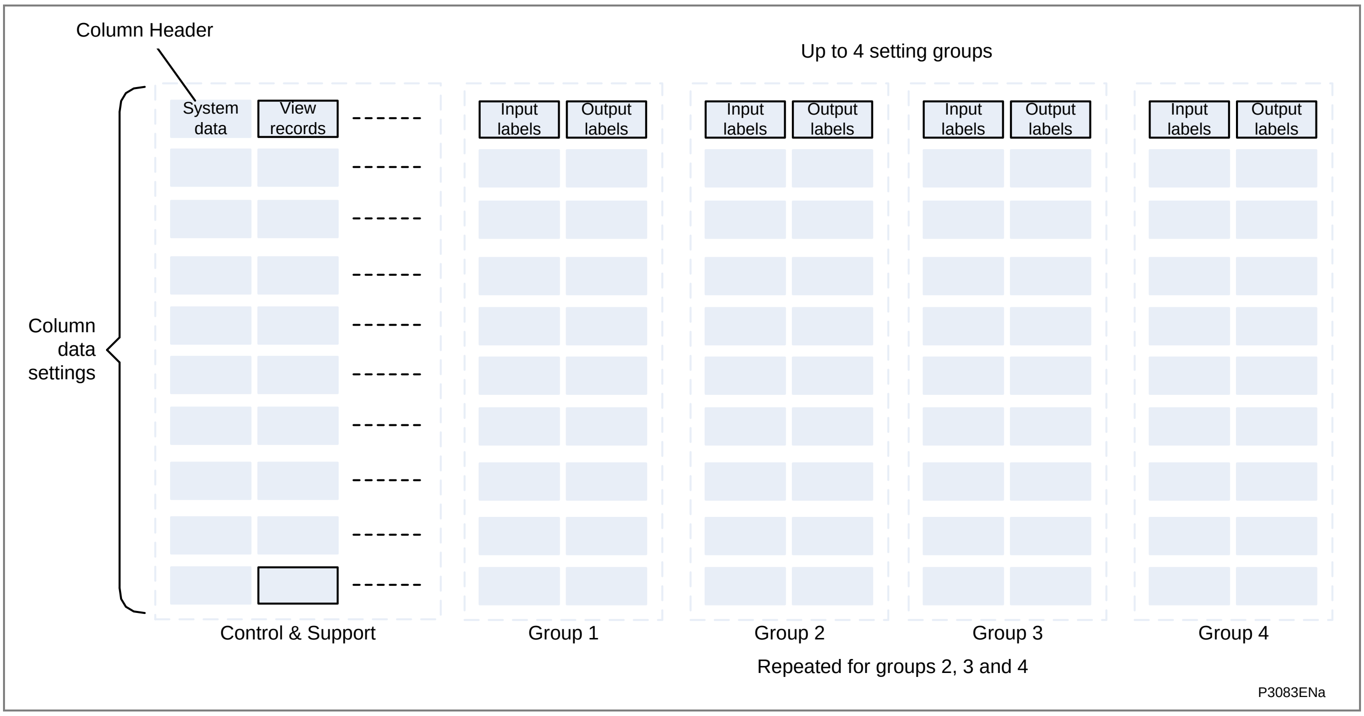


Figure 3 - Menu structure

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

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

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

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

3.1 Protection Settings

The settings include the following items:

- Input and Output element labels

There are four groups of settings, with each group containing the same setting cells. One group of settings is selected as the active group, and is used by the configuration elements.

3.2 Disturbance Recording Settings

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

3.3 Control and Support Settings

The control and support settings include:

- Configuration settings
- Active setting group
- Language settings
- Communications settings
- Event & maintenance record settings
- User interface settings
- Commissioning settings

4 CYBER SECURITY

4.1 Cyber Security Settings

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

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

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

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

4.2 Role Based Access Control (RBAC)

The Role Based Access Control (RBAC) is a method to restrict resource access to authorized users. RBAC is an alternative to traditional Mandatory Access Control (MAC) and Discretionary Access Control (DAC).

A key feature of RBAC model is that all access is through roles. A role is essentially a collection of permissions, and all users receive permissions only through the roles to which they are assigned, or through roles they inherit through the role hierarchy.

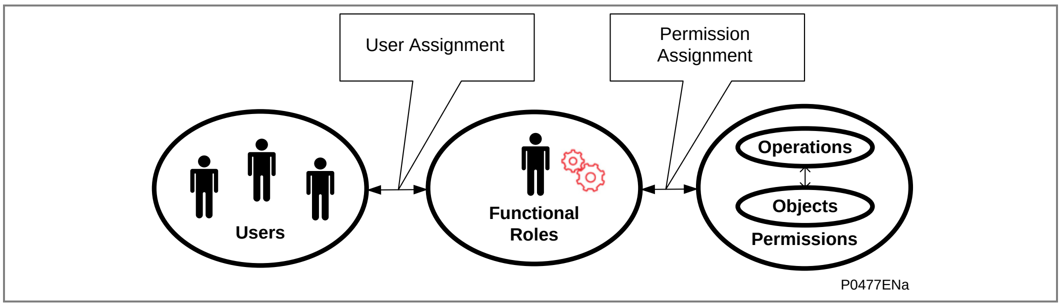


Figure 4 - RBAC Role structure

Roles are created for various job activities. The ***Permissions***, to perform certain operations, are assigned to specific roles. ***Users*** are assigned particular roles, and through those role assignments acquire the computer permissions to perform particular computer-system functions. Since ***users*** are not assigned permissions directly, but only acquire them through their role (or roles), management of individual user rights becomes a matter of simply assigning appropriate roles to the user's account; this simplifies common operations, such as adding a user, or changing user's account.

4.3 User Roles and Rights

Different named roles are associated with different access rights. Roles and Rights are setup in a pre-defined arrangement, according to the IEC62351 standard, but customized to the MiCOM Px4x equipment.

When the user tries to access an IED, they need to login using their own username and their own password. The username/password combination is then checked against the records stored on the IED. If they are allowed to login, a message appears which shows them what Role they have been assigned to. It is the role that defines their access to the relevant parts of the system.

In a similar way in which a set of pre-defined Roles have been created, a pre-defined set of Rights have been created.

These Rights give different permissions to look at what devices may be present, what those devices may contain, manage data within those devices (directly or by using files) and configure rights for other people.

5 RELAY CONFIGURATION

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

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

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

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

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

6 FRONT PANEL USER INTERFACE (KEYPAD AND LCD)

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

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

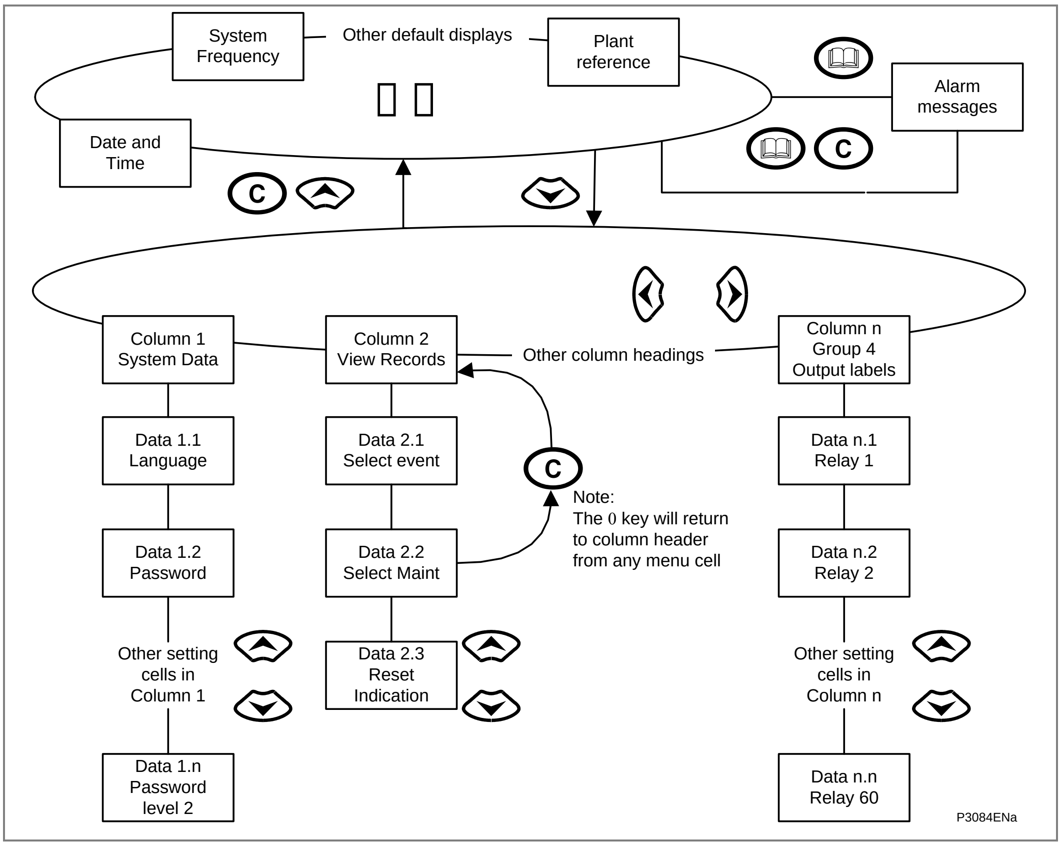


Figure 5 - Front panel user interface

6.1 Default Display and Menu Time-Out

The front panel menu has a default display. To change it, the Engineer Role will be required and the following items can be selected:

- Banner
- Date and time
- Relay Description (user defined)
- Plant Reference (user defined)
- Access Level

From the default display, the user can switch the default display to other default display items using the ◁ and ▷ keys. The default display will be saved as the last viewed items automatically. If the user tries to change the default display, Engineer Role will be requested (if the current access role is not that of an Engineer).

When user is browsing the relay menu structure with default access right, if there is no keypad activity for the 15 minutes (i.e. the timeout period), the default display will revert from the last viewed menu structure (can be any location from the menu structure) and the LCD backlight will turn off.

When user is logged in with Engineer Role, the menu timeout time may be shorter than 15 minutes. This depends on the value of inactive timer (e.g. if the inactive timer is set to shorter than 15 minutes). If menu timeout happens, any setting changes that have not been confirmed will be lost and the original setting values maintained.

Whenever there is an uncleared alarm present in the relay (e.g. fault record, protection alarm, control alarm etc.) the default display will be replaced by:

```
Alarms/Faults
Present
```

Entry to the menu structure of the relay is made from the default display and is not affected if the display is showing the Alarms/Faults present message.

6.2 Navigating Menus and Browsing Settings

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

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

6.3 Navigating the Hotkey Menu

To access the hotkey menu from the default display:

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

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

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

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

6.3.1 Setting Group Selection

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

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

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

6.3.2 Control Inputs - User Assignable Functions

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

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

6.3.3 Hotkey Menu Navigation

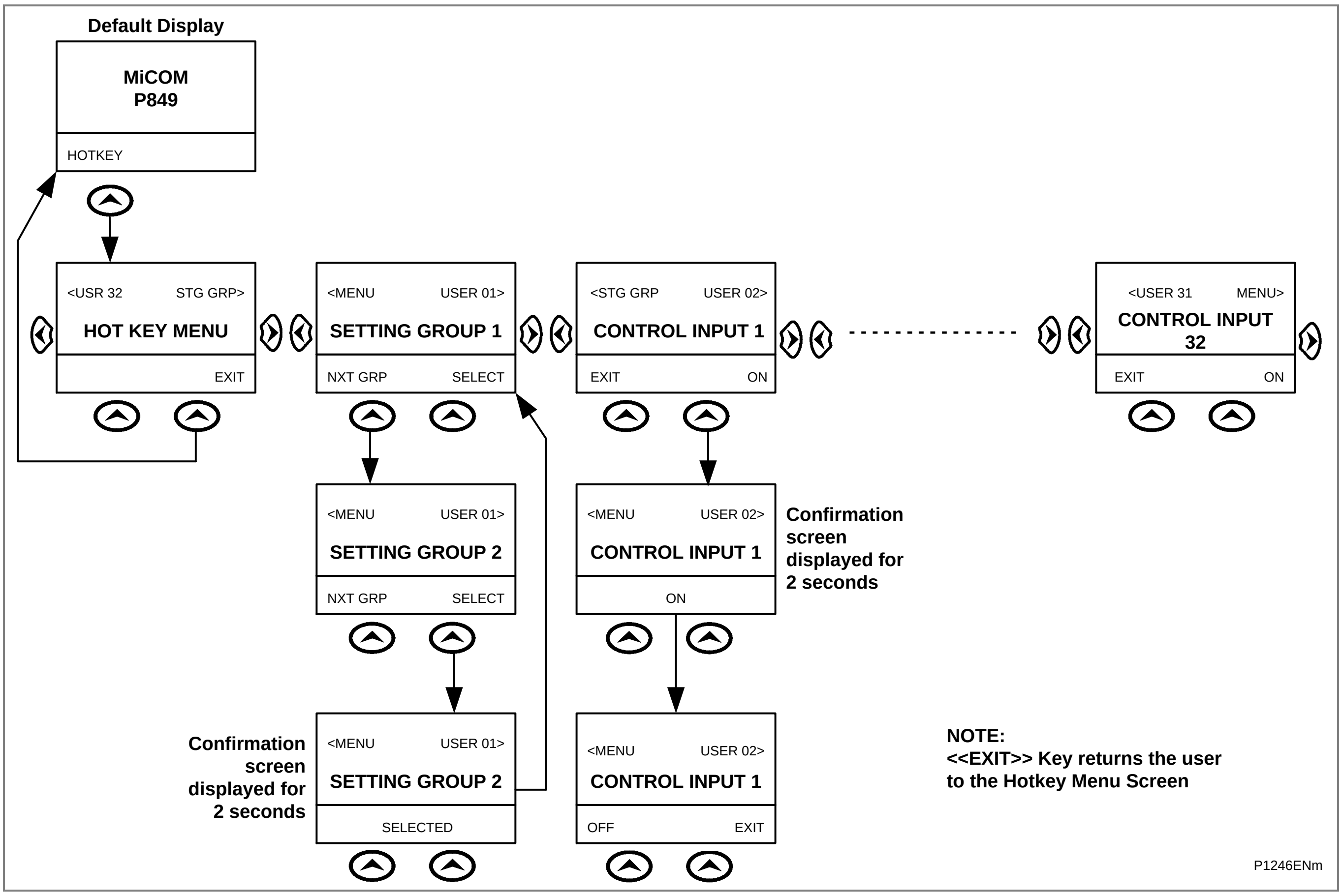


Figure 6 - Hotkey menu navigation

6.4 How to Login

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

6.4.1 Local Default Access

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

See Table 3 for the applied cases.

6.4.2 Auto Login

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

CS Version	Interface	RBAC/PW Cases	Login Process
CSL1	Front panel	Factory RBAC	Auto login with **EngineerLevel**
		Customized RBAC	Local Default Access Enabled: Login with **Local Default Access** Local Default Access Disabled: Login with **Prompt User List**
	Courier Interface	All cases	Login with **Prompt User List**
CSL0	Front panel	Factory RBAC	Auto login with **EngineerLevel**
		Password changed	**EngineerLevel** password is “AAAA” or is disabled/blank: Auto login with **EngineerLevel** **OperatorLevel** password is “AAAA” or is disabled/blank: Auto login with **OperatorLevel** **EngineerLevel** and **OperatorLevel** password changed: Auto login with **ViewerLevel Access**
	Courier Interface	Factory RBAC	Auto login with **EngineerLevel**
		Password changed	**EngineerLevel** password is “AAAA” or is disabled/blank: Auto login with **EngineerLevel** **OperatorLevel** password is “AAAA” or is disabled/blank: Auto login with **OperatorLevel** **EngineerLevel** and **OperatorLevel** password changed: Login with **Prompt User List**

Table 3 – Auto Login process

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

6.4.3 Login with Prompt User List

This login process will happen if:

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

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

6.5 Reading and Clearing of Alarm Messages and Fault Records

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

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

```
Press clear to
reset alarms
```

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

6.6 Setting Changes

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

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

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

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

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

6.7 How to Logout (at the Front Panel)

If you have been configuring the IED, you should 'log out'. You do this by going up to the top of the menu tree. When you are at the default display level and you press the Cancel button, you may be prompted to log out with this display:

```
ENTER TO LOG OUT
CLEAR TO CANCEL
```

You will only be asked this question if your password level is higher than the fallback level.

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

```
LOGGED OUT
Access Level <x>
```

Where x is the current fallback level.

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

```
LOGOUT CANCELLED
Access Level <x>
```

Where x is the current access level.

7 FRONT COMMUNICATION PORT USER INTERFACE

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

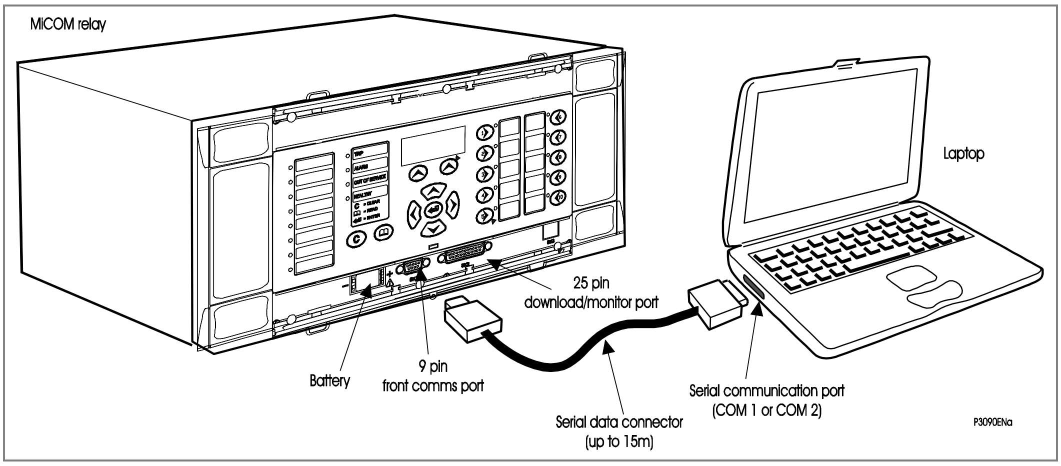


Figure 7 - Front port connection

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

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

Table 4 - Front port DCE pin connections

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

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

Table 5 - DTE devices serial port pin connections

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

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

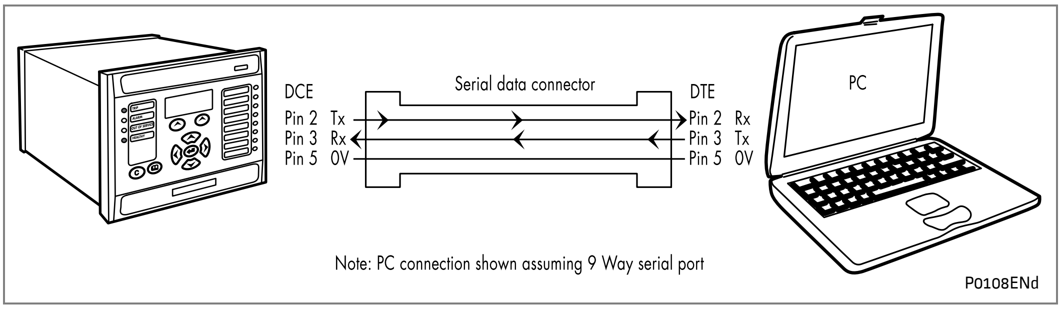


Figure 8 - PC relay signal connection

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

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

Table 6 - Relay front port settings

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

7.1 Front Courier Port

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

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

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

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

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

8 MICOM S1 STUDIO RELAY COMMUNICATIONS BASICS

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

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

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

8.1 PC Requirements

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

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

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

Note 1	*Operating system with Windows Updates updated on 2015/05.*
Note 2	*Operating system without Windows Updates installed.*
Note 3	*Both configurations do not include Data Models HDD requirements. Data Models typically need from 1 GB to 15 GB of hard disk space.*

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

Easergy Studio Additional components

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

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

8.2 Connecting to the Relay using Easergy Studio

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

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

8.3 Off-Line Use of Easergy Studio

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

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

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

SETTINGS

CHAPTER 4

Date:	12/2017
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.
Hardware Suffix:	M
Software Version:	B2
Connection Diagrams:	10P849xx (xx = 01 to 06)

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TABLES

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1 INTRODUCTION

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

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

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

2 RELAY SETTINGS

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

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

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

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

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

2.1 Default Settings Restore

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

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

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

3 CONFIGURATION MENU

Col	Row	Courier Text	Default Setting	Available Settings
Description				
09	00	CONFIGURATION		
This column contains all the general configuration options				
09	01	Restore Defaults	No Operation	0 = No Operation, 1 = All Settings, 2 = Setting Group 1, 3 = Setting Group 2, 4 = Setting Group 3, 5 = Setting Group 4
Setting to restore a setting group to factory default settings. To restore the default values to the settings in any Group settings, set the ‘restore defaults’ cell to the relevant Group number. Alternatively it is possible to set the ‘restore defaults’ cell to ‘all settings’ to restore the default values to all of the IED’s settings, not just the Group settings. The default settings will initially be placed in the scratchpad and will only be used by the IED after they have been confirmed by the user. Note: Restoring defaults to all settings includes the rear communication port settings, which may result in communication via the rear port being disrupted if the new (default) settings do not match those of the master station.				
09	02	Setting Group	Select via Menu	0 = Select via Menu or 1 = Select via PSL
Allows setting group changes to be initiated via Opto Input or via Menu				
09	03	Active Settings	Group 1	0 = Group 1, 1 = Group 2, 2 = Group 3, 3 = Group 4
Selects the active setting group.				
09	04	Save Changes	No Operation	0 = No Operation, 1 = Save, 2 = Abort
Saves all IED settings.				
09	05	Copy From	Group 1	0 = Group 1, 1 = Group 2, 2 = Group 3, 3 = Group 4
Allows displayed settings to be copied from a selected setting group				
09	06	Copy To	No Operation	0 = No Operation, 1 = Group 1, 2 = Group 2, 3 = Group 3
Allows displayed settings to be copied to a selected setting group				
09	07	Setting Group 1	Enabled	0 = Disabled or 1 = Enabled
Enables or disables Group 1 settings.If the setting group is disabled from the configuration, then all associated settings and signals are hidden, with the exception of this setting.				
09	08	Setting Group 2	Disabled	0 = Disabled or 1 = Enabled
Enables or disables Group 2 settings.If the setting group is disabled from the configuration, then all associated settings and signals are hidden, with the exception of this setting.				
09	09	Setting Group 3	Disabled	0 = Disabled or 1 = Enabled
Enables or disables Group 3 settings. If the setting group is disabled from the configuration, then all associated settings and signals are hidden, with the exception of this setting.				
09	0A	Setting Group 4	Disabled	0 = Disabled or 1 = Enabled
Enables or disables Group 4 settings. If the setting group is disabled from the configuration, then all associated settings and signals are hidden, with the exception of this setting.				
09	25	Input Labels	Visible	0 = Invisible, 1 = Visible
Sets the Input Labels menu visible further on in the IED setting menu.				
09	26	Output Labels	Visible	0 = Invisible, 1 = Visible
Sets the Output Labels menu visible further on in the IED setting menu.				
09	29	Record Control	Invisible	0 = Invisible, 1 = Visible
Sets the Record Control menu visible further on in the IED settings menu.				
09	2A	Disturb Recorder	Invisible	0 = Invisible, 1 = Visible
Sets the Disturbance Recorder menu visible further on in the IED settings menu.				

Col	Row	Courier Text	Default Setting	Available Settings
Description				
09	2B	Measure't Setup	Invisible	0 = Invisible, 1 = Visible
Sets the Measurement Setup menu visible further on in the IED settings menu.				
09	2C	Comms Settings	Visible	0 = Invisible, 1 = Visible
Sets the Communications Settings menu visible further on in the IED settings menu. These are the settings associated with the 1st and 2nd rear communications ports				
09	2D	Commission Tests	Visible	0 = Invisible, 1 = Visible
Sets the Commissioning Tests menu visible further on in the IED settings menu.				
09	2F	Control Inputs	Visible	0 = Invisible, 1 = Visible
Activates the Control Input status and operation menu further on in the IED setting menu.				
09	35	Ctrl I/P Config	Visible	0 = Invisible, 1 = Visible
Sets the Control Input Configuration menu visible further on in the IED setting menu.				
09	36	Ctrl I/P Labels	Visible	0 = Invisible, 1 = Visible
Sets the Control Input Labels menu visible further on in the IED setting menu.				
09	39	Direct Access	Enabled	0 = Disabled or 1 = Enabled
Defines whether direct access is allowed or not. The front direct access keys that are used as a short cut function of the menu may be: Disabled – No function visible on the LCD. Enabled – All control functions mapped to the Hotkeys. Not available on Chinese version relays.				
09	40	InterMiCOM	Disabled	0 = Disabled or 1 = Enabled
InterMiCOM - ZN0025 required in slot A				
09	50	Function Key	Visible	0 = Invisible, 1 = Visible
Sets the Function Key menu visible further on in the IED setting menu.				
09	70	VIR I/P Labels	Invisible	0 = Invisible, 1 = Visible
This makes the virtual input label settings visible or invisible.				
09	80	VIR O/P Labels	Invisible	0 = Invisible, 1 = Visible
This makes the virtual output label settings visible or invisible.				
09	90	Usr Alarm Labels	Invisible	0 = Invisible, 1 = Visible
This makes the user alarm label settings visible or invisible.				
09	FB	RP1 Read Only	Disabled	0 = Disabled or 1 = Enabled
Enable Remote Read Only Mode on RP1 courier or IEC60870-5-103 communication protocol. Visible when comms options are: 1 – Courier, 3 – CS103, 6&G – IEC61850 with 1st Rear Courier, 7&H – IEC61850 with 1st Rear CS103.				
09	FC	RP2 Read Only	Disabled	0 = Disabled or 1 = Enabled
Enable Remote Read Only Mode on RP2 courier communication protocol. Visible when hardware options are: 7, 8, E or F.				
09	FD	NIC Read Only	Disabled	0 = Disabled or 1 = Enabled
Enable Remote Read Only Mode on the Network Interface card (IEC 61850 tunneled courier). Visible when comms options are: 6&G – IEC61850 with 1st Rear Courier, 7&H – IEC61850 with 1st Rear CS103, B&L– IEC61850 with DNPoE with DNP .				
09	FF	LCD Contrast	11	0 to 31 step 1
Sets the LCD contrast.				

Table 1 - Configuration settings

4 GROUPED PROTECTION SETTINGS

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

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

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

4.1 Input Labels

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

Col	Row	Courier Text	Default Setting	Available Settings
Description				
4A	00	GROUP 1: INPUT LABELS		
GROUP 1: INPUT LABELS				
4A	01	Opto Input 1	Input L1	From 32 to 234 step 1
Label for Opto Input 1				
4A	02	Opto Input 2	Input L2	From 32 to 234 step 1
Label for Opto Input 2				
4A	03	Opto Input 3	Input L3	From 32 to 234 step 1
Label for Opto Input 3				
4A	04	Opto Input 4	Input L4	From 32 to 234 step 1
Label for Opto Input 4				
4A	05	Opto Input 5	Input L5	From 32 to 234 step 1
Label for Opto Input 5				
4A	06	Opto Input 6	Input L6	From 32 to 234 step 1
Label for Opto Input 6				
4A	07	Opto Input 7	Input L7	From 32 to 234 step 1
Label for Opto Input 7				
4A	08	Opto Input 8	Input L8	From 32 to 234 step 1
Label for Opto Input 8				
4A	09	Opto Input 9	Input L9	From 32 to 234 step 1
Label for Opto Input 9				
4A	0A	Opto Input 10	Input L10	From 32 to 234 step 1
Label for Opto Input 10				
4A	0B	Opto Input 11	Input L11	From 32 to 234 step 1
Label for Opto Input 11				
4A	0C	Opto Input 12	Input L12	From 32 to 234 step 1
Label for Opto Input 12				
4A	0D	Opto Input 13	Input L13	From 32 to 234 step 1

Col	Row	Courier Text	Default Setting	Available Settings
Description				
Label for Opto Input 13				
4A	0E	Opto Input 14	Input L14	From 32 to 234 step 1
Label for Opto Input 14				
4A	0F	Opto Input 15	Input L15	From 32 to 234 step 1
Label for Opto Input 15				
4A	10	Opto Input 16	Input L16	From 32 to 234 step 1
Label for Opto Input 16				
4A	11	Opto Input 17	Input L17	From 32 to 234 step 1
Label for Opto Input 17				
4A	12	Opto Input 18	Input L18	From 32 to 234 step 1
Label for Opto Input 18				
4A	13	Opto Input 19	Input L19	From 32 to 234 step 1
Label for Opto Input 19				
4A	14	Opto Input 20	Input L20	From 32 to 234 step 1
Label for Opto Input 20				
4A	15	Opto Input 21	Input L21	From 32 to 234 step 1
Label for Opto Input 21				
4A	16	Opto Input 22	Input L22	From 32 to 234 step 1
Label for Opto Input 22				
4A	17	Opto Input 23	Input L23	From 32 to 234 step 1
Label for Opto Input 23				
4A	18	Opto Input 24	Input L24	From 32 to 234 step 1
Label for Opto Input 24				
4A	19	Opto Input 25	Input L25	From 32 to 234 step 1
Label for Opto Input 25				
4A	1A	Opto Input 26	Input L26	From 32 to 234 step 1
Label for Opto Input 26				
4A	1B	Opto Input 27	Input L27	From 32 to 234 step 1
Label for Opto Input 27				
4A	1C	Opto Input 28	Input L28	From 32 to 234 step 1
Label for Opto Input 28				
4A	1D	Opto Input 29	Input L29	From 32 to 234 step 1
Label for Opto Input 29				
4A	1E	Opto Input 30	Input L30	From 32 to 234 step 1
Label for Opto Input 30				
4A	1F	Opto Input 31	Input L31	From 32 to 234 step 1
Label for Opto Input 31				
4A	20	Opto Input 32	Input L32	From 32 to 234 step 1
Label for Opto Input 32				
4A	21	Opto Input 33	Input L33	From 32 to 234 step 1
Label for Opto Input 33				
4A	22	Opto Input 34	Input L34	From 32 to 234 step 1
Label for Opto Input 34				

Col	Row	Courier Text	Default Setting	Available Settings
		Description		
4A	23	Opto Input 35	Input L35	From 32 to 234 step 1
Label for Opto Input 35				
4A	24	Opto Input 36	Input L36	From 32 to 234 step 1
Label for Opto Input 36				
4A	25	Opto Input 37	Input L37	From 32 to 234 step 1
Label for Opto Input 37				
4A	26	Opto Input 38	Input L38	From 32 to 234 step 1
Label for Opto Input 38				
4A	27	Opto Input 39	Input L39	From 32 to 234 step 1
Label for Opto Input 39				
4A	28	Opto Input 40	Input L40	From 32 to 234 step 1
Label for Opto Input 40				
4A	29	Opto Input 41	Input L41	From 32 to 234 step 1
Label for Opto Input 41				
4A	2A	Opto Input 42	Input L42	From 32 to 234 step 1
Label for Opto Input 42				
4A	2B	Opto Input 43	Input L43	From 32 to 234 step 1
Label for Opto Input 43				
4A	2C	Opto Input 44	Input L44	From 32 to 234 step 1
Label for Opto Input 44				
4A	2D	Opto Input 45	Input L45	From 32 to 234 step 1
Label for Opto Input 45				
4A	2E	Opto Input 46	Input L46	From 32 to 234 step 1
Label for Opto Input 46				
4A	2F	Opto Input 47	Input L47	From 32 to 234 step 1
Label for Opto Input 47				
4A	30	Opto Input 48	Input L48	From 32 to 234 step 1
Label for Opto Input 48				
4A	31	Opto Input 49	Input L49	From 32 to 234 step 1
Label for Opto Input 49				
4A	32	Opto Input 50	Input L50	From 32 to 234 step 1
Label for Opto Input 50				
4A	33	Opto Input 51	Input L51	From 32 to 234 step 1
Label for Opto Input 51				
4A	34	Opto Input 52	Input L52	From 32 to 234 step 1
Label for Opto Input 52				
4A	35	Opto Input 53	Input L53	From 32 to 234 step 1
Label for Opto Input 53				
4A	36	Opto Input 54	Input L54	From 32 to 234 step 1
Label for Opto Input 54				
4A	37	Opto Input 55	Input L55	From 32 to 234 step 1
Label for Opto Input 55				
4A	38	Opto Input 56	Input L56	From 32 to 234 step 1

Col	Row	Courier Text	Default Setting	Available Settings
Description				
Label for Opto Input 56				
4A	39	Opto Input 57	Input L57	From 32 to 234 step 1
Label for Opto Input 57				
4A	3A	Opto Input 58	Input L58	From 32 to 234 step 1
Label for Opto Input 58				
4A	3B	Opto Input 59	Input L59	From 32 to 234 step 1
Label for Opto Input 59				
4A	3C	Opto Input 60	Input L60	From 32 to 234 step 1
Label for Opto Input 60				
4A	3D	Opto Input 61	Input L61	From 32 to 234 step 1
Label for Opto Input 61				
4A	3E	Opto Input 62	Input L62	From 32 to 234 step 1
Label for Opto Input 62				
4A	3F	Opto Input 63	Input L63	From 32 to 234 step 1
Label for Opto Input 63				
4A	40	Opto Input 64	Input L64	From 32 to 234 step 1
Label for Opto Input 64				

Table 2 – Input labels settings

4.2 Output Labels

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

Col	Row	Courier Text	Default Setting	Available Settings
Description				
4B	00	GROUP 2: OUTPUT LABELS		
GROUP 1: OUTPUT LABELS				
4B	01	Relay 1	Output R1	From 32 to 234 step 1
Label for Output Relay 1				
4B	02	Relay 2	Output R2	From 32 to 234 step 1
Label for Output Relay 2				
4B	03	Relay 3	Output R3	From 32 to 234 step 1
Label for Output Relay 3				
4B	04	Relay 4	Output R4	From 32 to 234 step 1
Label for Output Relay 4				
4B	05	Relay 5	Output R5	From 32 to 234 step 1
Label for Output Relay 5				
4B	06	Relay 6	Output R6	From 32 to 234 step 1
Label for Output Relay 6				
4B	07	Relay 7	Output R7	From 32 to 234 step 1
Label for Output Relay 7				

Col	Row	Courier Text	Default Setting	Available Settings
Description				
4B	08	Relay 8	Output R8	From 32 to 234 step 1
Label for Output Relay 8				
4B	09	Relay 9	Output R9	From 32 to 234 step 1
Label for Output Relay 9				
4B	0A	Relay 10	Output R10	From 32 to 234 step 1
Label for Output Relay 10				
4B	0B	Relay 11	Output R11	From 32 to 234 step 1
Label for Output Relay 11				
4B	0C	Relay 12	Output R12	From 32 to 234 step 1
Label for Output Relay 12				
4B	0D	Relay 13	Output R13	From 32 to 234 step 1
Label for Output Relay 13				
4B	0E	Relay 14	Output R14	From 32 to 234 step 1
Label for Output Relay 14				
4B	0F	Relay 15	Output R15	From 32 to 234 step 1
Label for Output Relay 15				
4B	10	Relay 16	Output R16	From 32 to 234 step 1
Label for Output Relay 16				
4B	11	Relay 17	Output R17	From 32 to 234 step 1
Label for Output Relay 17				
4B	12	Relay 18	Output R18	From 32 to 234 step 1
Label for Output Relay 18				
4B	13	Relay 19	Output R19	From 32 to 234 step 1
Label for Output Relay 19				
4B	14	Relay 20	Output R20	From 32 to 234 step 1
Label for Output Relay 20				
4B	15	Relay 21	Output R21	From 32 to 234 step 1
Label for Output Relay 21				
4B	16	Relay 22	Output R22	From 32 to 234 step 1
Label for Output Relay 22				
4B	17	Relay 23	Output R23	From 32 to 234 step 1
Label for Output Relay 23				
4B	18	Relay 24	Output R24	From 32 to 234 step 1
Label for Output Relay 24				
4B	19	Relay 25	Output R25	From 32 to 234 step 1
Label for Output Relay 25				
4B	1A	Relay 26	Output R26	From 32 to 234 step 1
Label for Output Relay 26				
4B	1B	Relay 27	Output R27	From 32 to 234 step 1
Label for Output Relay 27				
4B	1C	Relay 28	Output R28	From 32 to 234 step 1
Label for Output Relay 28				
4B	1D	Relay 29	Output R29	From 32 to 234 step 1

Col	Row	Courier Text	Default Setting	Available Settings
Description				
Label for Output Relay 29				
4B	1E	Relay 30	Output R30	From 32 to 234 step 1
Label for Output Relay 30				
4B	1F	Relay 31	Output R31	From 32 to 234 step 1
Label for Output Relay 31				
4B	20	Relay 32	Output R32	From 32 to 234 step 1
Label for Output Relay 32				
4B	21	Relay 33	Output R33	From 32 to 234 step 1
Label for Output Relay 33				
4B	22	Relay 34	Output R34	From 32 to 234 step 1
Label for Output Relay 34				
4B	23	Relay 35	Output R35	From 32 to 234 step 1
Label for Output Relay 35				
4B	24	Relay 36	Output R36	From 32 to 234 step 1
Label for Output Relay 36				
4B	25	Relay 37	Output R37	From 32 to 234 step 1
Label for Output Relay 37				
4B	26	Relay 38	Output R38	From 32 to 234 step 1
Label for Output Relay 38				
4B	27	Relay 39	Output R39	From 32 to 234 step 1
Label for Output Relay 39				
4B	28	Relay 40	Output R40	From 32 to 234 step 1
Label for Output Relay 40				
4B	29	Relay 41	Output R41	From 32 to 234 step 1
Label for Output Relay 41				
4B	2A	Relay 42	Output R42	From 32 to 234 step 1
Label for Output Relay 42				
4B	2B	Relay 43	Output R43	From 32 to 234 step 1
Label for Output Relay 43				
4B	2C	Relay 44	Output R44	From 32 to 234 step 1
Label for Output Relay 44				
4B	2D	Relay 45	Output R45	From 32 to 234 step 1
Label for Output Relay 45				
4B	2E	Relay 46	Output R46	From 32 to 234 step 1
Label for Output Relay 46				
4B	2F	Relay 47	Output R47	From 32 to 234 step 1
Label for Output Relay 47				
4B	30	Relay 48	Output R48	From 32 to 234 step 1
Label for Output Relay 48				
4B	31	Relay 49	Output R49	From 32 to 234 step 1
Label for Output Relay 49				
4B	32	Relay 50	Output R50	From 32 to 234 step 1
Label for Output Relay 50				

Col	Row	Courier Text	Default Setting	Available Settings
Description				
4B	33	Relay 51	Output R51	From 32 to 234 step 1
Label for Output Relay 51				
4B	34	Relay 52	Output R52	From 32 to 234 step 1
Label for Output Relay 52				
4B	35	Relay 53	Output R53	From 32 to 234 step 1
Label for Output Relay 53				
4B	36	Relay 54	Output R54	From 32 to 234 step 1
Label for Output Relay 54				
4B	37	Relay 55	Output R55	From 32 to 234 step 1
Label for Output Relay 55				
4B	38	Relay 56	Output R56	From 32 to 234 step 1
Label for Output Relay 56				
4B	39	Relay 57	Output R57	From 32 to 234 step 1
Label for Output Relay 57				
4B	3A	Relay 58	Output R58	From 32 to 234 step 1
Label for Output Relay 58				
4B	3B	Relay 59	Output R59	From 32 to 234 step 1
Label for Output Relay 59				
4B	3C	Relay 60	Output R60	From 32 to 234 step 1
Label for Output Relay 60				

Table 3 – Output labels settings

5 CONTROL AND SUPPORT SETTINGS

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

- Function configuration settings
- Reset LEDs
- Active setting group
- Password (CSL0) & language settings
- Communications settings
- Record settings
- User interface settings
- Commissioning settings

5.1 System Data

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

Col	Row	Courier Text	Default Setting	Available Settings
Description				
00	00	SYSTEM DATA		
This column contains general system settings				
00	01	Language	English	English, French, German, Russian, Spanish, Chinese(UI only)
The default language used by the device. Selectable as English, French, German, Spanish and Chinese (UI only).				
00	03	Sys Fn Links	0	Bit 00=Trip LED S/Reset (1 = enable self reset)
Setting to allow the fixed function trip LED to be self resetting (set to 1 to extinguish the LED after a period of healthy restoration of load current).				
00	04	Description	MiCOM P849	32 to 234 step 1
Editable 16-character description of the unit				
00	05	Plant Reference	MiCOM	32 to 234 step 1
Plant description: Can be edited				
00	06	Model Number	Model Number	<Model number>
Displays the model number. This can not be edited				
00	08	Serial Number	Serial Number	<Serial number>
Displays the serial number. This can not be edited.				
00	09	Frequency	50 Hz	50 Hz or 60 Hz
Sets the mains frequency				
00	0A	Comms Level	2	<conformance level displayed>
Displays the conformance of the relay to the Courier Level 2 comms				
00	0B	Relay Address	255 1 1 1	0 to 255 step 1 (Courier) 1 to 247 step 1 (Modbus) 0 to 254 step 1 (CS103) 0 to 65519 step 1 (DNP3)
Set the first rear port relay address. Build = Courier (Address available via LCD) Build = Modbus (Address available via LCD) Build = CS103 (Address available via LCD) Build = DNP3.0 (Address available via LCD)				
00	0C	Plant Status		Not Settable
Not used				

Col	Row	Courier Text	Default Setting	Available Settings
Description				
00	0D	Control Status		Not used
Not used				
00	0E	Active Group	1	Not Settable
Displays the active settings group				
00	11	Software Ref. 1		<Software Ref. 1>
Displays the relay software version including protocol and relay model.				
00	12	Software Ref. 2		<Software Ref. 2>
Relay Ethernet card software reference. Visible when Ethernet card fitted.				
00	14	NIC Platform Ref		<NIC platform reference>
Displays the relay NIC platform reference. Visible when Ethernet card fitted.				
00	15	IEC61850 Edition	2	1 or 2
Selects IEC 61850 Editions, Edition 1 or Edition 2. This setting can only be changed via UI and the changes will cause the Ethernet board to reboot.				
00	16	ETH COMM Mode	Dual IP	Dual IP, PRP, HSR
Sets the redundancy protocol. This setting can only be changed via the UI and the changes will cause the Ethernet board to reboot.				
00	20	Opto I/P Status		Not Settable
Display the status of the available opto inputs fitted.				
00	21	Relay O/P Status		Not Settable
Displays the status of the first 32 output relays.				
00	22	Alarm Status 1		Not Settable
This menu cell displays the status of the first 32 alarms as a binary string. 1 indicates an ON state and 0 an OFF state. Includes fixed and user settable alarms. See Data Type G96-1 in the Menu Database document, P849/EN/MD for details.				
00	30	Opto I/P Status		Not Settable
Displays the status of opto-isolated inputs (number of opto inputs depending on the model).				
00	31	Opto I/P Status2		Not Settable
Displays the status of opto-isolated inputs (number of opto inputs depending on the model).				
00	40	Relay O/P Status		Not Settable
Displays the status of the first 32 output relays.				
00	41	Relay O/P Status2		Not Settable
Displays the status of the next 32 output relays				
00	50	Alarm Status 1		Not Settable
This menu cell displays the status of the first 32 alarms as a binary string. 1 indicates an ON state and 0 an OFF state. Includes fixed and user settable alarms. See Data Type G96-1 in the Menu Database document, P849/EN/MD for details.				
00	51	Alarm Status 2		Not Settable
This menu cell displays the status of the second 32 alarms as a binary string.1 indicates an ON state and 0 an OFF state. See Data Type G96-2 in the Menu Database document, P849/EN/MD for details.				
00	52	Alarm Status 3		Not Settable
This menu cell displays the status of the third 32 alarms as a binary string. 1 indicates an ON state and 0 an OFF state. Assigned specifically for platform alarms. See Data Type G228 in the Menu Database document, P849/EN/MD for details.				
00	D0	Access Level	ENGINEER	Not Settable
Display the Role(s) of the current logged in user, if no one logged in, it shall be "NONE".				
00	D3	New Eng.Level PW		ASCII 33 to 122
Allows user to change password for EngineerLevel. Visible on UI only.				

Col	Row	Courier Text	Default Setting	Available Settings
Description				
00	D4	New Op.Level PW		ASCII 33 to 122
Allows user to change password for OperatorLevel. Visible on UI only.				
00	DF	Security Feature	3	Not Settable
Displays the level of cyber security implemented				
00	E1	Password		<Password>
Used to send encrypted password. Not visible on UI.				
00	E5	Encryption Salt		<Encryption Salt>
Random data used with encrypted password. Not visible on UI.				
00	F1	Enter Username		<User Name>
User selection for login. Not visible on UI.				
00	F2	Number of users	2	Not Settable
Shows the number of users configured within the relays RBAC.				
00	F3	New UI pwd		<Second Simple Password>
Hidden cell reserved for second password modification. Not in use currently.				
00	F4	New password		<Encrpted Password>
Allow password change if engineer or operator logged in and CSL0 model. Not visible on UI.				

Table 4 - System data settings

Important	***Dual IP is not mutually exclusive with PRP/HSR, Dual IP is automatically supported even if the IED is operated under HSR or PRP Mode.***

5.2 Date and Time

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

Col	Row	Courier Text	Default Setting	Available Settings
Description				
08	00	DATE AND TIME		
This column contains Date and Time settings				
08	01	Date/Time		Not Settable
Displays the IED’s current date and time. Not visible on UI.				
08	02	Date		<Date>
Front Panel Menu only				
08	03	Time		<Time>
Front Panel Menu only				
08	04	IRIG-B Sync	Disabled	0 = Disabled or 1 = Enabled
Enable IRIG-B time synchronization.				
08	05	IRIG-B Status		Not Settable
Displays the status of IRIG-B				
08	06	Battery Status		Not Settable
Displays whether the battery is healthy or not				
08	07	Battery Alarm	Enabled	0 = Disabled or 1 = Enabled
Enables or disables battery alarm. The battery alarm needs to be disabled when a battery is removed or not used				
08	13	SNTP Status		Not Settable
IEC61850 or DNP3.0 over Ethernet versions only. Displays information about the SNTP time synchronization status				

Col	Row	Courier Text	Default Setting	Available Settings
Description				
08	20	LocalTime Enable	Disabled	0 = Disabled, 1 = Fixed or 2 = Flexible
Setting to turn on/off local time adjustments. Disabled - No local time zone will be maintained. Time synchronization from any interface will be used to directly set the master clock and all displayed (or read) times on all interfaces will be based on the master clock with no adjustment. Fixed - A local time zone adjustment can be defined using the LocalTime offset setting and all interfaces will use local time except SNTP time synchronization and IEC 61850 timestamps. Flexible - A local time zone adjustment can be defined using the LocalTime offset setting and each interface can be assigned to the UTC zone or local time zone with the exception of the local interfaces which will always be in the local time zone and IEC 61850/SNTP which will always be in the UTC zone.				
08	21	LocalTime Offset	0min	From -720min to 720min step 15min
Setting to specify an offset of -12 to +12 hrs in 15 minute intervals for local time zone. This adjustment is applied to the time based on the master clock which is UTC/GMT				
08	22	DST Enable	Enabled	0 = Disabled or 1 = Enabled
Setting to turn on/off daylight saving time adjustment to local time.				
08	23	DST Offset	60min	From 30min to 60min step 30min
Setting to specify daylight saving offset which will be used for the time adjustment to local time.				
08	24	DST Start	Last	0 = First, 1 = Second, 2 = Third, 3 = Fourth or 4 = Last
Setting to specify the week of the month in which daylight saving time adjustment starts				
08	25	DST Start Day	Sunday	0 = Sunday, 1 = Monday, 2 = Tuesday, 3 = Wednesday, 4 = Thursday, 5 = Friday or 6 = Saturday
Setting to specify the day of the week in which daylight saving time adjustment starts				
08	26	DST Start Month	March	0 = January, 1 = February, 2 = March, 3 = April, 4 = May, 5 = June, 6 = July, 7 = August, 8 = September, 9 = October, 10 = November or 11 = December
Setting to specify the month in which daylight saving time adjustment starts				
08	27	DST Start Mins	60min	From 0min to 1425min step 15min
Setting to specify the time of day in which daylight saving time adjustment starts. This is set relative to 00:00 hrs on the selected day when time adjustment is to start				
08	28	DST End	Last	0 = First, 1 = Second, 2 = Third, 3 = Fourth or 4 = Last
Setting to specify the week of the month in which daylight saving time adjustment ends				
08	29	DST End Day	Sunday	0 = Sunday, 1 = Monday, 2 = Tuesday, 3 = Wednesday, 4 = Thursday, 5 = Friday or 6 = Saturday
Setting to specify the day of the week in which daylight saving time adjustment ends				
08	2A	DST End Month	October	0 = January, 1 = February, 2 = March, 3 = April, 4 = May, 5 = June, 6 = July, 7 = August, 8 = September, 9 = October, 10 = November or 11 = December
Setting to specify the month in which daylight saving time adjustment ends				
08	2B	DST End Mins	60min	From 0min to 1425min step 15min
Setting to specify the time of day in which daylight saving time adjustment ends. This is set relative to 00:00 hrs on the selected day when time adjustment is to end				
08	30	RP1 Time Zone	Local	0 = UTC or 1 = Local
Setting for the rear port 1 interface to specify if time synchronization received will be local or universal time co-ordinated				
08	31	RP2 Time Zone	Local	0 = UTC or 1 = Local
Setting for the rear port 2 interface to specify if time synchronization received will be local or universal time co-ordinated				

Col	Row	Courier Text	Default Setting	Available Settings
Description				
08	32	DNPOE Time Zone	Local	0 = UTC or 1 = Local
IEC61850+DNP3oE versions only. Setting to specify if time synchronisation received will be local or universal time co-ordinated.				
08	33	Tunnel Time Zone	Local	0 = UTC or 1 = Local
Ethernet versions only for tunnelled courier. Setting to specify if time synchronization received will be local or universal time co-ordinated				

Table 5 - Date and time settings

5.3 Record Control

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

Col	Row	Courier Text	Default Setting	Available Settings
Description				
0B	00	RECORD CONTROL		
This column contains settings for Record Controls				
0B	01	Clear Events	No	0 = No or 1 = Yes
Selecting “Yes” will cause the existing event log to be cleared and an event will be generated indicating that the events have been erased.				
0B	03	Clear Maint	No	0 = No or 1 = Yes
Selecting “Yes” will cause the existing maint log to be cleared and an event will be generated indicating that the maint records have been erased.				
0B	04	Alarm Event	Enabled	0 = No or 1 = Yes
Disabling this setting means that all the occurrences that produce an alarm will result in no event being generated.				
0B	05	Relay O/P Event	Enabled	0 = Disabled or 1 = Enabled
Disabling this setting means that no event will be generated for any change in logic output state.				
0B	06	Opto Input Event	Enabled	0 = Disabled or 1 = Enabled
Disabling this setting means that no event will be generated for any change in logic input state.				
0B	07	General Event	Enabled	0 = Disabled or 1 = Enabled
Disabling this setting means that no General Events are generated				
0B	09	Maint Rec Event	Enabled	0 = Disabled or 1 = Enabled
Disabling this setting means that no event will be generated for any occurrence that produces a maintenance record.				
0B	0A	Protection Event	Enabled	0 = Disabled or 1 = Enabled
Disabling this setting means that any operation of protection elements will not be logged as an event				
0B	30	Clear Dist Recs	No	0 = No or 1 = Yes
Selecting “Yes” will cause the existing disturbance records to be cleared and an event will be generated indicating that the disturbance records have been erased.				
0B	31	Security Event	Enabled	0 = Disabled or 1 = Enabled
Disabling this setting means that any operation of security elements will not be logged as an event				
0B	40	DDB 31 - 0	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				

<table>
<tr><th>Col</th><th>Row</th><th>Courier Text</th><th>Default Setting</th><th>Available Settings</th></tr>
<tr><th colspan="5">Description</th></tr>
<tr><td>0B</td><td>41</td><td>DDB 63 - 32</td><td>11111111111111111111111111111111(bin)</td><td>32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled</td></tr>
<tr><td colspan="5">Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.</td></tr>
<tr><td>0B</td><td>42</td><td>DDB 95 - 64</td><td>11111111111111111111111111111111(bin)</td><td>32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled</td></tr>
<tr><td colspan="5">Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.</td></tr>
<tr><td>0B</td><td>43</td><td>DDB 127 - 96</td><td>11111111111111111111111111111111(bin)</td><td>32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled</td></tr>
<tr><td colspan="5">Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.</td></tr>
<tr><td>0B</td><td>44</td><td>DDB 159 - 128</td><td>11111111111111111111111111111111(bin)</td><td>32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled</td></tr>
<tr><td colspan="5">Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.</td></tr>
<tr><td>0B</td><td>45</td><td>DDB 191 - 160</td><td>11111111111111111111111111111111(bin)</td><td>32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled</td></tr>
<tr><td colspan="5">Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.</td></tr>
<tr><td>0B</td><td>46</td><td>DDB 223 - 192</td><td>11111111111111111111111111111111(bin)</td><td>32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled</td></tr>
<tr><td colspan="5">Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.</td></tr>
<tr><td>0B</td><td>47</td><td>DDB 255 - 224</td><td>11111111111111111111111111111111(bin)</td><td>32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled</td></tr>
<tr><td colspan="5">Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.</td></tr>
<tr><td>0B</td><td>48</td><td>DDB 287 - 256</td><td>11111111111111111111111111111111(bin)</td><td>32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled</td></tr>
<tr><td colspan="5">Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.</td></tr>
<tr><td>0B</td><td>49</td><td>DDB 319 - 288</td><td>11111111111111111111111111111111(bin)</td><td>32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled</td></tr>
<tr><td colspan="5">Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.</td></tr>
<tr><td>0B</td><td>4A</td><td>DDB 351 - 320</td><td>11111111111111111111111111111111(bin)</td><td>32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled</td></tr>
<tr><td colspan="5">Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.</td></tr>
<tr><td>0B</td><td>4B</td><td>DDB 383 - 352</td><td>11111111111111111111111111111111(bin)</td><td>32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled</td></tr>
</table>

<table>
<tr><th>Col</th><th>Row</th><th>Courier Text</th><th>Default Setting</th><th>Available Settings</th></tr>
<tr><th colspan="5">Description</th></tr>
<tr><td colspan="5">Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.</td></tr>
<tr><td>0B</td><td>4C</td><td>DDB 415 - 384</td><td>11111111111111111111111111111111(bin)</td><td>32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled</td></tr>
<tr><td colspan="5">Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.</td></tr>
<tr><td>0B</td><td>4D</td><td>DDB 447 - 416</td><td>11111111111111111111111111111111(bin)</td><td>32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled</td></tr>
<tr><td colspan="5">Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.</td></tr>
<tr><td>0B</td><td>4E</td><td>DDB 479 - 448</td><td>11111111111111111111111111111111(bin)</td><td>32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled</td></tr>
<tr><td colspan="5">Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.</td></tr>
<tr><td>0B</td><td>4F</td><td>DDB 511 - 480</td><td>11111111111111111111111111111111(bin)</td><td>32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled</td></tr>
<tr><td colspan="5">Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.</td></tr>
<tr><td>0B</td><td>50</td><td>DDB 543 - 512</td><td>11111111111111111111111111111111(bin)</td><td>32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled</td></tr>
<tr><td colspan="5">Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.</td></tr>
<tr><td>0B</td><td>51</td><td>DDB 575 - 544</td><td>11111111111111111111111111111111(bin)</td><td>32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled</td></tr>
<tr><td colspan="5">Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.</td></tr>
<tr><td>0B</td><td>52</td><td>DDB 607 - 576</td><td>11111111111111111111111111111111(bin)</td><td>32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled</td></tr>
<tr><td colspan="5">Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.</td></tr>
<tr><td>0B</td><td>53</td><td>DDB 639 - 608</td><td>11111111111111111111111111111111(bin)</td><td>32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled</td></tr>
<tr><td colspan="5">Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.</td></tr>
<tr><td>0B</td><td>54</td><td>DDB 671 - 640</td><td>11111111111111111111111111111111(bin)</td><td>32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled</td></tr>
<tr><td colspan="5">Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.</td></tr>
<tr><td>0B</td><td>55</td><td>DDB 703 - 672</td><td>11111111111111111111111111111111(bin)</td><td>32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled</td></tr>
<tr><td colspan="5">Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.</td></tr>
</table>

Col	Row	Courier Text	Default Setting	Available Settings
Description				
0B	56	DDB 735 - 704	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
0B	57	DDB 767 - 736	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
0B	58	DDB 799 - 768	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
0B	59	DDB 831 - 800	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
0B	5A	DDB 863 - 832	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
0B	5B	DDB 895 - 864	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
0B	5C	DDB 927 - 896	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
0B	5D	DDB 959 - 928	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
0B	5E	DDB 991 - 960	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
0B	5F	DDB 1023 - 992	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
0B	60	DDB 1055 - 1024	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled

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

Col	Row	Courier Text	Default Setting	Available Settings
Description				
0B	6B	DDB 1407 - 1376	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
0B	6C	DDB 1439 - 1408	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
0B	6D	DDB 1471 - 1440	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
0B	6E	DDB 1503 - 1472	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
0B	6F	DDB 1535 - 1504	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
0B	70	DDB 1567 - 1536	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
0B	71	DDB 1599 - 1568	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
0B	72	DDB 1631 - 1600	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
0B	73	DDB 1663 - 1632	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
0B	74	DDB 1695 - 1664	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
0B	75	DDB 1727 - 1696	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled

Col	Row	Courier Text	Default Setting	Available Settings
Description				
Choose whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
0B	76	DDB 1759- 1728	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
0B	77	DDB 1791- 1760	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
0B	78	DDB 1823 - 1792	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
0B	79	DDB 1855 - 1824	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
0B	7A	DDB 1887 - 1856	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
0B	7B	DDB 1919 - 1888	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
0B	7C	DDB 1951 - 1920	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
0B	7D	DDB 1983 - 1952	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
0B	7E	DDB 2015 - 1984	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				
0B	7F	DDB 2047 - 2016	11111111111111111111111111111111(bin)	32-bit binary setting: 1 = event recording Enabled, 0 = event recording Disabled
Chooses whether any individual DDB's should be deselected as a stored event, by setting the relevant bit to 0 (zero). Typically used for repetitive recurrent changes such as an Opto input assigned for Minute Pulse clock synchronizing.				

Table 6 - Record control settings

Important	***This column is visible when the "Record Control" setting ("Configuration" column) = "visible".***

5.4 Disturbance Recorder Settings

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

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

Note	*In previous editions of this manual, this topic was described as the "Precise Event Recorder Settings".*

Col	Row	Courier Text	Default Setting	Available Settings
Description				
0C	00	DISTURB RECORDER		
This column contains settings for the Disturbance Recorder				
0C	01	Duration	1.5 s	From 100 ms to 10.5 s step 10 ms
This sets the overall recording time.				
0C	02	Trigger Position	33.30 %	From 0 % to 100 % step 0.1 %
This sets the trigger point as a percentage of the duration. For example, the default settings show that the overall recording time is set to 1.5 s with the trigger point being at 33.3% of this, giving 0.5 s pre-fault and 1s post fault recording times.				
0C	03	Trigger Mode	Single	0 = Single or 1 = Extended
If set to single mode, if a further trigger occurs whilst a recording is taking place, the recorder will ignore the trigger. However, if this has been set to Extended, the post trigger timer will be reset to zero, thereby extending the recording time.				
0C	04	Analog Channel 1	Disturb. Freq.	Not Settable
Displays the sampling rate of 1kHz in the disturbance record				
0C	0D	Digital Input 1	Relay 1	Any O/P Contacts or Any Opto Inputs or Internal Digital Signals. See data type G32.
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
0C	0E	Input 1 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
0C	0F	Digital Input 2	Relay 2	Same as Digital Input 1
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
0C	10	Input 2 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
0C	11	Digital Input 3	Relay 3	Same as Digital Input 1
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
0C	12	Input 3 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
0C	13	Digital Input 4	Relay 4	Same as Digital Input 1
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				

Col	Row	Courier Text	Default Setting	Available Settings
Description				
0C	14	Input 4 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
0C	15	Digital Input 5	Relay 5	Same as Digital Input 1
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
0C	16	Input 5 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
0C	17	Digital Input 6	Relay 6	Same as Digital Input 1
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
0C	18	Input 6 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
0C	19	Digital Input 7	Relay 7	Same as Digital Input 1
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
0C	1A	Input 7 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
0C	1B	Digital Input 8	Relay 8	Same as Digital Input 1
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
0C	1C	Input 8 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
0C	1D	Digital Input 9	Relay 9	Same as Digital Input 1
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
0C	1E	Input 9 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
0C	1F	Digital Input 10	Relay 10	Same as Digital Input 1
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
0C	20	Input 10 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
0C	21	Digital Input 11	Relay 11	Same as Digital Input 1
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
0C	22	Input 11 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
0C	23	Digital Input 12	Relay 12	Same as Digital Input 1
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				

Col	Row	Courier Text	Default Setting	Available Settings
Description				
0C	24	Input 12 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
0C	25	Digital Input 13	Opto 1	Same as Digital Input 1
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
0C	26	Input 13 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
0C	27	Digital Input 14	Opto 2	Same as Digital Input 1
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
0C	28	Input 14 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
0C	29	Digital Input 15	Opto 3	Same as Digital Input 1
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
0C	2A	Input 15 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
0C	2B	Digital Input 16	Opto 4	Same as Digital Input 1
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
0C	2C	Input 16 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
0C	2D	Digital Input 17	Opto 5	Same as Digital Input 1
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
0C	2E	Input 17 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
0C	2F	Digital Input 18	Opto 6	Same as Digital Input 1
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
0C	30	Input 18 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
0C	31	Digital Input 19	Opto 7	Same as Digital Input 1
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
0C	32	Input 19 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
0C	33	Digital Input 20	Opto 8	Same as Digital Input 1
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				

Col	Row	Courier Text	Default Setting	Available Settings
Description				
0C	34	Input 20 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
0C	35	Digital Input 21	Opto 9	Same as Digital Input 1
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
0C	36	Input 21 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
0C	37	Digital Input 22	Opto 10	Same as Digital Input 1
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
0C	38	Input 22 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
0C	39	Digital Input 23	Opto 11	Same as Digital Input 1
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
0C	3A	Input 23 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
0C	3B	Digital Input 24	Opto 12	Same as Digital Input 1
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
0C	3C	Input 24 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
0C	3D	Digital Input 25	Unused	Same as Digital Input 1
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
0C	3E	Input 25 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
0C	3F	Digital Input 26	Unused	Same as Digital Input 1
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
0C	40	Input 26 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
0C	41	Digital Input 27	Unused	Same as Digital Input 1
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
0C	42	Input 27 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
0C	43	Digital Input 28	Unused	Same as Digital Input 1
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				

Col	Row	Courier Text	Default Setting	Available Settings
Description				
0C	44	Input 28 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
0C	45	Digital Input 29	Unused	Same as Digital Input 1
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
0C	46	Input 29 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
0C	47	Digital Input 30	Unused	Same as Digital Input 1
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
0C	48	Input 30 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
0C	49	Digital Input 31	Unused	Same as Digital Input 1
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
0C	4A	Input 31 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				
0C	4B	Digital Input 32	Unused	Same as Digital Input 1
The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc.				
0C	4C	Input 32 Trigger	No Trigger	0 = No Trigger, 1 = Trigger L/H, 2 = Trigger H/L
Any of the digital channels may be selected to trigger the disturbance recorder on either a low to high or a high to low transition.				

Table 7 – Disturbance recorder settings

5.5 Measurement Setup

Col	Row	Courier Text	Default Setting	Available Settings
Description				
0D	00	MEASURE'T SETUP		
This column contains settings for the measurement setup				
0D	01	Default Display	Banner	Not Settable
This displays the default display which is possible to change whilst at the default level using the arrow keys. Only visible on UI.				

Table 8 - Measurement Setup settings

5.6 Communications

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

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

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

- Settings for Courier Protocol
- Settings for IEC60870-5-103
- Settings for Modbus Protocol
- Settings for DNP3.0 protocol
- Settings for Ethernet port – IEC61850 protocol
- Settings for Ethernet port – IEC61850 + DNPoE
- Settings for Rear Port 2

  The destination address on the master side does not need to configured for DNP3.0 Over Ethernet connection, and it is also not linked to the relay address. In Ethernet connection, it is the IP address that identifies the connection.

Important ***The Setting ranges are different with different protocols.***

Col	Row	Courier Text	Default Setting	Available Settings
Description				
0E	00	COMMUNICATIONS		
This column contains general communications settings				
0E	01	RP1 Protocol		Not Settable
Indicates the communications protocol that will be used on the rear communications port.				
0E	02	RP1 Address	255 1 1 1	0 to 255 step 1 (Courier) 1 to 247 step 1 (Modbus) 0 to 254 step 1 (CS103) 0 to 65519 step 1 (DNP3)
Rear Port 1 Protocol device address. This cell sets the unique address for the relay such that only one relay is accessed by master station software.				
0E	03	RP1 InactivTimer	15min	From 1mins to 30mins step 1mins
Rear Port 1 Protocol inactivity timer. This cell controls how long the relay will wait without receiving any messages on the rear port before it reverts to its default state, including resetting any password access that was enabled.				
0E	04	RP1 Baud Rate	19200 bits/s	0=9600 bits/s 1=19200 bits/s 2=38400 bits/s (Modbus) 0=9600 bits/s 1=19200 bits/s (CS103) 0=1200 bits/s 1=2400 bits/s 2=4800 bits/s 3=9600 bits/s 4=19200 bits/s 5=38400 bits/s (DNP3)
Rear Port 1 Protocol serial bit/baud rate. This cell controls the communication speed between IED and master station. It is important that both IED and master station are set at the same speed setting.				
0E	05	RP1 Parity	None	0 = Odd, 1 = Even, 2 = None
Rear Port 1 Protocol parity. This cell controls the parity format used in the data frames. It is important that both IED and master station are set with the same parity setting.				
0E	06	RP1 Meas Period	10s	From 1s to 60s step 1s
Rear Port 1 IEC60870-5-103 Protocol measurment period. IEC60870-5-103 versions only. This cell controls the time interval that the IED will use between sending measurement data to the master station.				
0E	07	RP1 PhysicalLink	RS485	0 = Copper or 1 = Fibre Optic

Col	Row	Courier Text	Default Setting	Available Settings
Description				
Rear Port 1 Physical link selector. This cell defines whether an electrical EIA(RS) 485 or fiber optic connection is being used for communication between the master station and IED. This cell is only visible if a fibre optic board is fitted.				
0E	08	RP1 Time Sync	Disabled	0 = Disabled or 1 = Enabled
Rear Port 1 DNP 3.0 Protocol time sync configuration. If set to Enabled the master station can be used to synchronize the time on the IED. If set to Disabled either the internal free running clock or IRIG-B input are used.				
0E	09	Modbus IEC Time	Standard IEC	0=Standard IEC (Existing format) 1=Reverse IEC (Company agreed format)
Controls the format of the time-date G12 data type. Modbus Only. When ‘Standard IEC’ is selected the time format complies with IEC60870-5-4 requirements such that byte 1 of the information is transmitted first, followed by bytes 2 through to 7. If ‘Reverse’ is selected the transmission of information is reversed.				
0E	0A	RP1 CS103Blcking	Disabled	0 = Disabled, 1 = Monitor Blocking or 2 = Command Blocking
IEC60870-5-103 versions only. There are three settings associated with this cell: Disabled - No blocking selected. Monitor Blocking - When the monitor blocking DDB Signal is active high, either by energizing an opto input or control input, reading of the status information and disturbance records is not permitted. When in this mode the IED returns a “termination of general interrogation” message to the master station. Command Blocking - When the command blocking DDB signal is active high, either by energizing an opto input or control input, all remote commands will be ignored (i.e. CB Trip/Close, change setting group etc.). When in this mode the IED returns a “negative acknowledgement of command” message to the master station.				
0E	0B	RP1 Card Status		Not Settable
Rear Port 1 Courier Protocol Status. This cell indicates the status of the communication card.				
0E	0C	RP1 Port Config	K-Bus	0 = K Bus or 1 = EIA485 (RS485)
Rear Port 1 Courier Protocol copper port configuration; K-Bus or EIA485. This cell defines whether an electrical KBus or EIA(RS)485 is being used for communication between the master station and relay.				
0E	0D	RP1 Comms Mode	IEC60870 FT1.2	0 = IEC60870 FT1.2 Frame or 1 = 10-bit no parity
Rear Port 1 Courier Protocol EIA485 mode. The choice is either IEC60870 FT1.2 for normal operation with 11-bit modems, or 10-bit no parity.				
0E	0E	RP1 Baud Rate	19200 bits/s	0 = 9600 bits/s, 1 = 19200 bits/s, 2 = 38400 bits/s
Rear Port 1 Courier Protocol EIA485 bit/baud rate. This cell controls the communication speed between relay and master station. It is important that both relay and master station are set at the same speed setting.				
0E	0F	Meas Scaling	Normalised	0 = Normalised, 1 = Primary, 2 = Secondary
DNP 3.0 and IEC61850+DNP3OE only. Setting to report analogue values in terms of primary, secondary or normalized (with respect to the CT/VT ratio setting) values.				
0E	10	Message Gap (ms)	0ms	From 0ms to 50ms step 1ms
DNP 3.0 and IEC61850+DNP3OE only. This setting determines the gap between reply fragments				
0E	11	DNP Need Time	10min	From 1minm to 30minm step 1minm
DNP 3.0 and IEC61850+DNP3OE only. The duration of time waited before requesting another time sync from the master.				
0E	12	DNP App Fragment	2048	100 to 2048 step 1
DNP 3.0 and IEC61850+DNP3OE only. The maximum message length (application fragment size) transmitted by the IED.				
0E	13	DNP App Timeout	2s	From 1s to 120s step 1s
DNP 3.0 and IEC61850+DNP3OE only. Duration of time waited, after sending a reply and awaiting a confirmation from the master.				
0E	14	DNP SBO Timeout	10s	From 1s to 10s step 1s
DNP 3.0 and IEC61850+DNP3OE only. Duration of time waited, after receiving a select command and awaiting an operate confirmation from the master				

<table>
<tr><th>Col</th><th>Row</th><th>Courier Text</th><th>Default Setting</th><th>Available Settings</th></tr>
<tr><th colspan="5">Description</th></tr>
<tr><td>0E</td><td>15</td><td>DNP Link Timeout</td><td>0s</td><td>From 0s to 120s step 1s</td></tr>
<tr><td colspan="5">DNP 3.0 and IEC61850+DNP3OE only. Duration of time that the IED will wait for a Data Link Confirmation from the master. A value of 0 means data link support disabled and 1 to 120 seconds is the timeout setting.</td></tr>
<tr><td>0E</td><td>1F</td><td>ETH Protocol</td><td></td><td>Not Settable</td></tr>
<tr><td colspan="5">Indicates the protocol used on the Network Interface Card. Visible when Ethernet card fitted</td></tr>
<tr><td>0E</td><td>22</td><td>MAC Addr 1</td><td></td><td>Not Settable</td></tr>
<tr><td colspan="5">Shows the MAC address of the 1st Ethernet port. Visible when Ethernet card fitted.</td></tr>
<tr><td>0E</td><td>23</td><td>MAC Addr 2</td><td></td><td>Not Settable</td></tr>
<tr><td colspan="5">Shows the MAC address of the 2nd Ethernet port. Visible when Ethernet card fitted.</td></tr>
<tr><td>0E</td><td>64</td><td>ETH Tunl Timeout</td><td>15 min</td><td>From 1mins to 30mins step 1mins</td></tr>
<tr><td colspan="5">Duration of time to wait before an inactive tunnel to Easergy Studio is reset. Visible when Ethernet card fitted.</td></tr>
<tr><td>0E</td><td>70</td><td>Redundancy Conf</td><td>Sub-Heading</td><td>Sub-Heading</td></tr>
<tr><td colspan="5">NIOS PARAMETERS. The redundant agency device configuration is used for SNMP server. This does not affect IEC61850 communications. Visible when redundant Ethernet card fitted and Comm Mode=PRP or HSR</td></tr>
<tr><td>0E</td><td>71</td><td>MAC Address</td><td></td><td>Not Settable</td></tr>
<tr><td colspan="5">MAC address for the NIOS. The redundant agency device configuration is used for SNMP server. This does not affect IEC61850 communications. Visible when redundant Ethernet card fitted and Comm Mode=PRP or HSR</td></tr>
<tr><td>0E</td><td>72</td><td>IP Address</td><td>0.0.0.0</td><td><IP address of relay></td></tr>
<tr><td colspan="5">A default IP address which is encoded from MAC address 169.254.2.zzz, zzz = mod
(The last byte of MAC address % 128 + 1)
The redundant agency device configuration is used for SNMP server. This does not affect IEC61850 communications. Visible when redundant Ethernet card fitted and Comm Mode=PRP or HSR</td></tr>
<tr><td>0E</td><td>73</td><td>Subnet Mask</td><td>0.0.0.0</td><td><Subnet mask of relay></td></tr>
<tr><td colspan="5">Subnet Mask for the NIOS. The redundant agency device configuration is used for SNMP server. This does not affect IEC61850 communications. Visible when redundant Ethernet card fitted and Comm Mode=PRP or HSR</td></tr>
<tr><td>0E</td><td>74</td><td>Gateway</td><td>0.0.0.0</td><td><Gateway address></td></tr>
<tr><td colspan="5">Gateway for the NIOS. The redundant agency device configuration is used for SNMP server. This does not affect IEC61850 communications. Visible when redundant Ethernet card fitted and Comm Mode=PRP or HSR</td></tr>
<tr><td>0E</td><td>80</td><td>REAR PORT2 (RP2)</td><td></td><td></td></tr>
<tr><td colspan="5">Visible when Rear Port 2 fitted.</td></tr>
<tr><td>0E</td><td>81</td><td>RP2 Protocol</td><td>Courier</td><td>Not Settable</td></tr>
<tr><td colspan="5">Rear Port 2 Protocol - "Courier". Indicates the communications protocol that will be used on the rear communications port.</td></tr>
<tr><td>0E</td><td>84</td><td>RP2 Card Status</td><td></td><td>Not Settable</td></tr>
<tr><td colspan="5">Rear Port 2 Courier Protocol Status</td></tr>
<tr><td>0E</td><td>88</td><td>RP2 Port Config</td><td>EIA232 (RS232)</td><td>0 = EIA232 (RS232),
1 = EIA485 (RS485),
2 = K-Bus</td></tr>
<tr><td colspan="5">Rear Port 2 Courier Protocol port configuration. This cell defines whether an electrical EIA(RS)232, EIA(RS)485 or KBus is being used for communication.</td></tr>
<tr><td>0E</td><td>8A</td><td>RP2 Comms Mode</td><td>IEC60870 FT1.2</td><td>0 = IEC60870 FT1.2 Frame or 1 = 10-bit no parity</td></tr>
<tr><td colspan="5">Rear Port 2 Courier Protocol EIA485 mode. The choice is either IEC60870 FT1.2 for normal operation with 11-bit modems, or 10-bit no parity.</td></tr>
<tr><td>0E</td><td>90</td><td>RP2 Address</td><td>255</td><td>0 to 255 step 1</td></tr>
<tr><td colspan="5">Rear Port 2 Courier Protocol device address. This cell sets the unique address for the relay such that only one relay is accessed by master station software.</td></tr>
<tr><td>0E</td><td>92</td><td>RP2 InactivTimer</td><td>15</td><td>From 1m to 30m step 1m</td></tr>
</table>

Col	Row	Courier Text	Default Setting	Available Settings
Description				
Rear Port 2 Courier Protocol inactivity timer. This cell controls how long the relay will wait without receiving any messages on the rear port before it reverts to its default state, including resetting any password access that was enabled.				
0E	94	RP2 Baud Rate	19200 bits/s	0 = 9600 bits/s, 1 = 19200 bits/s, 2 = 38400 bits/s
Rear Port 2 Courier Protocol EIA485 bit/baud rate. This cell controls the communication speed between relay and master station. It is important that both relay and master station are set at the same speed setting.				

Table 9 - Communication settings

The destination address on the master side does not need to be configured for DNP3.0 Over Ethernet connection, and it is not linked to the relay address. Using the Ethernet connection, the connection is identified by the IP address.

5.7 Commissioning Tests

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

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

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

Col	Row	Courier Text	Default Setting	Available Settings
Description				
0F	00	COMMISSION TESTS		
This column contains commissioning test settings				
0F	01	Opto I/P Status		Not Settable
This menu cell displays the status of the available IED's opto-isolated inputs as a binary string, a '1' indicating an energized opto-isolated input and a '0' a de-energized one.				
0F	02	Opto I/P Status2		Not Settable
This menu cell displays the status of the available IED's opto-isolated inputs as a binary string, a '1' indicating an energized opto-isolated input and a '0' a de-energized one.				
0F	03	Relay O/P Status		Not Settable
This menu cell displays the status of the digital data bus (DDB) signals that result in energization of the available output relays as a binary string, a '1' indicating an operated state and '0' a non-operated state. When the 'Test Mode' cell is set to 'Enabled' the 'Relay O/P Status' cell does not show the current status of the output relays and hence can not be used to confirm operation of the output relays. Therefore it will be necessary to monitor the state of each contact in turn.				
0F	04	Relay O/P Status2		Not Settable
This menu cell displays the status of the digital data bus (DDB) signals that result in energization of the available output relays as a binary string, a '1' indicating an operated state and '0' a non-operated state. When the 'Test Mode' cell is set to 'Enabled' the 'Relay O/P Status' cell does not show the current status of the output relays and hence can not be used to confirm operation of the output relays. Therefore it will be necessary to monitor the state of each contact in turn.				
0F	05	Test Port Status		Not Settable
This menu cell displays the status of the eight digital data bus (DDB) signals that have been allocated in the 'Monitor Bit' cells.				
0F	07	Monitor Bit 1	192	From 0 to 2047 step 1
The eight 'Monitor Bit' cells allow the user to select the status of which digital data bus signals can be observed in the 'Test Port Status' cell or via the monitor/download port.				

Col	Row	Courier Text	Default Setting	Available Settings
Description				
0F	08	Monitor Bit 2	194	From 0 to 2047 step 1
The eight ‘Monitor Bit’ cells allow the user to select the status of which digital data bus signals can be observed in the ‘Test Port Status’ cell or via the monitor/download port.				
0F	09	Monitor Bit 3	196	From 0 to 2047 step 1
The eight ‘Monitor Bit’ cells allow the user to select the status of which digital data bus signals can be observed in the ‘Test Port Status’ cell or via the monitor/download port.				
0F	0A	Monitor Bit 4	198	From 0 to 2047 step 1
The eight ‘Monitor Bit’ cells allow the user to select the status of which digital data bus signals can be observed in the ‘Test Port Status’ cell or via the monitor/download port.				
0F	0B	Monitor Bit 5	200	From 0 to 2047 step 1
The eight ‘Monitor Bit’ cells allow the user to select the status of which digital data bus signals can be observed in the ‘Test Port Status’ cell or via the monitor/download port.				
0F	0C	Monitor Bit 6	202	From 0 to 2047 step 1
The eight ‘Monitor Bit’ cells allow the user to select the status of which digital data bus signals can be observed in the ‘Test Port Status’ cell or via the monitor/download port.				
0F	0D	Monitor Bit 7	204	From 0 to 2047 step 1
The eight ‘Monitor Bit’ cells allow the user to select the status of which digital data bus signals can be observed in the ‘Test Port Status’ cell or via the monitor/download port.				
0F	0E	Monitor Bit 8	206	From 0 to 2047 step 1
The eight ‘Monitor Bit’ cells allow the user to select the status of which digital data bus signals can be observed in the ‘Test Port Status’ cell or via the monitor/download port.				
0F	0F	Test Mode	Disabled	0 = Disabled, 1 = Test Mode, 2 = Contacts Blocked
The Test Mode menu cell is used to allow secondary injection testing to be performed on the IED without operation of the trip contacts. It also enables a facility to directly test the output contacts by applying menu controlled test signals. To select test mode the Test Mode menu cell should be set to ‘Test Mode’, which takes the IED out of service. It also causes an alarm condition to be recorded and the yellow ‘Out of Service’ LED to illuminate and an alarm message ‘Prot’n. Disabled’ is given. In IEC 60870-5-103 builds changes the Cause of Transmission, COT, to Test Mode. To enable testing of output contacts the Test Mode cell should be set to Contacts Blocked. This blocks the protection from operating the contacts and enables the test pattern and contact test functions which can be used to manually operate the output contacts. This mode also blocks maintenance, counters and freezes any information stored in the Circuit Breaker Condition column. Also in IEC 60870-5-103 builds changes the Cause of Transmission, COT, to Test Mode. Once testing is complete the cell must be set back to ‘Disabled’ to restore the IED back to service. In IEC61850 models using edition 2 mode, selecting Test Mode or Contacts Blocked will change the behaviour of all active logical nodes to test. The quality of all data will also indicate test.				
0F	10	Test Pattern	00000000000000000000000000000000 (bin)	0 = No Operation, 1 = Apply Test, 2 = Remove Test
The Test Patern cell is used to select the output relay contacts that will be tested when the ‘Contact Test’ cell is set to ‘Apply Test’. The cell has a binary string with one bit for each user-configurable output contact which can be set to ‘1’ to operate the output under test conditions and ‘0’ to not operate it. IEC60870 Test Mode Change.				
0F	11	Test Pattern2	00000000000000000000000000000000 (bin)	0 = No Operation or 1 = Apply Test
This cell is used to select the second 32 output relay contacts that will be tested when the ‘Contact Test’ cell is set to ‘Apply Test’.				
0F	12	Contact Test	No Operation	0=No Operation 1=3 Pole Test
When the ‘Apply Test’ command in this cell is issued the contacts set for operation (set to ‘1’) in the ‘Test Pattern’ cell change state. After the test has been applied the command text on the LCD will change to ‘No Operation’ and the contacts will remain in the Test State until reset issuing the ‘Remove Test’ command. The command text on the LCD will again revert to ‘No Operation’ after the ‘Remove Test’ command has been issued. Note: When the ‘Test Mode’ cell is set to ‘Enabled’ the ‘Relay O/P Status’ cell does not show the current status of the output relays and hence can not be used to confirm operation of the output relays. Therefore it will be necessary to monitor the state of each contact in turn.				

Col	Row	Courier Text	Default Setting	Available Settings
Description				
0F	13	Test LEDs	No Operation	No Operation or Apply Test
When the ‘Apply Test’ command in this cell is issued, the eighteen user-programmable LEDs will illuminate for approximately 2 seconds before they extinguish and the command text on the LCD reverts to ‘No Operation’.				
0F	15	Red LED Status		Not Settable
This cell is an eighteen bit binary string that indicates which of the user-programmable LEDs on the IED are illuminated with the Red LED input active when accessing the IED from a remote location, a ‘1’ indicating a particular LED is lit and a ‘0’ not lit.				
0F	16	Green LED Status		Not Settable
This cell is an eighteen bit binary string that indicates which of the user-programmable LEDs on the IED are illuminated with the Green LED input active when accessing the IED from a remote location, a ‘1’ indicating a particular LED is lit and a ‘0’ not lit.				
0F	20	DDB 31 - 0		Not Settable
Displays the status of DDB signals				
0F	21	DDB 63 - 32		Not Settable
Displays the status of DDB signals				
0F	22	DDB 95 - 64		Not Settable
Displays the status of DDB signals				
0F	23	DDB 127 - 96		Not Settable
Displays the status of DDB signals				
0F	24	DDB 159 - 128		Not Settable
Displays the status of DDB signals				
0F	25	DDB 191 - 160		Not Settable
Displays the status of DDB signals				
0F	26	DDB 223 - 192		Not Settable
Displays the status of DDB signals				
0F	27	DDB 255 - 224		Not Settable
Displays the status of DDB signals				
0F	28	DDB 287 - 256		Not Settable
Displays the status of DDB signals				
0F	29	DDB 319 - 288		Not Settable
Displays the status of DDB signals				
0F	2A	DDB 351 - 320		Not Settable
Displays the status of DDB signals				
0F	2B	DDB 383 - 352		Not Settable
Displays the status of DDB signals				
0F	2C	DDB 415 - 384		Not Settable
Displays the status of DDB signals				
0F	2D	DDB 447 - 416		Not Settable
Displays the status of DDB signals				
0F	2E	DDB 479 - 448		Not Settable
Displays the status of DDB signals				
0F	2F	DDB 511 - 480		Not Settable
Displays the status of DDB signals				
0F	30	DDB 543 - 512		Not Settable
Displays the status of DDB signals				
0F	31	DDB 575 - 544		Not Settable

Col	Row	Courier Text	Default Setting	Available Settings
Description				
Displays the status of DDB signals				
0F	32	DDB 607 - 576		Not Settable
Displays the status of DDB signals				
0F	33	DDB 639 - 608		Not Settable
Displays the status of DDB signals				
0F	34	DDB 671 - 640		Not Settable
Displays the status of DDB signals				
0F	35	DDB 703 - 672		Not Settable
Displays the status of DDB signals				
0F	36	DDB 735 - 704		Not Settable
Displays the status of DDB signals				
0F	37	DDB 767 - 736		Not Settable
Displays the status of DDB signals				
0F	38	DDB 799 - 768		Not Settable
Displays the status of DDB signals				
0F	39	DDB 831 - 800		Not Settable
Displays the status of DDB signals				
0F	3A	DDB 863 - 832		Not Settable
Displays the status of DDB signals				
0F	3B	DDB 895 - 864		Not Settable
Displays the status of DDB signals				
0F	3C	DDB 927 - 896		Not Settable
Displays the status of DDB signals				
0F	3D	DDB 959 - 928		Not Settable
Displays the status of DDB signals				
0F	3E	DDB 991 - 960		Not Settable
Displays the status of DDB signals				
0F	3F	DDB 1023 - 992		Not Settable
Displays the status of DDB signals				
0F	40	DDB 1055 - 1024		Not Settable
Displays the status of DDB signals				
0F	41	DDB 1087 - 1056		Not Settable
Displays the status of DDB signals				
0F	42	DDB 1119 - 1088		Not Settable
Displays the status of DDB signals				
0F	43	DDB 1151 - 1120		Not Settable
Displays the status of DDB signals				
0F	44	DDB 1183 - 1152		Not Settable
Displays the status of DDB signals				
0F	45	DDB 1215 - 1184		Not Settable
Displays the status of DDB signals				
0F	46	DDB 1247 - 1216		Not Settable
Displays the status of DDB signals				

Col	Row	Courier Text	Default Setting	Available Settings
Description				
0F	47	DDB 1279 - 1248		Not Settable
Displays the status of DDB signals				
0F	48	DDB 1311 - 1280		Not Settable
Displays the status of DDB signals				
0F	49	DDB 1343 - 1312		Not Settable
Displays the status of DDB signals				
0F	4A	DDB 1375 - 1344		Not Settable
Displays the status of DDB signals				
0F	4B	DDB 1407 - 1376		Not Settable
Displays the status of DDB signals				
0F	4C	DDB 1439 - 1408		Not Settable
Displays the status of DDB signals				
0F	4D	DDB 1471 - 1440		Not Settable
Displays the status of DDB signals				
0F	4E	DDB 1503 - 1472		Not Settable
Displays the status of DDB signals				
0F	4F	DDB 1535 - 1504		Not Settable
Displays the status of DDB signals				
0F	50	DDB 1567 - 1536		Not Settable
Displays the status of DDB signals				
0F	51	DDB 1599 - 1568		Not Settable
Displays the status of DDB signals				
0F	52	DDB 1631 - 1600		Not Settable
Displays the status of DDB signals				
0F	53	DDB 1663 - 1632		Not Settable
Displays the status of DDB signals				
0F	54	DDB 1695 - 1664		Not Settable
Displays the status of DDB signals				
0F	55	DDB 1727 - 1696		Not Settable
Displays the status of DDB signals				
0F	56	DDB 1759- 1728		Not Settable
Displays the status of DDB signals				
0F	57	DDB 1791- 1760		Not Settable
Displays the status of DDB signals				
0F	58	DDB 1823 - 1792		Not Settable
Displays the status of DDB signals				
0F	59	DDB 1855 - 1824		Not Settable
Displays the status of DDB signals				
0F	5A	DDB 1887 - 1856		Not Settable
Displays the status of DDB signals				
0F	5B	DDB 1919 - 1888		Not Settable
Displays the status of DDB signals				
0F	5C	DDB 1951 - 1920		Not Settable

Col	Row	Courier Text	Default Setting	Available Settings
Description				
Displays the status of DDB signals				
0F	5D	DDB 1983 - 1952		Not Settable
Displays the status of DDB signals				
0F	5E	DDB 2015 - 1984		Not Settable
Displays the status of DDB signals				
0F	5F	DDB 2047 - 2016		Not Settable
Displays the status of DDB signals				
0F	FF	Unused		
A dummy cell, used for DNP3				

Table 10 - Commission test settings

5.8 Opto Configuration

This menu is used to set the opto-isolated inputs.

Col	Row	Courier Text	Default Setting	Available Settings
Description				
11	00	OPTO CONFIG		
This column contains opto-input configuration settings				
11	01	Global Nominal V	48/54V	0 = 24-27V, 1 = 30-34V, 2 = 48-54V, 3 = 110-125V, 4 = 220-250V or 5 = Custom
Sets the nominal battery voltage for all opto inputs by selecting one of the five standard ratings in the Global Nominal V settings. If Custom is selected then each opto input can individually be set to a nominal voltage value.				
11	02	Opto Input 1	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 40, depending on the IED and I/O configuration.				
11	03	Opto Input 2	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	04	Opto Input 3	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	05	Opto Input 4	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	06	Opto Input 5	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	07	Opto Input 6	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				

Col	Row	Courier Text	Default Setting	Available Settings
Description				
11	08	Opto Input 7	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	09	Opto Input 8	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	0A	Opto Input 9	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	0B	Opto Input 10	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	0C	Opto Input 11	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	0D	Opto Input 12	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	0E	Opto Input 13	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	0F	Opto Input 14	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	10	Opto Input 15	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	11	Opto Input 16	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	12	Opto Input 17	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	13	Opto Input 18	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	14	Opto Input 19	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V

Col	Row	Courier Text	Default Setting	Available Settings
Description				
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	15	Opto Input 20	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	16	Opto Input 21	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	17	Opto Input 22	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	18	Opto Input 23	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	19	Opto Input 24	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	1A	Opto Input 25	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	1B	Opto Input 26	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	1C	Opto Input 27	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	1D	Opto Input 28	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	1E	Opto Input 29	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	1F	Opto Input 30	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	20	Opto Input 31	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				

Col	Row	Courier Text	Default Setting	Available Settings
Description				
11	21	Opto Input 32	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	22	Opto Input 33	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	23	Opto Input 34	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	24	Opto Input 35	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	25	Opto Input 36	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	26	Opto Input 37	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	27	Opto Input 38	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	28	Opto Input 39	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	29	Opto Input 40	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	2A	Opto Input 41	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	2B	Opto Input 42	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	2C	Opto Input 43	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	2D	Opto Input 44	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V

Col	Row	Courier Text	Default Setting	Available Settings
Description				
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	2E	Opto Input 45	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	2F	Opto Input 46	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	30	Opto Input 47	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	31	Opto Input 48	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	32	Opto Input 49	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	33	Opto Input 50	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	34	Opto Input 51	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	35	Opto Input 52	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	36	Opto Input 53	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	37	Opto Input 54	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	38	Opto Input 55	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	39	Opto Input 56	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				

Col	Row	Courier Text	Default Setting	Available Settings
Description				
11	3A	Opto Input 57	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	3B	Opto Input 58	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	3C	Opto Input 59	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	3D	Opto Input 60	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	3E	Opto Input 61	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	3F	Opto Input 62	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	40	Opto Input 63	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	41	Opto Input 64	48/54V	0 = 24/27V, 1 = 30/34V, 2 = 48/54V, 3 = 110/125V or 4 = 220/250V
Each opto input can individually be set to a nominal voltage value if custom is selected for the global setting. The number of inputs may be up to 32, depending on the IED and I/O configuration.				
11	50	Opto Filter Cntl	11111111111111111111111111111111 (bin)	32-bit binary setting: 0 = Off, 1= Energized
Selects each of the first 32 inputs with a pre-set filter of ½ cycle that renders the input immune to induced noise on the wiring. The number of available bits depends on the I/O configuration.				
11	51	Opto Filter Cntl2	00000000000000001111111111111111 (bin)	32-bit binary setting: 0 = Off, 1= Energized
Selects each of the next 32 inputs with a pre-set filter of ½ cycle that renders the input immune to induced noise on the wiring. The number of available bits depends on the I/O configuration.				
11	80	Characteristic	Standard 60%-80%	0 = Standard 60% to 80% or 1 = 50% to 70%
Selects the pick-up and drop-off characteristics of the opto's. Selecting the standard setting means they nominally provide a Logic 1 or On value for Voltages ≥80% of the set lower nominal voltage and a Logic 0 or Off value for the voltages ≤60% of the set higher nominal voltage.				

Table 11 - Opto Config settings

5.9 Control Inputs

The control inputs column displays the control inputs status. It can be used to set, or reset individually each control input.

The "CTRL INPUTS" column is visible when the "Commission tests" setting ("Configuration" column) = "visible".

Col	Row	Courier Text	Default Setting	Available Settings
Description				
12	00	CONTROL INPUTS		
This column contains settings for the type of control input (32 in all)				
12	01	Ctrl I/P Status	00000000000000000000000000000000(bin)	Binary Flag (32 bits) Indexed String (0 = Reset, 1 = Set)
Cell that is used to set (1) and reset (0) the selected Control Input by simply scrolling and changing the status of selected bits. This command will be then recognized and executed in the PSL. Alternatively, each of the 32 Control input can also be set and reset using the individual menu setting cells as follows:				
12	02	Control Input 1	No Operation	0 = No Operation, 1 = SET , 2 = RESET
Setting to allow Control Inputs 1 set/ reset.				
12	03	Control Input 2	No Operation	0 = No Operation, 1 = Set , 2 = Reset
Setting to allow Control Inputs 2 set/ reset.				
12	04	Control Input 3	No Operation	0 = No Operation, 1 = Set , 2 = Reset
Setting to allow Control Inputs 3 set/ reset.				
12	05	Control Input 4	No Operation	0 = No Operation, 1 = Set , 2 = Reset
Setting to allow Control Inputs 4 set/ reset.				
12	06	Control Input 5	No Operation	0 = No Operation, 1 = Set , 2 = Reset
Setting to allow Control Inputs 5 set/ reset.				
12	07	Control Input 6	No Operation	0 = No Operation, 1 = Set , 2 = Reset
Setting to allow Control Inputs 6 set/ reset.				
12	08	Control Input 7	No Operation	0 = No Operation, 1 = Set , 2 = Reset
Setting to allow Control Inputs 7 set/ reset.				
12	09	Control Input 8	No Operation	0 = No Operation, 1 = Set , 2 = Reset
Setting to allow Control Inputs 8 set/ reset.				
12	0A	Control Input 9	No Operation	0 = No Operation, 1 = Set , 2 = Reset
Setting to allow Control Inputs 9 set/ reset.				
12	0B	Control Input 10	No Operation	0 = No Operation, 1 = Set , 2 = Reset
Setting to allow Control Inputs 10 set/ reset.				
12	0C	Control Input 11	No Operation	0 = No Operation, 1 = Set , 2 = Reset
Setting to allow Control Inputs 11 set/ reset.				
12	0D	Control Input 12	No Operation	0 = No Operation, 1 = Set , 2 = Reset
Setting to allow Control Inputs 12 set/ reset.				
12	0E	Control Input 13	No Operation	0 = No Operation, 1 = Set , 2 = Reset
Setting to allow Control Inputs 13 set/ reset.				
12	0F	Control Input 14	No Operation	0 = No Operation, 1 = Set , 2 = Reset
Setting to allow Control Inputs 14 set/ reset.				
12	10	Control Input 15	No Operation	0 = No Operation, 1 = Set , 2 = Reset
Setting to allow Control Inputs 15 set/ reset.				
12	11	Control Input 16	No Operation	0 = No Operation, 1 = Set , 2 = Reset
Setting to allow Control Inputs 16 set/ reset.				
12	12	Control Input 17	No Operation	0 = No Operation, 1 = Set , 2 = Reset
Setting to allow Control Inputs 17 set/ reset.				
12	13	Control Input 18	No Operation	0 = No Operation, 1 = Set , 2 = Reset

Col	Row	Courier Text	Default Setting	Available Settings
Description				
Setting to allow Control Inputs 18 set/ reset.				
12	14	Control Input 19	No Operation	0 = No Operation, 1 = Set , 2 = Reset
Setting to allow Control Inputs 19 set/ reset.				
12	15	Control Input 20	No Operation	0 = No Operation, 1 = Set , 2 = Reset
Setting to allow Control Inputs 20 set/ reset.				
12	16	Control Input 21	No Operation	0 = No Operation, 1 = Set , 2 = Reset
Setting to allow Control Inputs 21 set/ reset.				
12	17	Control Input 22	No Operation	0 = No Operation, 1 = Set , 2 = Reset
Setting to allow Control Inputs 22 set/ reset.				
12	18	Control Input 23	No Operation	0 = No Operation, 1 = Set , 2 = Reset
Setting to allow Control Inputs 23 set/ reset.				
12	19	Control Input 24	No Operation	0 = No Operation, 1 = Set , 2 = Reset
Setting to allow Control Inputs 24 set/ reset.				
12	1A	Control Input 25	No Operation	0 = No Operation, 1 = Set , 2 = Reset
Setting to allow Control Inputs 25 set/ reset.				
12	1B	Control Input 26	No Operation	0 = No Operation, 1 = Set , 2 = Reset
Setting to allow Control Inputs 26 set/ reset.				
12	1C	Control Input 27	No Operation	0 = No Operation, 1 = Set , 2 = Reset
Setting to allow Control Inputs 27 set/ reset.				
12	1D	Control Input 28	No Operation	0 = No Operation, 1 = Set , 2 = Reset
Setting to allow Control Inputs 28 set/ reset.				
12	1E	Control Input 29	No Operation	0 = No Operation, 1 = Set , 2 = Reset
Setting to allow Control Inputs 29 set/ reset.				
12	1F	Control Input 30	No Operation	0 = No Operation, 1 = Set , 2 = Reset
Setting to allow Control Inputs 30 set/ reset.				
12	20	Control Input 31	No Operation	0 = No Operation, 1 = Set , 2 = Reset
Setting to allow Control Inputs 31 set/ reset.				
12	21	Control Input 32	No Operation	0 = No Operation, 1 = Set , 2 = Reset
Setting to allow Control Inputs 32 set/ reset.				

Table 12 - Control Inputs settings

5.10 Ctrl I/P Config.

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

This column is visible when the “Control I/P Config” setting (“Configuration” column) = “visible”.

Col	Row	Courier Text	Default Setting	Available Settings
Description				
13	00	CTRL I/P CONFIG		
This column contains settings for the type of control input (32 in all)				

Col	Row	Courier Text	Default Setting	Available Settings
Description				
13	01	Hotkey Enabled	11111111111111111111111111111111 (bin)	32-bit binary setting: 0=Not accessible via Hotkey Menu or 1=Accessible via Hotkey Menu
Hotkey Menu - Control Input availability. Setting to allow the control inputs to be individually assigned to the Hotkey menu by setting '1' in the appropriate bit in the Hotkey Enabled cell. The hotkey menu allows the control inputs to be set, reset or pulsed without the need to enter the CONTROL INPUTS column. Not available on Chinese version relays.				
13	10	Control Input 1	Latched	0 = Latched or 1 = Pulsed
Individual Control Input Type. Configures the control inputs as either 'latched' or 'pulsed'. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10 ms after the set command is given and will then reset automatically (i.e. no reset command required).				
13	11	Ctrl Command 1	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Individual Control Input Command Text.. Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
13	14	Control Input 2	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'.				
13	15	Ctrl Command 2	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
13	18	Control Input 3	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'.				
13	19	Ctrl Command 3	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
13	1C	Control Input 4	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'.				
13	1D	Ctrl Command 4	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
13	20	Control Input 5	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'.				
13	21	Ctrl Command 5	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
13	24	Control Input 6	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'.				
13	25	Ctrl Command 6	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
13	28	Control Input 7	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'.				
13	29	Ctrl Command 7	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED

Col	Row	Courier Text	Default Setting	Available Settings
Description				
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
13	2C	Control Input 8	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'.				
13	2D	Ctrl Command 8	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
13	30	Control Input 9	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'.				
13	31	Ctrl Command 9	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
13	34	Control Input 10	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'.				
13	35	Ctrl Command 10	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
13	38	Control Input 11	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'.				
13	39	Ctrl Command 11	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
13	3C	Control Input 12	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'.				
13	3D	Ctrl Command 12	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
13	40	Control Input 13	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'.				
13	41	Ctrl Command 13	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
13	44	Control Input 14	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'.				
13	45	Ctrl Command 14	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
13	48	Control Input 15	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'.				
13	49	Ctrl Command 15	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED

Col	Row	Courier Text	Default Setting	Available Settings
Description				
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
13	4C	Control Input 16	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'.				
13	4D	Ctrl Command 16	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
13	50	Control Input 17	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'.				
13	51	Ctrl Command 17	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
13	54	Control Input 18	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'.				
13	55	Ctrl Command 18	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
13	58	Control Input 19	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'.				
13	59	Ctrl Command 19	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
13	5C	Control Input 20	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'.				
13	5D	Ctrl Command 20	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
13	60	Control Input 21	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'.				
13	61	Ctrl Command 21	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
13	64	Control Input 22	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'.				
13	65	Ctrl Command 22	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
13	68	Control Input 23	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either 'latched' or 'pulsed'.				
13	69	Ctrl Command 23	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED

Col	Row	Courier Text	Default Setting	Available Settings
Description				
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
13	6C	Control Input 24	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either ‘latched’ or ‘pulsed’.				
13	6D	Ctrl Command 24	SET/RESET	0 = On/Off or 1 = Set/Reset or 2 = In/Out or 3 = Enabled/Disabled
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
13	70	Control Input 25	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either ‘latched’ or ‘pulsed’.				
13	71	Ctrl Command 25	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
13	74	Control Input 26	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either ‘latched’ or ‘pulsed’.				
13	75	Ctrl Command 26	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
13	78	Control Input 27	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either ‘latched’ or ‘pulsed’.				
13	79	Ctrl Command 27	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
13	7C	Control Input 28	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either ‘latched’ or ‘pulsed’.				
13	7D	Ctrl Command 28	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
13	80	Control Input 29	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either ‘latched’ or ‘pulsed’.				
13	81	Ctrl Command 29	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
13	84	Control Input 30	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either ‘latched’ or ‘pulsed’.				
13	85	Ctrl Command 30	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
13	88	Control Input 31	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either ‘latched’ or ‘pulsed’.				
13	89	Ctrl Command 31	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED

Col	Row	Courier Text	Default Setting	Available Settings
Description				
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				
13	8C	Control Input 32	Latched	0 = Latched or 1 = Pulsed
Configures the control inputs as either ‘latched’ or ‘pulsed’.				
13	8D	Ctrl Command 32	SET/RESET	0 = ON/OFF, 1 = SET/RESET, 2 = IN/OUT, 3 = ENABLED/DISABLED
Allows the SET / RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as ON / OFF, IN / OUT etc.				

Table 13 - Control input config settings

The “INTERMICOM COMMS” column contains all the information to configure the communication channel and also contains the channel statistics and diagnostic facilities. The InterMiCOM communication can be enabled or disabled in the “Configuration” column.

5.11 InterMiCOM Communication Channel

Col	Row	Courier Text	Default Setting	Available Settings
Description				
15	00	INTERMICOM COMMS		
This column contains settings for InterMiCOM Communications (second rear comms board is fitted)				
15	01	IM Input Status		Not Settable
Displays the status of each InterMiCOM input signal, with IM1 signal starting from the right. When loop back mode is set, all bits will display zero.				
15	02	IM Output Status		Not Settable
Displays the status of each InterMiCOM output signal.				
15	10	Source Address	1	From 1 to 10 step 1
Setting for the unique IED address that is encoded in the InterMiCOM sent message.				
15	11	Received Address	2	From 1 to 10 step 1
The aim of setting addresses is to establish pairs of IED's which will only communicate with each other. Should an inadvertent channel misrouting or spurious loopback occur, an error will be logged, and the erroneous received data will be rejected. As an example, in a 2 ended scheme the following address setting would be correct: Local IED: Source Address = 1, Receive Address = 2 Remote IED: Source Address = 2, Receive Address = 1				
15	12	Baud Rate	9600	0 = 600, 1 = 1200, 2 = 2400, 3 = 4800, 4 = 9600 or 5 = 19200
Setting of the signalling speed in terms of number of bits per second. The speed will match the capability of the MODEM or other characteristics of the channel provided.				
15	20	Ch Statistics	Invisible	0 = Invisible, 1 = Visible
Settings that makes visible or invisible Channel Statistics on the LCD. The statistic is reset by either IED’s powering down or using the ‘Reset Statistics’ cell.				
15	21	Rx Direct Count		Not Settable
Displays the number of valid Direct Tripping messages since last counter reset.				
15	22	Rx Perm Count		Not Settable
Displays the number of valid Permissive Tripping messages since last counter reset.				
15	23	Rx Block Count		Not Settable
Displays the number of valid Blocking messages since last counter reset.				
15	24	Rx NewDataCount		Not Settable

Col	Row	Courier Text	Default Setting	Available Settings
Description				
Displays the number of different messages (change events) since last counter reset.				
15	25	Rx ErroredCount		Not Settable
Displays the number of invalid received messages since last counter reset.				
15	26	Lost Messages		Not Settable
Displays the difference between the number of messages that were supposed to be received (based on set Baud Rate) and actual valid received messages since last reset.				
15	30	Elapsed Time		Not Settable
Displays the time in seconds since last counter reset.				
15	31	Reset Statistics	No	0 = No, 1 = Yes
Command that allows all Statistics and Channel Diagnostics to be reset.				
15	40	Ch Diagnostics	Invisible	0 = Invisible, 1 = Visible
Setting that makes visible or invisible Channel Diagnostics on the LCD. The diagnostic is reset by either IED's powering down or using the 'Reset Statistics' cell.				
15	41	Data CD Status		Not Settable
Indicates when the DCD line (pin 1 on EIA232 Connector) is energized. OK = DCD is energized FAIL = DCD is de-energized Absent = 2nd Rear port board is not fitted				
15	42	FrameSync Status		Not Settable
Indicates when the message structure and synchronization is valid. OK = Valid message structure and synchronization FAIL = Synchronization has been lost Absent = 2nd Rear port board is not fitted Unavailable = Hardware error present				
15	43	Message Status		Not Settable
Indicates when the percentage of received valid messages has fallen below the 'IM Msg Alarm Lvl' setting within the alarm time period. OK = Acceptable ratio of lost messages FAIL = Unacceptable ratio of lost messages Absent = 2nd Rear port board is not fitted Unavailable = Hardware error present				
15	44	Channel Status		Not Settable
Indicates the state of the InterMiCOM communication channel. OK = Channel healthy FAIL = Channel failure Absent = 2nd Rear port board is not fitted Unavailable = Hardware error present				
15	45	IM H/W Status		Not Settable
Indicates the state of InterMiCOM hardware OK = InterMiCOM hardware healthy Read or Write Error = InterMiCOM failure Absent = 2nd Rear port is not fitted or failed to initialize.				
15	50	Loopback Mode	Disabled	0 = Disabled, 1 = Internal or 2 = External
Setting to allow testing of the InterMiCOM channel. When 'Internal' is selected, only the local InterMiCOM software functionality is tested, whereby the IED will receive its own sent data. 'External' setting allows a hardware and software check, with an external link required to jumper the sent data onto the receive channel. During normal service condition Loopback mode must be disabled.				
15	51	Test Pattern	11111111 (bin)	Allows specific bit statuses to be inserted directly into the InterMiCOM message, to substitute real data. This is used for testing purposes.

Col	Row	Courier Text	Default Setting	Available Settings
Description				
Allows specific bit statuses to be inserted directly into the InterMiCOM message, to substitute real data. This is used for testing purposes.				
15	52	Loopback Status		Not Settable
Indicates the status of the InterMiCOM loopback mode OK = Loopback software (and hardware) is working correctly FAIL = Loopback mode failure Unavailable = Hardware error present.				

Table 14 - InterMiCOM Communications settings

5.12 InterMiCOM Configuration

The "INTERMICOM CONF" column selects the format of each signal and its fallback operation mode.

InterMiCOM provides 8 commands over a single communications link, with the mode of operation of each command being individually selectable within the "IM# Cmd Type" cell (# = 1 to 8).

Col	Row	Courier Text	Default Setting	Available Settings
Description				
16	00	INTERMICOM CONF		
This column contains settings for InterMiCOM Configuration (second rear comms board is fitted)				
16	01	IM Msg Alarm Lvl	0.25	From 0% to 100% step 0.1%
Setting that is used to alarm for poor channel quality. If during the fixed 1.6s window the ratio of invalid messages to the total number of messages that should be received (based upon the 'Baud Rate' setting) exceeds the above threshold, a 'Message Fail' alarm will be issued.				
16	10	IM1 Cmd Type	Direct	0 = Disabled, 1 = Direct 2 = Permissive or 3 = Blocking
Setting that defines the operative mode of the InterMiCOM_1 signal. Selecting the channel response for this bit to Blocking allows fastest signalling, whereas setting to Direct offers higher security at the expense of speed. Selecting the channel response for this bit to Permissive offers higher dependability				
16	11	IM1 FallBackMode	Default	0 = Default or 1 = Latched
Setting that defines the status of IM1 signal in case of heavy noise and message synchronization being lost. If set to 'Latching' the last valid IM1 status will be maintained until the new valid message is received. If set to 'Default', the IM1 status, pre-defined by the user in 'IM1 DefaultValue' cell will be set. A new valid message will replace 'IM1 DefaultValue', once the channel recovers.				
16	12	IM1 DefaultValue	0	0 to 1 step 1
Setting that defines the IM1 fallback status.				
16	13	IM1 FrameSyncTim	1.5s	From 0.01s to 1.5 step 10ms
Time delay after which 'IM1 DefaultValue' is applied, providing that no valid message is received in the meantime.				
16	18	IM2 Cmd Type	Direct	0 = Disabled, 1 = Direct 2 = Permissive or 3 = Blocking
Setting that defines the operative mode of the InterMiCOM_2 signal. Selecting the channel response for this bit to Blocking allows fastest signalling, whereas setting to Direct offers higher security at the expense of speed. Selecting the channel response for this bit to Permissive offers higher dependability				
16	19	IM2 FallBackMode	Default	0 = Default or 1 = Latched
Setting that defines the status of IM2 signal in case of heavy noise and message synchronization being lost. If set to 'Latching' the last valid IM2 status will be maintained until the new valid message is received. If set to 'Default', the IM2 status, pre-defined by the user in 'IM2 DefaultValue' cell will be set. A new valid message will replace 'IM2 DefaultValue', once the channel recovers.				

Col	Row	Courier Text	Default Setting	Available Settings
Description				
16	1A	IM2 DefaultValue	0	0 to 1 step 1
Setting that defines the IM2 fallback status.				
16	1B	IM2 FrameSyncTim	1.5s	From 0.01s to 1.5 step 10ms
Time delay after which 'IM2 DefaultValue' is applied, providing that no valid message is received in the meantime.				
16	20	IM3 Cmd Type	Direct	0 = Disabled, 1 = Direct 2 = Permissive or 3 = Blocking
Setting that defines the operative mode of the InterMiCOM_3 signal. Selecting the channel response for this bit to Blocking allows fastest signalling, whereas setting to Direct offers higher security at the expense of speed. Selecting the channel response for this bit to Permissive offers higher dependability				
16	21	IM3 FallBackMode	Default	0 = Default or 1 = Latched
Setting that defines the status of IM3 signal in case of heavy noise and message synchronization being lost. If set to 'Latching' the last valid IM3 status will be maintained until the new valid message is received. If set to 'Default', the IM3 status, pre-defined by the user in 'IM3 DefaultValue' cell will be set. A new valid message will replace 'IM3 DefaultValue', once the channel recovers.				
16	22	IM3 DefaultValue	0	0 to 1 step 1
Setting that defines the IM3 fallback status.				
16	23	IM3 FrameSyncTim	1.5s	From 0.01s to 1.5 step 10ms
Time delay after which 'IM3 DefaultValue' is applied, providing that no valid message is received in the meantime.				
16	28	IM4 Cmd Type	Direct	0 = Disabled, 1 = Direct 2 = Permissive or 3 = Blocking
Setting that defines the operative mode of the InterMiCOM_4 signal. Selecting the channel response for this bit to Blocking allows fastest signalling, whereas setting to Direct offers higher security at the expense of speed. Selecting the channel response for this bit to Permissive offers higher dependability				
16	29	IM4 FallBackMode	Default	0 = Default or 1 = Latched
Setting that defines the status of IM4 signal in case of heavy noise and message synchronization being lost. If set to 'Latching' the last valid IM4 status will be maintained until the new valid message is received. If set to 'Default', the IM4 status, pre-defined by the user in 'IM4 DefaultValue' cell will be set. A new valid message will replace 'IM4 DefaultValue', once the channel recovers.				
16	2A	IM4 DefaultValue	0	0 to 1 step 1
Setting that defines the IM4 fallback status.				
16	2B	IM4 FrameSyncTim	1.5s	From 0.01s to 1.5 step 10ms
Time delay after which 'IM4 DefaultValue' is applied, providing that no valid message is received in the meantime.				
16	30	IM5 Cmd Type	Direct	0 = Disabled, 1 = Direct 2 = Permissive or 3 = Blocking
Setting that defines the operative mode of the InterMiCOM_5 signal. Selecting the channel response for this bit to Blocking allows fastest signalling, whereas setting to Direct offers higher security at the expense of speed. Selecting the channel response for this bit to Permissive offers higher dependability				
16	31	IM5 FallBackMode	Default	0 = Default or 1 = Latched
Setting that defines the status of IM5 signal in case of heavy noise and message synchronization being lost. If set to 'Latching' the last valid IM5 status will be maintained until the new valid message is received. If set to 'Default', the IM5 status, pre-defined by the user in 'IM5 DefaultValue' cell will be set. A new valid message will replace 'IM5 DefaultValue', once the channel recovers.				
16	32	IM5 DefaultValue	0	0 to 1 step 1
Setting that defines the IM5 fallback status.				
16	33	IM5 FrameSyncTim	1.5s	From 0.01s to 1.5s step 0.01s
Time delay after which 'IM5 DefaultValue' is applied.				

Col	Row	Courier Text	Default Setting	Available Settings
Description				
16	38	IM6 Cmd Type	Direct	0 = Disabled, 1 = Direct 2 = Permissive or 3 = Blocking
Setting that defines the operative mode of the InterMiCOM_6 signal. Selecting the channel response for this bit to Blocking allows fastest signalling, whereas setting to Direct offers higher security at the expense of speed. Selecting the channel response for this bit to Permissive offers higher dependability				
16	39	IM6 FallBackMode	Default	0 = Default or 1 = Latched
Setting that defines the status of IM6 signal in case of heavy noise and message synchronization being lost. If set to 'Latching' the last valid IM6 status will be maintained until the new valid message is received. If set to 'Default', the IM6 status, pre-defined by the user in 'IM6 DefaultValue' cell will be set. A new valid message will replace 'IM6 DefaultValue', once the channel recovers.				
16	3A	IM6 DefaultValue	0	0 to 1 step 1
Setting that defines the IM6 fallback status.				
16	3B	IM6 FrameSyncTim	1.5s	From 0.01s to 1.5 step 10ms
Time delay after which 'IM6 DefaultValue' is applied.				
16	40	IM7 Cmd Type	Direct	0 = Disabled, 1 = Direct 2 = Permissive or 3 = Blocking
Setting that defines the operative mode of the InterMiCOM_7 signal. Selecting the channel response for this bit to Blocking allows fastest signalling, whereas setting to Direct offers higher security at the expense of speed. Selecting the channel response for this bit to Permissive offers higher dependability				
16	41	IM7 FallBackMode	Default	0 = Default or 1 = Latched
Setting that defines the status of IM7 signal in case of heavy noise and message synchronization being lost. If set to 'Latching' the last valid IM7 status will be maintained until the new valid message is received. If set to 'Default', the IM7 status, pre-defined by the user in 'IM7 DefaultValue' cell will be set. A new valid message will replace 'IM7 DefaultValue', once the channel recovers.				
16	42	IM7 DefaultValue	0	0 to 1 step 1
Setting that defines the IM7 fallback status.				
16	43	IM7 FrameSyncTim	1.5s	From 0.01s to 1.5s step 0.01s
Time delay after which 'IM7 DefaultValue' is applied.				
16	48	IM8 Cmd Type	Direct	0 = Disabled, 1 = Direct 2 = Permissive or 3 = Blocking
Setting that defines the operative mode of the InterMiCOM_8 signal. Selecting the channel response for this bit to Blocking allows fastest signalling, whereas setting to Direct offers higher security at the expense of speed. Selecting the channel response for this bit to Permissive offers higher dependability				
16	49	IM8 FallBackMode	Default	0 = Default or 1 = Latched
Setting that defines the status of IM8 signal in case of heavy noise and message synchronization being lost. If set to 'Latching' the last valid IM8 status will be maintained until the new valid message is received. If set to 'Default', the IM8 status, pre-defined by the user in 'IM8 DefaultValue' cell will be set. A new valid message will replace 'IM8 DefaultValue', once the channel recovers.				
16	4A	IM8 DefaultValue	0	0 to 1 step 1
Setting that defines the IM8 fallback status.				
16	4B	IM8 FrameSyncTim	1.5s	From 0.01s to 1.5 step 10ms
Time delay after which 'IM8 DefaultValue' is applied.				

Table 15 - interMiCOM Conf settings

5.13 Function Keys

The lock setting allows a function key output that is set to toggle mode to be locked in its current active state. In toggle mode a single key press will set/latch the function key output as high or low in programmable scheme logic. This feature can be used to enable/disable relay functions. In the normal mode the function key output will remain high as long as the key is pressed. The Fn. Key label allows the text of the function key to be changed to something more suitable for the application.
The “Function keys” column is visible when the “Function key” setting (“Configuration” column) = “visible”.

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

Col	Row	Courier Text	Default Setting	Available Settings
Description				
Sets the function key in toggle or normal mode. In ‘Toggle’ mode, a single key press will set/latch the function key output as ‘high’ or ‘low’ in programmable scheme logic. This feature can be used to enable/disable IED functions. In the ‘Normal’ mode the function key output will remain ‘high’ as long as key is pressed.				
17	0D	Fn Key 4 Label	Function Key 4	From 32 to 234 step 1
Allows the text of the function key to be changed to something more suitable for the application.				
17	0E	Fn Key 5	Unlocked	0 = Disabled, 1 = Unlocked (Enabled), 2 = Locked
Setting to activate function key. The ‘Lock’ setting allows a function key output that is set to toggle mode to be locked in its current active position.				
17	0F	Fn Key 5 Mode	Normal	0 = Normal or 1 = Toggled
Sets the function key in toggle or normal mode. In ‘Toggle’ mode, a single key press will set/latch the function key output as ‘high’ or ‘low’ in programmable scheme logic. This feature can be used to enable/disable IED functions. In the ‘Normal’ mode the function key output will remain ‘high’ as long as key is pressed.				
17	10	Fn Key 5 Label	Function Key 5	From 32 to 234 step 1
Allows the text of the function key to be changed to something more suitable for the application.				
17	11	Fn Key 6	Unlocked	0 = Disabled, 1 = Unlocked (Enabled), 2 = Locked
Setting to activate function key. The ‘Lock’ setting allows a function key output that is set to toggle mode to be locked in its current active position.				
17	12	Fn Key 6 Mode	Normal	0 = Normal or 1 = Toggled
Sets the function key in toggle or normal mode. In ‘Toggle’ mode, a single key press will set/latch the function key output as ‘high’ or ‘low’ in programmable scheme logic. This feature can be used to enable/disable IED functions. In the ‘Normal’ mode the function key output will remain ‘high’ as long as key is pressed.				
17	13	Fn Key 6 Label	Function Key 6	From 32 to 234 step 1
Allows the text of the function key to be changed to something more suitable for the application.				
17	14	Fn Key 7	Unlocked	0 = Disabled, 1 = Unlocked (Enabled), 2 = Locked
Setting to activate function key. The ‘Lock’ setting allows a function key output that is set to toggle mode to be locked in its current active position.				
17	15	Fn Key 7 Mode	Normal	0 = Normal or 1 = Toggled
Sets the function key in toggle or normal mode. In ‘Toggle’ mode, a single key press will set/latch the function key output as ‘high’ or ‘low’ in programmable scheme logic. This feature can be used to enable/disable IED functions. In the ‘Normal’ mode the function key output will remain ‘high’ as long as key is pressed.				
17	16	Fn Key 7 Label	Function Key 7	From 32 to 234 step 1
Allows the text of the function key to be changed to something more suitable for the application.				
17	17	Fn Key 8	Unlocked	0 = Disabled, 1 = Unlocked (Enabled), 2 = Locked
Setting to activate function key. The ‘Lock’ setting allows a function key output that is set to toggle mode to be locked in its current active position.				
17	18	Fn Key 8 Mode	Normal	0 = Normal or 1 = Toggled
Sets the function key in toggle or normal mode. In ‘Toggle’ mode, a single key press will set/latch the function key output as ‘high’ or ‘low’ in programmable scheme logic. This feature can be used to enable/disable IED functions. In the ‘Normal’ mode the function key output will remain ‘high’ as long as key is pressed.				
17	19	Fn Key 8 Label	Function Key 8	From 32 to 234 step 1
Allows the text of the function key to be changed to something more suitable for the application.				
17	1A	Fn Key 9	Unlocked	0 = Disabled, 1 = Unlocked (Enabled), 2 = Locked
Setting to activate function key. The ‘Lock’ setting allows a function key output that is set to toggle mode to be locked in its current active position.				

Col	Row	Courier Text	Default Setting	Available Settings
Description				
17	1B	Fn Key 9 Mode	Normal	0 = Normal or 1 = Toggled
Sets the function key in toggle or normal mode. In 'Toggle' mode, a single key press will set/latch the function key output as 'high' or 'low' in programmable scheme logic. This feature can be used to enable/disable IED functions. In the 'Normal' mode the function key output will remain 'high' as long as key is pressed.				
17	1C	Fn Key 9 Label	Function Key 9	From 32 to 234 step 1
Allows the text of the function key to be changed to something more suitable for the application.				
17	1D	Fn Key 10	Unlocked	0 = Disabled, 1 = Unlocked (Enabled), 2 = Locked
Setting to activate function key. The 'Lock' setting allows a function key output that is set to toggle mode to be locked in its current active position.				
17	1E	Fn Key 10 Mode	Normal	0 = Normal or 1 = Toggled
Sets the function key in toggle or normal mode. In 'Toggle' mode, a single key press will set/latch the function key output as 'high' or 'low' in programmable scheme logic. This feature can be used to enable/disable IED functions. In the 'Normal' mode the function key output will remain 'high' as long as key is pressed.				
17	1F	Fn Key 10 Label	Function Key 10	From 32 to 234 step 1
Allows the text of the function key to be changed to something more suitable for the application.				

Table 16 - Function keys settings

5.14 IED Configurator

The contents of the IED CONFIGURATOR column (for IEC 61850 configuration) are mostly data cells, displayed for information but not editable. To edit the configuration, you need to use the IED (Intelligent Electronic Device) configurator tool within the Schneider Electric MiCOM S1 Studio software.

Col	Row	Courier Text	Default Setting	Available Settings
Description				
19	00	IED CONFIGURATOR		
This column contains IED Configurator settings (IEC61850 builds)				
19	05	Switch Conf.Bank	No action	0 = No action or 1 = Switch banks
Setting which allows the user to switch between the current configuration, held in the Active Memory Bank (and partly displayed below), to the configuration sent to and held in the Inactive Memory Bank.				
19	0A	Restore Conf.	No action	0 = No Action or 1 = Restore Conf
Used to restore data from MCL(MiCOM Configuration Language)/CID (Configured IED Descriptor) file. This file is specific, containing a single devices IEC61850 configuration information, and used for transferring data to/from the MiCOM IED.				
19	10	Active Conf.Name		Not Settable
The name of the configuration in the Active Memory Bank, usually taken from the SCL file.				
19	11	Active Conf.Rev		Not Settable
Configuration Revision number of the configuration in the Active Memory Bank, usually taken from the SCL file.				
19	20	Inact.Conf.Name		Not Settable
The name of the configuration in the Inactive Memory Bank, usually taken from the SCL file.				
19	21	Inact.Conf.Rev		Not Settable
Configuration Revision number of the configuration in the Inactive Memory Bank, usually taken from the SCL file.				
19	30	IP PARAMETERS		
IP PARAMETERS				
19	31	IP address 1		Not Settable
Displays the unique network IP address that identifies the relay on interface 1. A default IP address is encoded from MAC address 169.254.0.xxx, xxx = mod (The last byte of MAC1, 128) + 1.				

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

Table 17 - IED configurator settings

5.15 Security Config Column

The SECURITY CONFIG column contains the main configuration settings for Security functions.

Col	Row	Courier Text	Default Setting	Available Settings
Description				
25	00	SECURITY CONFIG		

Col	Row	Courier Text	Default Setting	Available Settings
Description				
This column contains settings for Security Configuration				
25	01	User Banner	ACCESS ONLY FOR AUTHORISED USERS	Not Settable
This banner is one of the default display options				
25	02	Attempts Limit	5	1 to 99 step 1
Adjust the number of attempts to enter a valid password. When the maximum number of attemps has been reached, access is blocked.				
25	04	Blocking Timer	4	From 1 to 1440 step 1
Adjust the blocking timer (minutes) after a password blocking. Once the password is blocked, this blocking timer is initiated. Only after the blocking timer has expired will access to the interface be unblocked, whereupon the attempts counter is reset to zero.				
25	05	Front Port	Enabled	0 = Disabled or 1 = Enabled
Enable or disable the front port access. To prevent accidental disbling of a port, a warning message “FRONT PORT TO BE DISABLED, CONFIRM” is required to be disabled.				
25	06	Rear Port 1	Enabled	0 = Disabled or 1 = Enabled
Enable or disable the rear port 1 access. To prevent accidental disbling of a port, a warning message “REAR PORT 1 TO BE DISABLED, CONFIRM” is required to be disabled.				
25	07	Rear Port 2	Enabled	0 = Disabled or 1 = Enabled
When fitted, enable or disable the rear port 2 access. To prevent accidental disabling of a port, a warning message “REAR PORT 2 TO BE DISABLED, CONFIRM” is required to be disabled.				
25	08	ETH Port 1	Enabled	0 = Disabled or 1 = Enabled
Enable or disable Ethernet logical port 1 access. Note: if this port is enabled or disabled, the Ethernet card will reboot. Single port Ethernet card or Redundant Ethernet card with Comm Mode=PRP or HSR				
25	09	ETH Port 1/2	Enabled	0 = Disabled or 1 = Enabled
Enable or disable the Ethernet logical port 1/2 access. Note: if these ports are enabled or disabled, the Ethernet card will reboot. Redundant Ethernet card with Comm Mode=Dual IP				
25	0A	ETH Port 2/3	Enabled	0 = Disabled or 1 = Enabled
Enable or disable the Ethernet logical port 2/3 access. Note: if these ports are enabled or disabled, the Ethernet card will reboot. Redundanct Ethernet card with Comm Mode=PRP or HSR				
25	0B	ETH Port 3	Enabled	0 = Disabled or 1 = Enabled
Enable or disable the Ethernet logical port 3 access. Note: if this port is enabled or disabled, the Ethernet card will reboot. Redundant Ethernet card with Comm Mode=Dual IP				
25	0C	Courier Tunnel	Enabled	0 = Disabled or 1 = Enabled
Enable or disable Logical Tunnelled Courier Port				
25	0D	IEC61850 or IEC61850+DNPoE	Enabled	0 = Disabled or 1 = Enabled
Enable or disable IEC61850 (and DNPoE for protocol option B or L) services				
25	11	Attempts Remain		
Indicates the number of attempts remaining to enter a password.				
25	12	Blk Time Remain		
Indicates the blocking time remaining (in minutes).				
25	21	Username 1		Not settable
User Name, visible in authorized courier client, only.				
25	22	Username 2		Not settable

Col	Row	Courier Text	Default Setting	Available Settings
Description				
User Name, visible in authorized courier client, only.				
25	23	Username 3		Not settable
User Name, visible in authorized courier client, only.				
25	24	Username 4		Not settable
User Name, visible in authorized courier client, only.				
25	25	Username 5		Not settable
User Name, visible in authorized courier client, only.				
25	26	Username 6		Not settable
User Name, visible in authorized courier client, only.				
25	27	Username 7		Not settable
User Name, visible in authorized courier client, only.				
25	28	Username 8		Not settable
User Name, visible in authorized courier client, only.				
25	29	Username 9		Not settable
User Name, visible in authorized courier client, only.				
25	2A	Username 10		Not settable
User Name, visible in authorized courier client, only.				
25	2B	Username 11		Not settable
User Name, visible in authorized courier client, only.				
25	2C	Username 12		Not settable
User Name, visible in authorized courier client, only.				
25	2D	Username 13		Not settable
User Name, visible in authorized courier client, only.				
25	2E	Username 14		Not settable
User Name, visible in authorized courier client, only.				
25	2F	Username 15		Not settable
User Name, visible in authorized courier client, only.				
25	FE	Security Code		Not Settable
Indicates the security code (user interface only). The security code is a read-only random 12-digit number. This Security Code should be noted for password recovery and the relay should not be power cycled until the reset RBAC code is entered.				
25	FF	Reset RBAC		33 to 122 step 1
Recovery password obtained from Schneider Electric can be entered here to restore the default RBAC. (user interface only)				

Table 18 - Security Config settings

5.16 Virtual Input Labels

Col	Row	Courier Text	Default Setting	Available Settings
Description				
26	00	VIR I/P LABELS		
This column contains settings for Virtual Input Labels				
26	01	Virtual Input 1	Virtual Input 1	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	02	Virtual Input 2	Virtual Input 2	From 32 to 234 step 1
Text label to describe each individual Virtual Input				

Col	Row	Courier Text	Default Setting	Available Settings
Description				
26	03	Virtual Input 3	Virtual Input 3	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	04	Virtual Input 4	Virtual Input 4	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	05	Virtual Input 5	Virtual Input 5	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	06	Virtual Input 6	Virtual Input 6	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	07	Virtual Input 7	Virtual Input 7	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	08	Virtual Input 8	Virtual Input 8	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	09	Virtual Input 9	Virtual Input 9	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	0A	Virtual Input 10	Virtual Input 10	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	0B	Virtual Input 11	Virtual Input 11	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	0C	Virtual Input 12	Virtual Input 12	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	0D	Virtual Input 13	Virtual Input 13	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	0E	Virtual Input 14	Virtual Input 14	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	0F	Virtual Input 15	Virtual Input 15	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	10	Virtual Input 16	Virtual Input 16	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	11	Virtual Input 17	Virtual Input 17	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	12	Virtual Input 18	Virtual Input 18	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	13	Virtual Input 19	Virtual Input 19	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	14	Virtual Input 20	Virtual Input 20	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	15	Virtual Input 21	Virtual Input 21	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	16	Virtual Input 22	Virtual Input 22	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	17	Virtual Input 23	Virtual Input 23	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	18	Virtual Input 24	Virtual Input 24	From 32 to 234 step 1

Col	Row	Courier Text	Default Setting	Available Settings
Description				
Text label to describe each individual Virtual Input				
26	19	Virtual Input 25	Virtual Input 25	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	1A	Virtual Input 26	Virtual Input 26	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	1B	Virtual Input 27	Virtual Input 27	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	1C	Virtual Input 28	Virtual Input 28	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	1D	Virtual Input 29	Virtual Input 29	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	1E	Virtual Input 30	Virtual Input 30	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	1F	Virtual Input 31	Virtual Input 31	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	20	Virtual Input 32	Virtual Input 32	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	21	Virtual Input 33	Virtual Input 33	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	22	Virtual Input 34	Virtual Input 34	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	23	Virtual Input 35	Virtual Input 35	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	24	Virtual Input 36	Virtual Input 36	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	25	Virtual Input 37	Virtual Input 37	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	26	Virtual Input 38	Virtual Input 38	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	27	Virtual Input 39	Virtual Input 39	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	28	Virtual Input 40	Virtual Input 40	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	29	Virtual Input 41	Virtual Input 41	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	2A	Virtual Input 42	Virtual Input 42	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	2B	Virtual Input 43	Virtual Input 43	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	2C	Virtual Input 44	Virtual Input 44	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	2D	Virtual Input 45	Virtual Input 45	From 32 to 234 step 1
Text label to describe each individual Virtual Input				

Col	Row	Courier Text	Default Setting	Available Settings
Description				
26	2E	Virtual Input 46	Virtual Input 46	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	2F	Virtual Input 47	Virtual Input 47	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	30	Virtual Input 48	Virtual Input 48	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	31	Virtual Input 49	Virtual Input 49	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	32	Virtual Input 50	Virtual Input 50	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	33	Virtual Input 51	Virtual Input 51	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	34	Virtual Input 52	Virtual Input 52	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	35	Virtual Input 53	Virtual Input 53	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	36	Virtual Input 54	Virtual Input 54	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	37	Virtual Input 55	Virtual Input 55	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	38	Virtual Input 56	Virtual Input 56	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	39	Virtual Input 57	Virtual Input 57	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	3A	Virtual Input 58	Virtual Input 58	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	3B	Virtual Input 59	Virtual Input 59	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	3C	Virtual Input 60	Virtual Input 60	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	3D	Virtual Input 61	Virtual Input 61	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	3E	Virtual Input 62	Virtual Input 62	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	3F	Virtual Input 63	Virtual Input 63	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	40	Virtual Input 64	Virtual Input 64	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	41	Virtual Input 65	Virtual Input 65	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	42	Virtual Input 66	Virtual Input 66	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	43	Virtual Input 67	Virtual Input 67	From 32 to 234 step 1

Col	Row	Courier Text	Default Setting	Available Settings
Description				
Text label to describe each individual Virtual Input				
26	44	Virtual Input 68	Virtual Input 68	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	45	Virtual Input 69	Virtual Input 69	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	46	Virtual Input 70	Virtual Input 70	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	47	Virtual Input 71	Virtual Input 71	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	48	Virtual Input 72	Virtual Input 72	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	49	Virtual Input 73	Virtual Input 73	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	4A	Virtual Input 74	Virtual Input 74	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	4B	Virtual Input 75	Virtual Input 75	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	4C	Virtual Input 76	Virtual Input 76	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	4D	Virtual Input 77	Virtual Input 77	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	4E	Virtual Input 78	Virtual Input 78	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	4F	Virtual Input 79	Virtual Input 79	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	50	Virtual Input 80	Virtual Input 80	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	51	Virtual Input 81	Virtual Input 81	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	52	Virtual Input 82	Virtual Input 82	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	53	Virtual Input 83	Virtual Input 83	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	54	Virtual Input 84	Virtual Input 84	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	55	Virtual Input 85	Virtual Input 85	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	56	Virtual Input 86	Virtual Input 86	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	57	Virtual Input 87	Virtual Input 87	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	58	Virtual Input 88	Virtual Input 88	From 32 to 234 step 1
Text label to describe each individual Virtual Input				

Col	Row	Courier Text	Default Setting	Available Settings
Description				
26	59	Virtual Input 89	Virtual Input 89	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	5A	Virtual Input 90	Virtual Input 90	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	5B	Virtual Input 91	Virtual Input 91	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	5C	Virtual Input 92	Virtual Input 92	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	5D	Virtual Input 93	Virtual Input 93	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	5E	Virtual Input 94	Virtual Input 94	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	5F	Virtual Input 95	Virtual Input 95	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	60	Virtual Input 96	Virtual Input 96	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	61	Virtual Input 97	Virtual Input 97	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	62	Virtual Input 98	Virtual Input 98	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	63	Virtual Input 99	Virtual Input 99	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	64	Virtual Input 100	Virtual Input 100	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	65	Virtual Input 101	Virtual Input 101	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	66	Virtual Input 102	Virtual Input 102	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	67	Virtual Input 103	Virtual Input 103	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	68	Virtual Input 104	Virtual Input 104	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	69	Virtual Input 105	Virtual Input 105	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	6A	Virtual Input 106	Virtual Input 106	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	6B	Virtual Input 107	Virtual Input 107	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	6C	Virtual Input 108	Virtual Input 108	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	6D	Virtual Input 109	Virtual Input 109	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	6E	Virtual Input 110	Virtual Input 110	From 32 to 234 step 1

Col	Row	Courier Text	Default Setting	Available Settings
Description				
Text label to describe each individual Virtual Input				
26	6F	Virtual Input 111	Virtual Input 111	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	70	Virtual Input 112	Virtual Input 112	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	71	Virtual Input 113	Virtual Input 113	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	72	Virtual Input 114	Virtual Input 114	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	73	Virtual Input 115	Virtual Input 115	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	74	Virtual Input 116	Virtual Input 116	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	75	Virtual Input 117	Virtual Input 117	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	76	Virtual Input 118	Virtual Input 118	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	77	Virtual Input 119	Virtual Input 119	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	78	Virtual Input 120	Virtual Input 120	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	79	Virtual Input 121	Virtual Input 121	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	7A	Virtual Input 122	Virtual Input 122	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	7B	Virtual Input 123	Virtual Input 123	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	7C	Virtual Input 124	Virtual Input 124	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	7D	Virtual Input 125	Virtual Input 125	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	7E	Virtual Input 126	Virtual Input 126	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	7F	Virtual Input 127	Virtual Input 127	From 32 to 234 step 1
Text label to describe each individual Virtual Input				
26	80	Virtual Input 128	Virtual Input 128	From 32 to 234 step 1
Text label to describe each individual Virtual Input				

Table 19 - Virtual Input Labels settings

5.17 Virtual Output Labels

Col	Row	Courier Text	Default Setting	Available Settings
Description				
27	00	VIR O/P LABELS		
This column contains settings for Virtual Output Labels				
27	01	Virtual Output 1	Virtual Output 1	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	02	Virtual Output 2	Virtual Output 2	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	03	Virtual Output 3	Virtual Output 3	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	04	Virtual Output 4	Virtual Output 4	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	05	Virtual Output 5	Virtual Output 5	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	06	Virtual Output 6	Virtual Output 6	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	07	Virtual Output 7	Virtual Output 7	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	08	Virtual Output 8	Virtual Output 8	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	09	Virtual Output 9	Virtual Output 9	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	0A	Virtual Output 10	Virtual Output 10	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	0B	Virtual Output 11	Virtual Output 11	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	0C	Virtual Output 12	Virtual Output 12	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	0D	Virtual Output 13	Virtual Output 13	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	0E	Virtual Output 14	Virtual Output 14	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	0F	Virtual Output 15	Virtual Output 15	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	10	Virtual Output 16	Virtual Output 16	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	11	Virtual Output 17	Virtual Output 17	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	12	Virtual Output 18	Virtual Output 18	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	13	Virtual Output 19	Virtual Output 19	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	14	Virtual Output 20	Virtual Output 20	From 32 to 234 step 1
Text label to describe each individual Virtual Output				

Col	Row	Courier Text	Default Setting	Available Settings
Description				
27	15	Virtual Output 21	Virtual Output 21	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	16	Virtual Output 22	Virtual Output 22	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	17	Virtual Output 23	Virtual Output 23	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	18	Virtual Output 24	Virtual Output 24	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	19	Virtual Output 25	Virtual Output 25	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	1A	Virtual Output 26	Virtual Output 26	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	1B	Virtual Output 27	Virtual Output 27	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	1C	Virtual Output 28	Virtual Output 28	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	1D	Virtual Output 29	Virtual Output 29	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	1E	Virtual Output 30	Virtual Output 30	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	1F	Virtual Output 31	Virtual Output 31	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	20	Virtual Output 32	Virtual Output 32	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	21	Virtual Output 33	Virtual Output 33	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	22	Virtual Output 34	Virtual Output 34	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	23	Virtual Output 35	Virtual Output 35	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	24	Virtual Output 36	Virtual Output 36	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	25	Virtual Output 37	Virtual Output 37	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	26	Virtual Output 38	Virtual Output 38	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	27	Virtual Output 39	Virtual Output 39	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	28	Virtual Output 40	Virtual Output 40	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	29	Virtual Output 41	Virtual Output 41	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	2A	Virtual Output 42	Virtual Output 42	From 32 to 234 step 1

Col	Row	Courier Text	Default Setting	Available Settings
Description				
Text label to describe each individual Virtual Output				
27	2B	Virtual Output 43	Virtual Output 43	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	2C	Virtual Output 44	Virtual Output 44	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	2D	Virtual Output 45	Virtual Output 45	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	2E	Virtual Output 46	Virtual Output 46	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	2F	Virtual Output 47	Virtual Output 47	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	30	Virtual Output 48	Virtual Output 48	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	31	Virtual Output 49	Virtual Output 49	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	32	Virtual Output 50	Virtual Output 50	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	33	Virtual Output 51	Virtual Output 51	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	34	Virtual Output 52	Virtual Output 52	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	35	Virtual Output 53	Virtual Output 53	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	36	Virtual Output 54	Virtual Output 54	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	37	Virtual Output 55	Virtual Output 55	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	38	Virtual Output 56	Virtual Output 56	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	39	Virtual Output 57	Virtual Output 57	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	3A	Virtual Output 58	Virtual Output 58	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	3B	Virtual Output 59	Virtual Output 59	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	3C	Virtual Output 60	Virtual Output 60	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	3D	Virtual Output 61	Virtual Output 61	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	3E	Virtual Output 62	Virtual Output 62	From 32 to 234 step 1
Text label to describe each individual Virtual Output				
27	3F	Virtual Output 63	Virtual Output 63	From 32 to 234 step 1
Text label to describe each individual Virtual Output				

Col	Row	Courier Text	Default Setting	Available Settings
Description				
27	40	Virtual Output 64	Virtual Output 64	From 32 to 234 step 1
Text label to describe each individual Virtual Output				

Table 20 - Virtual Output Labels settings

5.18 User Alarm Labels

Col	Row	Courier Text	Default Setting	Available Settings
Description				
28	00	USR ALARM LABELS		
This column contains User Alarm Labels				
28	01	SR User Alarm 1	SR User Alarm 1	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	02	SR User Alarm 2	SR User Alarm 2	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	03	SR User Alarm 3	SR User Alarm 3	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	04	SR User Alarm 4	SR User Alarm 4	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	05	SR User Alarm 5	SR User Alarm 5	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	06	SR User Alarm 6	SR User Alarm 6	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	07	SR User Alarm 7	SR User Alarm 7	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	08	SR User Alarm 8	SR User Alarm 8	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	09	SR User Alarm 9	SR User Alarm 9	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	0A	SR User Alarm 10	SR User Alarm 10	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	0B	SR User Alarm 11	SR User Alarm 11	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	0C	SR User Alarm 12	SR User Alarm 12	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	0D	SR User Alarm 13	SR User Alarm 13	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	0E	SR User Alarm 14	SR User Alarm 14	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	0F	SR User Alarm 15	SR User Alarm 15	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	10	SR User Alarm 16	SR User Alarm 16	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	11	SR User Alarm 17	SR User Alarm 17	From 32 to 234 step 1

Col	Row	Courier Text	Default Setting	Available Settings
Description				
Text label to describe each individual User Alarm				
28	12	MR User Alamr 18	MR User Alamr 18	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	13	MR User Alamr 19	MR User Alamr 19	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	14	MR User Alamr 20	MR User Alamr 20	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	15	MR User Alamr 21	MR User Alamr 21	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	16	MR User Alamr 22	MR User Alamr 22	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	17	MR User Alamr 23	MR User Alamr 23	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	18	MR User Alamr 24	MR User Alamr 24	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	19	MR User Alamr 25	MR User Alamr 25	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	1A	MR User Alamr 26	MR User Alamr 26	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	1B	MR User Alamr 27	MR User Alamr 27	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	1C	MR User Alamr 28	MR User Alamr 28	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	1D	MR User Alamr 29	MR User Alamr 29	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	1E	MR User Alamr 30	MR User Alamr 30	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	1F	MR User Alamr 31	MR User Alamr 31	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	20	MR User Alamr 32	MR User Alamr 32	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	21	MR User Alamr 33	MR User Alamr 33	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	22	MR User Alamr 34	MR User Alamr 34	From 32 to 234 step 1
Text label to describe each individual User Alarm				
28	23	MR User Alamr 34	MR User Alamr 34	From 32 to 234 step 1
Text label to describe each individual User Alarm				

Table 21 - User Alarm Labels settings

5.19 Control Input Labels

The “CTRL I/P Labels” column is visible when the “Control I/P Labels” setting (“Configuration” column) = “visible”.

Col	Row	Courier Text	Default Setting	Available Settings
Description				
29	00	CTRL I/P LABELS		
This column contains settings for Control Input Labels				
29	01	Control Input 1	Control Input 1	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
29	02	Control Input 2	Control Input 2	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
29	03	Control Input 3	Control Input 3	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
29	04	Control Input 4	Control Input 4	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
29	05	Control Input 5	Control Input 5	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
29	06	Control Input 6	Control Input 6	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
29	07	Control Input 7	Control Input 7	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
29	08	Control Input 8	Control Input 8	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
29	09	Control Input 9	Control Input 9	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
29	0A	Control Input 10	Control Input 10	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
29	0B	Control Input 11	Control Input 11	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
29	0C	Control Input 12	Control Input 12	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
29	0D	Control Input 13	Control Input 13	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
29	0E	Control Input 14	Control Input 14	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
29	0F	Control Input 15	Control Input 15	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
29	10	Control Input 16	Control Input 16	From 32 to 234 step 1

Col	Row	Courier Text	Default Setting	Available Settings
Description				
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
29	11	Control Input 17	Control Input 17	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
29	12	Control Input 18	Control Input 18	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
29	13	Control Input 19	Control Input 19	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
29	14	Control Input 20	Control Input 20	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
29	15	Control Input 21	Control Input 21	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
29	16	Control Input 22	Control Input 22	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
29	17	Control Input 23	Control Input 23	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
29	18	Control Input 24	Control Input 24	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
29	19	Control Input 25	Control Input 25	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
29	1A	Control Input 26	Control Input 26	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
29	1B	Control Input 27	Control Input 27	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
29	1C	Control Input 28	Control Input 28	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
29	1D	Control Input 29	Control Input 29	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
29	1E	Control Input 30	Control Input 30	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
29	1F	Control Input 31	Control Input 31	From 32 to 234 step 1
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				
29	20	Control Input 32	Control Input 32	From 32 to 234 step 1

Col	Row	Courier Text	Default Setting	Available Settings
Description				
Text label to describe each individual control input. This text is displayed when a control input is accessed by the hotkey menu. It is displayed in the programmable scheme logic description of the control input				

Table 22 - Control Input settings

OPERATION

CHAPTER 5

Date:	12/2017
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.
Hardware Suffix:	M
Software Version:	B2
Connection Diagrams:	10P849xx (xx = 01 to 06)

CONTENTS

FIGURES

TABLES

1 OPERATION OF FUNCTIONS

1.1 Programmable Scheme Logic

1.1.1 Level Settings

Name	Range	Step Size
Time delay t	0-14400000ms	1ms

Table 1 - Time delay settings

1.1.2 Accuracy

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

Table 2 - Accuracy timings

1.2 IRIG-B Signal Only

If a satellite time clock signal conforming to IRIG-B is provided and the relay has the optional IRIG-B port fitted, the satellite clock equipment should be energised.

In the event of the auxiliary supply failing, with a battery fitted in the compartment behind the bottom access cover, the time and date will be maintained. Therefore, when the auxiliary supply is restored, the time and date will be correct and not need to be set again.

1.3 Trip LED Logic

The trip LED can be reset when the flags for the last fault are displayed or via dedicated DDBs. The flags are displayed automatically after a trip occurs, or can be selected in the fault record menu. The reset of trip LED and the fault records is performed by pressing the ⓒ key once the fault record has been read.

1.4 Function Keys

The relay offers users 10 function keys for programming any operator control functionality via PSL. Each function key has an associated programmable tri-colour LED that can be programmed to give the desired indication on function key activation.

These function keys can be used to trigger any function that they are connected to as part of the PSL. The function key commands can be found in the ‘Function Keys’ menu (see the Settings chapter). In the ‘Fn. Key Status’ menu cell there is a 10-bit word which represent the 10 function key commands and their status can be read from this 10-bit word.

In the programmable scheme logic editor 10 function key signals, which can be set to a logic 1 or On state, as described above, are available to perform control functions defined by the user.

The “Function Keys” column has ‘Fn. Key n Mode’ cell which allows the user to configure the function key as either ‘Toggled’ or ‘Normal’. In the ‘Toggle’ mode the function key DDB signal output will remain in the set state until a reset command is given, by activating the function key on the next key press. In the ‘Normal’ mode, the function key DDB signal will remain energized for as long as the function key is pressed and will then reset automatically.

A minimum pulse duration can be programmed for a function key by adding a minimum pulse timer to the function key DDB output signal.

The “Fn. Key n Status” cell is used to enable/unlock or disable the function key signals in PSL. The ‘Lock’ setting has been specifically provided to allow the locking of a function key thus preventing further activation of the key on consequent key presses. This allows function keys that are set to ‘Toggled’ mode and their DDB signal active ‘high’, to be locked in their active state thus preventing any further key presses from deactivating the associated function. Locking a function key that is set to the “Normal” mode causes the associated DDB signals to be permanently off. This safety feature prevents any inadvertent function key presses from activating or deactivating critical relay functions.

The “Fn. Key Labels” cell makes it possible to change the text associated with each individual function key. This text will be displayed when a function key is accessed in the function key menu, or it can be displayed in the PSL.

The status of the function keys is stored in battery backed memory. In the event that the auxiliary supply is interrupted the status of all the function keys will be recorded. Following the restoration of the auxiliary supply the status of the function keys, prior to supply failure, will be reinstated. If the battery is missing or flat the function key DDB signals will set to logic 0 once the auxiliary supply is restored.

Note	*The relay will only recognize a single function key press at a time and that a minimum key press duration of approximately 200msec. is required before the key press is recognized in PSL. This deglitching feature avoids accidental double presses.*

1.5 Setting Groups Selection

The setting groups can be changed either via opto inputs, via a menu selection, via the hotkey menu or via function keys. In the Configuration column if 'Setting Group - select via optos' is selected then any opto input or function key can be programmed in PSL to select the setting group as shown in the table below. If 'Setting Group - select via menu' is selected then in the Configuration column the 'Active Settings - Group1/2/3/4' can be used to select the setting group.

The setting group can be changed via the hotkey menu providing ‘Setting Group select via menu’ is chosen.

Two DDB signals are available in PSL for selecting a setting group via an opto input or function key selection. The following table illustrates the setting group that is active on activation of the relevant DDB signals.

DDB 1122 ‘SG Select x1’	DDB 1123 ‘SG Select 1x’	Selected setting group
0	0	1
1	0	2
0	1	3
1	1	4

Table 3 - Setting group active on activation of DDB signals

1.6 Control Inputs

The control inputs function as software switches that can be set or reset either locally or remotely. These inputs can be used to trigger any function that they are connected to as part of the PSL. There are three setting columns associated with the control inputs that are: “CONTROL INPUTS”, “CTRL. I/P CONFIG.” and “CTRL. I/P LABELS”. The function of these columns is described below:

Menu Text	Default Setting	Setting Range	Step Size
CONTROL INPUTS			
Ctrl I/P Status	00000000000000000000000000000000		
Control Input 1	No Operation	No Operation, Set, Reset	
Control Input 2 to 32	No Operation	No Operation, Set, Reset	

Table 4 - Control inputs

The Control Input commands can be found in the ‘Control Input’ menu. In the ‘Ctrl. I/P status’ menu cell there is a 32 bit word which represent the 32 control input commands. The status of the 32 control inputs can be read from this 32-bit word. The 32 control inputs can also be set and reset from this cell by setting a 1 to set or 0 to reset a particular control input. Alternatively, each of the 32 Control Inputs can be set and reset using the individual menu setting cells ‘Control Input 1, 2, 3’ etc. The Control Inputs are available through the relay menu as described above and also via the rear communications.

In the programmable scheme logic editor 32 Control Input signals, DDB 800 – 831, which can be set to a logic 1 or On state, as described above, are available to perform control functions defined by the user.

Menu Text	Default Setting	Setting Range	Step Size
CTRL. I/P CONFIG.			
Hotkey Enabled	11111111111111111111111111111111		
Control Input 1	Latched	Latched, Pulsed	
Ctrl Command 1	SET/RESET	SET/RESET, IN/OUT, ENABLED/DISABLED, ON/OFF	
Control Input 2 to 32	Latched	Latched, Pulsed	
Ctrl Command 2 to 32	SET/RESET	SET/RESET, IN/OUT, ENABLED/DISABLED, ON/OFF	
Menu Text	Default Setting	Setting Range	Step Size
CTRL. I/P LABELS			
Control Input 1	Control Input 1	16 character text	
Control Input 2 to 32	Control Input 2 to 32	16 character text	

Table 5 – CTRL. I/P Config

The **CTRL. I/P CONFIG.** column has several functions one of which allows the user to configure the control inputs as either **latched** or **pulsed**. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10ms after the set command is given and will then reset automatically (i.e. no reset command required).

In addition to the latched/pulsed option this column also allows the control inputs to be individually assigned to the **Hotkey** menu by setting **1** in the appropriate bit in the **Hotkey Enabled** cell. The hotkey menu allows the control inputs to be set, reset or pulsed without the need to enter the **CONTROL INPUTS** column. The **Ctrl. Command** cell also allows the SET/RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as **ON/OFF**, **IN/OUT** etc.

The **CTRL. I/P LABELS** column makes it possible to change the text associated with each individual control input. This text will be displayed when a control input is accessed by the hotkey menu, or it can be displayed in the PSL.

Note	*With the exception of pulsed operation, the status of the control inputs is stored in battery backed memory. In the event that the auxiliary supply is interrupted the status of all the inputs will be recorded. Following the restoration of the auxiliary supply the status of the control inputs, prior to supply failure, will be reinstated. If the battery is missing or flat the control inputs will set to logic 0 once the auxiliary supply is restored.*

1.7 Real Time Clock Synchronization via Opto-Inputs

In modern protective schemes it is often desirable to synchronize the relays real time clock so that events from different relays can be placed in chronological order. This can be done using the IRIG-B input, if fitted, or via the communication interface connected to the substation control system. In addition to these methods the Px4x range offers the facility to synchronize via an opto-input by routing it in PSL to DDB 1131 ('Time Sync.'). Pulsing this input will result in the real time clock snapping to the nearest minute. The recommended pulse duration is 20ms to be repeated no more than once per minute. An example of the time sync. function is shown.

Time of “Sync. Pulse”	Corrected time
19:47:00 to 19:47:29	19:47:00 This assumes a time format of hh:mm:ss
19:47:30 to 19:47:59	19:48:00

Table 6 – Time of Sync and Corrected Time

Note	*The above assumes a time format of hh:mm:ss*

To avoid the event buffer from being filled with unnecessary time sync. events, it is possible to ignore any event that generated by the time sync. opto input. This can be done by applying the following settings:

Menu text	Value
RECORD CONTROL	
Opto Input Event	Enabled
DDB 63 – 32 (Opto Inputs)	Set “Time Sync.” associated opto to 0

Table 7 – Record Control

To improve the recognition time of the time sync. opto input by approximately 10 ms, the opto input filtering could be disabled. This is achieved by setting the appropriate bit to 0 in the **Opto Filter Cntl** cell in the **OPTO CONFIG** column.

Disabling the filtering may make the opto input more susceptible to induced noise. Fortunately the effects of induced noise can be minimized by using the methods described in the *Product Design* chapter.

1.8 Enhanced Opto Time Stamping

Each opto-input sample will be time stamped within a tolerance of ±1ms with respect to the relay's Real Time Clock. These time stamps are used for the opto event logs and for the disturbance recording. The relay needs to be synchronized accurately to an external clock source such as the GPS clock and the synchronization shall consist of IRIG-B and SNTP through Ethernet communication. The time synchronization accuracy of the relay is 1ms through IRIG-B (both modulated and de-modulated) and SNTP. The total time stamping accuracy, with reference to an external clock source, also takes the time synchronization accuracy into consideration.

For both the filtered and unfiltered opto inputs, the time stamp of an opto change event is the sampling time at which the opto change of state has occurred. If a mixture of filtered and unfiltered optos changes state at the same sampling interval, these state changes are reported as a single event. The enhanced opto event time stamping is consistent across all the implemented protocols. The GOOSE messages are published in a timely manner and are not delayed by any event filtering mechanisms that are used to align the event time stamps.

1.9 InterMiCOM Teleprotection

InterMiCOM is a protection signalling system that is an optional feature of MiCOM Px40 relays and provides a cost-effective alternative to discrete carrier equipment. InterMiCOM sends eight signals between the two relays in the scheme, with each signal having a selectable operation mode to provide an optimal combination of speed, security and dependability in accordance with the application. Once the information is received, it may be assigned in the Programmable Scheme Logic to any function as specified by the user's application.

1.9.1 Protection Signalling

In order to achieve fast fault clearance and correct discrimination for faults anywhere within a high voltage power network, it is necessary to signal between the points at which protection relays are connected. Two distinct types of protection signalling can be identified:

1.9.1.1 Communications Media

Note	*The MiCOM P849 devices only use electrical connections (EIA(RS)232, port SK5)*

InterMiCOM can transfer up to eight commands over one communication channel. Due to recent expansions in communication networks, most signaling channels are now digital schemes using multiplexed fiber optics. For this reason, InterMiCOM provides a standard EIA(RS)232 output using digital signaling techniques. This digital signal can be converted using suitable devices to any communications media as required. The EIA(RS)232 output may alternatively be connected to a MODEM link.

Regardless of whether analogue or digital systems are being used, all the requirements of teleprotection commands are governed by an international standard IEC60834-1:1999 and InterMiCOM is compliant with the essential requirements of this standard. This standard governs the speed requirements of the commands as well as the probability of unwanted commands being received (security) and the probability of missing commands (dependability).

1.9.1.2 General Features and Implementation

InterMiCOM provides eight commands over a single communications link, with the mode of operation of each command being individually selectable within the **IM# Cmd Type** cell. **Blocking** mode provides the fastest signaling speed (available on commands 1 - 4), **Direct Intertrip** mode provides the most secure signaling (available on commands 1 - 8) and **Permissive** mode provides the most dependable signaling (available on commands 5 - 8). Each command can also be disabled so that it has no effect in the logic of the relay.

Since many applications will involve the commands being sent over a multiplexed communications channel, it is necessary to ensure that only data from the correct relay is used. Both relays in the scheme must be programmed with a unique pair of addresses that correspond with each other in the **Source Address** and **Receive Address** cells. For example, at the local end relay if we set the **Source Address** to 1, the **Receive Address** at the remote end relay must also be set to 1. Similarly, if the remote end relay has a **Source Address** set to 2, the **Receive Address** at the local end must also be set to 2. All four addresses must not be set identical in any given relay scheme if the possibility of incorrect signaling is to be avoided.

Noise in the communications channel should not be interpreted as valid messages by the relay. For this reason, InterMiCOM uses a combination of unique pair addressing described above, basic signal format checking and for **Direct Intertrip** commands an 8-bit Cyclic Redundancy Check (CRC) is also performed. This CRC calculation is performed at both the sending and receiving end relay for each message and then compared in order to maximize the security of the **Direct Intertrip** commands.

Most of the time the communications will perform adequately and the presence of the various checking algorithms in the message structure will ensure that InterMiCOM signals are processed correctly. However, careful consideration is also required for the periods of extreme noise pollution or the unlikely situation of total communications failure and how the relay should react.

During periods of extreme noise, it is possible that the synchronization of the message structure will be lost and it may become impossible to decode the full message accurately. During this noisy period, the last good command can be maintained until a new valid message is received by setting the “**IM# FallBackMode**” cell to “**Latched**”. Alternatively, if the synchronization is lost for a period of time, a known fallback state can be assigned to the command by setting the “**IM# FallBackMode**” cell to “**Default**”. In this latter case, the time period will need to be set in the “**IM# FrameSynTim**” cell and the default value will need to be set in “**IM# DefaultValue**” cell. As soon as a full valid message is seen by the relay all the timer periods are reset and the new valid command states are used. An alarm is provided if the noise on the channel becomes excessive.

If there is a total communications failure, the relay will use the fallback (failsafe) strategy as described above. Total failure of the channel is considered when no message data is received for four power system cycles or if there is a loss of the DCD line.

1.9.1.3 Physical Connections

InterMiCOM on the Px40 relays is implemented using a 9-pin '**D**' type female connector (labeled SK5) located at the bottom of the 2nd Rear communication board. This connector on the Px40 relay is wired in DTE (Data Terminating Equipment) mode, as shown in the *EIA(RS)232 Physical Connections* table:

Pin	Acronym	InterMiCOM Usage
1	DCD	"Data Carrier Detect" is only used when connecting to modems otherwise this should be tied high by connecting to terminal 4.
2	RxD	"Receive Data"
3	TxD	"Transmit Data"
4	DTR	"Data Terminal Ready" is permanently tied high by the hardware since InterMiCOM requires a permanently open communication channel.
5	GND	"Signal Ground"
6	Not used	-
7	RTS	"Ready To Send" is permanently tied high by the hardware since InterMiCOM requires a permanently open communication channel.
8	Not used	-
9	Not used	-

Table 8 - InterMICOM D9 port pin-out connections

Depending upon whether a direct or modem connection between the two relays in the scheme is being used, the required pin connections are described below.

1.9.1.4 Direct Connection

The EIA(RS)232 protocol only allows for short transmission distances due to the signalling levels used and therefore the connection shown below is limited to less than 15m. However, this may be extended by introducing suitable EIA(RS)232 to fiber optic convertors, such as the CILI 204. Depending upon the type of convertor and fiber used, direct communication over a few kilometres can easily be achieved.

This type of connection should also be used when connecting to multiplexers that have no ability to control the DCD line.

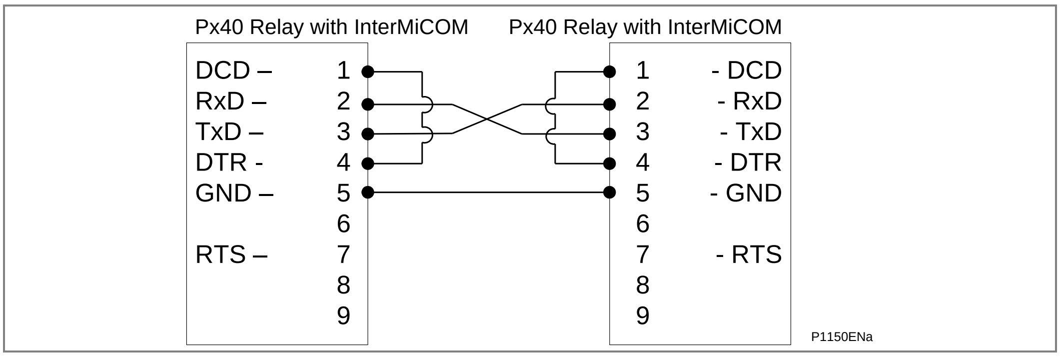


Figure 1 - Direct connection within the local substation

1.9.1.5 Modem Connection

For long distance communication, modems may be used in which the case the following connections should be made.

This type of connection should also be used when connecting to multiplexers that have the ability to control the DCD line. With this type of connection it should be noted that the maximum distance between the Px40 relay and the modem should be 15m, and that a baud rate suitable for the communications path used should be selected.

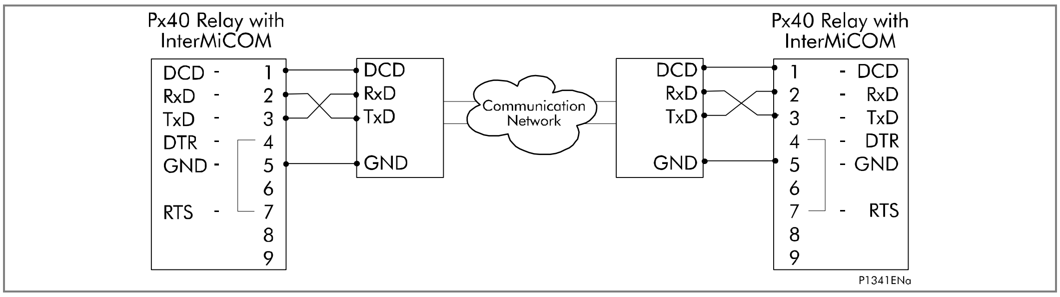


Figure 2 - InterMICOM teleprotection via a MODEM link

1.9.2 Functional Assignment

Even though settings are made on the relay to control the mode of the intertrip signals, it is necessary to assign interMiCOM input and output signals in the relay Programmable Scheme Logic (PSL) if InterMiCOM is to be successfully implemented.

It should be noted that when an InterMiCOM signal is sent from the local relay, only the remote end relay will react to this command. The local end relay will only react to InterMiCOM commands initiated at the remote end. InterMiCOM is thus suitable for teleprotection schemes requiring Duplex signaling.

1.9.3 InterMiCOM Settings

The settings necessary for the implementation of InterMiCOM are contained within two columns of the relay menu structure. The first column entitled “INTERMICOM COMMS” contains all the information to configure the communication channel and also contains the channel statistics and diagnostic facilities. The second column entitled “INTERMICOM CONF” selects the format of each signal and its fallback operation mode. The following tables show the relay menus including the available setting ranges and factory defaults.

Once the relay operation has been confirmed using the loopback test facilities, it will be necessary to ensure that the communications between the two relays in the scheme are reliable. To facilitate this, a list of channel statistics and diagnostics are available in the InterMiCOM COMMS column:

1.9.3.1 Setting Guidelines

The settings required for the InterMiCOM signalling are largely dependant upon whether a direct or indirect (modem/multiplexed) connection between the scheme ends is used.

Direct connections will either be short metallic or dedicated fiber optic (using CILI204) based and hence can be set to have the highest signalling speed of 19200b/s. Due to this high signalling rate, the difference in operating speed between the direct, permissive and blocking type signals is so small that the most secure signalling (direct intertrip) can be selected without any significant loss of speed. In turn, since the direct intertrip signalling requires the full checking of the message frame structure and CRC checks, it would seem prudent that the “IM# Fallback Mode” be set to “Default” with a minimal intentional delay by setting “IM# FrameSyncTim” to 10msecs. In other words, whenever two consecutive messages have an invalid structure, the relay will immediately revert to the default value until a new valid message is received.

For indirect connections, the settings that should be applied will become more application and communication media dependent. As for the direct connections, it may be appealing to consider only the fastest baud rate but this will usually increase the cost of the necessary modem/multiplexer.

In addition, devices operating at these high baud rates may suffer from “data jams” during periods of interference and in the event of communication interruptions, may require longer re-synchronization periods.
Both of these factors will reduce the effective communication speed thereby leading to a recommended baud rate setting of 9600b/s. It should be noted that as the baud rate decreases, the communications become more robust with fewer interruptions, but that overall signalling times will increase.

Since it is likely that slower baud rates will be selected, the choice of signalling mode becomes significant. However, once the signalling mode has been chosen it is necessary to consider what should happen during periods of noise when message structure and content can be lost.

If “Blocking” mode is selected, only a small amount of the total message is actually used to provide the signal, which means that in a noisy environment there is still a good likelihood of receiving a valid message. In this case, it is recommended that the “IM# Fallback Mode” is set to “Default” with a reasonably long “IM# FrameSyncTim”.

If “Direct Intertrip” mode is selected, the whole message structure must be valid and checked to provide the signal, which means that in a very noisy environment the chances of receiving a valid message are quite small. In this case, it is recommended that the “IM# Fallback Mode” is set to “Default” with a minimum “IM# FrameSyncTim” setting i.e. whenever a non-valid message is received, InterMiCOM will use the set default value.

If “Permissive” mode is selected, the chances of receiving a valid message is between that of the “Blocking” and “Direct Intertrip” modes. In this case, it is possible that the “IM# Fallback Mode” is set to “Latched”. The table below highlights the recommended “IM# FrameSyncTim” settings for the different signalling modes and baud rates:

Baud Rate	Minimum Recommended “IM# FrameSyncTim” Setting		Minimum Setting	Maximum Setting
	Direct Intertrip Mode	Blocking Mode		
600	100	250	100	1500
1200	50	130	50	1500
2400	30	70	30	1500
4800	20	40	20	1500
9600	10	20	10	1500
19200	10	10	10	1500

Table 9 - Recommended Frame Synchronism Time settings

Note	*No recommended setting is given for the Permissive mode since it is anticipated that "Latched" operation will be selected. However, if "Default mode" is selected, the "IM# FrameSyncTim" setting should be set greater than the minimum settings listed above. If the "IM# FrameSyncTim" setting is set lower than the minimum setting listed above, there is a danger that the relay will monitor a correct change in message as a corrupted message. A setting of 25% is recommended for the communications failure alarm.*

1.9.3.2 InterMiCOM Statistics & Diagnostics

It is possible to hide the channel diagnostics and statistics from view by setting the "**Ch Statistics**" and/or "**Ch Diagnostics**" cells to "**Invisible**". All channel statistics are reset when the relay is powered up, or by user selection using the "**Reset Statistics**" cell.

1.9.4 Testing InterMiCOM

1.9.4.1 InterMiCOM Loopback Testing & Diagnostics

A number of features are included within the InterMiCOM function to assist a user in commissioning and diagnosing any problems that may exist in the communications link. "Loopback" test facilities, located within the INTERMICOM COMMS column of the relay menu, provide a user with the ability to check the software and hardware of the InterMiCOM signalling.

By selecting "Loopback Mode" to "Internal", only the internal software of the relay is checked whereas "External" will check both the software and hardware used by InterMiCOM. In the latter case, it is necessary to connect the transmit and receive pins together (pins 2 and 3) and ensure that the DCD signal is held high (connect pin 1 and pin 4 together). When the relay is switched into "Loopback Mode" the relay will automatically use generic addresses and will inhibit the InterMiCOM messages to the PSL by setting all eight InterMiCOM message states to zero. The loopback mode will be indicated on the relay frontplate by the amber Alarm LED being illuminated and a LCD alarm message, "IM Loopback".

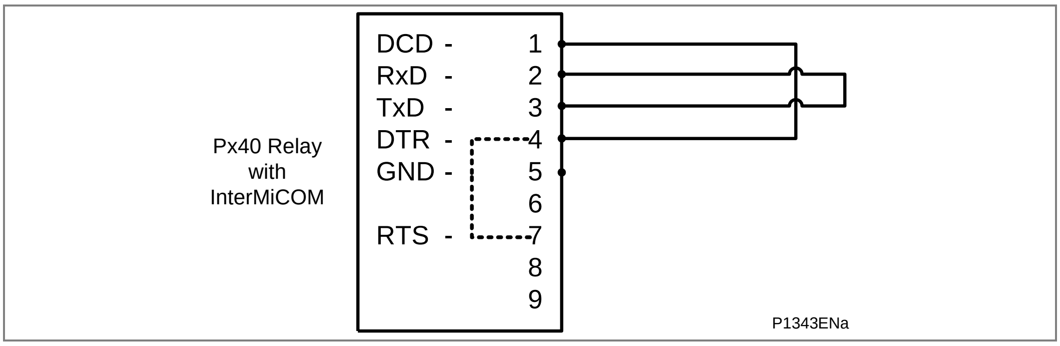


Figure 3 - Connections for External Loopback mode

Once the relay is switched into either of the Loopback modes, a test pattern can be entered in the “Test Pattern” cell which is then transmitted through the software and/or hardware. Providing all connections are correct and the software is working correctly, the “Loopback Status” cell will display “OK”. An unsuccessful test would be indicated by “FAIL”, whereas a hardware error will be indicated by “UNAVAILABLE”. Whilst the relay is in loopback test mode, the “IM Output Status” cell will only show the “Test Pattern” settings, whilst the “IM Input Status” cell will indicate that all inputs to the PSL have been forced to zero.

Care should be taken to ensure that once the loopback testing is complete, the “Loopback Mode” is set to “Disabled” thereby switching the InterMiCOM channel back in to service. With the loopback mode disabled, the “IM Output Status” cell will show the InterMiCOM messages being sent from the local relay, whilst the “IM Input Status” cell will show the received InterMiCOM messages (received from the remote end relay) being used by the PSL.

Once the relay operation has been confirmed using the loopback test facilities, it will be necessary to ensure that the communications between the two relays in the scheme are reliable. To facilitate this, a list of channel statistics and diagnostics are available in the InterMiCOM COMMS column – see section 10.2. It is possible to hide the channel diagnostics and statistics from view by setting the “Ch Statistics” and/or “Ch Diagnostics” cells to “Invisible”. All channel statistics are reset when the relay is powered up, or by user selection using the “Reset Statistics” cell.

Another indication of the amount of noise on the channel is provided by the communications failure alarm. Within a fixed 1.6 second time period the relay calculates the percentage of invalid messages received compared to the total number of messages that should have been received based upon the “Baud Rate” setting. If this percentage falls below the threshold set in the “IM Msg Alarm Lvl” cell, a “Message Fail” alarm will be raised.

1.10 Read Only Mode

With IEC 61850 and Ethernet / Internet communication capabilities, security has become a pressing issue. The Px40 relay provides a facility to allow the user to enable or disable the change in configuration remotely. This feature is available only in relays with Courier, Courier with IEC 60870-5-103, Courier with IEC 61850 and Courier with IEC 60870-5-103 and IEC 61850 protocol options. It has to be noted that in IEC 60870-5-103 protocol, Read Only Mode function is different from the existing Command block feature.

1.10.1 Protocol/Port Implementation

1.10.1.1 IEC 60870-5-103 Protocol on Rear Port 1

The protocol does not support settings but the indications, measurands and disturbance records commands are available at the interface.

Allowed:

Poll Class 1 (read spontaneous events)
Poll Class 2 (read measurands)
GI sequence (ASDU7 'Start GI', Poll Class 1)
Transmission of Disturbance Records sequence (ASDU24, ASDU25, Poll Class 1)
Time Synchronization (ASDU6)
General Commands (ASDU20), namely:

- INF23 activate characteristic 1
- INF24 activate characteristic 2
- INF25 activate characteristic 3
- INF26 activate characteristic 4

Blocked:

Write parameter (=change setting) (private ASDUs)
General Commands (ASDU20), namely:

- INF16 auto-recloser on/off
- INF19 LED reset
- Private INFs (e.g CB open/close, Control Inputs)

1.10.1.2 Courier Protocol on Rear Port 1/2 and Ethernet

Allowed:

- Read settings, statuses, measurands
- Read records (event, fault, disturbance)
- Time Synchronization command
- Change active setting group command

Blocked:

Write settings
All controls, including:

- Reset Indication (Trip LED)
- Operate Control Inputs
- CB operations
- Auto-reclose operations
- Reset demands
- Clear event / fault / maintenance / disturbance records
- Test LEDs & contacts

1.10.1.3 IEC 61850

Allowed:

- Read statuses, measurands
- Generate Reports
- Extract Disturbance Records
- Time Synchronization
- Change active setting group

Blocked:

All controls, including:

- Operate Control Inputs
- Reset LEDs

1.10.2 Courier Database Support

Three new settings, one for each remote communications port at the back of the relay are created to support the enabling and disabling of the read only mode at each port.

The **NIC Read Only** setting will apply to all the communications protocols (including the Tunnelled Courier) that are transmitted via the Ethernet Port. Their default values are ‘Disabled’.

Depending on the product options, the Modbus and DNP3 communications interfaces that do not support the feature will ignore these settings.

The remote read only mode is also available in the PSL via three dedicated DDB signals:

- RP1 Read Only
- RP2 Read Only
- NIC Read Only

Through careful scheme logic design, the activations of these read only signals can be facilitated via Opto Inputs, Control Inputs and Function Keys.

These DDBs are available in every build, however they are effective only in Courier, IEC 60870-5-103 build and in latest IEC 61850. The setting cells are not available in Modbus and DNP3.0.

2 OPERATION OF RECORDING FACILITIES

The MiCOM P849 contains the following recording facilities:

- Real time clock for time synchronization
- Event and disturbance recording facilities

2.1 Real Time Clock, Time Synchronization

The MiCOM P849 provides real time clock and time synchronisation.

The time synchronisation is available through:

- IRIG-B port
- Serial communication port
- Ethernet port
- Opto (opto time synchr)

Time synchronization uses Courier, Modbus, IEC60850-5-103, DNP3 or IEC61850 protocols.

Publishing GOOSE does not contain time stamp. Events are time stamped at reception at the other end (for example when it is received by P746).

2.2 Standard Event Recording Facilities

A sequence of time-tagged events is available. The product provides up to 512 non-volatile event records.

The following list items are stored as events:

- Recognition of change of state of logic (optically isolated) inputs
- Recognition of change of state of output relays
- Alarms
- Maintenance records
- Settings changes (local and remote)

2.3 Disturbance Recording Facilities

The product stores disturbance records in non-volatile (battery backed-up) memory. Each disturbance recording contains 32 digital data channels.

2.4 User Alarms

Thirty-five user alarms are available, the first 17 are self-reset and the next 18 are manual-reset. The user alarm labels can be set in the setting file and these labels are displayed in the PSL file as well.

APPLICATION NOTES

CHAPTER 6

Date:	12/2017
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.
Hardware Suffix:	M
Software Version:	B2
Connection Diagrams:	10P849xx (xx = 01 to 06)

CONTENTS

TABLES

FIGURES

1 APPLICATION OF THE MICOM P849 DEVICE

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

MiCOM P849 Input & Output Extension device combines solutions to provide these application with the standard benefits of the MiCOM Px40 platform. This section describes how MiCOM P849 can be used within these applications.

- Protection Application
- Control Application

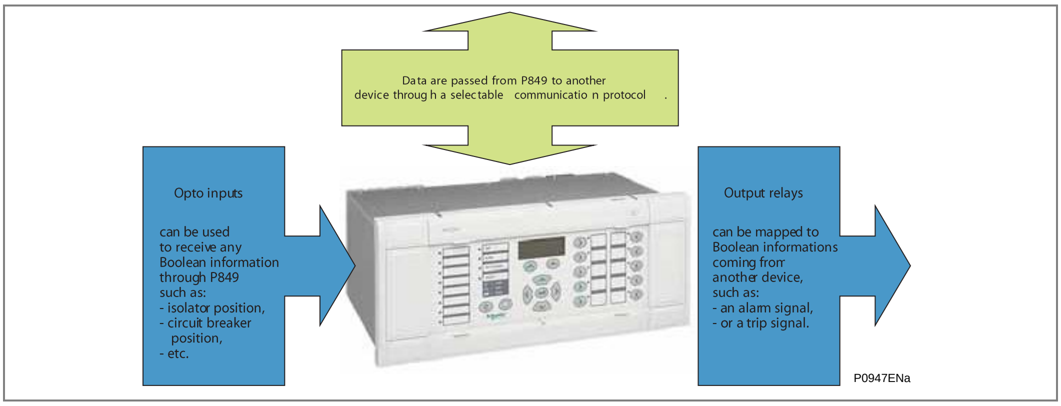


Figure 1 – P849 opto inputs and outputs

1.1 Protection Application

1.1.1 Definition

The protection application is characterised by the ability of the device to communicate IEC61850-8.1 over either a single Ethernet network or a redundant Ethernet network.

The MiCOM P849 is able to extend the number of IO of any device at all voltage levels (from MV up to HV transmission), regardless of manufacturer (IEC61850 communication through GOOSEs and Reports).

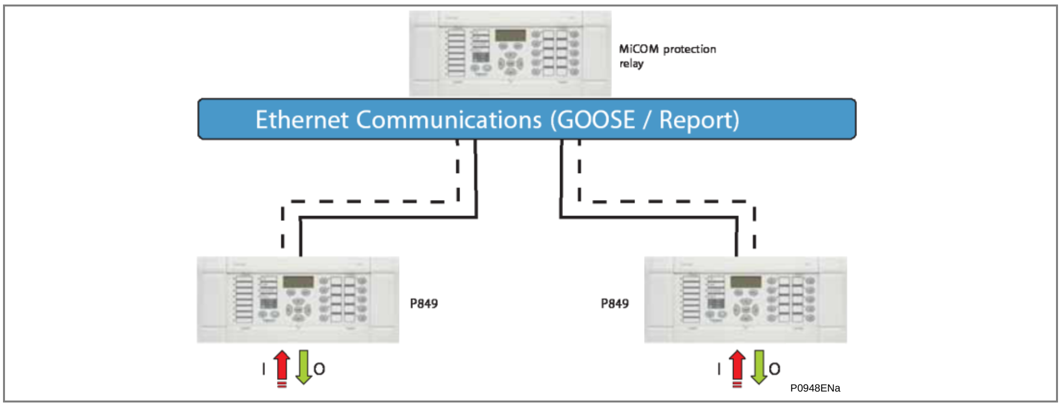


Figure 2 – P849 Ethernet communications

1.1.2 MiCOM P746 and P849 Use Cases

P849 can increase the number of inputs and outputs of MiCOM P746 in one box mode as well as in three box mode.

1.1.2.1 P746 One Box and P849 Use Case

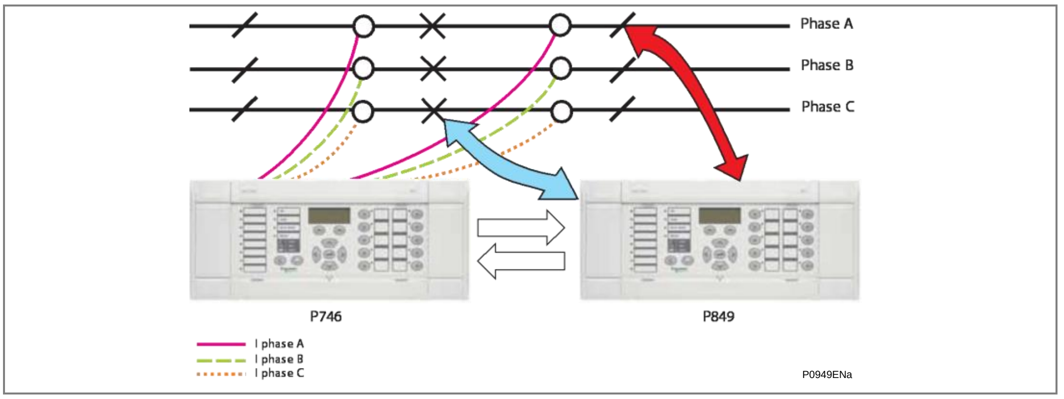


Figure 3 – P746/P849 phases A, B and C

In this case, the P849 can send the status of switchgear to the P746 through GOOSE messages.

P849 can also be used to open a Circuit Breaker based on a command sent from P746 through GOOSE message.

The inter-device communication can also be done through InterMiCOM proprietary protocol.

1.1.2.2 P746 Three Box and P849 Use Case

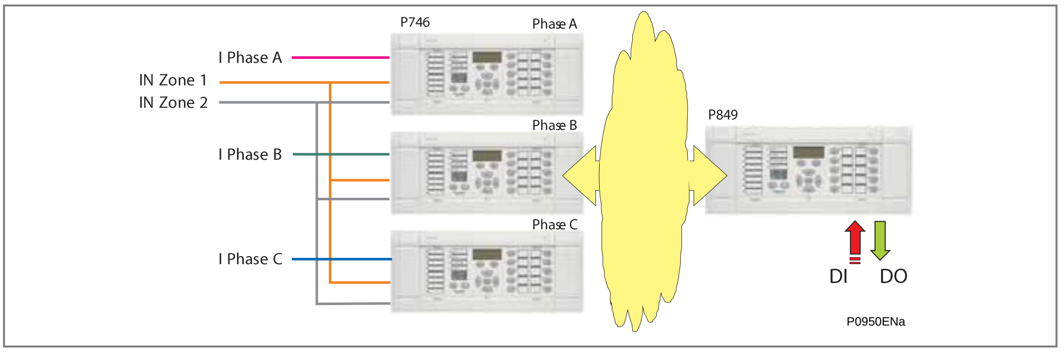


Figure 4 - P746 three box and P849 use case

In this use case the P849 can send to P746 relays the status of the switchgear using GOOSE.

P849 can also be used to open a Circuit Breaker based on a command sent from P746 through GOOSE message.

Note	*The inter-device network is also used for Inter P746 communications.*

It is recommended that GOOSE messages are exchanged between P746 protection relays and P849 over a Redundant Ethernet network.

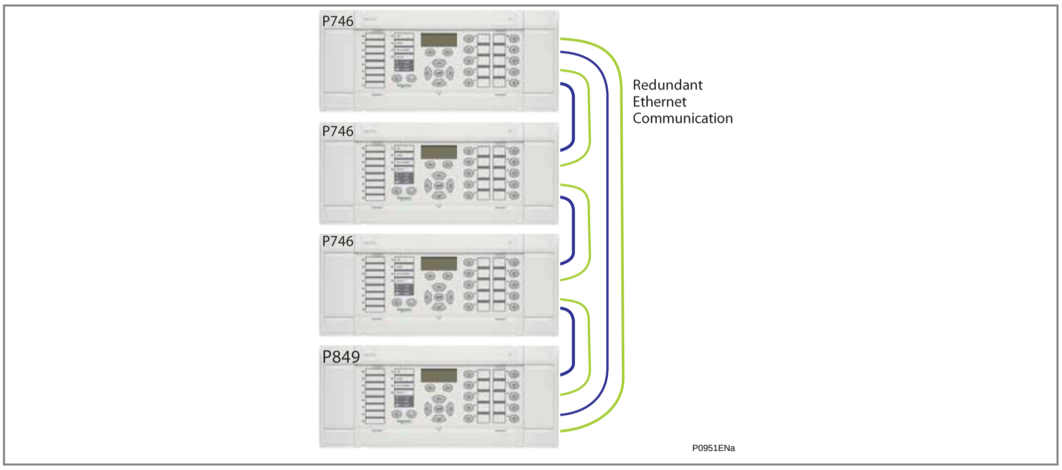


Figure 5 – P746 & P849 redundant Ethernet communications

1.1.2.3 P746 3 Box and Multiple P849 Use Case

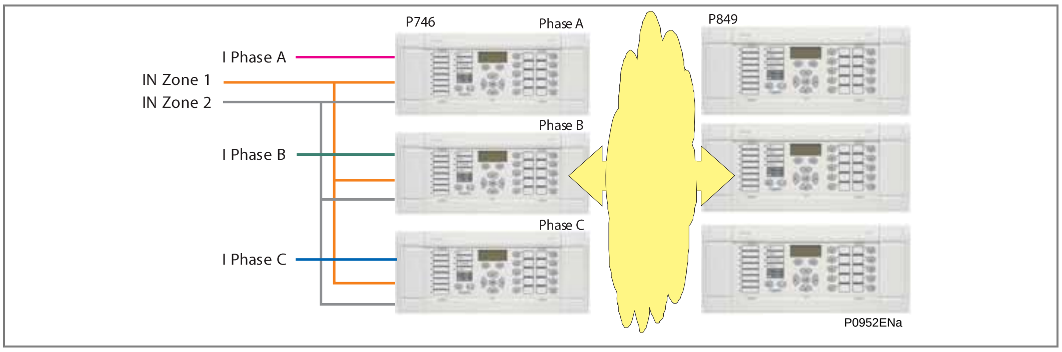


Figure 6 - P746 three box and multiple P849 use case

The number of P849 that can be connected to device or a system of devices is not limited.

The number of P849 used will depend of customer application and more precisely on the corresponding required number of digital inputs and digital outputs by the application.

1.1.3 GOOSE Testing Mode

An inbuilt GOOSE Testing Mode is provided to facilitate IEC61850 commissioning.

From front panel of the device the user will be able to process GOOSE Testing mode.

This function is performed through PSL and can be customized to some particular application cases if required. The demonstration example below is based on P746.

It is supposed that he connected P746 is also in GOOSE Testing Mode or has got adequate PSL to answer P849 GOOSEs.

It consists in sending and receiving Test GOOSEs and check that they are correctly sent and received.

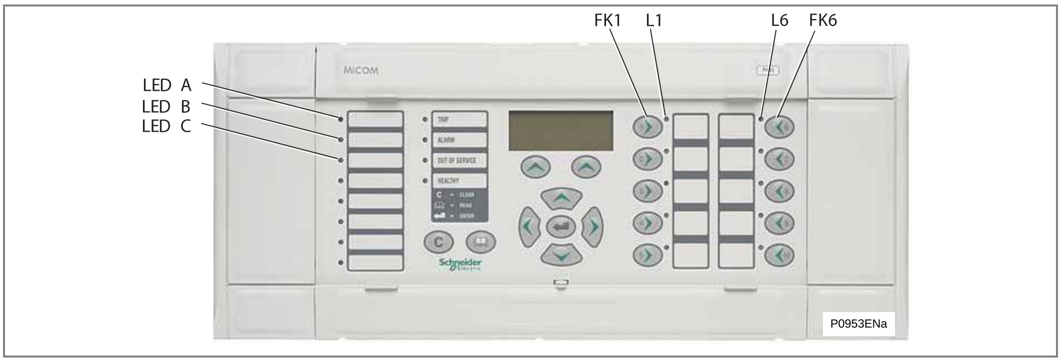


Figure 7 – GOOSE testing mode

To activate GOOSE Testing Mode press Function key 1

To send a testing GOOSE message press Function key 6.

LED A, B and C are used to check that the P849 receives correctly GOOSEs.

1.1.3.1 GOOSE Testing Mode in case of P746 One Box Mode

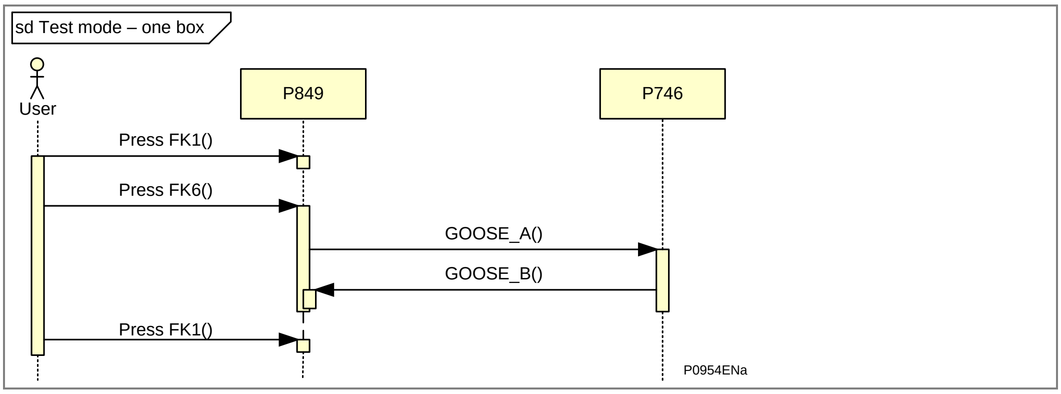


Figure 8 – GOOSE testing mode in case of P746 one box mode

GOOSE_A and GOOSE_B are test GOOSE messages (please refer to default PSL for more detail) LED A on the relay lights on as soon as GOOSE_B is received by P849.

1.1.3.2 GOOSE Testing Mode in case of P746 Three Box Mode

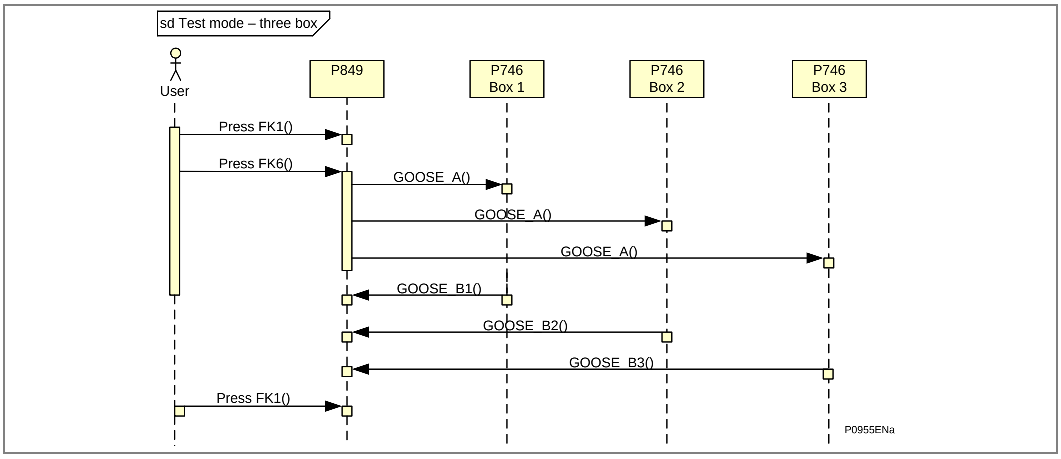


Figure 9 - GOOSE testing mode in case of P746 three box mode

GOOSE_A and GOOSE_B are test GOOSE messages (please refer to default PSL for more detail).

- LED A on the P849 lights as soon as GOOSE_B1 is received by P849.
- LED B on the P849 lights as soon as GOOSE_B2 is received by P849.
- LED C on the P849 lights as soon as GOOSE_B3 is received by P849.

This proves that GOOSE messages are correctly exchanged between P849 and P746-Box1.

1.2 Control Application

1.2.1 Definition

MiCOM P849 can communicate with the usual legacy protocols and thus will behave as Remote Terminal Unit (Communication to Digital Control System).

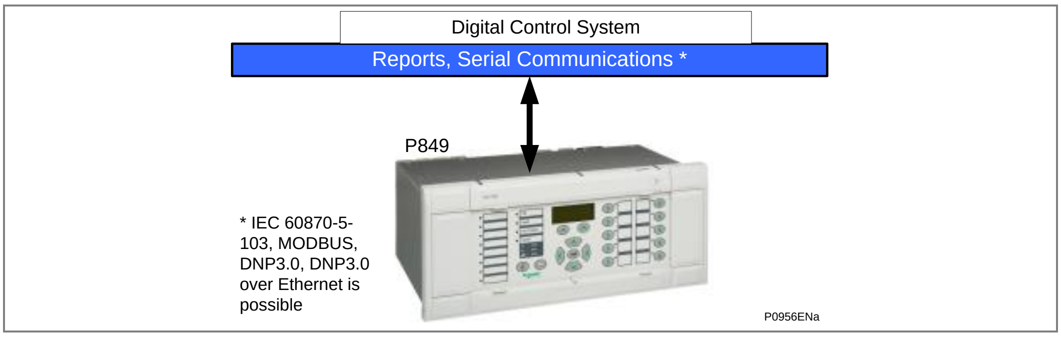


Figure 10 – P849 reports and serial communications

2 APPLICATION OF MICOM P849 FUNCTIONS

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

The non-protection features for the scheme are summarised below:

- Standard event and disturbance recording – Comprehensive analysis available via standard event lists, and precise event records which can be accessed locally via the relay LCD or remotely via the serial communication link.
- Real time clock/time synchronisation – Time synchronisation available via IRIG-B input.
- Four settings groups – Independent remotely selectable setting groups to allow for customer specific applications.
- Commissioning test facilities.
- Continuous self monitoring – extensive self checking routines to ensure maximum reliability.
- Graphical Programmable Scheme Logic (PSL) – allowing user control logic to be tailored to the specific application.

2.1 Function Keys

The relay offers users 10 function keys for programming any operator control functionality via PSL. Each function key has an associated programmable tri-colour LED that can be programmed to give the desired indication on function key activation.

These function keys can be used to trigger any function that they are connected to as part of the PSL. The function key commands can be found in the ‘Function Keys’ menu (see the Settings chapter). In the ‘Fn. Key Status’ menu cell there is a 10-bit word which represent the 10 function key commands and their status can be read from this 10-bit word.

In the programmable scheme logic editor 10 function key signals, which can be set to a logic 1 or On state, as described above, are available to perform control functions defined by the user.

The “Function Keys” column has ‘Fn. Key n Mode’ cell which allows the user to configure the function key as either ‘Toggled’ or ‘Normal’. In the ‘Toggle’ mode the function key DDB signal output will remain in the set state until a reset command is given, by activating the function key on the next key press. In the ‘Normal’ mode, the function key DDB signal will remain energized for as long as the function key is pressed and will then reset automatically.

A minimum pulse duration can be programmed for a function key by adding a minimum pulse timer to the function key DDB output signal.

The “Fn. Key n Status” cell is used to enable/unlock or disable the function key signals in PSL. The ‘Lock’ setting has been specifically provided to allow the locking of a function key thus preventing further activation of the key on consequent key presses. This allows function keys that are set to ‘Toggled’ mode and their DDB signal active ‘high’, to be locked in their active state thus preventing any further key presses from deactivating the associated function. Locking a function key that is set to the “Normal” mode causes the associated DDB signals to be permanently off. This safety feature prevents any inadvertent function key presses from activating or deactivating critical relay functions.

The “Fn. Key Labels” cell makes it possible to change the text associated with each individual function key. This text will be displayed when a function key is accessed in the function key menu, or it can be displayed in the PSL.

The status of the function keys is stored in battery backed memory. In the event that the auxiliary supply is interrupted the status of all the function keys will be recorded. Following the restoration of the auxiliary supply the status of the function keys, prior to supply failure, will be reinstated. If the battery is missing or flat the function key DDB signals will set to logic 0 once the auxiliary supply is restored.

Note	*The relay will only recognize a single function key press at a time and that a minimum key press duration of approximately 200msec. is required before the key press is recognized in PSL. This deglitching feature avoids accidental double presses.*

DDB: 'Function Key' (see the Programmable Logic chapter)

The activation of the function key will drive an associated DDB signal. The DDB signal will remain active depending on the programmed setting i.e. toggled or normal. Toggled mode means the DDB signal will remain latched or unlatched on key press and normal means the DDB will only be active for the duration of the key press.

DDB: 'FnKey LED 1 Red'

Ten programmable tri-colour LEDs associated with each function key are used to indicate the status of the associated pushbutton's function. Each LED can be programmed to indicate red, yellow or green as required. The green LED is configured by driving the green DDB input. The red LED is configured by driving the red DDB input. The yellow LED is configured by driving the red and green DDB inputs simultaneously. When the LED is activated the associated DDB signal will be asserted. For example, if FnKey Led 1 Red is activated, DDB will be asserted.

DDB 'FnKey LED 1 Grn'

The same explanation as for Fnkey 1 Red applies.

DDB 'LED 1 Red'

Eight programmable tri-colour LEDs that can be programmed to indicate red, yellow or green as required. The green LED is configured by driving the green DDB input. The red LED is configured by driving the red DDB input. The yellow LED is configured by driving the red and green DDB inputs simultaneously. When the LED is activated the associated DDB signal will be asserted. For example, if Led 1 Red is activated, DDB #640 will be asserted.

DDB 'LED 1 Grn'

The same explanation as for LED 1 Red applies.

2.2 Opto Inputs Configuration

This series of relays have universal opto-isolated logic inputs that can be programmed for the nominal battery voltage of the circuit of which they are a part. This allows different voltages for different circuits such as signaling and tripping. They can also be programmed as Standard 60% - 80% or 50% - 70% to satisfy different operating constraints.
Threshold levels are shown in this table:

Nominal battery voltage (Vdc)	Standard 60% - 80%		50% - 70%	
	No operation (Logic 0) Vdc	Operation (Logic 1) Vdc	No operation (Logic 0) Vdc	Operation (Logic 1) Vdc
24/27	<16.2	>19.2	<12.0	>16.8
30/34	<20.4	>24.0	<15.0	>21.0
48/54	<32.4	>38.4	<24.0	>33.6
110/125	<75.0	>88.0	<55.0	>77.0
220/250	<150.0	>176.0	<110	>154

Table 1 - Opto-Config Threshold Levels

This lower value eliminates fleeting pick-ups that may occur during a battery earth fault, when stray capacitance may present up to 50% of battery voltage across an input.

Each input also has selectable filtering. This allows a pre-set ½ cycle filter to be used to prevent induced noise on the wiring. However, although the ½ cycle filter is secure it can be slow, particularly for intertripping. If the ½ cycle filter is switched off to improve speed, double pole switching or screened twisted cable may be needed on the input to reduce ac noise.

2.3 Hotkeys / Control Inputs

2.3.1 Control Inputs

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

This column is visible when the “Control I/P Config” setting (“Configuration” column) = “visible”.

There are three setting columns associated with the control inputs that are: “CONTROL INPUTS”, “CTRL. I/P CONFIG.” and “CTRL. I/P LABELS”. The function of these columns is described below.

The Control Input commands can be found in the ‘Control Input’ menu. In the ‘Ctrl I/P Status’ menu cell there is a 32 bit word which represent the 32 control input commands. The status of the 32 control inputs can be read from this 32 bit word. The 32 control inputs can also be set and reset from this cell by setting a 1 to set or 0 to reset a particular control input. Alternatively, each of the 32 Control Inputs can be set and reset using the individual menu setting cells ‘Control Input 1, 2, 3’ etc. The Control Inputs are available through the relay menu as described above and also via the rear communications.

The two hotkeys in the front panel can perform a direct command if a dedicated PSL has been previously created using DDB: '**CONTROL INPUT**' cells (see the Programmable Logic chapter). The relay offers 32 control inputs which can be activated by the Hotkey manually or by the IEC 103 remote communication.

2.3.2 Control I/P Configuration

The **CTRL. I/P CONFIG.** column has several functions one of which allows the user to configure the control inputs as either **latched** or **pulsed**. A latched control input will remain in the set state until a reset command is given, either by the menu or the serial communications. A pulsed control input, however, will remain energized for 10ms after the set command is given and will then reset automatically (i.e. no reset command required).

In addition to the latched/pulsed option this column also allows the control inputs to be individually assigned to the **Hotkey** menu by setting **1** in the appropriate bit in the **Hotkey Enabled** cell. The hotkey menu allows the control inputs to be set, reset or pulsed without the need to enter the **CONTROL INPUTS** column. The **Ctrl. Command** cell also allows the SET/RESET text, displayed in the hotkey menu, to be changed to something more suitable for the application of an individual control input, such as **ON/OFF**, **IN/OUT** etc.

2.3.3 Control I/P Labels

The **CTRL. I/P LABELS** column makes it possible to change the text associated with each individual control input. This text will be displayed when a control input is accessed by the hotkey menu, or it can be displayed in the PSL.

Note	*With the exception of pulsed operation, the status of the control inputs is stored in battery backed memory. In the event that the auxiliary supply is interrupted the status of all the inputs will be recorded. Following the restoration of the auxiliary supply the status of the control inputs, prior to supply failure, will be reinstated. If the battery is missing or flat the control inputs will set to logic 0 once the auxiliary supply is restored.*

USING THE PSL EDITOR

CHAPTER 7

Date:	11/2016	
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.	
Hardware Suffix:	All MiCOM Px4x products	
Software Version:	All MiCOM Px4x products	
Connection Diagrams:	P14x (P141, P142, P143 & P145): 10P141xx (xx = 01 to 02) 10P142xx (xx = 01 to 05) 10P143xx (xx = 01 to 11) 10P145xx (xx = 01 to 11) P24x (P241, P242 & P243): 10P241xx (xx = 01 to 02) 10P242xx (xx = 01) 10P243xx (xx = 01) P34x (P342, P343, P344, P345 & P391): 10P342xx (xx = 01 to 17) 10P343xx (xx = 01 to 19) 10P344xx (xx = 01 to 12) 10P345xx (xx = 01 to 07) 10P391xx (xx = 01 to 02) P445: 10P445xx (xx = 01 to 04) P44x: 10P44101 (SH 1 & 2) 10P44201 (SH 1 & 2) 10P44202 (SH 1) 10P44203 (SH 1 & 2) 10P44401 (SH 1) 10P44402 (SH 1) 10P44403 (SH 1 & 2) 10P44404 (SH 1) 10P44405 (SH 1) 10P44407 (SH 1 & 2) P44y (P443 & P446): 10P44303 (SH 01 and 03) 10P44304 (SH 01 and 03) 10P44305 (SH 01 and 03) 10P44306 (SH 01 and 03) 10P44600 10P44601 (SH 1 to 2) 10P44602 (SH 1 to 2) 10P44603 (SH 1 to 2)	P54x (P543, P544, P545 & P546): 10P54302 (SH 1 to 2) 10P54303 (SH 1 to 2) 10P54400 10P54404 (SH 1 to 2) 10P54405 (SH 1 to 2) 10P54502 (SH 1 to 2) 10P54503 (SH 1 to 2) 10P54600 10P54604 (SH 1 to 2) 10P54605 (SH 1 to 2) 10P54606 (SH 1 to 2) P547: 10P54702xx (xx = 01 to 02) 10P54703xx (xx = 01 to 02) 10P54704xx (xx = 01 to 02) 10P54705xx (xx = 01 to 02) P64x (P642, P643 & P645): 10P642xx (xx = 1 to 10) 10P643xx (xx = 1 to 6) 10P645xx (xx = 1 to 9) P74x: 10P740xx (xx = 01 to 07) P746: 10P746xx (xx = 00 to 21) P841: 10P84100 10P84101 (SH 1 to 2) 10P84102 (SH 1 to 2) 10P84103 (SH 1 to 2) 10P84104 (SH 1 to 2) 10P84105 (SH 1 to 2) P849: 10P849xx (xx = 01 to 06)

CONTENTS

FIGURES

TABLES

Notes:

1 OVERVIEW

The purpose of the Programmable Scheme Logic (PSL) is to allow the relay user to configure an individual protection scheme to suit their own particular application. This is achieved through the use of programmable logic gates and delay timers.

The input to the PSL is any combination of the status of opto inputs. It is also used to assign the mapping of functions to the opto inputs and output contacts, the outputs of the protection elements, e.g. protection starts and trips, and the outputs of the fixed protection scheme logic. The fixed scheme logic provides the relay's standard protection schemes.

The PSL itself consists of software logic gates and timers. The logic gates can be programmed to perform a range of different logic functions and can accept any number of inputs. The timers are used either to create a programmable delay, and/or to condition the logic outputs, e.g. to create a pulse of fixed duration on the output regardless of the length of the pulse on the input. The outputs of the PSL are the LEDs on the front panel of the relay and the output contacts at the rear.

The execution of the PSL logic is event driven; the logic is processed whenever any of its inputs change, for example as a result of a change in one of the digital input signals or a trip output from a protection element. Also, only the part of the PSL logic that is affected by the particular input change that has occurred is processed. This reduces the amount of processing time that is used by the PSL; even with large, complex PSL schemes the relay trip time will not lengthen.

This system provides flexibility for the user to create their own scheme logic design. However, it also means that the PSL can be configured into a very complex system; hence setting of the PSL is implemented through the PC support package MiCOM S1 Studio.

Note	*MiCOM S1 Studio has been renamed as Easergy Studio.*

2 EASERGY STUDIO (MICOM S1 STUDIO) PSL EDITOR

Note	*MiCOM S1 Studio has been renamed as Easergy Studio.*

The PSL Editor can be used inside Easergy Studio (MiCOM S1 Studio) or directly.

This chapter assumes that you are using the PSL Editor from within Easergy Studio (MiCOM S1 Studio).

If you use it from Easergy Studio (MiCOM S1 Studio), the Studio software will be locked whilst you are using the PSL editor software. The Studio software will be unlocked when you close the PSL Editor software.

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

2.1 How to Obtain Easergy Studio (MiCOM S1 Studio) Software

Easergy Studio (MiCOM S1 Studio) is available from the Schneider Electric website:

- www.schneider-electric.com

2.2 To Start Easergy Studio (MiCOM S1 Studio)

To Start the Easergy Studio (MiCOM S1 Studio) software, click the **Start** > **Programs** > **Schneider Electric** > **MiCOM S1 Studio** > **MiCOM S1 Studio** menu option.

2.3 To Open a Pre-Existing System

Within Easergy Studio (MiCOM S1 Studio), click the **File** + **Open System** menu option.

Navigate to where the scheme is stored, then double-click to open the scheme.

2.4 To Start the PSL Editor

The PSL editor lets you connect to any MiCOM device front port, retrieve and edit its PSL files and send the modified file back to a suitable MiCOM device.

Px30 and Px40 products are edited different versions of the PSL Editor. There is one link to the Px30 editor and one link to the Px40 editor.

To start the PSL editor for Px40 products:

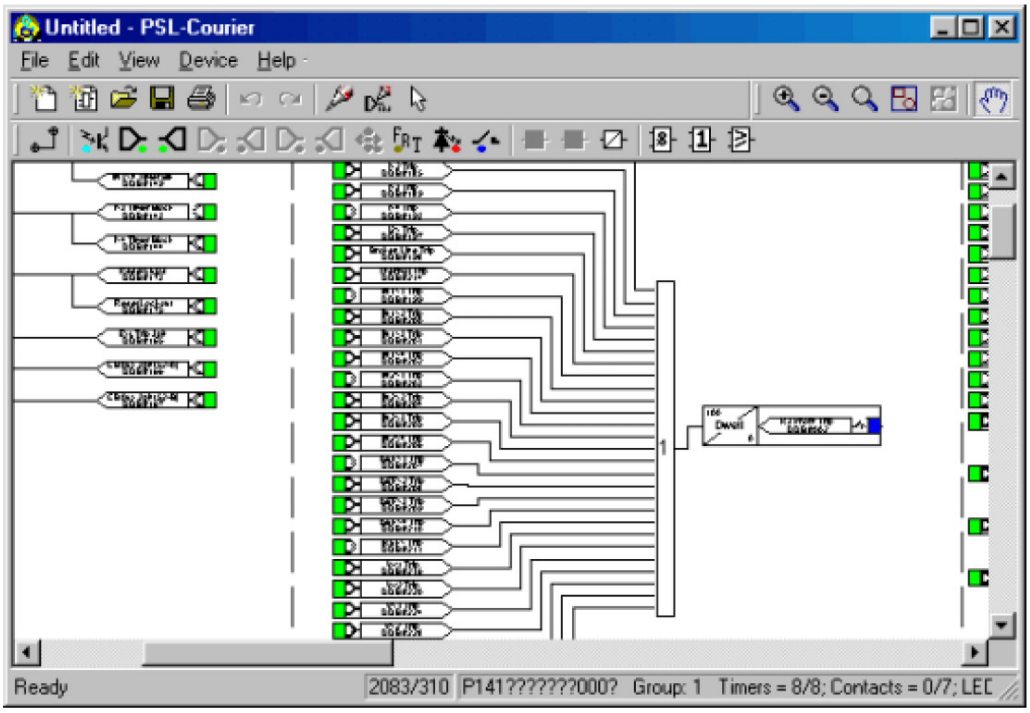
Highlight the PSL file you wish to edit, and then either:

Double-click the highlighted PSL file,

Click the open icon or

In the MiCOM S1 Studio main menu, select Tools > PSL PSL editor (Px40) menu.

The PSL Editor will then start, and show you the relevant PSL Diagram(s) for the file you have opened. An example of such a PSL diagram is shown in the *Example of a PSL editor module* diagram.



P0280ENa

Figure 1 - Example of a PSL editor module

2.5 How to use MiCOM PSL Editor

The MiCOM PSL editor lets you:

- Start a new PSL diagram
- Extract a PSL file from a MiCOM Px40 IED
- Open a diagram from a PSL file
- Add logic components to a PSL file
- Move components in a PSL file
- Edit link of a PSL file
- Add link to a PSL file
- Highlight path in a PSL file
- Use a conditioner output to control logic
- Download PSL file to a MiCOM Px40 IED
- Print PSL files

For a detailed discussion on how to use these functions, please refer to the Easergy Studio (MiCOM S1 Studio) User Manual.

2.6 Warnings

Before the scheme is sent to the relay checks are done. Various warning messages may be displayed as a result of these checks.

The Editor first reads in the model number of the connected relay, then compares it with the stored model number. A "wildcard" comparison is used. If a model mismatch occurs, a warning is generated before sending starts. Both the stored model number and the number read from the relay are displayed with the warning. However, the user must decide if the settings to be sent are compatible with the relay that is connected. Ignoring the warning could lead to undesired behavior of the relay.

If there are any potential problems of an obvious nature then a list will be generated. The types of potential problems that the program attempts to detect are:

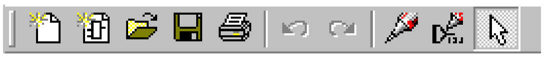
- One or more gates, LED signals, contact signals, and/or timers have their outputs linked directly back to their inputs. An erroneous link of this sort could lock up the relay, or cause other more subtle problems to arise.
- Inputs to Trigger (ITT) exceeds the number of inputs. If a programmable gate has its ITT value set to greater than the number of actual inputs; the gate can never activate. There is no lower ITT value check. A 0-value does not generate a warning.
- Too many gates. There is a theoretical upper limit of 256 gates in a scheme, but the practical limit is determined by the complexity of the logic. In practice the scheme would have to be very complex, and this error is unlikely to occur.
- Too many links. There is no fixed upper limit to the number of links in a scheme. However, as with the maximum number of gates, the practical limit is determined by the complexity of the logic. In practice the scheme would have to be very complex, and this error is unlikely to occur.

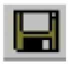
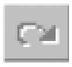
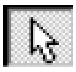
3 TOOLBAR AND COMMANDS

There are a number of toolbars available for easy navigation and editing of PSL.

3.1 Standard Tools

For file management and printing.

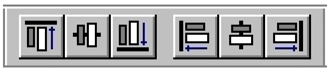


	Blank Scheme	Create a blank scheme based on a relay model.
	Default Configuration	Create a default scheme based on a relay model.
	Open	Open an existing diagram.
	Save	Save the active diagram.
	Print	Display the Windows Print dialog, enabling you to print the current diagram.
	Undo	Undo the last action.
	Redo	Redo the previously undone action.
	Redraw	Redraw the diagram.
	No of DDBs	Display the DDB numbers of the links.
	Calculate CRC	Calculate unique number based on both the function and layout of the logic.
	Compare Files	Compare current file with another stored on disk.
	Select	Enable the select function. While this button is active, the mouse pointer is displayed as an arrow. This is the default mouse pointer. It is sometimes referred to as the selection pointer.

Point to a component and click the left mouse button to select it. Several components may be selected by clicking the left mouse button on the diagram and dragging the pointer to create a rectangular selection area.

3.2 Alignment Tools

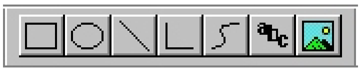
To align logic elements horizontally or vertically into groups.

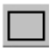


	Align Top	Align all selected components so the top of each is level with the others.
	Align Middle	Align all selected components so the middle of each is level with the others.
	Align Bottom	Align all selected components so the bottom of each is level with the others.
	Align Left	Align all selected components so the leftmost point of each is level with the others.
	Align Centre	Align all selected components so the centre of each is level with the others.
	Align Right	Align all selected components so the rightmost point of each is level with the others.

3.3 Drawing Tools

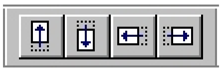
To add text comments and other annotations, for easier reading of PSL schemes.



	Rectangle	When selected, move the mouse pointer to where you want one of the corners to be hold down the left mouse button and move it to where you want the diagonally opposite corner to be. Release the button. To draw a square hold down the SHIFT key to ensure height and width remain the same.
	Ellipse	When selected, move the mouse pointer to where you want one of the corners to be hold down the left mouse button and move until the ellipse is the size you want it to be. Release the button. To draw a circle hold down the SHIFT key to ensure height and width remain the same.
	Line	When selected, move the mouse pointer to where you want the line to start, hold down left mouse, move to the position of the end of the line and release button. To draw horizontal or vertical lines only hold down the SHIFT key.
	Polyline	When selected, move the mouse pointer to where you want the polyline to start and click the left mouse button. Now move to the next point on the line and click the left button. Double click to indicate the final point in the polyline.
	Curve	When selected, move the mouse pointer to where you want the polycurve to start and click the left mouse button. Each time you click the button after this a line will be drawn, each line bisects its associated curve. Double click to end. The straight lines will disappear leaving the polycurve. Note: whilst drawing the lines associated with the polycurve, a curve will not be displayed until either three lines in succession have been drawn or the polycurve line is complete.
	Text	When selected, move the mouse pointer to where you want the text to begin and click the left mouse button. To change the font, size or colour, or text attributes select Properties from the right mouse button menu.
	Image	When selected, the Open dialog is displayed, enabling you to select a bitmap or icon file. Click Open, position the mouse pointer where you want the image to be and click the left mouse button.

3.4 Nudge Tools

To move logic elements.



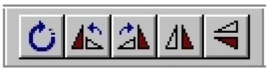
The nudge tool buttons enable you to shift a selected component a single unit in the selected direction, or five pixels if the SHIFT key is held down.

As well as using the tool buttons, single unit nudge actions on the selected components can be achieved using the arrow keys on the keyboard.

	Nudge Up	Shift the selected component(s) upwards by one unit. Holding down the SHIFT key while clicking on this button will shift the component five units upwards.
	Nudge Down	Shift the selected component(s) downwards by one unit. Holding down the SHIFT key while clicking on this button will shift the component five units downwards.
	Nudge Left	Shift the selected component(s) to the left by one unit. Holding down the SHIFT key while clicking on this button will shift the component five units to the left.
	Nudge Right	Shift the selected component(s) to the right by one unit. Holding down the SHIFT key while clicking on this button will shift the component five units to the right.

3.5 Rotation Tools

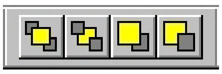
To spin, mirror and flip.

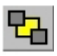
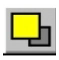


	Free Rotate	Enable the rotation function. While rotation is active components may be rotated as required. Press the ESC key or click on the diagram to disable the function.
	Rotate Left	Rotate the selected component 90 degrees to the left.
	Rotate Right	Rotate the selected component 90 degrees to the right.
	Flip Horizontal	Flip the component horizontally.
	Flip Vertical	Flip the component vertically.

3.6 Structure Tools

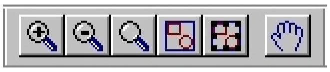
To change the stacking order of logic components.



	Bring to Front	Bring the selected components in front of all other components.
	Send to Back	Bring the selected components behind all other components.
	Bring Forward	Bring the selected component forward one layer.
	Send Backward	Send the selected component backwards one layer.

3.7 Zoom and Pan Tools

For scaling the displayed screen size, viewing the entire PSL, or zooming to a selection.



 Zoom In — Increases the Zoom magnification by 25%.

 Zoom Out — Decreases the Zoom magnification by 25%.

 Zoom — Enable the zoom function. While this button is active, the mouse pointer is displayed as a magnifying glass. Right-clicking will zoom out and left-clicking will zoom in. Press the ESC key to return to the selection pointer. Click and drag to zoom in to an area.

 Zoom to Fit — Display at the highest magnification that will show all the diagram's components.

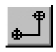
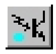
 Zoom to Selection — Display at the highest magnification that will show the selected component(s).

 Pan — Enable the pan function. While this button is active, the mouse pointer is displayed as a hand. Hold down the left mouse button and drag the pointer across the diagram to pan. Press the ESC key to return to the selection pointer.

3.8 Logic Symbols

This toolbar provides icons to place each type of logic element into the scheme diagram. Not all elements are available in all devices. Icons will only be displayed for those elements available in the selected device. Depending on the device, the toolbar may not include Function key or coloured LED conditioner/signal or Contact conditioner or SR Gate icons.

P2718ENa

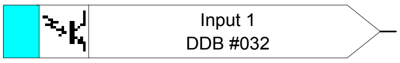
Link Create a link between two logic symbols.	
Opto Signal Create an opto signal.	
Input Signal Create an input signal.	
Output Signal Create an output signal.	
GOOSE In Create an input signal to logic to receive a UCA2.0 or IEC 61850 GOOSE message transmitted from another IED.	
GOOSE Out Create an output signal from logic to transmit a UCA2.0 or IEC 61850 GOOSE message to another IED.	
Control In Create an input signal to logic that can be operated from an external command.	
Integral Intertripping In/InterMiCOM In Create an input signal to logic to receive a MiCOM command transmitted from another IED. InterMiCOM is not available for all products.	

Integral Intertripping Out/InterMiCOM OutCreate an output signal from logic to transmit a MiCOM command to another IED. InterMiCOM is not available for all products.	
Function Key Create a function key input signal.	
Trigger Signal Create a fault record trigger.	
LED Signal Create an LED input signal that repeats the status of the LED. The icon colour shows whether the product uses mono-colour or tri-color LEDs.	
Contact Signal Create a contact signal.	
LED Conditioner Create a LED conditioner. The icon colour shows whether the product uses mono-colour or tri-color LEDs.	
Contact Conditioner Create a contact conditioner. Contact conditioning is not available for all products.	
Timer Create a timer.	
AND Gate Create an AND Gate.	
OR Gate Create an OR Gate.	
Programmable Gate Create a programmable gate.	
SR gate Create an SR gate.	

4 PSL LOGIC SIGNALS PROPERTIES

The logic signal toolbar is used for the selection of logic signals.

This allows you to link signals together to program the PSL. A number of different properties are associated with each signal. In the following sections, these are characterized by the use of an icon from the toolbar; together with a signal name and a DDB number. The name and DDB number are shown in a pointed rectangular block, which includes a colour code, the icon, the name, DDB No and a directional pointer. One example of such a block (for P54x for Opto Signal 1 DDB No #032) is shown below:



More examples of these are shown in the following properties sections.

Important	**The DDB Numbers vary according to the particular product and the particular name, so that Opto Signal 1 may not be DDB No #032 for all products. The various names and DDB numbers illustrated below are provided as an example.** **You need to look up the DDB numbers for the signal and the specific MiCOM product you are working on in the relevant DDB table for your chosen product.** **Available functions will depend on model/firmware version.**

4.1 Signal Properties Menu

The logic signal toolbar is used for the selection of logic signals. To use this:

- Use the logic toolbar to select logic signals.
  This is enabled by default but to hide or show it, select **View** > **Logic Toolbar**.
- Zoom in or out of a logic diagram using the toolbar icon or select **View** > **Zoom Percent**.
- Right-click any logic signal and a context-sensitive menu appears.
- Certain logic elements show the **Properties…** option. Select this and a **Component Properties** window appears. The Component Properties window and the signals listed vary depending on the logic symbol selected.

The following subsections describe each of the available logic symbols.

4.2 Link Properties

Links form the logical link between the output of a signal, gate or condition and the input to any element.

Any link that is connected to the input of a gate can be inverted. Right-click the input and select **Properties…**. The **Link Properties** window appears.

Figure 2 - Link properties

4.2.1 Rules for Linking Symbols

An inverted link is shown with a small circle on the input to a gate. A link must be connected to the input of a gate to be inverted.

Links can only be started from the output of a signal, gate, or conditioner, and can only be ended at an input to any element.

Signals can only be an input or an output. To follow the convention for gates and conditioners, input signals are connected from the left and output signals to the right. The Editor automatically enforces this convention.

A link is refused for the following reasons:

- An attempt to connect to a signal that is already driven. The reason for the refusal may not be obvious because the signal symbol may appear elsewhere in the diagram.

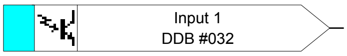
  Right-click the link and select Highlight to find the other signal. Click anywhere on the diagram to disable the highlight.

- An attempt is made to repeat a link between two symbols. The reason for the refusal may not be obvious because the existing link may be represented elsewhere in the diagram.

4.3 Opto Signal Properties

Each opto input can be selected and used for programming in PSL. Activation of the opto input drives an associated DDB signal.

For example, activating opto Input L1 asserts DDB 032 in the PSL for the P14x, P34x, P44y, P445, P54x, P547, P74x, P746, P841, P849 products.

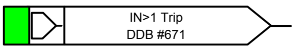


DDB Nos	*"Input 1 DDB #064" applies to: P24x, P64x.* *"Opto Label DDB #064" applies to: P44x.*

4.4 Input Signal Properties

Relay logic functions provide logic output signals that can be used for programming in PSL. Depending on the relay functionality, operation of an active relay function drives an associated DDB signal in PSL.

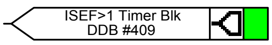
For example, DDB 671 is asserted in the PSL for the P44y, P547 & P841 product if the active earth fault 1, stage 1 protection operate/trip.



4.5 Output Signal Properties

Relay logic functions provide logic input signals that can be used for programming in PSL. Depending on the relay functionality, activation of the output signal will drive an associated DDB signal in PSL and cause an associated response to the relay function.

For example, if DDB 409 is asserted in the PSL for the P44y, P54x, P547 and P841 product, it will block the sensitive earth function stage 1 timer.



4.6 GOOSE Input Signal Properties

The PSL interfaces with the GOOSE Scheme Logic using virtual inputs. The Virtual Inputs can be used in much the same way as the Opto Input signals.

The logic that drives each of the Virtual Inputs is contained within the relay's GOOSE Scheme Logic file. It is possible to map any number of bit-pairs, from any enrolled device, using logic gates onto a Virtual Input (see Easergy Studio (MiCOM S1 Studio) User Manual for more details). The number of available GOOSE virtual inputs is shown in the *Programmable Logic* chapter.

For example DDB 224 will be asserted in PSL for the P44y, P54x, P547 & P841 product should virtual input 1 operate.

4.7 GOOSE Output Signal Properties

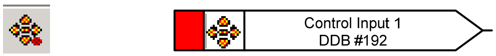
The PSL interfaces with the GOOSE Scheme Logic using 32 virtual outputs. Virtual outputs can be mapped to bit-pairs for transmitting to any enrolled devices.

For example if DDB 256 is asserted in PSL for the P44y, P54x, P547 and P841 product, Virtual Output 32 and its associated mappings will operate.

4.8 Control In Signal Properties

There are 32 control inputs which can be activated via the relay menu, 'hotkeys' or via rear communications. Depending on the programmed setting i.e. latched or pulsed, an associated DDB signal will be activated in PSL when a control input is operated

For example, when operated control input 1 will assert DDB 192 in the PSL for the P44y, P54x, P547 and P841 products.

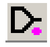


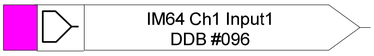
4.9 InterMiCOM Output Commands Properties

There are 16 InterMiCOM outputs that could be selected and use for teleprotection, remote commands, etc. "InterMiCOM Out" is a send command to a remote end that could be mapped to any logic output or opto input. This will be transmitted to the remote end as corresponding "InterMiCOM In" command for the P14x, P44y, P445 & P54x products.

4.10 InterMiCOM Input Commands Properties

There are 16 InterMiCOM inputs that could be selected and use for teleprotection, remote commands, etc. “InterMiCOM In” is a received signal from remote end that could be mapped to a selected output relay or logic input.



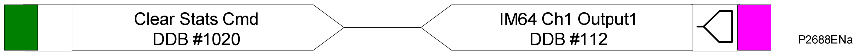


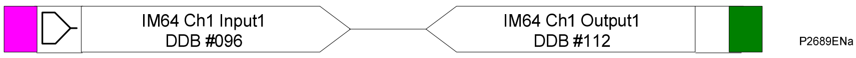
Example:

Relay End A — At end A, InterMiCOM Output 1 is mapped to the command indication “Clear Statistics” (issued at end A).

Relay End B — At end B, InterMiCOM Input 1 is mapped to the command “Clear Statistics”.

Upon receive of IM64 1 from relay at end A, the relay at end B will reset its statistics.





4.11 Function Key Properties

Each function key can be selected and used for programming in PSL. Activation of the function key will drive an associated DDB signal and the DDB signal will remain active depending on the programmed setting i.e. toggled or normal. Toggled mode means the DDB signal will remain latched or unlatched on key press and normal means the DDB will only be active for the duration of the key press.

For example, operate function key 1 to assert DDB 1096 in the PSL for the P44y, P54x, P547 or P841 products.

4.12 Fault Recorder Trigger Properties

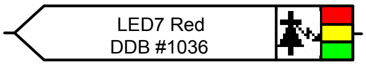
The fault recording facility can be activated by driving the fault recorder trigger DDB signal.

For example assert DDB 702 to activate the fault recording in the PSL for the P44y, P54x, P547 or P841 product.

4.13 LED Signal Properties

All programmable LEDs will drive associated DDB signal when the LED is activated.

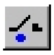
For example DDB 1036 will be asserted when LED 7 is activated for the P44y, P54x, P547 or P841 product.



4.14 Contact Signal Properties

All relay output contacts will drive associated DDB signal when the output contact is activated.

For example, DDB 009 will be asserted when output R10 is activated for all products.



4.15 LED Conditioner Properties

1. Select the **LED name** from the list (only shown when inserting a new symbol).

2. Configure the LED output to be Red, Yellow or Green.

   Configure a Green LED by driving the Green DDB input.
   Configure a RED LED by driving the RED DDB input.
   Configure a Yellow LED by driving the RED and GREEN DDB inputs simultaneously.

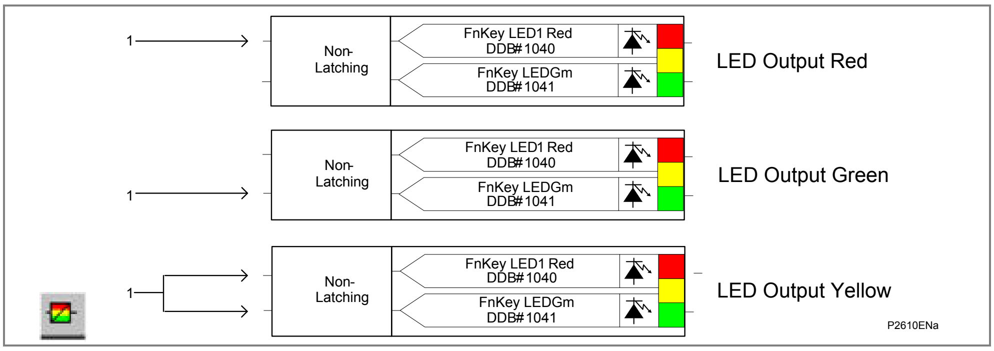


Figure 3 - Red, green and yellow LED outputs

3. Configure the LED output to be latching or non-latching.

DDB #642 and DDB #643 applies to these products: P14x, P44x, P74x, P746 and P849.

DDB #1040 and DDB #1041 applies to these products: P24x, P34x, P44y, P54x, P547, P64x and P841.

4.16 Contact Conditioner Properties

Each contact can be conditioned with an associated timer that can be selected for pick up, drop off, dwell, pulse, pick-up/drop-off, straight-through, or latching operation.

Straight-through means it is not conditioned in any way whereas **Latching** is used to create a sealed-in or lockout type function.

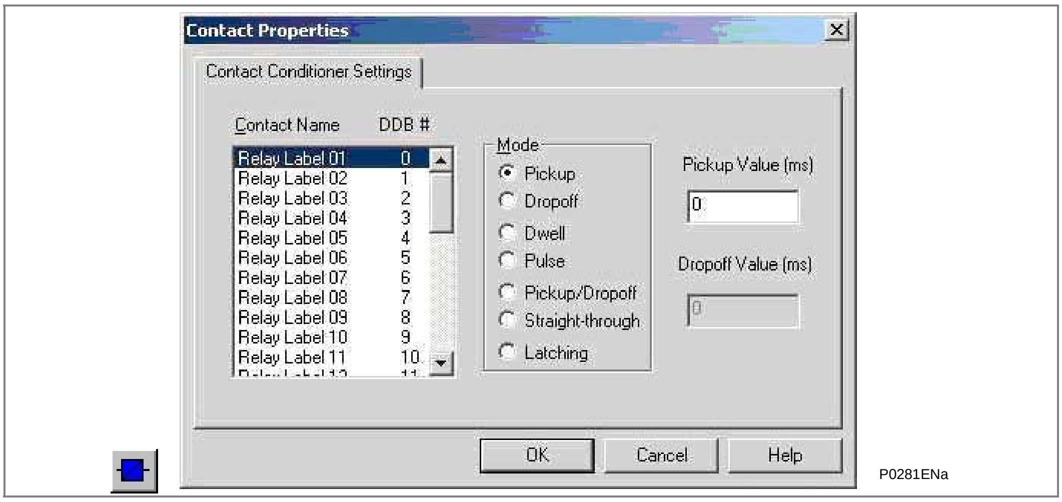


Figure 4 - Contact conditioner settings

1. Select the contact **name** from the **Contact Name** list (only shown when inserting a new symbol).
2. Choose the conditioner type required in the **Mode** tick list.
3. Set the **Pick-up** Time (in milliseconds), if required.
4. Set the **Drop-off** Time (in milliseconds), if required.

4.17 Timer Properties

Each timer can be selected for pick up, drop off, dwell, pulse or pick-up/drop-off operation.

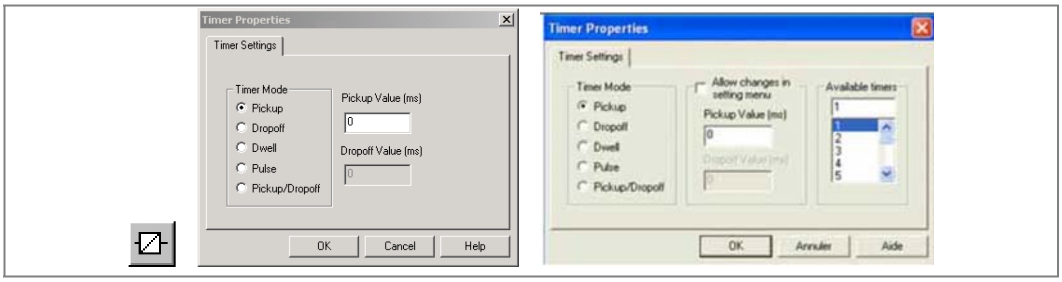


Figure 5 - Timer settings

1. Choose the operation mode from the **Timer Mode** tick list.
2. Set the Pick-up Time (in milliseconds), if required.
3. Set the Drop-off Time (in milliseconds), if required.

4.18 Gate Properties

A Gate may be an AND, OR, or programmable gate.

	An **AND** gate requires that all inputs are TRUE for the output to be TRUE.
	An **OR** gate requires that one or more input is TRUE for the output to be TRUE.
	A **Programmable** gate requires that the number of inputs that are TRUE is equal to or greater than its 'Inputs to Trigger' setting for the output to be TRUE.

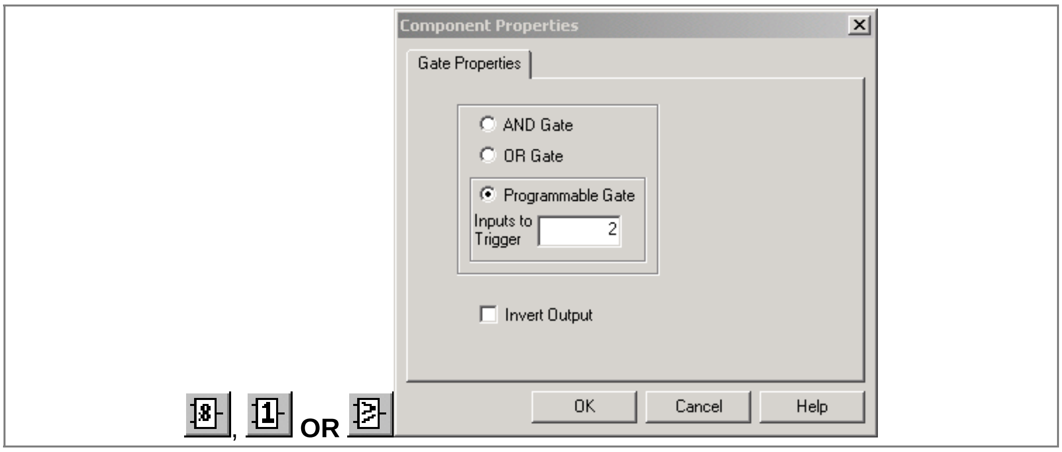


Figure 6 - Gate properties

1. Select the Gate type AND, OR, or Programmable.
2. Set the number of inputs to trigger when Programmable is selected.
3. Select if the output of the gate should be inverted using the Invert Output check box. An inverted output is indicated with a "bubble" on the gate output.

4.19 SR Programmable Gate Properties

For many products a number of programmable SR Latches are added. They are configured by an appropriate version of PSL Editor (S1v2.14 version 5.0.0 or greater) where an SRQ icon features on the toolbar.

Each SR latch has a Q output. The Q output may be inverted in the PSL Editor under the SR Latch component properties window. The SR Latches may be configured as Standard (no input dominant), Set Dominant or Reset Dominant in the PSL Editor under the SR Latch component properties window. The truth table for the SR Latches is given below.

A **Programmable** SR gate can be selected to operate with these latch properties:

S input	R input	O - Standard	O – Set input dominant	O – Rest input dominant
0	0	0	0	0
0	1	0	0	0
1	0	1	1	1
1	1	0	1	1

Table 1 - SR programmable gate properties

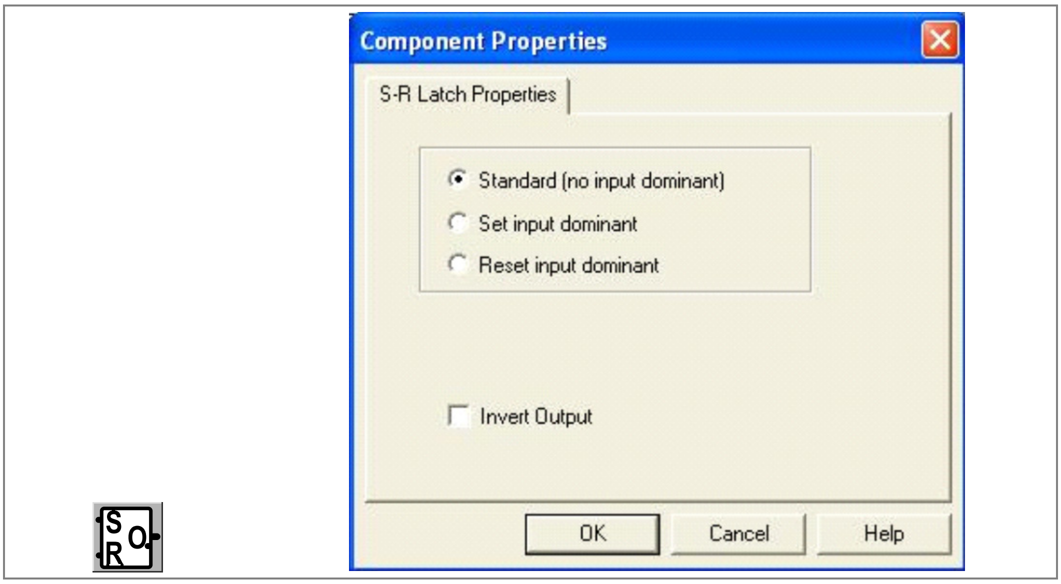


Figure 7 - SR latch component properties

Select if the output of the gate should be inverted using the Invert Output check box. An inverted output is indicated with a "bubble" on the gate output.

4.20 PSL Signal Grouping Modes

PSL Signal Grouping Nodes
For Software Version D1a and later, these DDB “Group” Nodes can be mapped to individual or multiple DDBs in the PSL:
PSL Group Sig 1
PSL Group Sig 2
PSL Group Sig 3
PSL Group Sig 4

There are now four additional ***DDB Group Sig x*** Nodes that can be mapped to individual or multiple DDBs in the PSL. These can then be set to trigger the DR via the DISTURBANCE RECORD menu.

These "Nodes" are general and can also be used to group signals together in the PSL for any other reason. These four nodes are available in each of the four PSL setting groups.

Number	PSL Group Sig
992	PSL Group Sig 1
993	PSL Group Sig 2
994	PSL Group Sig 3
995	PSL Group Sig 4

1. For a control input, the DR can be triggered directly by triggering directly from the Individual Control Input (e.g. Low to High (L to H) change)
2. For an input that cannot be triggered directly, or where any one of a number of DDBs are required to trigger a DR, map the DDBs to the new PSL Group sig n and then trigger the DR on this.

e.g. in the PSL:

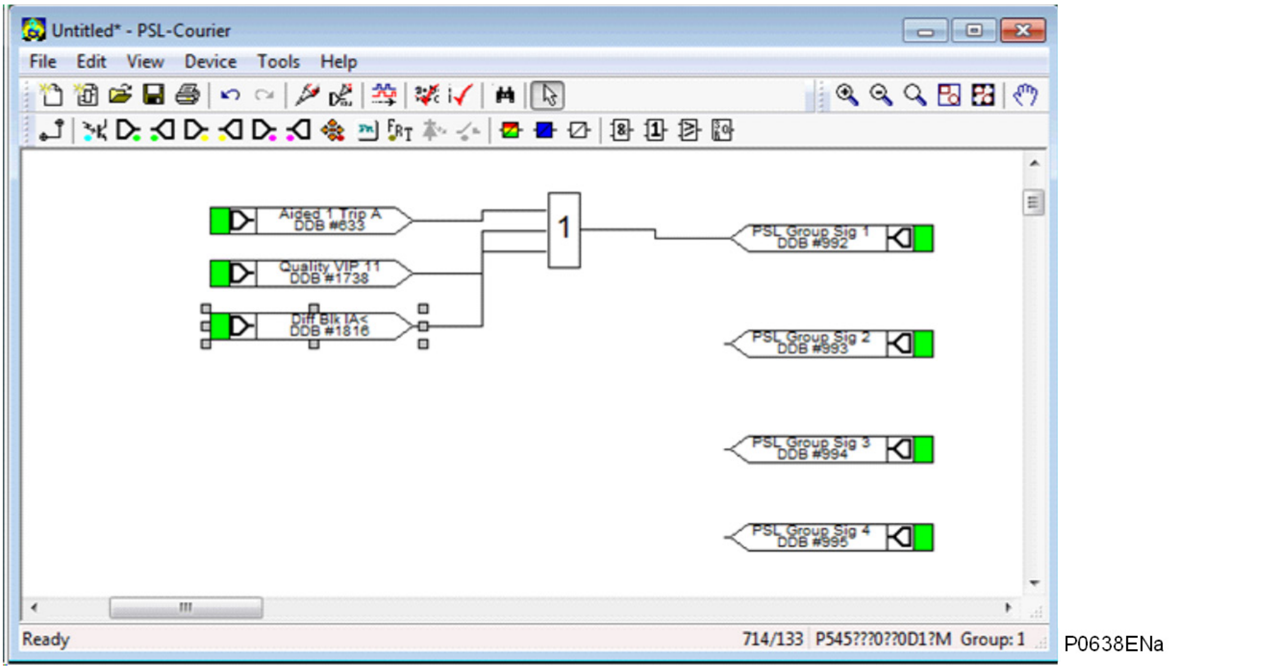


Figure 8 - PSL diagram

In the DR Settings:

- Digital Input 1 is triggered by the PSL Group Sig 1 (L to H)
- Digital Input 2 is triggered by Control Input 1 (L to H)

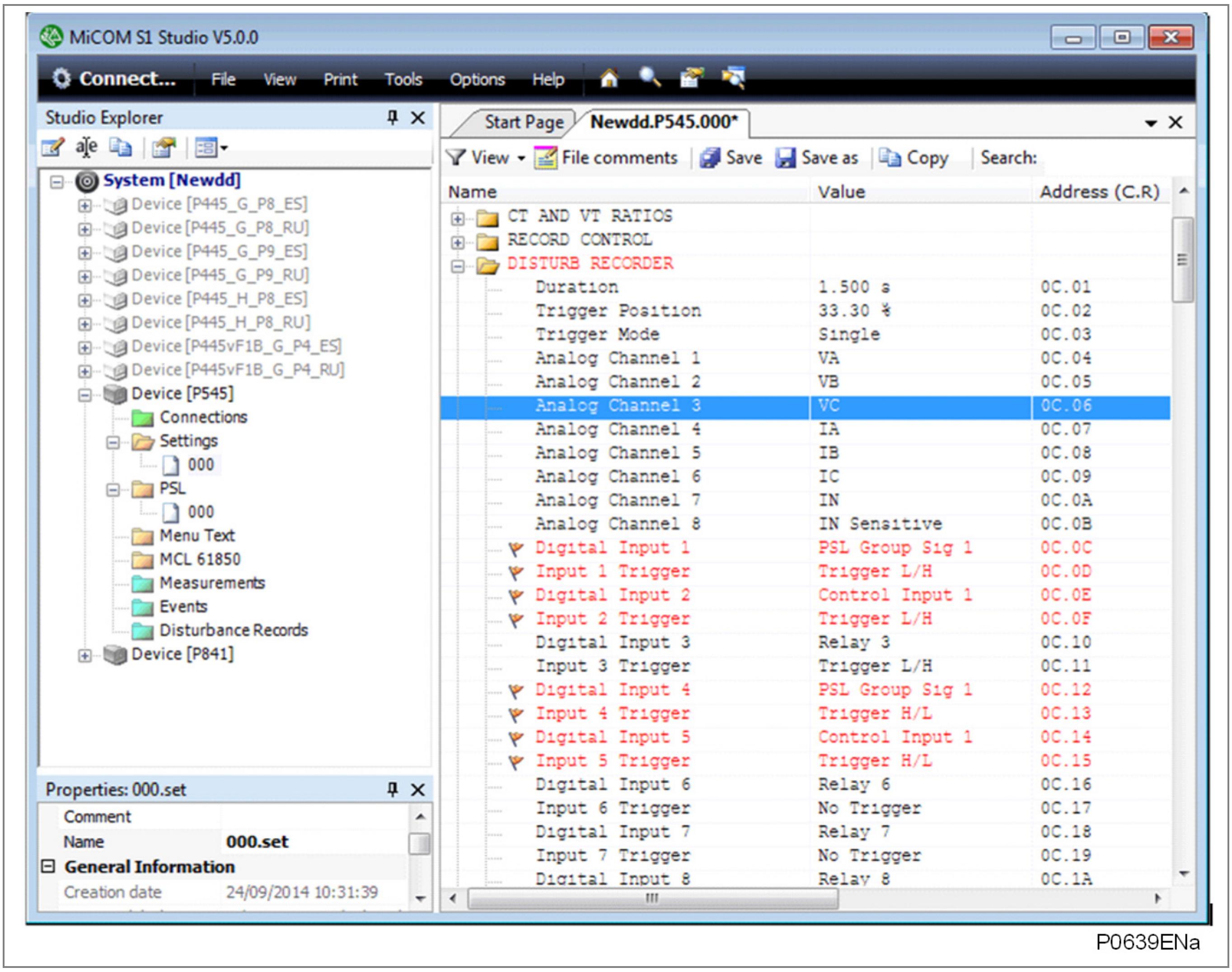


Figure 9 – Easergy Studio (MiCOM S1 Studio) Disturb Recorder table diagram

If triggering on both edges is required map another DR channel to the H/L as well
Digital Input 4 is triggered by the PSL Group Sig 1 (H to L)
Digital Input 5 is triggered by Control Input 1 (H to L)

5 SPECIFIC TASKS

Note	*MiCOM S1 Studio has been renamed as Easergy Studio.*

5.1 Digital Input Label Operation

The digital input labels can be modified via the MiCOM Px40 user interface or Easergy Studio (MiCOM S1 Studio). The following example is using S1 Studio Version 5.0.0. The digital input labels are available in the “DR CHAN LABELS” folder in the settings file as shown below:

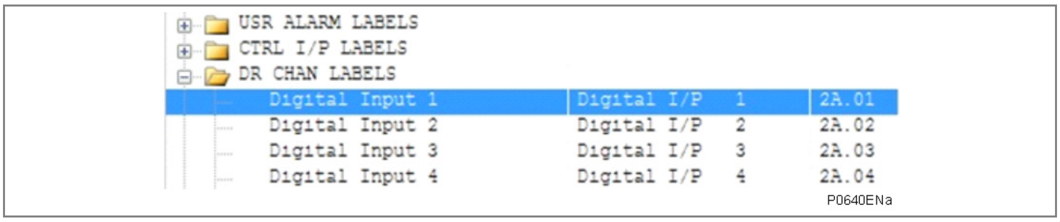


Figure 10 - DR Chan Labels tree

Easergy Studio (MiCOM S1 Studio) removes leading spaces from the value field so making the ‘D’ look as if it’s the 1st character in the label. The default values above in fact have a leading space which is used to switch off the use of the label as show below in the change settings view.

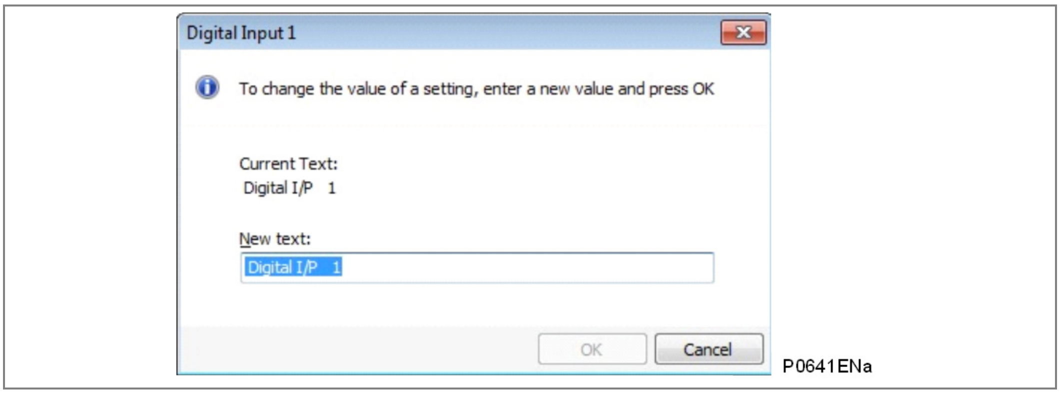


Figure 11 - Digital Input 1 dialog box

Pressing OK will save the setting and return to the settings page as follows:

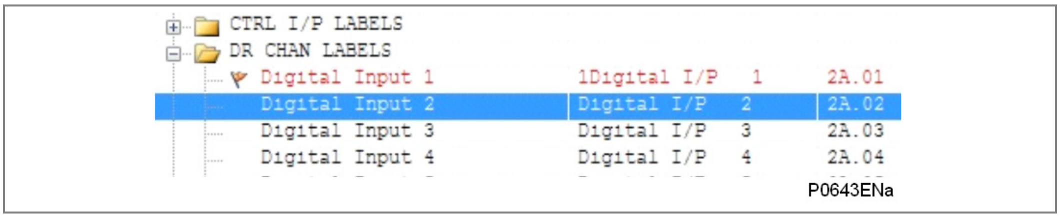


Figure 12 - DR Chan Labels tree

Digital Input 1 label will now be used in the Disturbance Record when the settings file is downloaded to the relay.

5.2 Virtual Input Label Operation

The Virtual Input labels can be modified via the MiCOM Px40 user interface or Easergy Studio (MiCOM S1 Studio). The following example is using S1 Studio Version 5.0.0.

The default labels are available in the “VIR I/P LABELS” (or “VIRT I/P LABELS”) folder in the settings file as shown below:

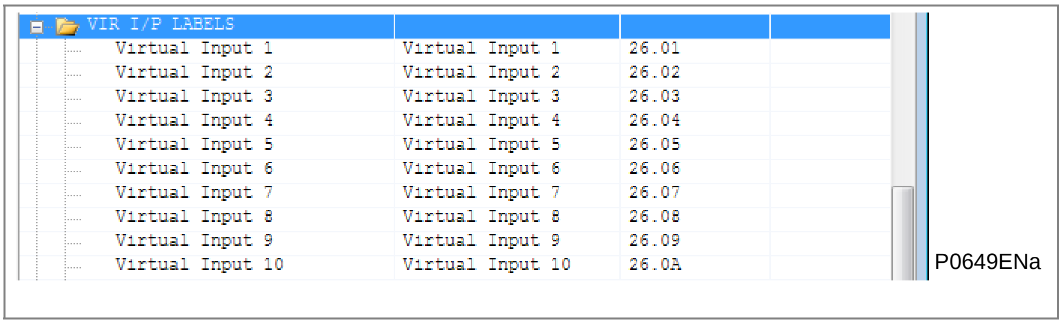


Figure 13 - MiCOM S1 Studio VIR I/P Labels Tree

The default “Virtual Input” labels can be changed to suit the customer requirements. For example, to change default text from “Virtual Input 1” to “Customer Func 1” open the ***Virtual Input 1*** dialog box, and change “Virtual Input 1” in the ***New Text:*** text box to be “Customer Func 1”, as follows:

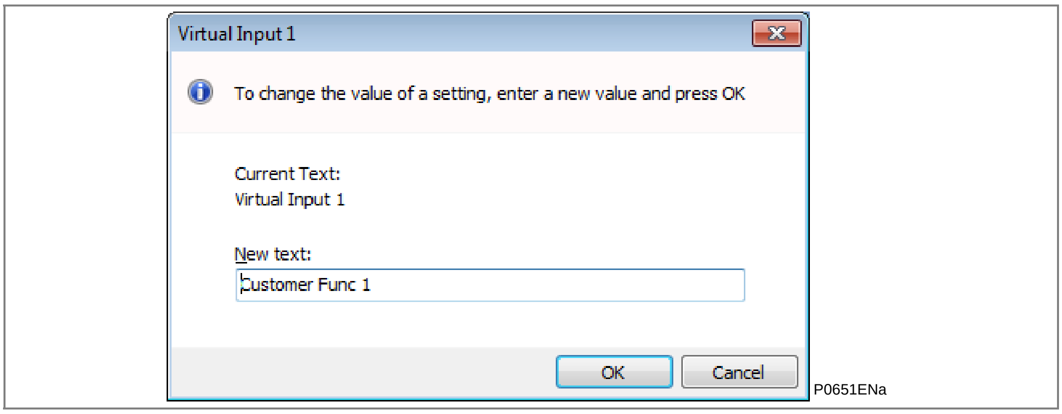


Figure 14 - Virtual Input 1 dialog box

Pressing OK will save the setting and return to the settings page as follows:

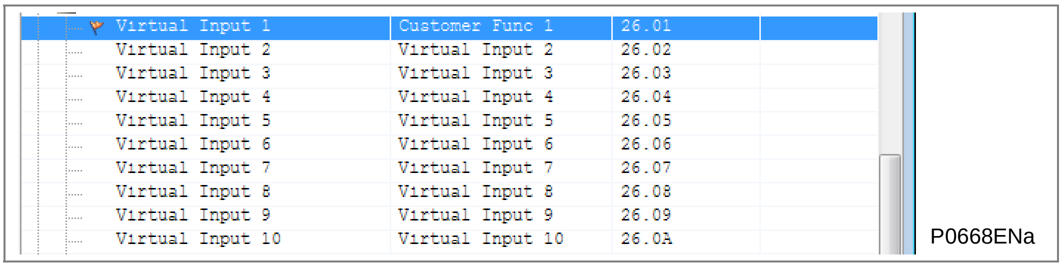


Figure 15 - Easergy Studio (MiCOM S1 Studio) VIR I/P Labels Tree

The above “Customer Func 1” label text will now be used in place of “Virtual Input 1” in the Disturbance / Event Records after the settings file is downloaded to the relay.

5.3 Virtual Output Label Operation

The Virtual Output labels can be modified via the MiCOM Px40 user interface or Easergy Studio (MiCOM S1 Studio). The following example is using S1 Studio Version 5.0.0.

The virtual Output labels are available in the “VIR O/P LABELS” ” (or “VIRT O/P LABELS”) folder in the settings file as shown below:

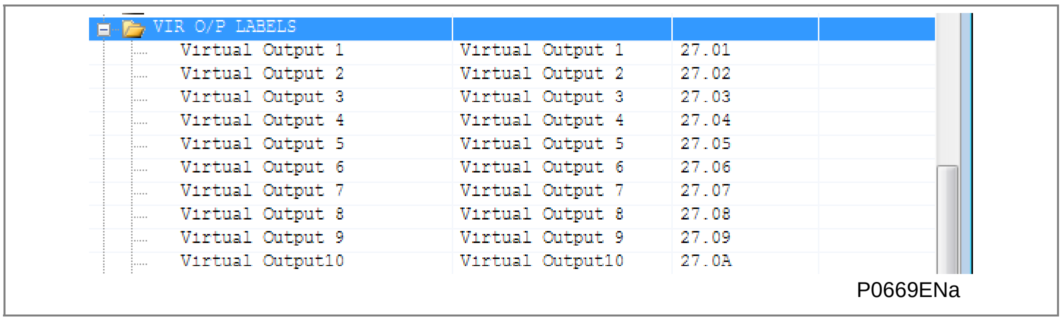


Figure 16 - Easergy Studio (MiCOM S1 Studio) VIR O/P Labels Tree

The default “Virtual Output Labels” can be changed to suit the customer requirements. The process is identical to the previously described procedure for the Virtual Input Labels.

5.4 SR/MR User Alarm Label Operation

The SR/MR User Alarm input labels can be modified via the MiCOM Px40 user interface or Easergy Studio (MiCOM S1 Studio). This example is using S1 Studio Version 5.0.0.

The default labels are available in the “USR ALARM LABELS” folder in the settings file as shown below:

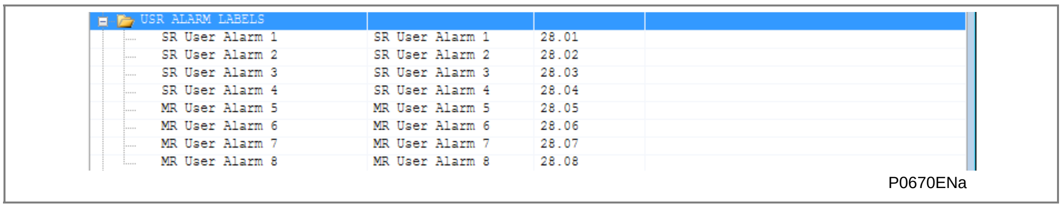


Figure 17 - Easergy Studio (MiCOM S1 Studio) USR Labels Tree

The default “SR User Alarm” and “MR User Alarm” labels can be changed to suit the customer requirements. For example, to change default text from “SR User Alarm 1” to “Customer Alarm 1” open the ***SR User Alarm 1*** dialog box and change “SR User Alarm 1” in the ***New Text:*** Text box to be “Customer Alarm 1”.

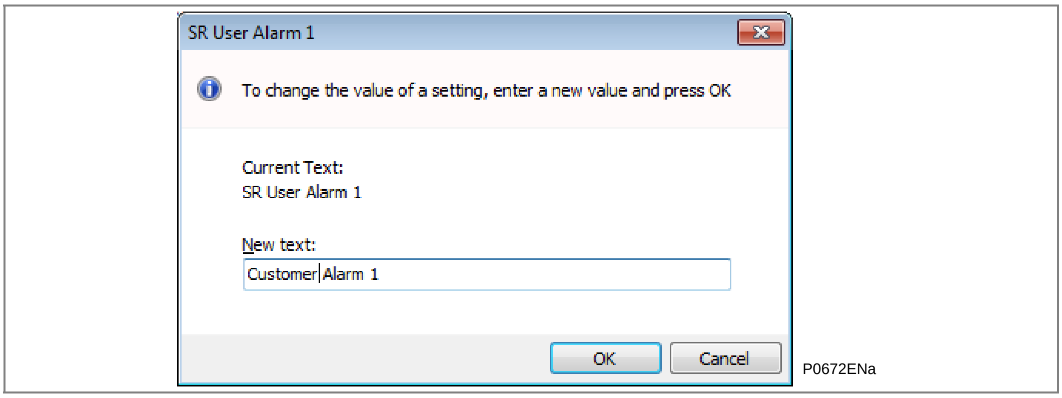


Figure 18 - Virtual Input 1 dialog box

Pressing OK will save the setting and return to the settings page as follows:

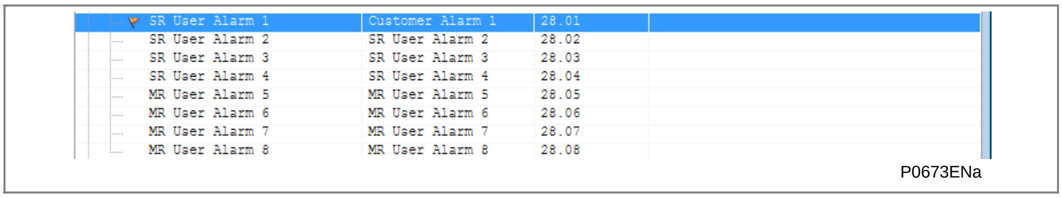


Figure 19 - Virtual Input 1 settings

The above “Customer Alarm 1” label text will now be used in place of “SR User Alarm 1” in the Disturbance / Event Records after the settings file is downloaded to the relay.

5.5 Settable Control Input Operation

The settings should be applied to all relays in the current differential protection scheme.

As from Software Versions C1/D1/F1/G4/H4/J4, there are now 32 Standard Control Inputs and 16 additional Settable Control Inputs available. These are settable via the “CONTROL INPUTS” folder and are located after the standard “Control Input” labels in the relevant settings file.

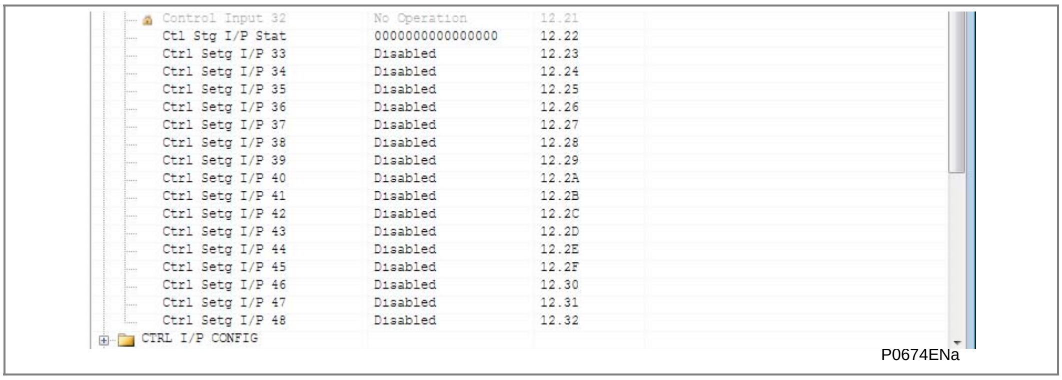


Figure 20 - Easergy Studio (MiCOM S1 Studio) Control Inputs tree

Each Settable control Input “Ctrl Setg I/P xx” can be controlled using Enable / Disable settings. To change from (the default) Disabled to Enabled, open the ***Ctrl Setg I/P xx*** dialog box, then change Disabled to Enabled in the ***New Setting*** drop-down list box:

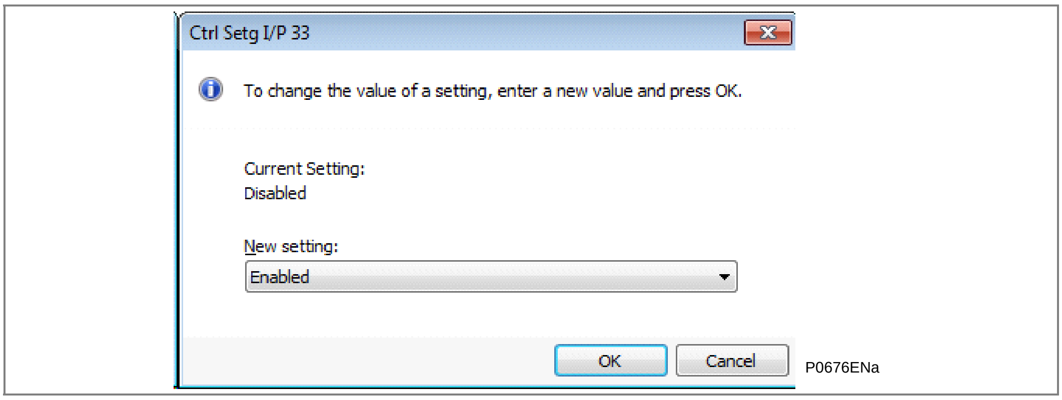


Figure 21 – Ctrl Setg I/P 33 dialog box

Pressing OK will save the setting and return to the settings page as follows:

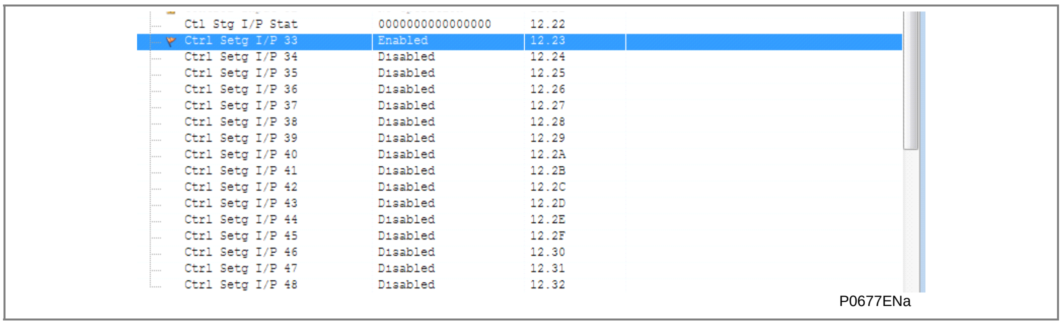


Figure 22 - Easergy Studio (MiCOM S1 Studio) Control Inputs (Ctl Setg I/P 33) tree

The setting “Ctl Stg I/P Stat” can be used to control multiple “Ctrl Setg I/P” at the same time, e.g. clear Ctrl Setg I/P 33 and set Ctrl Setg I/P 34 to 38, but please note that the status will not be reflected in the individual inputs settings or vice versa.

This cell may be hidden in the Easergy Studio (MiCOM S1 Studio) files.

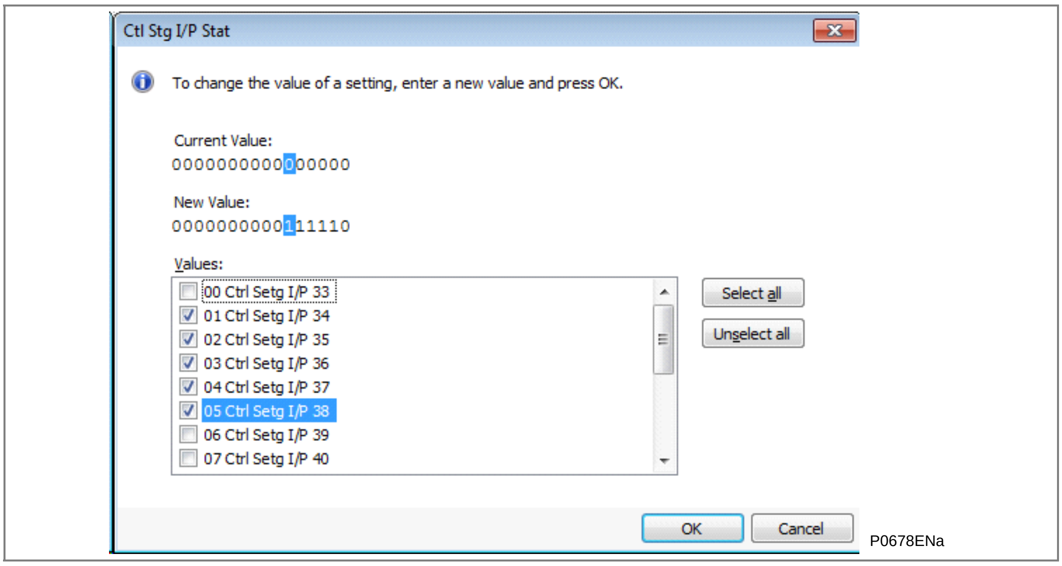


Figure 23 – Ctrl Stg I/P Stat dialog box

5.6 Settable Control Setg I/P Label Operation (P14x, P44y, P54x, P445 & P841 only)

The default labels are available in the “CTRL I/P LABELS” folder and are located after the standard “Control Input” labels in the settings file as shown below:

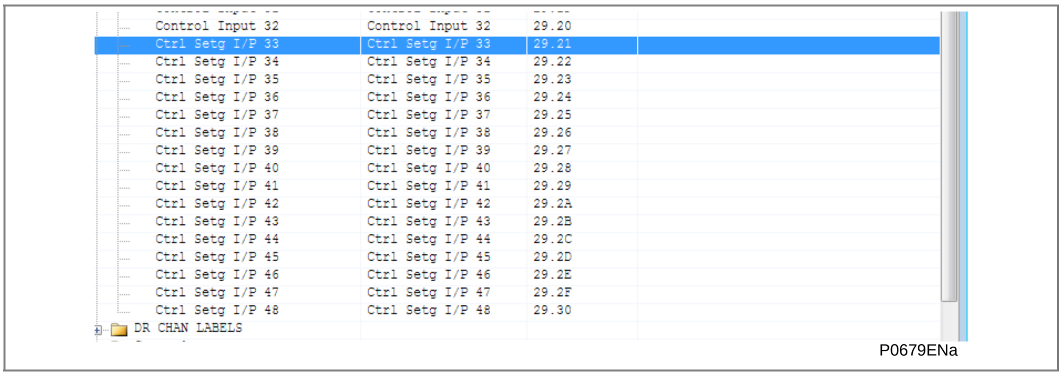


Figure 24 - Easergy Studio (MiCOM S1 Studio) Control I/P Labels (Ctl Setg I/P 33) tree

The default “Ctrl Setg I/P” labels can be changed to suit the customer requirements using the same procedure as for the standard “Control Inputs”. For example to change the default text from “Ctrl Setg I/P 33” to “Custom Ctrl Sg 1” open the ***Ctrl Setg I/P 33*** dialog box, then change “Ctrl Setg I/P 33” in the ***New Text:*** box to be “Custom Ctrl Sg 1”.

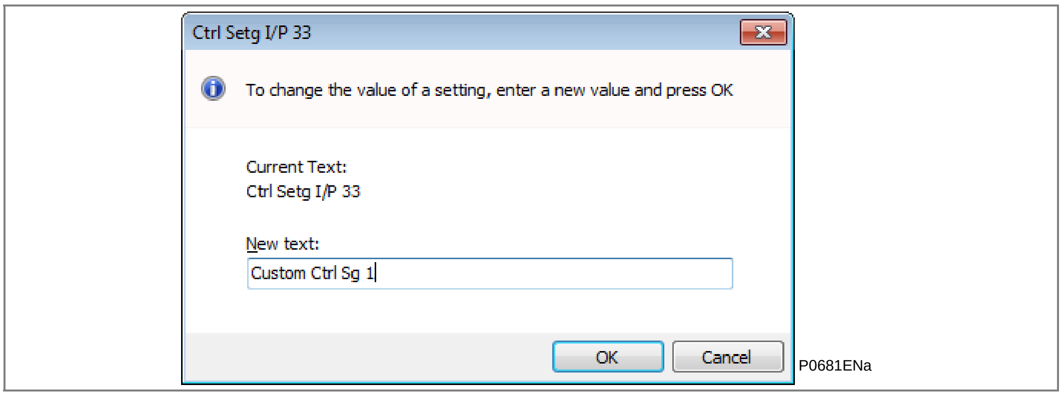


Figure 25 – Ctrl Setg I/P 33 dialog box

Pressing OK will save the setting and return to the settings page as follows:

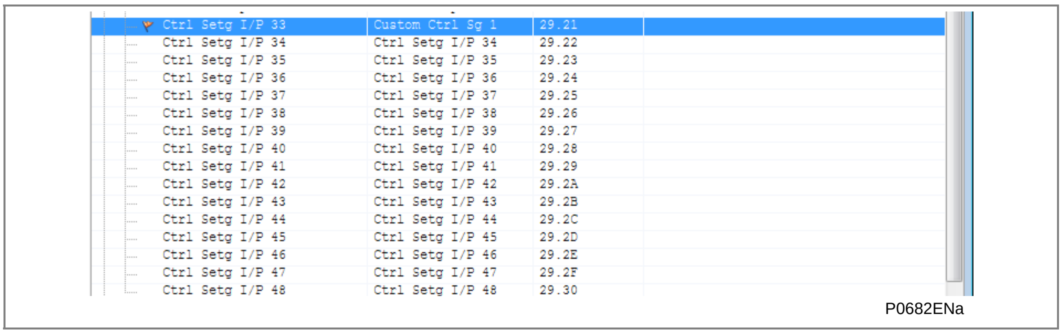


Figure 26 - Easergy Studio (MiCOM S1 Studio) Control I/P Labels (Ctl Setg I/P 33) tree

The above “Custom Ctrl Sg 1” label text will now be used in place of “Ctrl Setg I/P 33” in the Disturbance / Event Records after the settings file is downloaded to the relay.

6 MAKING A RECORD OF MICOM PX40 DEVICE SETTINGS

6.1 Using Easergy Studio (MiCOM S1 Studio) to Manage Device Settings

An engineer often needs to create a record of what settings have been applied to a device. In the past, they could have used paper printouts of all the available settings, and mark up the ones they had used. Keeping such a paper-based Settings Records could be time-consuming and prone to error (e.g. due to being settings written down incorrectly).

The Easergy Studio (MiCOM S1 Studio) software lets you read from or write to MiCOM devices.

- **Extract** lets you download all the settings from a MiCOM Px40 device. A summary is given in the ***Extract Settings from a MiCOM Px40 Device*** section.
- **Send** lets you send the settings you currently have open in Easergy Studio (MiCOM S1 Studio). A summary is given in the ***Send Settings to a MiCOM Px40 Device*** section.

In most cases, it will be quicker and less error prone to extract settings electronically and store them in a settings file on a memory stick. In this way, there will be a digital record which is certain to be accurate. It is also possible to archive these settings files in a repository; so they can be used again or adapted for another use.

Full details of how to do this is provided in the Easergy Studio (MiCOM S1 Studio) help.

A quick summary of the main steps is given here. In each case, you need to make sure that:

- Your computer includes the Easergy Studio (MiCOM S1 Studio) software.
- Your computer and the MiCOM device are powered on.
- You have used a suitable cable to connect your computer to the MiCOM device (Front Port, Rear Port, Ethernet port or Modem as available).

6.2 Extract Settings from a MiCOM Px40 Device

Full details of how to do this is provided in the Easergy Studio (MiCOM S1 Studio) help.

As a quick guide, you need to do the following:

1. In Easergy Studio (MiCOM S1 Studio), click the Quick Connect… button.
2. Select the relevant Device Type in the Quick Connect dialog box.
3. Click the relevant port in the Port Selection dialog box.
4. Enter the relevant connection parameters in the Connection Parameters dialog box and click the Finish button
5. Studio will try to communicate with the Px40 device. It will display a connected message if the connection attempt is successful.
6. The device will appear in the Studio Explorer pane on the top-left hand side of the interface.
7. Click the + button to expand the options for the device, then click on the Settings folder.
8. Right-click on Settings and select the Extract Settings link to read the settings on the device and store them on your computer or a memory stick attached to your computer.
9. After retrieving the settings file, close the dialog box by clicking the Close button.

6.3 Send Settings to a MiCOM Px40 Device

Full details of how to do this is provided in the Easergy Studio (MiCOM S1 Studio) help.

As a quick guide, you need to do the following:

1. In Easergy Studio (MiCOM S1 Studio), click the Quick Connect… button.
2. Select the relevant Device Type in the Quick Connect dialog box.
3. Click the relevant port in the Port Selection dialog box.
4. Enter the relevant connection parameters in the Connection Parameters dialog box and click the Finish button
5. Studio will try to communicate with the Px40 device. It will display a connected message if the connection attempt is successful.
6. The device will appear in the Studio Explorer pane on the top-left hand side of the interface.
7. Click the + button to expand the options for the device, then click on the Settings link.
8. Right-click on the device name and select the Send link.

Note	*When you send settings to a MiCOM Px40 device, the data is stored in a temporary location at first. This temporary data is tested to make sure it is complete. If the temporary data is complete, it will be programmed into the MiCOM Px40 device. This avoids the risk of a device being programmed with incomplete or corrupt settings.*

9. In the Send To dialog box, select the settings file(s) you wish to send, then click the Send button.
10. Close the the Send To dialog box by clicking the Close button.

PROGRAMMABLE LOGIC

CHAPTER 8

Date:	12/2017
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.
Hardware Suffix:	M
Software Version:	B2
Connection Diagrams:	10P849xx (xx = 01 to 06)

CONTENTS

TABLES

FIGURES

Notes:

1 OVERVIEW

The purpose of the Programmable Scheme Logic (PSL) is to allow the user to configure an individual protection scheme to suit their own particular application. This is achieved through the use of programmable logic gates and delay timers.

The input to the PSL is any combination of the status of opto inputs. It is also used to assign the mapping of functions to the opto inputs and output contacts, the outputs of the protection elements, e.g. protection starts and trips, and the outputs of the fixed protection scheme logic. The fixed scheme logic provides the relay's standard protection schemes.

The PSL itself consists of software logic gates and timers. The logic gates can be programmed to perform a range of different logic functions and can accept any number of inputs. The timers are used either to create a programmable delay, and/or to condition the logic outputs, e.g. to create a pulse of fixed duration on the output regardless of the length of the pulse on the input. The outputs of the PSL are the LEDs on the front panel of the relay and the output contacts at the rear.

The execution of the PSL logic is event driven; the logic is processed whenever any of its inputs change, for example as a result of a change in one of the digital input signals. Also, only the part of the PSL logic that is affected by the particular input change that has occurred is processed. This reduces the amount of processing time that is used by the PSL. This means that even with large, complex PSL schemes the device trip time will not lengthen.

This system provides flexibility for the user to create their own scheme logic design. It also means that the PSL can be configured into a very complex system, hence setting of the PSL is implemented through the PC support package MiCOM S1 Studio.

How to edit the PSL schemes is described in the "Using the PSL Editor" chapter.

This chapter contains details of the logic nodes which are specific to this product, together with any PSL diagrams which we have published for this product.

2 DESCRIPTION OF THE DIGITAL DATABASE (DDB)

The following table shows the available DDB Numbers, a Description of what they are and which product (or products) they apply to. If a DDB Number is not shown, it is not used in this range of products.

DDB No	Source	Description	English Text
0	SW	DDB_OUTPUT_RELAY_1	Output Relay 1
1	SW	DDB_OUTPUT_RELAY_2	Output Relay 2
2	SW	DDB_OUTPUT_RELAY_3	Output Relay 3
3	SW	DDB_OUTPUT_RELAY_4	Output Relay 4
4	SW	DDB_OUTPUT_RELAY_5	Output Relay 5
5	SW	DDB_OUTPUT_RELAY_6	Output Relay 6
6	SW	DDB_OUTPUT_RELAY_7	Output Relay 7
7	SW	DDB_OUTPUT_RELAY_8	Output Relay 8
8	SW	DDB_OUTPUT_RELAY_9	Output Relay 9
9	SW	DDB_OUTPUT_RELAY_10	Output Relay 10
10	SW	DDB_OUTPUT_RELAY_11	Output Relay 11
11	SW	DDB_OUTPUT_RELAY_12	Output Relay 12
12	SW	DDB_OUTPUT_RELAY_13	Output Relay 13
13	SW	DDB_OUTPUT_RELAY_14	Output Relay 14
14	SW	DDB_OUTPUT_RELAY_15	Output Relay 15
15	SW	DDB_OUTPUT_RELAY_16	Output Relay 16
16	SW	DDB_OUTPUT_RELAY_17	Output Relay 17
17	SW	DDB_OUTPUT_RELAY_18	Output Relay 18
18	SW	DDB_OUTPUT_RELAY_19	Output Relay 19
19	SW	DDB_OUTPUT_RELAY_20	Output Relay 20
20	SW	DDB_OUTPUT_RELAY_21	Output Relay 21
21	SW	DDB_OUTPUT_RELAY_22	Output Relay 22
22	SW	DDB_OUTPUT_RELAY_23	Output Relay 23
23	SW	DDB_OUTPUT_RELAY_24	Output Relay 24
24	SW	DDB_OUTPUT_RELAY_25	Output Relay 25
25	SW	DDB_OUTPUT_RELAY_26	Output Relay 26
26	SW	DDB_OUTPUT_RELAY_27	Output Relay 27
27	SW	DDB_OUTPUT_RELAY_28	Output Relay 28
28	SW	DDB_OUTPUT_RELAY_29	Output Relay 29
29	SW	DDB_OUTPUT_RELAY_30	Output Relay 30
30	SW	DDB_OUTPUT_RELAY_31	Output Relay 31
31	SW	DDB_OUTPUT_RELAY_32	Output Relay 32
32	SW	DDB_OUTPUT_RELAY_33	Output Relay 33
33	SW	DDB_OUTPUT_RELAY_34	Output Relay 34
34	SW	DDB_OUTPUT_RELAY_35	Output Relay 35
35	SW	DDB_OUTPUT_RELAY_36	Output Relay 36
36	SW	DDB_OUTPUT_RELAY_37	Output Relay 37
37	SW	DDB_OUTPUT_RELAY_38	Output Relay 38
38	SW	DDB_OUTPUT_RELAY_39	Output Relay 39
39	SW	DDB_OUTPUT_RELAY_40	Output Relay 40
40	SW	DDB_OUTPUT_RELAY_41	Output Relay 41
41	SW	DDB_OUTPUT_RELAY_42	Output Relay 42
42	SW	DDB_OUTPUT_RELAY_43	Output Relay 43
43	SW	DDB_OUTPUT_RELAY_44	Output Relay 44
44	SW	DDB_OUTPUT_RELAY_45	Output Relay 45
45	SW	DDB_OUTPUT_RELAY_46	Output Relay 46
46	SW	DDB_OUTPUT_RELAY_47	Output Relay 47
47	SW	DDB_OUTPUT_RELAY_48	Output Relay 48
48	SW	DDB_OUTPUT_RELAY_49	Output Relay 49
49	SW	DDB_OUTPUT_RELAY_50	Output Relay 50

DDB No	Source	Description	English Text
50	SW	DDB_OUTPUT_RELAY_51	Output Relay 51
51	SW	DDB_OUTPUT_RELAY_52	Output Relay 52
52	SW	DDB_OUTPUT_RELAY_53	Output Relay 53
53	SW	DDB_OUTPUT_RELAY_54	Output Relay 54
54	SW	DDB_OUTPUT_RELAY_55	Output Relay 55
55	SW	DDB_OUTPUT_RELAY_56	Output Relay 56
56	SW	DDB_OUTPUT_RELAY_57	Output Relay 57
57	SW	DDB_OUTPUT_RELAY_58	Output Relay 58
58	SW	DDB_OUTPUT_RELAY_59	Output Relay 59
59	SW	DDB_OUTPUT_RELAY_60	Output Relay 60
60	SW	DDB_UNUSED_60	DDB_UNUSED
61	SW	DDB_UNUSED_61	DDB_UNUSED
62	SW	DDB_UNUSED_62	DDB_UNUSED
63	SW	DDB_UNUSED_63	DDB_UNUSED
64	SW	DDB_OPTO_ISOLATOR_1	Opto Isolator Input 1
65	SW	DDB_OPTO_ISOLATOR_2	Opto Isolator Input 2
66	SW	DDB_OPTO_ISOLATOR_3	Opto Isolator Input 3
67	SW	DDB_OPTO_ISOLATOR_4	Opto Isolator Input 4
68	SW	DDB_OPTO_ISOLATOR_5	Opto Isolator Input 5
69	SW	DDB_OPTO_ISOLATOR_6	Opto Isolator Input 6
70	SW	DDB_OPTO_ISOLATOR_7	Opto Isolator Input 7
71	SW	DDB_OPTO_ISOLATOR_8	Opto Isolator Input 8
72	SW	DDB_OPTO_ISOLATOR_9	Opto Isolator Input 9
73	SW	DDB_OPTO_ISOLATOR_10	Opto Isolator Input 10
74	SW	DDB_OPTO_ISOLATOR_11	Opto Isolator Input 11
75	SW	DDB_OPTO_ISOLATOR_12	Opto Isolator Input 12
76	SW	DDB_OPTO_ISOLATOR_13	Opto Isolator Input 13
77	SW	DDB_OPTO_ISOLATOR_14	Opto Isolator Input 14
78	SW	DDB_OPTO_ISOLATOR_15	Opto Isolator Input 15
79	SW	DDB_OPTO_ISOLATOR_16	Opto Isolator Input 16
80	SW	DDB_OPTO_ISOLATOR_17	Opto Isolator Input 17
81	SW	DDB_OPTO_ISOLATOR_18	Opto Isolator Input 18
82	SW	DDB_OPTO_ISOLATOR_19	Opto Isolator Input 19
83	SW	DDB_OPTO_ISOLATOR_20	Opto Isolator Input 20
84	SW	DDB_OPTO_ISOLATOR_21	Opto Isolator Input 21
85	SW	DDB_OPTO_ISOLATOR_22	Opto Isolator Input 22
86	SW	DDB_OPTO_ISOLATOR_23	Opto Isolator Input 23
87	SW	DDB_OPTO_ISOLATOR_24	Opto Isolator Input 24
88	SW	DDB_OPTO_ISOLATOR_25	Opto Isolator Input 25
89	SW	DDB_OPTO_ISOLATOR_26	Opto Isolator Input 26
90	SW	DDB_OPTO_ISOLATOR_27	Opto Isolator Input 27
91	SW	DDB_OPTO_ISOLATOR_28	Opto Isolator Input 28
92	SW	DDB_OPTO_ISOLATOR_29	Opto Isolator Input 29
93	SW	DDB_OPTO_ISOLATOR_30	Opto Isolator Input 30
94	SW	DDB_OPTO_ISOLATOR_31	Opto Isolator Input 31
95	SW	DDB_OPTO_ISOLATOR_32	Opto Isolator Input 32
96	SW	DDB_OPTO_ISOLATOR_33	Opto Isolator Input 33
97	SW	DDB_OPTO_ISOLATOR_34	Opto Isolator Input 34
98	SW	DDB_OPTO_ISOLATOR_35	Opto Isolator Input 35
99	SW	DDB_OPTO_ISOLATOR_36	Opto Isolator Input 36
100	SW	DDB_OPTO_ISOLATOR_37	Opto Isolator Input 37
101	SW	DDB_OPTO_ISOLATOR_38	Opto Isolator Input 38
102	SW	DDB_OPTO_ISOLATOR_39	Opto Isolator Input 39
103	SW	DDB_OPTO_ISOLATOR_40	Opto Isolator Input 40
104	SW	DDB_OPTO_ISOLATOR_41	Opto Isolator Input 41

DDB No	Source	Description	English Text
105	SW	DDB_OPTO_ISOLATOR_42	Opto Isolator Input 42
106	SW	DDB_OPTO_ISOLATOR_43	Opto Isolator Input 43
107	SW	DDB_OPTO_ISOLATOR_44	Opto Isolator Input 44
108	SW	DDB_OPTO_ISOLATOR_45	Opto Isolator Input 45
109	SW	DDB_OPTO_ISOLATOR_46	Opto Isolator Input 46
110	SW	DDB_OPTO_ISOLATOR_47	Opto Isolator Input 47
111	SW	DDB_OPTO_ISOLATOR_48	Opto Isolator Input 48
112	SW	DDB_OPTO_ISOLATOR_49	Opto Isolator Input 49
113	SW	DDB_OPTO_ISOLATOR_50	Opto Isolator Input 50
114	SW	DDB_OPTO_ISOLATOR_51	Opto Isolator Input 51
115	SW	DDB_OPTO_ISOLATOR_52	Opto Isolator Input 52
116	SW	DDB_OPTO_ISOLATOR_53	Opto Isolator Input 53
117	SW	DDB_OPTO_ISOLATOR_54	Opto Isolator Input 54
118	SW	DDB_OPTO_ISOLATOR_55	Opto Isolator Input 55
119	SW	DDB_OPTO_ISOLATOR_56	Opto Isolator Input 56
120	SW	DDB_OPTO_ISOLATOR_57	Opto Isolator Input 57
121	SW	DDB_OPTO_ISOLATOR_58	Opto Isolator Input 58
122	SW	DDB_OPTO_ISOLATOR_59	Opto Isolator Input 59
123	SW	DDB_OPTO_ISOLATOR_60	Opto Isolator Input 60
124	SW	DDB_OPTO_ISOLATOR_61	Opto Isolator Input 61
125	SW	DDB_OPTO_ISOLATOR_62	Opto Isolator Input 62
126	SW	DDB_OPTO_ISOLATOR_63	Opto Isolator Input 63
127	SW	DDB_OPTO_ISOLATOR_64	Opto Isolator Input 64
128	PSL	DDB_OUTPUT_CON_1	Relay Conditioner 1
129	PSL	DDB_OUTPUT_CON_2	Relay Conditioner 2
130	PSL	DDB_OUTPUT_CON_3	Relay Conditioner 3
131	PSL	DDB_OUTPUT_CON_4	Relay Conditioner 4
132	PSL	DDB_OUTPUT_CON_5	Relay Conditioner 5
133	PSL	DDB_OUTPUT_CON_6	Relay Conditioner 6
134	PSL	DDB_OUTPUT_CON_7	Relay Conditioner 7
135	PSL	DDB_OUTPUT_CON_8	Relay Conditioner 8
136	PSL	DDB_OUTPUT_CON_9	Relay Conditioner 9
137	PSL	DDB_OUTPUT_CON_10	Relay Conditioner 10
138	PSL	DDB_OUTPUT_CON_11	Relay Conditioner 11
139	PSL	DDB_OUTPUT_CON_12	Relay Conditioner 12
140	PSL	DDB_OUTPUT_CON_13	Relay Conditioner 13
141	PSL	DDB_OUTPUT_CON_14	Relay Conditioner 14
142	PSL	DDB_OUTPUT_CON_15	Relay Conditioner 15
143	PSL	DDB_OUTPUT_CON_16	Relay Conditioner 16
144	PSL	DDB_OUTPUT_CON_17	Relay Conditioner 17
145	PSL	DDB_OUTPUT_CON_18	Relay Conditioner 18
146	PSL	DDB_OUTPUT_CON_19	Relay Conditioner 19
147	PSL	DDB_OUTPUT_CON_20	Relay Conditioner 20
148	PSL	DDB_OUTPUT_CON_21	Relay Conditioner 21
149	PSL	DDB_OUTPUT_CON_22	Relay Conditioner 22
150	PSL	DDB_OUTPUT_CON_23	Relay Conditioner 23
151	PSL	DDB_OUTPUT_CON_24	Relay Conditioner 24
152	PSL	DDB_OUTPUT_CON_25	Relay Conditioner 25
153	PSL	DDB_OUTPUT_CON_26	Relay Conditioner 26
154	PSL	DDB_OUTPUT_CON_27	Relay Conditioner 27
155	PSL	DDB_OUTPUT_CON_28	Relay Conditioner 28
156	PSL	DDB_OUTPUT_CON_29	Relay Conditioner 29
157	PSL	DDB_OUTPUT_CON_30	Relay Conditioner 30
158	PSL	DDB_OUTPUT_CON_31	Relay Conditioner 31
159	PSL	DDB_OUTPUT_CON_32	Relay Conditioner 32

DDB No	Source	Description	English Text
160	PSL	DDB_OUTPUT_CON_33	Relay Conditioner 33
161	PSL	DDB_OUTPUT_CON_34	Relay Conditioner 34
162	PSL	DDB_OUTPUT_CON_35	Relay Conditioner 35
163	PSL	DDB_OUTPUT_CON_36	Relay Conditioner 36
164	PSL	DDB_OUTPUT_CON_37	Relay Conditioner 37
165	PSL	DDB_OUTPUT_CON_38	Relay Conditioner 38
166	PSL	DDB_OUTPUT_CON_39	Relay Conditioner 39
167	PSL	DDB_OUTPUT_CON_40	Relay Conditioner 40
168	PSL	DDB_OUTPUT_CON_41	Relay Conditioner 41
169	PSL	DDB_OUTPUT_CON_42	Relay Conditioner 42
170	PSL	DDB_OUTPUT_CON_43	Relay Conditioner 43
171	PSL	DDB_OUTPUT_CON_44	Relay Conditioner 44
172	PSL	DDB_OUTPUT_CON_45	Relay Conditioner 45
173	PSL	DDB_OUTPUT_CON_46	Relay Conditioner 46
174	PSL	DDB_OUTPUT_CON_47	Relay Conditioner 47
175	PSL	DDB_OUTPUT_CON_48	Relay Conditioner 48
176	PSL	DDB_OUTPUT_CON_49	Relay Conditioner 49
177	PSL	DDB_OUTPUT_CON_50	Relay Conditioner 50
178	PSL	DDB_OUTPUT_CON_51	Relay Conditioner 51
179	PSL	DDB_OUTPUT_CON_52	Relay Conditioner 52
180	PSL	DDB_OUTPUT_CON_53	Relay Conditioner 53
181	PSL	DDB_OUTPUT_CON_54	Relay Conditioner 54
182	PSL	DDB_OUTPUT_CON_55	Relay Conditioner 55
183	PSL	DDB_OUTPUT_CON_56	Relay Conditioner 56
184	PSL	DDB_OUTPUT_CON_57	Relay Conditioner 57
185	PSL	DDB_OUTPUT_CON_58	Relay Conditioner 58
186	PSL	DDB_OUTPUT_CON_59	Relay Conditioner 59
187	PSL	DDB_OUTPUT_CON_60	Relay Conditioner 60
188	SW	DDB_UNUSED_188	DDB_UNUSED
189	SW	DDB_UNUSED_189	DDB_UNUSED
190	SW	DDB_UNUSED_190	DDB_UNUSED
191	SW	DDB_UNUSED_191	DDB_UNUSED
192	SW	DDB_OUTPUT_TRI_LED_1_RED	Tri-LED - 1 - Red
193	SW	DDB_OUTPUT_TRI_LED_1_GRN	Tri-LED - 1 - Green
194	SW	DDB_OUTPUT_TRI_LED_2_RED	Tri-LED - 2 - Red
195	SW	DDB_OUTPUT_TRI_LED_2_GRN	Tri-LED - 2 - Green
196	SW	DDB_OUTPUT_TRI_LED_3_RED	Tri-LED - 3 - Red
197	SW	DDB_OUTPUT_TRI_LED_3_GRN	Tri-LED - 3 - Green
198	SW	DDB_OUTPUT_TRI_LED_4_RED	Tri-LED - 4 - Red
199	SW	DDB_OUTPUT_TRI_LED_4_GRN	Tri-LED - 4 - Green
200	SW	DDB_OUTPUT_TRI_LED_5_RED	Tri-LED - 5 - Red
201	SW	DDB_OUTPUT_TRI_LED_5_GRN	Tri-LED - 5 - Green
202	SW	DDB_OUTPUT_TRI_LED_6_RED	Tri-LED - 6 - Red
203	SW	DDB_OUTPUT_TRI_LED_6_GRN	Tri-LED - 6 - Green
204	SW	DDB_OUTPUT_TRI_LED_7_RED	Tri-LED - 7 - Red
205	SW	DDB_OUTPUT_TRI_LED_7_GRN	Tri-LED - 7 - Green
206	SW	DDB_OUTPUT_TRI_LED_8_RED	Tri-LED - 8 - Red
207	SW	DDB_OUTPUT_TRI_LED_8_GRN	Tri-LED - 8 - Green
208	SW	DDB_OUTPUT_TRI_LED_9_RED	Tri-LED - 9 - Red
209	SW	DDB_OUTPUT_TRI_LED_9_GRN	Tri-LED - 9 - Green
210	SW	DDB_OUTPUT_TRI_LED_10_RED	Tri-LED - 10 - Red
211	SW	DDB_OUTPUT_TRI_LED_10_GRN	Tri-LED - 10 - Green
212	SW	DDB_OUTPUT_TRI_LED_11_RED	Tri-LED - 11 - Red
213	SW	DDB_OUTPUT_TRI_LED_11_GRN	Tri-LED - 11 - Green
214	SW	DDB_OUTPUT_TRI_LED_12_RED	Tri-LED - 12 - Red

DDB No	Source	Description	English Text
215	SW	DDB_OUTPUT_TRI_LED_12_GRN	Tri-LED - 12 - Green
216	SW	DDB_OUTPUT_TRI_LED_13_RED	Tri-LED - 13 - Red
217	SW	DDB_OUTPUT_TRI_LED_13_GRN	Tri-LED - 13 - Green
218	SW	DDB_OUTPUT_TRI_LED_14_RED	Tri-LED - 14 - Red
219	SW	DDB_OUTPUT_TRI_LED_14_GRN	Tri-LED - 14 - Green
220	SW	DDB_OUTPUT_TRI_LED_15_RED	Tri-LED - 15 - Red
221	SW	DDB_OUTPUT_TRI_LED_15_GRN	Tri-LED - 15 - Green
222	SW	DDB_OUTPUT_TRI_LED_16_RED	Tri-LED - 16 - Red
223	SW	DDB_OUTPUT_TRI_LED_16_GRN	Tri-LED - 16 - Green
224	SW	DDB_OUTPUT_TRI_LED_17_RED	Tri-LED - 17 - Red
225	SW	DDB_OUTPUT_TRI_LED_17_GRN	Tri-LED - 17 - Green
226	SW	DDB_OUTPUT_TRI_LED_18_RED	Tri-LED - 18 - Red
227	SW	DDB_OUTPUT_TRI_LED_18_GRN	Tri-LED - 18 - Green
228	SW	DDB_UNUSED_228	DDB_UNUSED
229	SW	DDB_UNUSED_229	DDB_UNUSED
230	SW	DDB_UNUSED_230	DDB_UNUSED
231	SW	DDB_UNUSED_231	DDB_UNUSED
232	SW	DDB_UNUSED_232	DDB_UNUSED
233	SW	DDB_UNUSED_233	DDB_UNUSED
234	SW	DDB_UNUSED_234	DDB_UNUSED
235	SW	DDB_UNUSED_235	DDB_UNUSED
236	SW	DDB_UNUSED_236	DDB_UNUSED
237	SW	DDB_UNUSED_237	DDB_UNUSED
238	SW	DDB_UNUSED_238	DDB_UNUSED
239	SW	DDB_UNUSED_239	DDB_UNUSED
240	SW	DDB_UNUSED_240	DDB_UNUSED
241	SW	DDB_UNUSED_241	DDB_UNUSED
242	SW	DDB_UNUSED_242	DDB_UNUSED
243	SW	DDB_UNUSED_243	DDB_UNUSED
244	SW	DDB_UNUSED_244	DDB_UNUSED
245	SW	DDB_UNUSED_245	DDB_UNUSED
246	SW	DDB_UNUSED_246	DDB_UNUSED
247	SW	DDB_UNUSED_247	DDB_UNUSED
248	SW	DDB_UNUSED_248	DDB_UNUSED
249	SW	DDB_UNUSED_249	DDB_UNUSED
250	SW	DDB_UNUSED_250	DDB_UNUSED
251	SW	DDB_UNUSED_251	DDB_UNUSED
252	SW	DDB_UNUSED_252	DDB_UNUSED
253	SW	DDB_UNUSED_253	DDB_UNUSED
254	SW	DDB_UNUSED_254	DDB_UNUSED
255	SW	DDB_UNUSED_255	DDB_UNUSED
256	PSL	DDB_TRI_LED_RED_CON_1	Tri-LED Conditioner - 1 - Red
257	PSL	DDB_TRI_LED_GRN_CON_1	Tri-LED Conditioner- 1 - Green
258	PSL	DDB_TRI_LED_RED_CON_2	Tri-LED Conditioner - 2 - Red
259	PSL	DDB_TRI_LED_GRN_CON_2	Tri-LED Conditioner - 2 - Green
260	PSL	DDB_TRI_LED_RED_CON_3	Tri-LED Conditioner - 3 - Red
261	PSL	DDB_TRI_LED_GRN_CON_3	Tri-LED Conditioner - 3 - Green
262	PSL	DDB_TRI_LED_RED_CON_4	Tri-LED Conditioner - 4 - Red
263	PSL	DDB_TRI_LED_GRN_CON_4	Tri-LED Conditioner - 4 - Green
264	PSL	DDB_TRI_LED_RED_CON_5	Tri-LED Conditioner - 5 - Red
265	PSL	DDB_TRI_LED_GRN_CON_5	Tri-LED Conditioner - 5 - Green
266	PSL	DDB_TRI_LED_RED_CON_6	Tri-LED Conditioner - 6 - Red
267	PSL	DDB_TRI_LED_GRN_CON_6	Tri-LED Conditioner - 6 - Green
268	PSL	DDB_TRI_LED_RED_CON_7	Tri-LED Conditioner - 7 - Red
269	PSL	DDB_TRI_LED_GRN_CON_7	Tri-LED Conditioner - 7 - Green

DDB No	Source	Description	English Text
270	PSL	DDB_TRI_LED_RED_CON_8	Tri-LED Conditioner - 8 - Red
271	PSL	DDB_TRI_LED_GRN_CON_8	Tri-LED Conditioner - 8 - Green
272	PSL	DDB_TRI_LED_RED_CON_9	Tri-LED Conditioner - 9 - Red
273	PSL	DDB_TRI_LED_GRN_CON_9	Tri-LED Conditioner - 9 - Green
274	PSL	DDB_TRI_LED_RED_CON_10	Tri-LED Conditioner - 10 - Red
275	PSL	DDB_TRI_LED_GRN_CON_10	Tri-LED Conditioner - 10 - Green
276	PSL	DDB_TRI_LED_RED_CON_11	Tri-LED Conditioner - 11 - Red
277	PSL	DDB_TRI_LED_GRN_CON_11	Tri-LED Conditioner - 11 - Green
278	PSL	DDB_TRI_LED_RED_CON_12	Tri-LED Conditioner - 12 - Red
279	PSL	DDB_TRI_LED_GRN_CON_12	Tri-LED Conditioner - 12 - Green
280	PSL	DDB_TRI_LED_RED_CON_13	Tri-LED Conditioner - 13 - Red
281	PSL	DDB_TRI_LED_GRN_CON_13	Tri-LED Conditioner - 13 - Green
282	PSL	DDB_TRI_LED_RED_CON_14	Tri-LED Conditioner - 14 - Red
283	PSL	DDB_TRI_LED_GRN_CON_14	Tri-LED Conditioner - 14 - Green
284	PSL	DDB_TRI_LED_RED_CON_15	Tri-LED Conditioner - 15 - Red
285	PSL	DDB_TRI_LED_GRN_CON_15	Tri-LED Conditioner - 15 - Green
286	PSL	DDB_TRI_LED_RED_CON_16	Tri-LED Conditioner - 16 - Red
287	PSL	DDB_TRI_LED_GRN_CON_16	Tri-LED Conditioner - 16 - Green
288	PSL	DDB_TRI_LED_RED_CON_17	Tri-LED Conditioner - 17 - Red
289	PSL	DDB_TRI_LED_GRN_CON_17	Tri-LED Conditioner - 17 - Green
290	PSL	DDB_TRI_LED_RED_CON_18	Tri-LED Conditioner - 18 - Red
291	PSL	DDB_TRI_LED_GRN_CON_18	Tri-LED Conditioner - 18 - Green
292	SW	DDB_GS_ACEPT_SIMU_ALM	IEC 61850 accept simulation GOOSE alarm
293	SW	DDB_UNUSED_293	DDB_UNUSED
294	SW	DDB_UNUSED_294	DDB_UNUSED
295	SW	DDB_UNUSED_295	DDB_UNUSED
296	SW	DDB_UNUSED_296	DDB_UNUSED
297	SW	DDB_UNUSED_297	DDB_UNUSED
298	SW	DDB_UNUSED_298	DDB_UNUSED
299	SW	DDB_UNUSED_299	DDB_UNUSED
300	SW	DDB_UNUSED_300	DDB_UNUSED
301	SW	DDB_UNUSED_301	DDB_UNUSED
302	SW	DDB_UNUSED_302	DDB_UNUSED
303	SW	DDB_UNUSED_303	DDB_UNUSED
304	SW	DDB_UNUSED_304	DDB_UNUSED
305	SW	DDB_UNUSED_305	DDB_UNUSED
306	SW	DDB_UNUSED_306	DDB_UNUSED
307	SW	DDB_UNUSED_307	DDB_UNUSED
308	SW	DDB_UNUSED_308	DDB_UNUSED
309	SW	DDB_UNUSED_309	DDB_UNUSED
310	SW	DDB_UNUSED_310	DDB_UNUSED
311	SW	DDB_UNUSED_311	DDB_UNUSED
312	SW	DDB_UNUSED_312	DDB_UNUSED
313	SW	DDB_UNUSED_313	DDB_UNUSED
314	SW	DDB_UNUSED_314	DDB_UNUSED
315	SW	DDB_UNUSED_315	DDB_UNUSED
316	SW	DDB_UNUSED_316	DDB_UNUSED
317	SW	DDB_UNUSED_317	DDB_UNUSED
318	SW	DDB_UNUSED_318	DDB_UNUSED
319	SW	DDB_UNUSED_319	DDB_UNUSED
320	SW	DDB_FN_KEY_1	Function Key 1
321	SW	DDB_FN_KEY_2	Function Key 2
322	SW	DDB_FN_KEY_3	Function Key 3
323	SW	DDB_FN_KEY_4	Function Key 4

DDB No	Source	Description	English Text
324	SW	DDB_FN_KEY_5	Function Key 5
325	SW	DDB_FN_KEY_6	Function Key 6
326	SW	DDB_FN_KEY_7	Function Key 7
327	SW	DDB_FN_KEY_8	Function Key 8
328	SW	DDB_FN_KEY_9	Function Key 9
329	SW	DDB_FN_KEY_10	Function Key 10
330	SW	DDB_UNUSED_330	DDB_UNUSED
331	SW	DDB_UNUSED_331	DDB_UNUSED
332	SW	DDB_UNUSED_332	DDB_UNUSED
333	SW	DDB_UNUSED_333	DDB_UNUSED
334	SW	DDB_UNUSED_334	DDB_UNUSED
335	SW	DDB_UNUSED_335	DDB_UNUSED
336	SW	DDB_UNUSED_336	DDB_UNUSED
337	SW	DDB_UNUSED_337	DDB_UNUSED
338	SW	DDB_UNUSED_338	DDB_UNUSED
339	SW	DDB_UNUSED_339	DDB_UNUSED
340	SW	DDB_UNUSED_340	DDB_UNUSED
341	SW	DDB_UNUSED_341	DDB_UNUSED
342	SW	DDB_UNUSED_342	DDB_UNUSED
343	SW	DDB_UNUSED_343	DDB_UNUSED
344	SW	DDB_UNUSED_344	DDB_UNUSED
345	SW	DDB_UNUSED_345	DDB_UNUSED
346	SW	DDB_UNUSED_346	DDB_UNUSED
347	SW	DDB_UNUSED_347	DDB_UNUSED
348	SW	DDB_UNUSED_348	DDB_UNUSED
349	SW	DDB_UNUSED_349	DDB_UNUSED
350	SW	DDB_UNUSED_350	DDB_UNUSED
351	SW	DDB_UNUSED_351	DDB_UNUSED
352	PSL	DDB_TIMERIN_1	Auxiliary Timer in 1
353	PSL	DDB_TIMERIN_2	Auxiliary Timer in 2
354	PSL	DDB_TIMERIN_3	Auxiliary Timer in 3
355	PSL	DDB_TIMERIN_4	Auxiliary Timer in 4
356	PSL	DDB_TIMERIN_5	Auxiliary Timer in 5
357	PSL	DDB_TIMERIN_6	Auxiliary Timer in 6
358	PSL	DDB_TIMERIN_7	Auxiliary Timer in 7
359	PSL	DDB_TIMERIN_8	Auxiliary Timer in 8
360	PSL	DDB_TIMERIN_9	Auxiliary Timer in 9
361	PSL	DDB_TIMERIN_10	Auxiliary Timer in 10
362	PSL	DDB_TIMERIN_11	Auxiliary Timer in 11
363	PSL	DDB_TIMERIN_12	Auxiliary Timer in 12
364	PSL	DDB_TIMERIN_13	Auxiliary Timer in 13
365	PSL	DDB_TIMERIN_14	Auxiliary Timer in 14
366	PSL	DDB_TIMERIN_15	Auxiliary Timer in 15
367	PSL	DDB_TIMERIN_16	Auxiliary Timer in 16
368	SW	DDB_TIMEROUT_1	Auxiliary Timer out 1
369	SW	DDB_TIMEROUT_2	Auxiliary Timer out 2
370	SW	DDB_TIMEROUT_3	Auxiliary Timer out 3
371	SW	DDB_TIMEROUT_4	Auxiliary Timer out 4
372	SW	DDB_TIMEROUT_5	Auxiliary Timer out 5
373	SW	DDB_TIMEROUT_6	Auxiliary Timer out 6
374	SW	DDB_TIMEROUT_7	Auxiliary Timer out 7
375	SW	DDB_TIMEROUT_8	Auxiliary Timer out 8
376	SW	DDB_TIMEROUT_9	Auxiliary Timer out 9
377	SW	DDB_TIMEROUT_10	Auxiliary Timer out 10
378	SW	DDB_TIMEROUT_11	Auxiliary Timer out 11

DDB No	Source	Description	English Text
379	SW	DDB_TIMEROUT_12	Auxiliary Timer out 12
380	SW	DDB_TIMEROUT_13	Auxiliary Timer out 13
381	SW	DDB_TIMEROUT_14	Auxiliary Timer out 14
382	SW	DDB_TIMEROUT_15	Auxiliary Timer out 15
383	SW	DDB_TIMEROUT_16	Auxiliary Timer out 16
384	SW	DDB_UNUSED_384	DDB_UNUSED
385	SW	DDB_UNUSED_385	DDB_UNUSED
386	SW	DDB_ILLEGAL_OPTO_SETTINGS_GROUP	Setting Group via opto invalid
387	SW	DDB_OOS_ALARM	Test Mode Enabled
388	SW	DDB_UNUSED_388	DDB_UNUSED
389	SW	DDB_UNUSED_389	DDB_UNUSED
390	SW	DDB_UNUSED_390	DDB_UNUSED
391	SW	DDB_UNUSED_391	DDB_UNUSED
392	SW	DDB_UNUSED_392	DDB_UNUSED
393	SW	DDB_UNUSED_393	DDB_UNUSED
394	SW	DDB_UNUSED_394	DDB_UNUSED
395	SW	DDB_UNUSED_395	DDB_UNUSED
396	SW	DDB_UNUSED_396	DDB_UNUSED
397	SW	DDB_UNUSED_397	DDB_UNUSED
398	SW	DDB_UNUSED_398	DDB_UNUSED
399	SW	DDB_UNUSED_399	DDB_UNUSED
400	SW	DDB_UNUSED_400	DDB_UNUSED
401	SW	DDB_UNUSED_401	DDB_UNUSED
402	SW	DDB_UNUSED_402	DDB_UNUSED
403	SW	DDB_UNUSED_403	DDB_UNUSED
404	SW	DDB_UNUSED_404	DDB_UNUSED
405	SW	DDB_UNUSED_405	DDB_UNUSED
406	SW	DDB_UNUSED_406	DDB_UNUSED
407	SW	DDB_UNUSED_407	DDB_UNUSED
408	SW	DDB_UNUSED_408	DDB_UNUSED
409	PSL	DDB_USER_ALARM_1	User definable Self Reset Alarm 1
410	PSL	DDB_USER_ALARM_2	User definable Self Reset Alarm 2
411	PSL	DDB_USER_ALARM_3	User definable Self Reset Alarm 3
412	PSL	DDB_USER_ALARM_4	User definable Self Reset Alarm 4
413	PSL	DDB_USER_ALARM_5	User definable Self Reset Alarm 5
414	PSL	DDB_USER_ALARM_6	User definable Self Reset Alarm 6
415	PSL	DDB_USER_ALARM_7	User definable Self Reset Alarm 7
416	PSL	DDB_USER_ALARM_8	User definable Self Reset Alarm 8
417	PSL	DDB_USER_ALARM_9	User definable Self Reset Alarm 9
418	PSL	DDB_USER_ALARM_10	User definable Self Reset Alarm 10
419	PSL	DDB_USER_ALARM_11	User definable Self Reset Alarm 11
420	PSL	DDB_USER_ALARM_12	User definable Self Reset Alarm 12
421	PSL	DDB_USER_ALARM_13	User definable Self Reset Alarm 13
422	PSL	DDB_USER_ALARM_14	User definable Self Reset Alarm 14
423	PSL	DDB_USER_ALARM_15	User definable Self Reset Alarm 15
424	PSL	DDB_USER_ALARM_16	User definable Self Reset Alarm 16
425	PSL	DDB_USER_ALARM_17	User definable Self Reset Alarm 17
426	PSL	DDB_USER_ALARM_18	User definable Manual Reset Alarm 18
427	PSL	DDB_USER_ALARM_19	User definable Manual Reset Alarm 19
428	PSL	DDB_USER_ALARM_20	User definable Manual Reset Alarm 20
429	PSL	DDB_USER_ALARM_21	User definable Manual Reset Alarm 21
430	PSL	DDB_USER_ALARM_22	User definable Manual Reset Alarm 22
431	PSL	DDB_USER_ALARM_23	User definable Manual Reset Alarm 23
432	PSL	DDB_USER_ALARM_24	User definable Manual Reset Alarm 24
433	PSL	DDB_USER_ALARM_25	User definable Manual Reset Alarm 25

DDB No	Source	Description	English Text
434	PSL	DDB_USER_ALARM_26	User definable Manual Reset Alarm 26
435	PSL	DDB_USER_ALARM_27	User definable Manual Reset Alarm 27
436	PSL	DDB_USER_ALARM_28	User definable Manual Reset Alarm 28
437	PSL	DDB_USER_ALARM_29	User definable Manual Reset Alarm 29
438	PSL	DDB_USER_ALARM_30	User definable Manual Reset Alarm 30
439	PSL	DDB_USER_ALARM_31	User definable Manual Reset Alarm 31
440	PSL	DDB_USER_ALARM_32	User definable Manual Reset Alarm 32
441	PSL	DDB_USER_ALARM_33	User definable Manual Reset Alarm 33
442	PSL	DDB_USER_ALARM_34	User definable Manual Reset Alarm 34
443	PSL	DDB_USER_ALARM_35	User definable Manual Reset Alarm 35
444	SW	DDB_UNUSED_444	DDB_UNUSED
445	SW	DDB_UNUSED_445	DDB_UNUSED
446	SW	DDB_UNUSED_446	DDB_UNUSED
447	SW	DDB_UNUSED_447	DDB_UNUSED
448	SW	DDB_BATTERY_FAIL_ALARM	Battery Failure Alarm
449	SW	DDB_FIELD_VOLTS_FAIL	Field Voltage Failure
450	SW	DDB_REAR_COMMS_FAIL	Rear Comms Failed
451	SW	DDB_GOOSE_MISSING_IED_ALARM	GOOSE IED Absent Alarm
452	SW	DDB_ECARD_NOT_FITTED_ALARM	Ethernet card not fitted Alarm
453	SW	DDB_NIC_NOT_RESPONDING_ALARM	Ethernet card not responding Alarm
454	SW	DDB_NIC_FATAL_ERROR_ALARM	Ethernet card fatal error Alarm
455	SW	DDB_NIC_SOFTWARE_RELOAD_ALARM	Ethernet card software reload Alarm
456	SW	DDB_INVALID_TCP_IP_CONFIG_ALARM	Bad TCP/IP Configuration Alarm
457	SW	DDB_INVALID_OSI_CONFIG_ALARM	Bad OSI Configuration Alarm
458	SW	DDB_DST_STATUS	If this location DST is in effect now
459	SW	DDB_SW_MISMATCH_ALARM	Main card/Ethernet card software mismatch Alarm
460	SW	DDB_IP_ADDRESS_CONFLICT_ALARM	IP Address conflict Alarm
461	SW	DDB_INTERMICOM_LOOPBACK_ALARM	InterMiCOM Loopback Fail
462	SW	DDB_INTERMICOM_MESSAGE_ALARM	InterMiCOM Message Fail
463	SW	DDB_INTERMICOM_DCD_ALARM	InterMiCOM Data CD Fail
464	SW	DDB_INTERMICOM_CHANNEL_ALARM	InterMiCOM Channel Fail
465	SW	DDB_BACKUP_SETTINGS_ALARM	Backup settings in use' Alarm
466	SW	DDB_INVALID_CONFIG_ALARM	Invalid IEC 61850 Configuration Alarm
467	SW	DDB_TEST_MODE_ALARM	Test Mode Activated Alarm
468	SW	DDB_CONT_BLK_ALARM	Contacts Blocked Alarm
469	SW	DDB_HW_MISMATCH_ALARM	Main card/Ethernet card hw option mismatch Alarm
470	SW	DDB_IEC61850_VER_MISMATCH_ALARM	Main card/Ethernet card IEC61850 ver mismatch Alarm
471	SW	DDB_INVALID_DNPOE_IP_ALARM	Invalid DNPoE IP Configuration Alarm
472	SW	DDB_UNUSED_472	DDB_UNUSED
473	SW	DDB_UNUSED_473	DDB_UNUSED
474	SW	DDB_UNUSED_474	DDB_UNUSED
475	SW	DDB_UNUSED_475	DDB_UNUSED
476	SW	DDB_UNUSED_476	DDB_UNUSED
477	SW	DDB_UNUSED_477	DDB_UNUSED
478	SW	DDB_UNUSED_478	DDB_UNUSED
479	SW	DDB_UNUSED_479	DDB_UNUSED
480	SW	DDB_UNUSED_480	DDB_UNUSED
481	SW	DDB_UNUSED_481	DDB_UNUSED
482	SW	DDB_UNUSED_482	DDB_UNUSED
483	SW	DDB_UNUSED_483	DDB_UNUSED
484	SW	DDB_UNUSED_484	DDB_UNUSED
485	SW	DDB_UNUSED_485	DDB_UNUSED

DDB No	Source	Description	English Text
486	SW	DDB_UNUSED_486	DDB_UNUSED
487	SW	DDB_UNUSED_487	DDB_UNUSED
488	SW	DDB_UNUSED_488	DDB_UNUSED
489	SW	DDB_UNUSED_489	DDB_UNUSED
490	SW	DDB_UNUSED_490	DDB_UNUSED
491	SW	DDB_UNUSED_491	DDB_UNUSED
492	SW	DDB_UNUSED_492	DDB_UNUSED
493	SW	DDB_UNUSED_493	DDB_UNUSED
494	SW	DDB_UNUSED_494	DDB_UNUSED
495	SW	DDB_UNUSED_495	DDB_UNUSED
496	SW	DDB_UNUSED_496	DDB_UNUSED
497	SW	DDB_UNUSED_497	DDB_UNUSED
498	SW	DDB_UNUSED_498	DDB_UNUSED
499	SW	DDB_UNUSED_499	DDB_UNUSED
500	SW	DDB_UNUSED_500	DDB_UNUSED
501	SW	DDB_UNUSED_501	DDB_UNUSED
502	SW	DDB_UNUSED_502	DDB_UNUSED
503	SW	DDB_UNUSED_503	DDB_UNUSED
504	SW	DDB_UNUSED_504	DDB_UNUSED
505	SW	DDB_UNUSED_505	DDB_UNUSED
506	SW	DDB_UNUSED_506	DDB_UNUSED
507	SW	DDB_UNUSED_507	DDB_UNUSED
508	SW	DDB_UNUSED_508	DDB_UNUSED
509	SW	DDB_UNUSED_509	DDB_UNUSED
510	SW	DDB_UNUSED_510	DDB_UNUSED
511	SW	DDB_UNUSED_511	DDB_UNUSED
512	SW	DDB_CONTROL_1	User Control 1
513	SW	DDB_CONTROL_2	User Control 2
514	SW	DDB_CONTROL_3	User Control 3
515	SW	DDB_CONTROL_4	User Control 4
516	SW	DDB_CONTROL_5	User Control 5
517	SW	DDB_CONTROL_6	User Control 6
518	SW	DDB_CONTROL_7	User Control 7
519	SW	DDB_CONTROL_8	User Control 8
520	SW	DDB_CONTROL_9	User Control 9
521	SW	DDB_CONTROL_10	User Control 10
522	SW	DDB_CONTROL_11	User Control 11
523	SW	DDB_CONTROL_12	User Control 12
524	SW	DDB_CONTROL_13	User Control 13
525	SW	DDB_CONTROL_14	User Control 14
526	SW	DDB_CONTROL_15	User Control 15
527	SW	DDB_CONTROL_16	User Control 16
528	SW	DDB_CONTROL_17	User Control 17
529	SW	DDB_CONTROL_18	User Control 18
530	SW	DDB_CONTROL_19	User Control 19
531	SW	DDB_CONTROL_20	User Control 20
532	SW	DDB_CONTROL_21	User Control 21
533	SW	DDB_CONTROL_22	User Control 22
534	SW	DDB_CONTROL_23	User Control 23
535	SW	DDB_CONTROL_24	User Control 24
536	SW	DDB_CONTROL_25	User Control 25
537	SW	DDB_CONTROL_26	User Control 26
538	SW	DDB_CONTROL_27	User Control 27
539	SW	DDB_CONTROL_28	User Control 28
540	SW	DDB_CONTROL_29	User Control 29

DDB No	Source	Description	English Text
541	SW	DDB_CONTROL_30	User Control 30
542	SW	DDB_CONTROL_31	User Control 31
543	SW	DDB_CONTROL_32	User Control 32
544	SW	DDB_UNUSED_544	DDB_UNUSED
545	SW	DDB_UNUSED_545	DDB_UNUSED
546	SW	DDB_UNUSED_546	DDB_UNUSED
547	SW	DDB_UNUSED_547	DDB_UNUSED
548	SW	DDB_UNUSED_548	DDB_UNUSED
549	SW	DDB_UNUSED_549	DDB_UNUSED
550	SW	DDB_UNUSED_550	DDB_UNUSED
551	SW	DDB_UNUSED_551	DDB_UNUSED
552	SW	DDB_UNUSED_552	DDB_UNUSED
553	SW	DDB_UNUSED_553	DDB_UNUSED
554	SW	DDB_UNUSED_554	DDB_UNUSED
555	SW	DDB_UNUSED_555	DDB_UNUSED
556	SW	DDB_UNUSED_556	DDB_UNUSED
557	SW	DDB_UNUSED_557	DDB_UNUSED
558	SW	DDB_UNUSED_558	DDB_UNUSED
559	SW	DDB_UNUSED_559	DDB_UNUSED
560	SW	DDB_UNUSED_560	DDB_UNUSED
561	SW	DDB_UNUSED_561	DDB_UNUSED
562	SW	DDB_UNUSED_562	DDB_UNUSED
563	SW	DDB_UNUSED_563	DDB_UNUSED
564	SW	DDB_UNUSED_564	DDB_UNUSED
565	SW	DDB_UNUSED_565	DDB_UNUSED
566	SW	DDB_UNUSED_566	DDB_UNUSED
567	SW	DDB_UNUSED_567	DDB_UNUSED
568	SW	DDB_UNUSED_568	DDB_UNUSED
569	SW	DDB_UNUSED_569	DDB_UNUSED
570	SW	DDB_UNUSED_570	DDB_UNUSED
571	SW	DDB_UNUSED_571	DDB_UNUSED
572	SW	DDB_UNUSED_572	DDB_UNUSED
573	SW	DDB_UNUSED_573	DDB_UNUSED
574	SW	DDB_UNUSED_574	DDB_UNUSED
575	SW	DDB_UNUSED_575	DDB_UNUSED
576	SW	DDB_INTERIN_1	InterMiCOM in 1
577	SW	DDB_INTERIN_2	InterMiCOM in 2
578	SW	DDB_INTERIN_3	InterMiCOM in 3
579	SW	DDB_INTERIN_4	InterMiCOM in 4
580	SW	DDB_INTERIN_5	InterMiCOM in 5
581	SW	DDB_INTERIN_6	InterMiCOM in 6
582	SW	DDB_INTERIN_7	InterMiCOM in 7
583	SW	DDB_INTERIN_8	InterMiCOM in 8
584	PSL	DDB_INTEROUT_1	InterMiCOM out 1
585	PSL	DDB_INTEROUT_2	InterMiCOM out 2
586	PSL	DDB_INTEROUT_3	InterMiCOM out 3
587	PSL	DDB_INTEROUT_4	InterMiCOM out 4
588	PSL	DDB_INTEROUT_5	InterMiCOM out 5
589	PSL	DDB_INTEROUT_6	InterMiCOM out 6
590	PSL	DDB_INTEROUT_7	InterMiCOM out 7
591	PSL	DDB_INTEROUT_8	InterMiCOM out 8
592	SW	DDB_IRIGB_SIGNAL_VALID	IRIG-B Status Signal Valid
593	SW	DDB_UNUSED_593	DDB_UNUSED
594	SW	DDB_UNUSED_594	DDB_UNUSED
595	SW	DDB_UNUSED_595	DDB_UNUSED

DDB No	Source	Description	English Text
596	SW	DDB_UNUSED_596	DDB_UNUSED
597	SW	DDB_UNUSED_597	DDB_UNUSED
598	SW	DDB_UNUSED_598	DDB_UNUSED
599	SW	DDB_UNUSED_599	DDB_UNUSED
600	SW	DDB_UNUSED_600	DDB_UNUSED
601	SW	DDB_UNUSED_601	DDB_UNUSED
602	SW	DDB_UNUSED_602	DDB_UNUSED
603	SW	DDB_UNUSED_603	DDB_UNUSED
604	SW	DDB_UNUSED_604	DDB_UNUSED
605	SW	DDB_UNUSED_605	DDB_UNUSED
606	SW	DDB_UNUSED_606	DDB_UNUSED
607	SW	DDB_UNUSED_607	DDB_UNUSED
608	PSL	DDB_GOOSEOUT_1	Virtual Output 01
609	PSL	DDB_GOOSEOUT_2	Virtual Output 02
610	PSL	DDB_GOOSEOUT_3	Virtual Output 03
611	PSL	DDB_GOOSEOUT_4	Virtual Output 04
612	PSL	DDB_GOOSEOUT_5	Virtual Output 05
613	PSL	DDB_GOOSEOUT_6	Virtual Output 06
614	PSL	DDB_GOOSEOUT_7	Virtual Output 07
615	PSL	DDB_GOOSEOUT_8	Virtual Output 08
616	PSL	DDB_GOOSEOUT_9	Virtual Output 09
617	PSL	DDB_GOOSEOUT_10	Virtual Output 10
618	PSL	DDB_GOOSEOUT_11	Virtual Output 11
619	PSL	DDB_GOOSEOUT_12	Virtual Output 12
620	PSL	DDB_GOOSEOUT_13	Virtual Output 13
621	PSL	DDB_GOOSEOUT_14	Virtual Output 14
622	PSL	DDB_GOOSEOUT_15	Virtual Output 15
623	PSL	DDB_GOOSEOUT_16	Virtual Output 16
624	PSL	DDB_GOOSEOUT_17	Virtual Output 17
625	PSL	DDB_GOOSEOUT_18	Virtual Output 18
626	PSL	DDB_GOOSEOUT_19	Virtual Output 19
627	PSL	DDB_GOOSEOUT_20	Virtual Output 20
628	PSL	DDB_GOOSEOUT_21	Virtual Output 21
629	PSL	DDB_GOOSEOUT_22	Virtual Output 22
630	PSL	DDB_GOOSEOUT_23	Virtual Output 23
631	PSL	DDB_GOOSEOUT_24	Virtual Output 24
632	PSL	DDB_GOOSEOUT_25	Virtual Output 25
633	PSL	DDB_GOOSEOUT_26	Virtual Output 26
634	PSL	DDB_GOOSEOUT_27	Virtual Output 27
635	PSL	DDB_GOOSEOUT_28	Virtual Output 28
636	PSL	DDB_GOOSEOUT_29	Virtual Output 29
637	PSL	DDB_GOOSEOUT_30	Virtual Output 30
638	PSL	DDB_GOOSEOUT_31	Virtual Output 31
639	PSL	DDB_GOOSEOUT_32	Virtual Output 32
640	PSL	DDB_GOOSEOUT_33	Virtual Output 33
641	PSL	DDB_GOOSEOUT_34	Virtual Output 34
642	PSL	DDB_GOOSEOUT_35	Virtual Output 35
643	PSL	DDB_GOOSEOUT_36	Virtual Output 36
644	PSL	DDB_GOOSEOUT_37	Virtual Output 37
645	PSL	DDB_GOOSEOUT_38	Virtual Output 38
646	PSL	DDB_GOOSEOUT_39	Virtual Output 39
647	PSL	DDB_GOOSEOUT_40	Virtual Output 40
648	PSL	DDB_GOOSEOUT_41	Virtual Output 41
649	PSL	DDB_GOOSEOUT_42	Virtual Output 42
650	PSL	DDB_GOOSEOUT_43	Virtual Output 43

DDB No	Source	Description	English Text
651	PSL	DDB_GOOSEOUT_44	Virtual Output 44
652	PSL	DDB_GOOSEOUT_45	Virtual Output 45
653	PSL	DDB_GOOSEOUT_46	Virtual Output 46
654	PSL	DDB_GOOSEOUT_47	Virtual Output 47
655	PSL	DDB_GOOSEOUT_48	Virtual Output 48
656	PSL	DDB_GOOSEOUT_49	Virtual Output 49
657	PSL	DDB_GOOSEOUT_50	Virtual Output 50
658	PSL	DDB_GOOSEOUT_51	Virtual Output 51
659	PSL	DDB_GOOSEOUT_52	Virtual Output 52
660	PSL	DDB_GOOSEOUT_53	Virtual Output 53
661	PSL	DDB_GOOSEOUT_54	Virtual Output 54
662	PSL	DDB_GOOSEOUT_55	Virtual Output 55
663	PSL	DDB_GOOSEOUT_56	Virtual Output 56
664	PSL	DDB_GOOSEOUT_57	Virtual Output 57
665	PSL	DDB_GOOSEOUT_58	Virtual Output 58
666	PSL	DDB_GOOSEOUT_59	Virtual Output 59
667	PSL	DDB_GOOSEOUT_60	Virtual Output 60
668	PSL	DDB_GOOSEOUT_61	Virtual Output 61
669	PSL	DDB_GOOSEOUT_62	Virtual Output 62
670	PSL	DDB_GOOSEOUT_63	Virtual Output 63
671	PSL	DDB_GOOSEOUT_64	Virtual Output 64
672	SW	DDB_UNUSED_672	DDB_UNUSED
673	SW	DDB_UNUSED_673	DDB_UNUSED
674	SW	DDB_UNUSED_674	DDB_UNUSED
675	SW	DDB_UNUSED_675	DDB_UNUSED
676	SW	DDB_UNUSED_676	DDB_UNUSED
677	SW	DDB_UNUSED_677	DDB_UNUSED
678	SW	DDB_UNUSED_678	DDB_UNUSED
679	SW	DDB_UNUSED_679	DDB_UNUSED
680	SW	DDB_UNUSED_680	DDB_UNUSED
681	SW	DDB_UNUSED_681	DDB_UNUSED
682	SW	DDB_UNUSED_682	DDB_UNUSED
683	SW	DDB_UNUSED_683	DDB_UNUSED
684	SW	DDB_UNUSED_684	DDB_UNUSED
685	SW	DDB_UNUSED_685	DDB_UNUSED
686	SW	DDB_UNUSED_686	DDB_UNUSED
687	SW	DDB_UNUSED_687	DDB_UNUSED
688	SW	DDB_UNUSED_688	DDB_UNUSED
689	SW	DDB_UNUSED_689	DDB_UNUSED
690	SW	DDB_UNUSED_690	DDB_UNUSED
691	SW	DDB_UNUSED_691	DDB_UNUSED
692	SW	DDB_UNUSED_692	DDB_UNUSED
693	SW	DDB_UNUSED_693	DDB_UNUSED
694	SW	DDB_UNUSED_694	DDB_UNUSED
695	SW	DDB_UNUSED_695	DDB_UNUSED
696	SW	DDB_UNUSED_696	DDB_UNUSED
697	SW	DDB_UNUSED_697	DDB_UNUSED
698	SW	DDB_UNUSED_698	DDB_UNUSED
699	SW	DDB_UNUSED_699	DDB_UNUSED
700	SW	DDB_UNUSED_700	DDB_UNUSED
701	SW	DDB_UNUSED_701	DDB_UNUSED
702	SW	DDB_UNUSED_702	DDB_UNUSED
703	SW	DDB_UNUSED_703	DDB_UNUSED
704	SW	DDB_UNUSED_704	DDB_UNUSED
705	SW	DDB_UNUSED_705	DDB_UNUSED

DDB No	Source	Description	English Text
706	SW	DDB_UNUSED_706	DDB_UNUSED
707	SW	DDB_UNUSED_707	DDB_UNUSED
708	SW	DDB_UNUSED_708	DDB_UNUSED
709	SW	DDB_UNUSED_709	DDB_UNUSED
710	SW	DDB_UNUSED_710	DDB_UNUSED
711	SW	DDB_UNUSED_711	DDB_UNUSED
712	SW	DDB_UNUSED_712	DDB_UNUSED
713	SW	DDB_UNUSED_713	DDB_UNUSED
714	SW	DDB_UNUSED_714	DDB_UNUSED
715	SW	DDB_UNUSED_715	DDB_UNUSED
716	SW	DDB_UNUSED_716	DDB_UNUSED
717	SW	DDB_UNUSED_717	DDB_UNUSED
718	SW	DDB_UNUSED_718	DDB_UNUSED
719	SW	DDB_UNUSED_719	DDB_UNUSED
720	SW	DDB_UNUSED_720	DDB_UNUSED
721	SW	DDB_UNUSED_721	DDB_UNUSED
722	SW	DDB_UNUSED_722	DDB_UNUSED
723	SW	DDB_UNUSED_723	DDB_UNUSED
724	SW	DDB_UNUSED_724	DDB_UNUSED
725	SW	DDB_UNUSED_725	DDB_UNUSED
726	SW	DDB_UNUSED_726	DDB_UNUSED
727	SW	DDB_UNUSED_727	DDB_UNUSED
728	SW	DDB_UNUSED_728	DDB_UNUSED
729	SW	DDB_UNUSED_729	DDB_UNUSED
730	SW	DDB_UNUSED_730	DDB_UNUSED
731	SW	DDB_UNUSED_731	DDB_UNUSED
732	SW	DDB_UNUSED_732	DDB_UNUSED
733	SW	DDB_UNUSED_733	DDB_UNUSED
734	SW	DDB_UNUSED_734	DDB_UNUSED
735	SW	DDB_UNUSED_735	DDB_UNUSED
736	SW	DDB_GOOSEIN_1	
737	SW	DDB_GOOSEIN_2	
738	SW	DDB_GOOSEIN_3	
739	SW	DDB_GOOSEIN_4	
740	SW	DDB_GOOSEIN_5	
741	SW	DDB_GOOSEIN_6	
742	SW	DDB_GOOSEIN_7	
743	SW	DDB_GOOSEIN_8	
744	SW	DDB_GOOSEIN_9	
745	SW	DDB_GOOSEIN_10	
746	SW	DDB_GOOSEIN_11	
747	SW	DDB_GOOSEIN_12	
748	SW	DDB_GOOSEIN_13	
749	SW	DDB_GOOSEIN_14	
750	SW	DDB_GOOSEIN_15	
751	SW	DDB_GOOSEIN_16	
752	SW	DDB_GOOSEIN_17	
753	SW	DDB_GOOSEIN_18	
754	SW	DDB_GOOSEIN_19	
755	SW	DDB_GOOSEIN_20	
756	SW	DDB_GOOSEIN_21	
757	SW	DDB_GOOSEIN_22	
758	SW	DDB_GOOSEIN_23	
759	SW	DDB_GOOSEIN_24	
760	SW	DDB_GOOSEIN_25	

DDB No	Source	Description	English Text
761	SW	DDB_GOOSEIN_26	
762	SW	DDB_GOOSEIN_27	
763	SW	DDB_GOOSEIN_28	
764	SW	DDB_GOOSEIN_29	
765	SW	DDB_GOOSEIN_30	
766	SW	DDB_GOOSEIN_31	
767	SW	DDB_GOOSEIN_32	
768	SW	DDB_GOOSEIN_33	
769	SW	DDB_GOOSEIN_34	
770	SW	DDB_GOOSEIN_35	
771	SW	DDB_GOOSEIN_36	
772	SW	DDB_GOOSEIN_37	
773	SW	DDB_GOOSEIN_38	
774	SW	DDB_GOOSEIN_39	
775	SW	DDB_GOOSEIN_40	
776	SW	DDB_GOOSEIN_41	
777	SW	DDB_GOOSEIN_42	
778	SW	DDB_GOOSEIN_43	
779	SW	DDB_GOOSEIN_44	
780	SW	DDB_GOOSEIN_45	
781	SW	DDB_GOOSEIN_46	
782	SW	DDB_GOOSEIN_47	
783	SW	DDB_GOOSEIN_48	
784	SW	DDB_GOOSEIN_49	
785	SW	DDB_GOOSEIN_50	
786	SW	DDB_GOOSEIN_51	
787	SW	DDB_GOOSEIN_52	
788	SW	DDB_GOOSEIN_53	
789	SW	DDB_GOOSEIN_54	
790	SW	DDB_GOOSEIN_55	
791	SW	DDB_GOOSEIN_56	
792	SW	DDB_GOOSEIN_57	
793	SW	DDB_GOOSEIN_58	
794	SW	DDB_GOOSEIN_59	
795	SW	DDB_GOOSEIN_60	
796	SW	DDB_GOOSEIN_61	
797	SW	DDB_GOOSEIN_62	
798	SW	DDB_GOOSEIN_63	
799	SW	DDB_GOOSEIN_64	
800	SW	DDB_GOOSEIN_65	
801	SW	DDB_GOOSEIN_66	
802	SW	DDB_GOOSEIN_67	
803	SW	DDB_GOOSEIN_68	
804	SW	DDB_GOOSEIN_69	
805	SW	DDB_GOOSEIN_70	
806	SW	DDB_GOOSEIN_71	
807	SW	DDB_GOOSEIN_72	
808	SW	DDB_GOOSEIN_73	
809	SW	DDB_GOOSEIN_74	
810	SW	DDB_GOOSEIN_75	
811	SW	DDB_GOOSEIN_76	
812	SW	DDB_GOOSEIN_77	
813	SW	DDB_GOOSEIN_78	
814	SW	DDB_GOOSEIN_79	
815	SW	DDB_GOOSEIN_80	

DDB No	Source	Description	English Text
816	SW	DDB_GOOSEIN_81	
817	SW	DDB_GOOSEIN_82	
818	SW	DDB_GOOSEIN_83	
819	SW	DDB_GOOSEIN_84	
820	SW	DDB_GOOSEIN_85	
821	SW	DDB_GOOSEIN_86	
822	SW	DDB_GOOSEIN_87	
823	SW	DDB_GOOSEIN_88	
824	SW	DDB_GOOSEIN_89	
825	SW	DDB_GOOSEIN_90	
826	SW	DDB_GOOSEIN_91	
827	SW	DDB_GOOSEIN_92	
828	SW	DDB_GOOSEIN_93	
829	SW	DDB_GOOSEIN_94	
830	SW	DDB_GOOSEIN_95	
831	SW	DDB_GOOSEIN_96	
832	SW	DDB_GOOSEIN_97	
833	SW	DDB_GOOSEIN_98	
834	SW	DDB_GOOSEIN_99	
835	SW	DDB_GOOSEIN_100	
836	SW	DDB_GOOSEIN_101	
837	SW	DDB_GOOSEIN_102	
838	SW	DDB_GOOSEIN_103	
839	SW	DDB_GOOSEIN_104	
840	SW	DDB_GOOSEIN_105	
841	SW	DDB_GOOSEIN_106	
842	SW	DDB_GOOSEIN_107	
843	SW	DDB_GOOSEIN_108	
844	SW	DDB_GOOSEIN_109	
845	SW	DDB_GOOSEIN_110	
846	SW	DDB_GOOSEIN_111	
847	SW	DDB_GOOSEIN_112	
848	SW	DDB_GOOSEIN_113	
849	SW	DDB_GOOSEIN_114	
850	SW	DDB_GOOSEIN_115	
851	SW	DDB_GOOSEIN_116	
852	SW	DDB_GOOSEIN_117	
853	SW	DDB_GOOSEIN_118	
854	SW	DDB_GOOSEIN_119	
855	SW	DDB_GOOSEIN_120	
856	SW	DDB_GOOSEIN_121	
857	SW	DDB_GOOSEIN_122	
858	SW	DDB_GOOSEIN_123	
859	SW	DDB_GOOSEIN_124	
860	SW	DDB_GOOSEIN_125	
861	SW	DDB_GOOSEIN_126	
862	SW	DDB_GOOSEIN_127	
863	SW	DDB_GOOSEIN_128	
864	SW	DDB_VIP_PUB_PRES_1	GOOSE Virtual input 1 publisher bit
865	SW	DDB_VIP_PUB_PRES_2	GOOSE Virtual input 2 publisher bit
866	SW	DDB_VIP_PUB_PRES_3	GOOSE Virtual input 3 publisher bit
867	SW	DDB_VIP_PUB_PRES_4	GOOSE Virtual input 4 publisher bit
868	SW	DDB_VIP_PUB_PRES_5	GOOSE Virtual input 5 publisher bit
869	SW	DDB_VIP_PUB_PRES_6	GOOSE Virtual input 6 publisher bit
870	SW	DDB_VIP_PUB_PRES_7	GOOSE Virtual input 7 publisher bit

DDB No	Source	Description	English Text
871	SW	DDB_VIP_PUB_PRES_8	GOOSE Virtual input 8 publisher bit
872	SW	DDB_VIP_PUB_PRES_9	GOOSE Virtual input 9 publisher bit
873	SW	DDB_VIP_PUB_PRES_10	GOOSE Virtual input 10 publisher bit
874	SW	DDB_VIP_PUB_PRES_11	GOOSE Virtual input 11 publisher bit
875	SW	DDB_VIP_PUB_PRES_12	GOOSE Virtual input 12 publisher bit
876	SW	DDB_VIP_PUB_PRES_13	GOOSE Virtual input 13 publisher bit
877	SW	DDB_VIP_PUB_PRES_14	GOOSE Virtual input 14 publisher bit
878	SW	DDB_VIP_PUB_PRES_15	GOOSE Virtual input 15 publisher bit
879	SW	DDB_VIP_PUB_PRES_16	GOOSE Virtual input 16 publisher bit
880	SW	DDB_VIP_PUB_PRES_17	GOOSE Virtual input 17 publisher bit
881	SW	DDB_VIP_PUB_PRES_18	GOOSE Virtual input 18 publisher bit
882	SW	DDB_VIP_PUB_PRES_19	GOOSE Virtual input 19 publisher bit
883	SW	DDB_VIP_PUB_PRES_20	GOOSE Virtual input 20 publisher bit
884	SW	DDB_VIP_PUB_PRES_21	GOOSE Virtual input 21 publisher bit
885	SW	DDB_VIP_PUB_PRES_22	GOOSE Virtual input 22 publisher bit
886	SW	DDB_VIP_PUB_PRES_23	GOOSE Virtual input 23 publisher bit
887	SW	DDB_VIP_PUB_PRES_24	GOOSE Virtual input 24 publisher bit
888	SW	DDB_VIP_PUB_PRES_25	GOOSE Virtual input 25 publisher bit
889	SW	DDB_VIP_PUB_PRES_26	GOOSE Virtual input 26 publisher bit
890	SW	DDB_VIP_PUB_PRES_27	GOOSE Virtual input 27 publisher bit
891	SW	DDB_VIP_PUB_PRES_28	GOOSE Virtual input 28 publisher bit
892	SW	DDB_VIP_PUB_PRES_29	GOOSE Virtual input 29 publisher bit
893	SW	DDB_VIP_PUB_PRES_30	GOOSE Virtual input 30 publisher bit
894	SW	DDB_VIP_PUB_PRES_31	GOOSE Virtual input 31 publisher bit
895	SW	DDB_VIP_PUB_PRES_32	GOOSE Virtual input 32 publisher bit
896	SW	DDB_VIP_PUB_PRES_33	GOOSE Virtual input 33 publisher bit
897	SW	DDB_VIP_PUB_PRES_34	GOOSE Virtual input 34 publisher bit
898	SW	DDB_VIP_PUB_PRES_35	GOOSE Virtual input 35 publisher bit
899	SW	DDB_VIP_PUB_PRES_36	GOOSE Virtual input 36 publisher bit
900	SW	DDB_VIP_PUB_PRES_37	GOOSE Virtual input 37 publisher bit
901	SW	DDB_VIP_PUB_PRES_38	GOOSE Virtual input 38 publisher bit
902	SW	DDB_VIP_PUB_PRES_39	GOOSE Virtual input 39 publisher bit
903	SW	DDB_VIP_PUB_PRES_40	GOOSE Virtual input 40 publisher bit
904	SW	DDB_VIP_PUB_PRES_41	GOOSE Virtual input 41 publisher bit
905	SW	DDB_VIP_PUB_PRES_42	GOOSE Virtual input 42 publisher bit
906	SW	DDB_VIP_PUB_PRES_43	GOOSE Virtual input 43 publisher bit
907	SW	DDB_VIP_PUB_PRES_44	GOOSE Virtual input 44 publisher bit
908	SW	DDB_VIP_PUB_PRES_45	GOOSE Virtual input 45 publisher bit
909	SW	DDB_VIP_PUB_PRES_46	GOOSE Virtual input 46 publisher bit
910	SW	DDB_VIP_PUB_PRES_47	GOOSE Virtual input 47 publisher bit
911	SW	DDB_VIP_PUB_PRES_48	GOOSE Virtual input 48 publisher bit
912	SW	DDB_VIP_PUB_PRES_49	GOOSE Virtual input 49 publisher bit
913	SW	DDB_VIP_PUB_PRES_50	GOOSE Virtual input 50 publisher bit
914	SW	DDB_VIP_PUB_PRES_51	GOOSE Virtual input 51 publisher bit
915	SW	DDB_VIP_PUB_PRES_52	GOOSE Virtual input 52 publisher bit
916	SW	DDB_VIP_PUB_PRES_53	GOOSE Virtual input 53 publisher bit
917	SW	DDB_VIP_PUB_PRES_54	GOOSE Virtual input 54 publisher bit
918	SW	DDB_VIP_PUB_PRES_55	GOOSE Virtual input 55 publisher bit
919	SW	DDB_VIP_PUB_PRES_56	GOOSE Virtual input 56 publisher bit
920	SW	DDB_VIP_PUB_PRES_57	GOOSE Virtual input 57 publisher bit
921	SW	DDB_VIP_PUB_PRES_58	GOOSE Virtual input 58 publisher bit
922	SW	DDB_VIP_PUB_PRES_59	GOOSE Virtual input 59 publisher bit
923	SW	DDB_VIP_PUB_PRES_60	GOOSE Virtual input 60 publisher bit
924	SW	DDB_VIP_PUB_PRES_61	GOOSE Virtual input 61 publisher bit
925	SW	DDB_VIP_PUB_PRES_62	GOOSE Virtual input 62 publisher bit

DDB No	Source	Description	English Text
926	SW	DDB_VIP_PUB_PRES_63	GOOSE Virtual input 63 publisher bit
927	SW	DDB_VIP_PUB_PRES_64	GOOSE Virtual input 64 publisher bit
928	SW	DDB_VIP_PUB_PRES_65	GOOSE Virtual input 65 publisher bit
929	SW	DDB_VIP_PUB_PRES_66	GOOSE Virtual input 66 publisher bit
930	SW	DDB_VIP_PUB_PRES_67	GOOSE Virtual input 67 publisher bit
931	SW	DDB_VIP_PUB_PRES_68	GOOSE Virtual input 68 publisher bit
932	SW	DDB_VIP_PUB_PRES_69	GOOSE Virtual input 69 publisher bit
933	SW	DDB_VIP_PUB_PRES_70	GOOSE Virtual input 70 publisher bit
934	SW	DDB_VIP_PUB_PRES_71	GOOSE Virtual input 71 publisher bit
935	SW	DDB_VIP_PUB_PRES_72	GOOSE Virtual input 72 publisher bit
936	SW	DDB_VIP_PUB_PRES_73	GOOSE Virtual input 73 publisher bit
937	SW	DDB_VIP_PUB_PRES_74	GOOSE Virtual input 74 publisher bit
938	SW	DDB_VIP_PUB_PRES_75	GOOSE Virtual input 75 publisher bit
939	SW	DDB_VIP_PUB_PRES_76	GOOSE Virtual input 76 publisher bit
940	SW	DDB_VIP_PUB_PRES_77	GOOSE Virtual input 77 publisher bit
941	SW	DDB_VIP_PUB_PRES_78	GOOSE Virtual input 78 publisher bit
942	SW	DDB_VIP_PUB_PRES_79	GOOSE Virtual input 79 publisher bit
943	SW	DDB_VIP_PUB_PRES_80	GOOSE Virtual input 80 publisher bit
944	SW	DDB_VIP_PUB_PRES_81	GOOSE Virtual input 81 publisher bit
945	SW	DDB_VIP_PUB_PRES_82	GOOSE Virtual input 82 publisher bit
946	SW	DDB_VIP_PUB_PRES_83	GOOSE Virtual input 83 publisher bit
947	SW	DDB_VIP_PUB_PRES_84	GOOSE Virtual input 84 publisher bit
948	SW	DDB_VIP_PUB_PRES_85	GOOSE Virtual input 85 publisher bit
949	SW	DDB_VIP_PUB_PRES_86	GOOSE Virtual input 86 publisher bit
950	SW	DDB_VIP_PUB_PRES_87	GOOSE Virtual input 87 publisher bit
951	SW	DDB_VIP_PUB_PRES_88	GOOSE Virtual input 88 publisher bit
952	SW	DDB_VIP_PUB_PRES_89	GOOSE Virtual input 89 publisher bit
953	SW	DDB_VIP_PUB_PRES_90	GOOSE Virtual input 90 publisher bit
954	SW	DDB_VIP_PUB_PRES_91	GOOSE Virtual input 91 publisher bit
955	SW	DDB_VIP_PUB_PRES_92	GOOSE Virtual input 92 publisher bit
956	SW	DDB_VIP_PUB_PRES_93	GOOSE Virtual input 93 publisher bit
957	SW	DDB_VIP_PUB_PRES_94	GOOSE Virtual input 94 publisher bit
958	SW	DDB_VIP_PUB_PRES_95	GOOSE Virtual input 95 publisher bit
959	SW	DDB_VIP_PUB_PRES_96	GOOSE Virtual input 96 publisher bit
960	SW	DDB_VIP_PUB_PRES_97	GOOSE Virtual input 97 publisher bit
961	SW	DDB_VIP_PUB_PRES_98	GOOSE Virtual input 98 publisher bit
962	SW	DDB_VIP_PUB_PRES_99	GOOSE Virtual input 99 publisher bit
963	SW	DDB_VIP_PUB_PRES_100	GOOSE Virtual input 100 publisher bit
964	SW	DDB_VIP_PUB_PRES_101	GOOSE Virtual input 101 publisher bit
965	SW	DDB_VIP_PUB_PRES_102	GOOSE Virtual input 102 publisher bit
966	SW	DDB_VIP_PUB_PRES_103	GOOSE Virtual input 103 publisher bit
967	SW	DDB_VIP_PUB_PRES_104	GOOSE Virtual input 104 publisher bit
968	SW	DDB_VIP_PUB_PRES_105	GOOSE Virtual input 105 publisher bit
969	SW	DDB_VIP_PUB_PRES_106	GOOSE Virtual input 106 publisher bit
970	SW	DDB_VIP_PUB_PRES_107	GOOSE Virtual input 107 publisher bit
971	SW	DDB_VIP_PUB_PRES_108	GOOSE Virtual input 108 publisher bit
972	SW	DDB_VIP_PUB_PRES_109	GOOSE Virtual input 109 publisher bit
973	SW	DDB_VIP_PUB_PRES_110	GOOSE Virtual input 110 publisher bit
974	SW	DDB_VIP_PUB_PRES_111	GOOSE Virtual input 111 publisher bit
975	SW	DDB_VIP_PUB_PRES_112	GOOSE Virtual input 112 publisher bit
976	SW	DDB_VIP_PUB_PRES_113	GOOSE Virtual input 113 publisher bit
977	SW	DDB_VIP_PUB_PRES_114	GOOSE Virtual input 114 publisher bit
978	SW	DDB_VIP_PUB_PRES_115	GOOSE Virtual input 115 publisher bit
979	SW	DDB_VIP_PUB_PRES_116	GOOSE Virtual input 116 publisher bit
980	SW	DDB_VIP_PUB_PRES_117	GOOSE Virtual input 117 publisher bit

DDB No	Source	Description	English Text
981	SW	DDB_VIP_PUB_PRES_118	GOOSE Virtual input 118 publisher bit
982	SW	DDB_VIP_PUB_PRES_119	GOOSE Virtual input 119 publisher bit
983	SW	DDB_VIP_PUB_PRES_120	GOOSE Virtual input 120 publisher bit
984	SW	DDB_VIP_PUB_PRES_121	GOOSE Virtual input 121 publisher bit
985	SW	DDB_VIP_PUB_PRES_122	GOOSE Virtual input 122 publisher bit
986	SW	DDB_VIP_PUB_PRES_123	GOOSE Virtual input 123 publisher bit
987	SW	DDB_VIP_PUB_PRES_124	GOOSE Virtual input 124 publisher bit
988	SW	DDB_VIP_PUB_PRES_125	GOOSE Virtual input 125 publisher bit
989	SW	DDB_VIP_PUB_PRES_126	GOOSE Virtual input 126 publisher bit
990	SW	DDB_VIP_PUB_PRES_127	GOOSE Virtual input 127 publisher bit
991	SW	DDB_VIP_PUB_PRES_128	GOOSE Virtual input 128 publisher bit
992	SW	DDB_VIP_QUALITY_1	GOOSE Virtual input 1 Quality bit
993	SW	DDB_VIP_QUALITY_2	GOOSE Virtual input 2 Quality bit
994	SW	DDB_VIP_QUALITY_3	GOOSE Virtual input 3 Quality bit
995	SW	DDB_VIP_QUALITY_4	GOOSE Virtual input 4 Quality bit
996	SW	DDB_VIP_QUALITY_5	GOOSE Virtual input 5 Quality bit
997	SW	DDB_VIP_QUALITY_6	GOOSE Virtual input 6 Quality bit
998	SW	DDB_VIP_QUALITY_7	GOOSE Virtual input 7 Quality bit
999	SW	DDB_VIP_QUALITY_8	GOOSE Virtual input 8 Quality bit
1000	SW	DDB_VIP_QUALITY_9	GOOSE Virtual input 9 Quality bit
1001	SW	DDB_VIP_QUALITY_10	GOOSE Virtual input 10 Quality bit
1002	SW	DDB_VIP_QUALITY_11	GOOSE Virtual input 11 Quality bit
1003	SW	DDB_VIP_QUALITY_12	GOOSE Virtual input 12 Quality bit
1004	SW	DDB_VIP_QUALITY_13	GOOSE Virtual input 13 Quality bit
1005	SW	DDB_VIP_QUALITY_14	GOOSE Virtual input 14 Quality bit
1006	SW	DDB_VIP_QUALITY_15	GOOSE Virtual input 15 Quality bit
1007	SW	DDB_VIP_QUALITY_16	GOOSE Virtual input 16 Quality bit
1008	SW	DDB_VIP_QUALITY_17	GOOSE Virtual input 17 Quality bit
1009	SW	DDB_VIP_QUALITY_18	GOOSE Virtual input 18 Quality bit
1010	SW	DDB_VIP_QUALITY_19	GOOSE Virtual input 19 Quality bit
1011	SW	DDB_VIP_QUALITY_20	GOOSE Virtual input 20 Quality bit
1012	SW	DDB_VIP_QUALITY_21	GOOSE Virtual input 21 Quality bit
1013	SW	DDB_VIP_QUALITY_22	GOOSE Virtual input 22 Quality bit
1014	SW	DDB_VIP_QUALITY_23	GOOSE Virtual input 23 Quality bit
1015	SW	DDB_VIP_QUALITY_24	GOOSE Virtual input 24 Quality bit
1016	SW	DDB_VIP_QUALITY_25	GOOSE Virtual input 25 Quality bit
1017	SW	DDB_VIP_QUALITY_26	GOOSE Virtual input 26 Quality bit
1018	SW	DDB_VIP_QUALITY_27	GOOSE Virtual input 27 Quality bit
1019	SW	DDB_VIP_QUALITY_28	GOOSE Virtual input 28 Quality bit
1020	SW	DDB_VIP_QUALITY_29	GOOSE Virtual input 29 Quality bit
1021	SW	DDB_VIP_QUALITY_30	GOOSE Virtual input 30 Quality bit
1022	SW	DDB_VIP_QUALITY_31	GOOSE Virtual input 31 Quality bit
1023	SW	DDB_VIP_QUALITY_32	GOOSE Virtual input 32 Quality bit
1024	SW	DDB_VIP_QUALITY_33	GOOSE Virtual input 33 Quality bit
1025	SW	DDB_VIP_QUALITY_34	GOOSE Virtual input 34 Quality bit
1026	SW	DDB_VIP_QUALITY_35	GOOSE Virtual input 35 Quality bit
1027	SW	DDB_VIP_QUALITY_36	GOOSE Virtual input 36 Quality bit
1028	SW	DDB_VIP_QUALITY_37	GOOSE Virtual input 37 Quality bit
1029	SW	DDB_VIP_QUALITY_38	GOOSE Virtual input 38 Quality bit
1030	SW	DDB_VIP_QUALITY_39	GOOSE Virtual input 39 Quality bit
1031	SW	DDB_VIP_QUALITY_40	GOOSE Virtual input 40 Quality bit
1032	SW	DDB_VIP_QUALITY_41	GOOSE Virtual input 41 Quality bit
1033	SW	DDB_VIP_QUALITY_42	GOOSE Virtual input 42 Quality bit
1034	SW	DDB_VIP_QUALITY_43	GOOSE Virtual input 43 Quality bit
1035	SW	DDB_VIP_QUALITY_44	GOOSE Virtual input 44 Quality bit

DDB No	Source	Description	English Text
1036	SW	DDB_VIP_QUALITY_45	GOOSE Virtual input 45 Quality bit
1037	SW	DDB_VIP_QUALITY_46	GOOSE Virtual input 46 Quality bit
1038	SW	DDB_VIP_QUALITY_47	GOOSE Virtual input 47 Quality bit
1039	SW	DDB_VIP_QUALITY_48	GOOSE Virtual input 48 Quality bit
1040	SW	DDB_VIP_QUALITY_49	GOOSE Virtual input 49 Quality bit
1041	SW	DDB_VIP_QUALITY_50	GOOSE Virtual input 50 Quality bit
1042	SW	DDB_VIP_QUALITY_51	GOOSE Virtual input 51 Quality bit
1043	SW	DDB_VIP_QUALITY_52	GOOSE Virtual input 52 Quality bit
1044	SW	DDB_VIP_QUALITY_53	GOOSE Virtual input 53 Quality bit
1045	SW	DDB_VIP_QUALITY_54	GOOSE Virtual input 54 Quality bit
1046	SW	DDB_VIP_QUALITY_55	GOOSE Virtual input 55 Quality bit
1047	SW	DDB_VIP_QUALITY_56	GOOSE Virtual input 56 Quality bit
1048	SW	DDB_VIP_QUALITY_57	GOOSE Virtual input 57 Quality bit
1049	SW	DDB_VIP_QUALITY_58	GOOSE Virtual input 58 Quality bit
1050	SW	DDB_VIP_QUALITY_59	GOOSE Virtual input 59 Quality bit
1051	SW	DDB_VIP_QUALITY_60	GOOSE Virtual input 60 Quality bit
1052	SW	DDB_VIP_QUALITY_61	GOOSE Virtual input 61 Quality bit
1053	SW	DDB_VIP_QUALITY_62	GOOSE Virtual input 62 Quality bit
1054	SW	DDB_VIP_QUALITY_63	GOOSE Virtual input 63 Quality bit
1055	SW	DDB_VIP_QUALITY_64	GOOSE Virtual input 64 Quality bit
1056	SW	DDB_VIP_QUALITY_65	GOOSE Virtual input 65 Quality bit
1057	SW	DDB_VIP_QUALITY_66	GOOSE Virtual input 66 Quality bit
1058	SW	DDB_VIP_QUALITY_67	GOOSE Virtual input 67 Quality bit
1059	SW	DDB_VIP_QUALITY_68	GOOSE Virtual input 68 Quality bit
1060	SW	DDB_VIP_QUALITY_69	GOOSE Virtual input 69 Quality bit
1061	SW	DDB_VIP_QUALITY_70	GOOSE Virtual input 70 Quality bit
1062	SW	DDB_VIP_QUALITY_71	GOOSE Virtual input 71 Quality bit
1063	SW	DDB_VIP_QUALITY_72	GOOSE Virtual input 72 Quality bit
1064	SW	DDB_VIP_QUALITY_73	GOOSE Virtual input 73 Quality bit
1065	SW	DDB_VIP_QUALITY_74	GOOSE Virtual input 74 Quality bit
1066	SW	DDB_VIP_QUALITY_75	GOOSE Virtual input 75 Quality bit
1067	SW	DDB_VIP_QUALITY_76	GOOSE Virtual input 76 Quality bit
1068	SW	DDB_VIP_QUALITY_77	GOOSE Virtual input 77 Quality bit
1069	SW	DDB_VIP_QUALITY_78	GOOSE Virtual input 78 Quality bit
1070	SW	DDB_VIP_QUALITY_79	GOOSE Virtual input 79 Quality bit
1071	SW	DDB_VIP_QUALITY_80	GOOSE Virtual input 80 Quality bit
1072	SW	DDB_VIP_QUALITY_81	GOOSE Virtual input 81 Quality bit
1073	SW	DDB_VIP_QUALITY_82	GOOSE Virtual input 82 Quality bit
1074	SW	DDB_VIP_QUALITY_83	GOOSE Virtual input 83 Quality bit
1075	SW	DDB_VIP_QUALITY_84	GOOSE Virtual input 84 Quality bit
1076	SW	DDB_VIP_QUALITY_85	GOOSE Virtual input 85 Quality bit
1077	SW	DDB_VIP_QUALITY_86	GOOSE Virtual input 86 Quality bit
1078	SW	DDB_VIP_QUALITY_87	GOOSE Virtual input 87 Quality bit
1079	SW	DDB_VIP_QUALITY_88	GOOSE Virtual input 88 Quality bit
1080	SW	DDB_VIP_QUALITY_89	GOOSE Virtual input 89 Quality bit
1081	SW	DDB_VIP_QUALITY_90	GOOSE Virtual input 90 Quality bit
1082	SW	DDB_VIP_QUALITY_91	GOOSE Virtual input 91 Quality bit
1083	SW	DDB_VIP_QUALITY_92	GOOSE Virtual input 92 Quality bit
1084	SW	DDB_VIP_QUALITY_93	GOOSE Virtual input 93 Quality bit
1085	SW	DDB_VIP_QUALITY_94	GOOSE Virtual input 94 Quality bit
1086	SW	DDB_VIP_QUALITY_95	GOOSE Virtual input 95 Quality bit
1087	SW	DDB_VIP_QUALITY_96	GOOSE Virtual input 96 Quality bit
1088	SW	DDB_VIP_QUALITY_97	GOOSE Virtual input 97 Quality bit
1089	SW	DDB_VIP_QUALITY_98	GOOSE Virtual input 98 Quality bit
1090	SW	DDB_VIP_QUALITY_99	GOOSE Virtual input 99 Quality bit

DDB No	Source	Description	English Text
1091	SW	DDB_VIP_QUALITY_100	GOOSE Virtual input 100 Quality bit
1092	SW	DDB_VIP_QUALITY_101	GOOSE Virtual input 101 Quality bit
1093	SW	DDB_VIP_QUALITY_102	GOOSE Virtual input 102 Quality bit
1094	SW	DDB_VIP_QUALITY_103	GOOSE Virtual input 103 Quality bit
1095	SW	DDB_VIP_QUALITY_104	GOOSE Virtual input 104 Quality bit
1096	SW	DDB_VIP_QUALITY_105	GOOSE Virtual input 105 Quality bit
1097	SW	DDB_VIP_QUALITY_106	GOOSE Virtual input 106 Quality bit
1098	SW	DDB_VIP_QUALITY_107	GOOSE Virtual input 107 Quality bit
1099	SW	DDB_VIP_QUALITY_108	GOOSE Virtual input 108 Quality bit
1100	SW	DDB_VIP_QUALITY_109	GOOSE Virtual input 109 Quality bit
1101	SW	DDB_VIP_QUALITY_110	GOOSE Virtual input 110 Quality bit
1102	SW	DDB_VIP_QUALITY_111	GOOSE Virtual input 111 Quality bit
1103	SW	DDB_VIP_QUALITY_112	GOOSE Virtual input 112 Quality bit
1104	SW	DDB_VIP_QUALITY_113	GOOSE Virtual input 113 Quality bit
1105	SW	DDB_VIP_QUALITY_114	GOOSE Virtual input 114 Quality bit
1106	SW	DDB_VIP_QUALITY_115	GOOSE Virtual input 115 Quality bit
1107	SW	DDB_VIP_QUALITY_116	GOOSE Virtual input 116 Quality bit
1108	SW	DDB_VIP_QUALITY_117	GOOSE Virtual input 117 Quality bit
1109	SW	DDB_VIP_QUALITY_118	GOOSE Virtual input 118 Quality bit
1110	SW	DDB_VIP_QUALITY_119	GOOSE Virtual input 119 Quality bit
1111	SW	DDB_VIP_QUALITY_120	GOOSE Virtual input 120 Quality bit
1112	SW	DDB_VIP_QUALITY_121	GOOSE Virtual input 121 Quality bit
1113	SW	DDB_VIP_QUALITY_122	GOOSE Virtual input 122 Quality bit
1114	SW	DDB_VIP_QUALITY_123	GOOSE Virtual input 123 Quality bit
1115	SW	DDB_VIP_QUALITY_124	GOOSE Virtual input 124 Quality bit
1116	SW	DDB_VIP_QUALITY_125	GOOSE Virtual input 125 Quality bit
1117	SW	DDB_VIP_QUALITY_126	GOOSE Virtual input 126 Quality bit
1118	SW	DDB_VIP_QUALITY_127	GOOSE Virtual input 127 Quality bit
1119	SW	DDB_VIP_QUALITY_128	GOOSE Virtual input 128 Quality bit
1120	SW	DDB_UNUSED_DR	Provides the "Unused" selection in G32
1121	PSL	DDB_TEST_MODE	Initiate Test Mode
1122	PSL	DDB_SG_SELECTOR_X1	Binary coded setting group selector 1
1123	PSL	DDB_SG_SELECTOR_1X	Binary coded setting group selector 2
1124	PSL	DDB_RP1_READ_ONLY	Remote Read Only 1 DDB
1125	PSL	DDB_RP2_READ_ONLY	Remote Read Only 2 DDB
1126	PSL	DDB_NIC_READ_ONLY	Remote Read Only NIC DDB
1127	PSL	DDB_MONITOR_BLOCKING	Monitor Block
1128	PSL	DDB_COMMAND_BLOCKING	Command Block
1129	SW	DDB_RESERVED_DISTREC	Provides the "Unused" selection in G32
1130	PSL	DDB_RESET_RELAYS_LEDS	Reset Latched Relays & LED’s
1131	PSL	DDB_TIME_SYNCH	Time synchronise to nearest minute on 0-1 change
1132	SW	DDB_LOGIC_0	Logic 0 for use in PSL (Never changes state!)
1133	SW	DDB_NIC_LINK_1_FAIL	Network Interface Card link 1 fail indication
1134	SW	DDB_NIC_LINK_2_FAIL	Network Interface Card link 1 fail indication
1135	SW	DDB_NIC_LINK_3_FAIL	Network Interface Card link 1 fail indication
1136	SW	DDB_UI_LOGGEDIN	User logged into UI
1137	SW	DDB_FCUR_LOGGEDIN	User logged into front port courier
1138	SW	DDB_RP1_LOGGEDIN	User logged into Rear Port1 courier
1139	SW	DDB_RP2_LOGGEDIN	User logged into Rear Port2 courier
1140	SW	DDB_TNL_LOGGEDIN	User logged into turnneled courier

DDB No	Source	Description	English Text
1141	SW	DDB_CPR_LOGGEDIN	User logged into co-processor courier
1142	SW	DDB_UNUSED_1142	
1143	SW	DDB_UNUSED_1143	
1144	SW	DDB_UNUSED_1144	DDB_UNUSED
1145	SW	DDB_UNUSED_1145	DDB_UNUSED
1146	SW	DDB_UNUSED_1146	DDB_UNUSED
1147	SW	DDB_UNUSED_1147	DDB_UNUSED
1148	SW	DDB_UNUSED_1148	DDB_UNUSED
1149	SW	DDB_UNUSED_1149	DDB_UNUSED
1150	SW	DDB_UNUSED_1150	DDB_UNUSED
1151	SW	DDB_UNUSED_1151	DDB_UNUSED
1152	SW	DDB_UNUSED_1152	DDB_UNUSED
1153	SW	DDB_UNUSED_1153	DDB_UNUSED
1154	SW	DDB_UNUSED_1154	DDB_UNUSED
1155	SW	DDB_UNUSED_1155	DDB_UNUSED
1156	SW	DDB_UNUSED_1156	DDB_UNUSED
1157	SW	DDB_UNUSED_1157	DDB_UNUSED
1158	SW	DDB_UNUSED_1158	DDB_UNUSED
1159	SW	DDB_UNUSED_1159	DDB_UNUSED
1160	SW	DDB_UNUSED_1160	DDB_UNUSED
1161	SW	DDB_UNUSED_1161	DDB_UNUSED
1162	SW	DDB_UNUSED_1162	DDB_UNUSED
1163	SW	DDB_UNUSED_1163	DDB_UNUSED
1164	SW	DDB_UNUSED_1164	DDB_UNUSED
1165	SW	DDB_UNUSED_1165	DDB_UNUSED
1166	SW	DDB_UNUSED_1166	DDB_UNUSED
1167	SW	DDB_UNUSED_1167	DDB_UNUSED
1168	SW	DDB_UNUSED_1168	DDB_UNUSED
1169	SW	DDB_UNUSED_1169	DDB_UNUSED
1170	SW	DDB_UNUSED_1170	DDB_UNUSED
1171	SW	DDB_UNUSED_1171	DDB_UNUSED
1172	SW	DDB_UNUSED_1172	DDB_UNUSED
1173	SW	DDB_UNUSED_1173	DDB_UNUSED
1174	SW	DDB_UNUSED_1174	DDB_UNUSED
1175	SW	DDB_UNUSED_1175	DDB_UNUSED
1176	SW	DDB_UNUSED_1176	DDB_UNUSED
1177	SW	DDB_UNUSED_1177	DDB_UNUSED
1178	SW	DDB_UNUSED_1178	DDB_UNUSED
1179	SW	DDB_UNUSED_1179	DDB_UNUSED
1180	SW	DDB_UNUSED_1180	DDB_UNUSED
1181	SW	DDB_UNUSED_1181	DDB_UNUSED
1182	SW	DDB_UNUSED_1182	DDB_UNUSED
1183	SW	DDB_UNUSED_1183	DDB_UNUSED
1184	SW	DDB_UNUSED_1184	DDB_UNUSED
1185	SW	DDB_UNUSED_1185	DDB_UNUSED
1186	SW	DDB_UNUSED_1186	DDB_UNUSED
1187	SW	DDB_UNUSED_1187	DDB_UNUSED
1188	SW	DDB_UNUSED_1188	DDB_UNUSED
1189	SW	DDB_UNUSED_1189	DDB_UNUSED
1190	SW	DDB_UNUSED_1190	DDB_UNUSED
1191	SW	DDB_UNUSED_1191	DDB_UNUSED
1192	SW	DDB_UNUSED_1192	DDB_UNUSED
1193	SW	DDB_UNUSED_1193	DDB_UNUSED
1194	SW	DDB_UNUSED_1194	DDB_UNUSED
1195	SW	DDB_UNUSED_1195	DDB_UNUSED

DDB No	Source	Description	English Text
1196	SW	DDB_UNUSED_1196	DDB_UNUSED
1197	SW	DDB_UNUSED_1197	DDB_UNUSED
1198	SW	DDB_UNUSED_1198	DDB_UNUSED
1199	SW	DDB_UNUSED_1199	DDB_UNUSED
1200	SW	DDB_UNUSED_1200	DDB_UNUSED
1201	SW	DDB_UNUSED_1201	DDB_UNUSED
1202	SW	DDB_UNUSED_1202	DDB_UNUSED
1203	SW	DDB_UNUSED_1203	DDB_UNUSED
1204	SW	DDB_UNUSED_1204	DDB_UNUSED
1205	SW	DDB_UNUSED_1205	DDB_UNUSED
1206	SW	DDB_UNUSED_1206	DDB_UNUSED
1207	SW	DDB_UNUSED_1207	DDB_UNUSED
1208	SW	DDB_UNUSED_1208	DDB_UNUSED
1209	SW	DDB_UNUSED_1209	DDB_UNUSED
1210	SW	DDB_UNUSED_1210	DDB_UNUSED
1211	SW	DDB_UNUSED_1211	DDB_UNUSED
1212	SW	DDB_UNUSED_1212	DDB_UNUSED
1213	SW	DDB_UNUSED_1213	DDB_UNUSED
1214	SW	DDB_UNUSED_1214	DDB_UNUSED
1215	SW	DDB_UNUSED_1215	DDB_UNUSED
1216	PSL	DDB_PSLINT_1	
1217	PSL	DDB_PSLINT_2	
1218	PSL	DDB_PSLINT_3	
1219	PSL	DDB_PSLINT_4	
1220	PSL	DDB_PSLINT_5	
1221	PSL	DDB_PSLINT_6	
1222	PSL	DDB_PSLINT_7	
1223	PSL	DDB_PSLINT_8	
1224	PSL	DDB_PSLINT_9	
1225	PSL	DDB_PSLINT_10	
1226	PSL	DDB_PSLINT_11	
1227	PSL	DDB_PSLINT_12	
1228	PSL	DDB_PSLINT_13	
1229	PSL	DDB_PSLINT_14	
1230	PSL	DDB_PSLINT_15	
1231	PSL	DDB_PSLINT_16	
1232	PSL	DDB_PSLINT_17	
1233	PSL	DDB_PSLINT_18	
1234	PSL	DDB_PSLINT_19	
1235	PSL	DDB_PSLINT_20	
1236	PSL	DDB_PSLINT_21	
1237	PSL	DDB_PSLINT_22	
1238	PSL	DDB_PSLINT_23	
1239	PSL	DDB_PSLINT_24	
1240	PSL	DDB_PSLINT_25	
1241	PSL	DDB_PSLINT_26	
1242	PSL	DDB_PSLINT_27	
1243	PSL	DDB_PSLINT_28	
1244	PSL	DDB_PSLINT_29	
1245	PSL	DDB_PSLINT_30	
1246	PSL	DDB_PSLINT_31	
1247	PSL	DDB_PSLINT_32	
1248	PSL	DDB_PSLINT_33	
1249	PSL	DDB_PSLINT_34	
1250	PSL	DDB_PSLINT_35	

DDB No	Source	Description	English Text
1251	PSL	DDB_PSLINT_36	
1252	PSL	DDB_PSLINT_37	
1253	PSL	DDB_PSLINT_38	
1254	PSL	DDB_PSLINT_39	
1255	PSL	DDB_PSLINT_40	
1256	PSL	DDB_PSLINT_41	
1257	PSL	DDB_PSLINT_42	
1258	PSL	DDB_PSLINT_43	
1259	PSL	DDB_PSLINT_44	
1260	PSL	DDB_PSLINT_45	
1261	PSL	DDB_PSLINT_46	
1262	PSL	DDB_PSLINT_47	
1263	PSL	DDB_PSLINT_48	
1264	PSL	DDB_PSLINT_49	
1265	PSL	DDB_PSLINT_50	
1266	PSL	DDB_PSLINT_51	
1267	PSL	DDB_PSLINT_52	
1268	PSL	DDB_PSLINT_53	
1269	PSL	DDB_PSLINT_54	
1270	PSL	DDB_PSLINT_55	
1271	PSL	DDB_PSLINT_56	
1272	PSL	DDB_PSLINT_57	
1273	PSL	DDB_PSLINT_58	
1274	PSL	DDB_PSLINT_59	
1275	PSL	DDB_PSLINT_60	
1276	PSL	DDB_PSLINT_61	
1277	PSL	DDB_PSLINT_62	
1278	PSL	DDB_PSLINT_63	
1279	PSL	DDB_PSLINT_64	
1280	PSL	DDB_PSLINT_65	
1281	PSL	DDB_PSLINT_66	
1282	PSL	DDB_PSLINT_67	
1283	PSL	DDB_PSLINT_68	
1284	PSL	DDB_PSLINT_69	
1285	PSL	DDB_PSLINT_70	
1286	PSL	DDB_PSLINT_71	
1287	PSL	DDB_PSLINT_72	
1288	PSL	DDB_PSLINT_73	
1289	PSL	DDB_PSLINT_74	
1290	PSL	DDB_PSLINT_75	
1291	PSL	DDB_PSLINT_76	
1292	PSL	DDB_PSLINT_77	
1293	PSL	DDB_PSLINT_78	
1294	PSL	DDB_PSLINT_79	
1295	PSL	DDB_PSLINT_80	
1296	PSL	DDB_PSLINT_81	
1297	PSL	DDB_PSLINT_82	
1298	PSL	DDB_PSLINT_83	
1299	PSL	DDB_PSLINT_84	
1300	PSL	DDB_PSLINT_85	
1301	PSL	DDB_PSLINT_86	
1302	PSL	DDB_PSLINT_87	
1303	PSL	DDB_PSLINT_88	
1304	PSL	DDB_PSLINT_89	
1305	PSL	DDB_PSLINT_90	

DDB No	Source	Description	English Text
1306	PSL	DDB_PSLINT_91	
1307	PSL	DDB_PSLINT_92	
1308	PSL	DDB_PSLINT_93	
1309	PSL	DDB_PSLINT_94	
1310	PSL	DDB_PSLINT_95	
1311	PSL	DDB_PSLINT_96	
1312	PSL	DDB_PSLINT_97	
1313	PSL	DDB_PSLINT_98	
1314	PSL	DDB_PSLINT_99	
1315	PSL	DDB_PSLINT_100	
1316	PSL	DDB_PSLINT_101	
1317	PSL	DDB_PSLINT_102	
1318	PSL	DDB_PSLINT_103	
1319	PSL	DDB_PSLINT_104	
1320	PSL	DDB_PSLINT_105	
1321	PSL	DDB_PSLINT_106	
1322	PSL	DDB_PSLINT_107	
1323	PSL	DDB_PSLINT_108	
1324	PSL	DDB_PSLINT_109	
1325	PSL	DDB_PSLINT_110	
1326	PSL	DDB_PSLINT_111	
1327	PSL	DDB_PSLINT_112	
1328	PSL	DDB_PSLINT_113	
1329	PSL	DDB_PSLINT_114	
1330	PSL	DDB_PSLINT_115	
1331	PSL	DDB_PSLINT_116	
1332	PSL	DDB_PSLINT_117	
1333	PSL	DDB_PSLINT_118	
1334	PSL	DDB_PSLINT_119	
1335	PSL	DDB_PSLINT_120	
1336	PSL	DDB_PSLINT_121	
1337	PSL	DDB_PSLINT_122	
1338	PSL	DDB_PSLINT_123	
1339	PSL	DDB_PSLINT_124	
1340	PSL	DDB_PSLINT_125	
1341	PSL	DDB_PSLINT_126	
1342	PSL	DDB_PSLINT_127	
1343	PSL	DDB_PSLINT_128	
1344	PSL	DDB_PSLINT_129	
1345	PSL	DDB_PSLINT_130	
1346	PSL	DDB_PSLINT_131	
1347	PSL	DDB_PSLINT_132	
1348	PSL	DDB_PSLINT_133	
1349	PSL	DDB_PSLINT_134	
1350	PSL	DDB_PSLINT_135	
1351	PSL	DDB_PSLINT_136	
1352	PSL	DDB_PSLINT_137	
1353	PSL	DDB_PSLINT_138	
1354	PSL	DDB_PSLINT_139	
1355	PSL	DDB_PSLINT_140	
1356	PSL	DDB_PSLINT_141	
1357	PSL	DDB_PSLINT_142	
1358	PSL	DDB_PSLINT_143	
1359	PSL	DDB_PSLINT_144	
1360	PSL	DDB_PSLINT_145	

DDB No	Source	Description	English Text
1361	PSL	DDB_PSLINT_146	
1362	PSL	DDB_PSLINT_147	
1363	PSL	DDB_PSLINT_148	
1364	PSL	DDB_PSLINT_149	
1365	PSL	DDB_PSLINT_150	
1366	PSL	DDB_PSLINT_151	
1367	PSL	DDB_PSLINT_152	
1368	PSL	DDB_PSLINT_153	
1369	PSL	DDB_PSLINT_154	
1370	PSL	DDB_PSLINT_155	
1371	PSL	DDB_PSLINT_156	
1372	PSL	DDB_PSLINT_157	
1373	PSL	DDB_PSLINT_158	
1374	PSL	DDB_PSLINT_159	
1375	PSL	DDB_PSLINT_160	
1376	PSL	DDB_PSLINT_161	
1377	PSL	DDB_PSLINT_162	
1378	PSL	DDB_PSLINT_163	
1379	PSL	DDB_PSLINT_164	
1380	PSL	DDB_PSLINT_165	
1381	PSL	DDB_PSLINT_166	
1382	PSL	DDB_PSLINT_167	
1383	PSL	DDB_PSLINT_168	
1384	PSL	DDB_PSLINT_169	
1385	PSL	DDB_PSLINT_170	
1386	PSL	DDB_PSLINT_171	
1387	PSL	DDB_PSLINT_172	
1388	PSL	DDB_PSLINT_173	
1389	PSL	DDB_PSLINT_174	
1390	PSL	DDB_PSLINT_175	
1391	PSL	DDB_PSLINT_176	
1392	PSL	DDB_PSLINT_177	
1393	PSL	DDB_PSLINT_178	
1394	PSL	DDB_PSLINT_179	
1395	PSL	DDB_PSLINT_180	
1396	PSL	DDB_PSLINT_181	
1397	PSL	DDB_PSLINT_182	
1398	PSL	DDB_PSLINT_183	
1399	PSL	DDB_PSLINT_184	
1400	PSL	DDB_PSLINT_185	
1401	PSL	DDB_PSLINT_186	
1402	PSL	DDB_PSLINT_187	
1403	PSL	DDB_PSLINT_188	
1404	PSL	DDB_PSLINT_189	
1405	PSL	DDB_PSLINT_190	
1406	PSL	DDB_PSLINT_191	
1407	PSL	DDB_PSLINT_192	
1408	PSL	DDB_PSLINT_193	
1409	PSL	DDB_PSLINT_194	
1410	PSL	DDB_PSLINT_195	
1411	PSL	DDB_PSLINT_196	
1412	PSL	DDB_PSLINT_197	
1413	PSL	DDB_PSLINT_198	
1414	PSL	DDB_PSLINT_199	
1415	PSL	DDB_PSLINT_200	

DDB No	Source	Description	English Text
1416	PSL	DDB_PSLINT_201	
1417	PSL	DDB_PSLINT_202	
1418	PSL	DDB_PSLINT_203	
1419	PSL	DDB_PSLINT_204	
1420	PSL	DDB_PSLINT_205	
1421	PSL	DDB_PSLINT_206	
1422	PSL	DDB_PSLINT_207	
1423	PSL	DDB_PSLINT_208	
1424	PSL	DDB_PSLINT_209	
1425	PSL	DDB_PSLINT_210	
1426	PSL	DDB_PSLINT_211	
1427	PSL	DDB_PSLINT_212	
1428	PSL	DDB_PSLINT_213	
1429	PSL	DDB_PSLINT_214	
1430	PSL	DDB_PSLINT_215	
1431	PSL	DDB_PSLINT_216	
1432	PSL	DDB_PSLINT_217	
1433	PSL	DDB_PSLINT_218	
1434	PSL	DDB_PSLINT_219	
1435	PSL	DDB_PSLINT_220	
1436	PSL	DDB_PSLINT_221	
1437	PSL	DDB_PSLINT_222	
1438	PSL	DDB_PSLINT_223	
1439	PSL	DDB_PSLINT_224	
1440	PSL	DDB_PSLINT_225	
1441	PSL	DDB_PSLINT_226	
1442	PSL	DDB_PSLINT_227	
1443	PSL	DDB_PSLINT_228	
1444	PSL	DDB_PSLINT_229	
1445	PSL	DDB_PSLINT_230	
1446	PSL	DDB_PSLINT_231	
1447	PSL	DDB_PSLINT_232	
1448	PSL	DDB_PSLINT_233	
1449	PSL	DDB_PSLINT_234	
1450	PSL	DDB_PSLINT_235	
1451	PSL	DDB_PSLINT_236	
1452	PSL	DDB_PSLINT_237	
1453	PSL	DDB_PSLINT_238	
1454	PSL	DDB_PSLINT_239	
1455	PSL	DDB_PSLINT_240	
1456	PSL	DDB_PSLINT_241	
1457	PSL	DDB_PSLINT_242	
1458	PSL	DDB_PSLINT_243	
1459	PSL	DDB_PSLINT_244	
1460	PSL	DDB_PSLINT_245	
1461	PSL	DDB_PSLINT_246	
1462	PSL	DDB_PSLINT_247	
1463	PSL	DDB_PSLINT_248	
1464	PSL	DDB_PSLINT_249	
1465	PSL	DDB_PSLINT_250	
1466	PSL	DDB_PSLINT_251	
1467	PSL	DDB_PSLINT_252	
1468	PSL	DDB_PSLINT_253	
1469	PSL	DDB_PSLINT_254	
1470	PSL	DDB_PSLINT_255	

DDB No	Source	Description	English Text
1471	PSL	DDB_PSLINT_256	
1472	PSL	DDB_PSLINT_257	
1473	PSL	DDB_PSLINT_258	
1474	PSL	DDB_PSLINT_259	
1475	PSL	DDB_PSLINT_260	
1476	PSL	DDB_PSLINT_261	
1477	PSL	DDB_PSLINT_262	
1478	PSL	DDB_PSLINT_263	
1479	PSL	DDB_PSLINT_264	
1480	PSL	DDB_PSLINT_265	
1481	PSL	DDB_PSLINT_266	
1482	PSL	DDB_PSLINT_267	
1483	PSL	DDB_PSLINT_268	
1484	PSL	DDB_PSLINT_269	
1485	PSL	DDB_PSLINT_270	
1486	PSL	DDB_PSLINT_271	
1487	PSL	DDB_PSLINT_272	
1488	PSL	DDB_PSLINT_273	
1489	PSL	DDB_PSLINT_274	
1490	PSL	DDB_PSLINT_275	
1491	PSL	DDB_PSLINT_276	
1492	PSL	DDB_PSLINT_277	
1493	PSL	DDB_PSLINT_278	
1494	PSL	DDB_PSLINT_279	
1495	PSL	DDB_PSLINT_280	
1496	PSL	DDB_PSLINT_281	
1497	PSL	DDB_PSLINT_282	
1498	PSL	DDB_PSLINT_283	
1499	PSL	DDB_PSLINT_284	
1500	PSL	DDB_PSLINT_285	
1501	PSL	DDB_PSLINT_286	
1502	PSL	DDB_PSLINT_287	
1503	PSL	DDB_PSLINT_288	
1504	PSL	DDB_PSLINT_289	
1505	PSL	DDB_PSLINT_290	
1506	PSL	DDB_PSLINT_291	
1507	PSL	DDB_PSLINT_292	
1508	PSL	DDB_PSLINT_293	
1509	PSL	DDB_PSLINT_294	
1510	PSL	DDB_PSLINT_295	
1511	PSL	DDB_PSLINT_296	
1512	PSL	DDB_PSLINT_297	
1513	PSL	DDB_PSLINT_298	
1514	PSL	DDB_PSLINT_299	
1515	PSL	DDB_PSLINT_300	
1516	SW	DDB_UNUSED_1516	DDB_UNUSED
1517	SW	DDB_UNUSED_1517	DDB_UNUSED
1518	SW	DDB_UNUSED_1518	DDB_UNUSED
1519	SW	DDB_UNUSED_1519	DDB_UNUSED
1520	SW	DDB_UNUSED_1520	DDB_UNUSED
1521	SW	DDB_UNUSED_1521	DDB_UNUSED
1522	SW	DDB_UNUSED_1522	DDB_UNUSED
1523	SW	DDB_UNUSED_1523	DDB_UNUSED
1524	SW	DDB_UNUSED_1524	DDB_UNUSED
1525	SW	DDB_UNUSED_1525	DDB_UNUSED

DDB No	Source	Description	English Text
1526	SW	DDB_UNUSED_1526	DDB_UNUSED
1527	SW	DDB_UNUSED_1527	DDB_UNUSED
1528	SW	DDB_UNUSED_1528	DDB_UNUSED
1529	SW	DDB_UNUSED_1529	DDB_UNUSED
1530	SW	DDB_UNUSED_1530	DDB_UNUSED
1531	SW	DDB_UNUSED_1531	DDB_UNUSED
1532	SW	DDB_UNUSED_1532	DDB_UNUSED
1533	SW	DDB_UNUSED_1533	DDB_UNUSED
1534	SW	DDB_UNUSED_1534	DDB_UNUSED
1535	SW	DDB_UNUSED_1535	DDB_UNUSED
1536	SW	DDB_UNUSED_1536	DDB_UNUSED
1537	SW	DDB_UNUSED_1537	DDB_UNUSED
1538	SW	DDB_UNUSED_1538	DDB_UNUSED
1539	SW	DDB_UNUSED_1539	DDB_UNUSED
1540	SW	DDB_UNUSED_1540	DDB_UNUSED
1541	SW	DDB_UNUSED_1541	DDB_UNUSED
1542	SW	DDB_UNUSED_1542	DDB_UNUSED
1543	SW	DDB_UNUSED_1543	DDB_UNUSED
1544	SW	DDB_UNUSED_1544	DDB_UNUSED
1545	SW	DDB_UNUSED_1545	DDB_UNUSED
1546	SW	DDB_UNUSED_1546	DDB_UNUSED
1547	SW	DDB_UNUSED_1547	DDB_UNUSED
1548	SW	DDB_UNUSED_1548	DDB_UNUSED
1549	SW	DDB_UNUSED_1549	DDB_UNUSED
1550	SW	DDB_UNUSED_1550	DDB_UNUSED
1551	SW	DDB_UNUSED_1551	DDB_UNUSED
1552	SW	DDB_UNUSED_1552	DDB_UNUSED
1553	SW	DDB_UNUSED_1553	DDB_UNUSED
1554	SW	DDB_UNUSED_1554	DDB_UNUSED
1555	SW	DDB_UNUSED_1555	DDB_UNUSED
1556	SW	DDB_UNUSED_1556	DDB_UNUSED
1557	SW	DDB_UNUSED_1557	DDB_UNUSED
1558	SW	DDB_UNUSED_1558	DDB_UNUSED
1559	SW	DDB_UNUSED_1559	DDB_UNUSED
1560	SW	DDB_UNUSED_1560	DDB_UNUSED
1561	SW	DDB_UNUSED_1561	DDB_UNUSED
1562	SW	DDB_UNUSED_1562	DDB_UNUSED
1563	SW	DDB_UNUSED_1563	DDB_UNUSED
1564	SW	DDB_UNUSED_1564	DDB_UNUSED
1565	SW	DDB_UNUSED_1565	DDB_UNUSED
1566	SW	DDB_UNUSED_1566	DDB_UNUSED
1567	SW	DDB_UNUSED_1567	DDB_UNUSED
1568	SW	DDB_UNUSED_1568	DDB_UNUSED
1569	SW	DDB_UNUSED_1569	DDB_UNUSED
1570	SW	DDB_UNUSED_1570	DDB_UNUSED
1571	SW	DDB_UNUSED_1571	DDB_UNUSED
1572	SW	DDB_UNUSED_1572	DDB_UNUSED
1573	SW	DDB_UNUSED_1573	DDB_UNUSED
1574	SW	DDB_UNUSED_1574	DDB_UNUSED
1575	SW	DDB_UNUSED_1575	DDB_UNUSED
1576	SW	DDB_UNUSED_1576	DDB_UNUSED
1577	SW	DDB_UNUSED_1577	DDB_UNUSED
1578	SW	DDB_UNUSED_1578	DDB_UNUSED
1579	SW	DDB_UNUSED_1579	DDB_UNUSED
1580	SW	DDB_UNUSED_1580	DDB_UNUSED

DDB No	Source	Description	English Text
1581	SW	DDB_UNUSED_1581	DDB_UNUSED
1582	SW	DDB_UNUSED_1582	DDB_UNUSED
1583	SW	DDB_UNUSED_1583	DDB_UNUSED
1584	SW	DDB_UNUSED_1584	DDB_UNUSED
1585	SW	DDB_UNUSED_1585	DDB_UNUSED
1586	SW	DDB_UNUSED_1586	DDB_UNUSED
1587	SW	DDB_UNUSED_1587	DDB_UNUSED
1588	SW	DDB_UNUSED_1588	DDB_UNUSED
1589	SW	DDB_UNUSED_1589	DDB_UNUSED
1590	SW	DDB_UNUSED_1590	DDB_UNUSED
1591	SW	DDB_UNUSED_1591	DDB_UNUSED
1592	SW	DDB_UNUSED_1592	DDB_UNUSED
1593	SW	DDB_UNUSED_1593	DDB_UNUSED
1594	SW	DDB_UNUSED_1594	DDB_UNUSED
1595	SW	DDB_UNUSED_1595	DDB_UNUSED
1596	SW	DDB_UNUSED_1596	DDB_UNUSED
1597	SW	DDB_UNUSED_1597	DDB_UNUSED
1598	SW	DDB_UNUSED_1598	DDB_UNUSED
1599	SW	DDB_UNUSED_1599	DDB_UNUSED
1600	SW	DDB_UNUSED_1600	DDB_UNUSED
1601	SW	DDB_UNUSED_1601	DDB_UNUSED
1602	SW	DDB_UNUSED_1602	DDB_UNUSED
1603	SW	DDB_UNUSED_1603	DDB_UNUSED
1604	SW	DDB_UNUSED_1604	DDB_UNUSED
1605	SW	DDB_UNUSED_1605	DDB_UNUSED
1606	SW	DDB_UNUSED_1606	DDB_UNUSED
1607	SW	DDB_UNUSED_1607	DDB_UNUSED
1608	SW	DDB_UNUSED_1608	DDB_UNUSED
1609	SW	DDB_UNUSED_1609	DDB_UNUSED
1610	SW	DDB_UNUSED_1610	DDB_UNUSED
1611	SW	DDB_UNUSED_1611	DDB_UNUSED
1612	SW	DDB_UNUSED_1612	DDB_UNUSED
1613	SW	DDB_UNUSED_1613	DDB_UNUSED
1614	SW	DDB_UNUSED_1614	DDB_UNUSED
1615	SW	DDB_UNUSED_1615	DDB_UNUSED
1616	SW	DDB_UNUSED_1616	DDB_UNUSED
1617	SW	DDB_UNUSED_1617	DDB_UNUSED
1618	SW	DDB_UNUSED_1618	DDB_UNUSED
1619	SW	DDB_UNUSED_1619	DDB_UNUSED
1620	SW	DDB_UNUSED_1620	DDB_UNUSED
1621	SW	DDB_UNUSED_1621	DDB_UNUSED
1622	SW	DDB_UNUSED_1622	DDB_UNUSED
1623	SW	DDB_UNUSED_1623	DDB_UNUSED
1624	SW	DDB_UNUSED_1624	DDB_UNUSED
1625	SW	DDB_UNUSED_1625	DDB_UNUSED
1626	SW	DDB_UNUSED_1626	DDB_UNUSED
1627	SW	DDB_UNUSED_1627	DDB_UNUSED
1628	SW	DDB_UNUSED_1628	DDB_UNUSED
1629	SW	DDB_UNUSED_1629	DDB_UNUSED
1630	SW	DDB_UNUSED_1630	DDB_UNUSED
1631	SW	DDB_UNUSED_1631	DDB_UNUSED
1632	SW	DDB_UNUSED_1632	DDB_UNUSED
1633	SW	DDB_UNUSED_1633	DDB_UNUSED
1634	SW	DDB_UNUSED_1634	DDB_UNUSED
1635	SW	DDB_UNUSED_1635	DDB_UNUSED

DDB No	Source	Description	English Text
1636	SW	DDB_UNUSED_1636	DDB_UNUSED
1637	SW	DDB_UNUSED_1637	DDB_UNUSED
1638	SW	DDB_UNUSED_1638	DDB_UNUSED
1639	SW	DDB_UNUSED_1639	DDB_UNUSED
1640	SW	DDB_UNUSED_1640	DDB_UNUSED
1641	SW	DDB_UNUSED_1641	DDB_UNUSED
1642	SW	DDB_UNUSED_1642	DDB_UNUSED
1643	SW	DDB_UNUSED_1643	DDB_UNUSED
1644	SW	DDB_UNUSED_1644	DDB_UNUSED
1645	SW	DDB_UNUSED_1645	DDB_UNUSED
1646	SW	DDB_UNUSED_1646	DDB_UNUSED
1647	SW	DDB_UNUSED_1647	DDB_UNUSED
1648	SW	DDB_UNUSED_1648	DDB_UNUSED
1649	SW	DDB_UNUSED_1649	DDB_UNUSED
1650	SW	DDB_UNUSED_1650	DDB_UNUSED
1651	SW	DDB_UNUSED_1651	DDB_UNUSED
1652	SW	DDB_UNUSED_1652	DDB_UNUSED
1653	SW	DDB_UNUSED_1653	DDB_UNUSED
1654	SW	DDB_UNUSED_1654	DDB_UNUSED
1655	SW	DDB_UNUSED_1655	DDB_UNUSED
1656	SW	DDB_UNUSED_1656	DDB_UNUSED
1657	SW	DDB_UNUSED_1657	DDB_UNUSED
1658	SW	DDB_UNUSED_1658	DDB_UNUSED
1659	SW	DDB_UNUSED_1659	DDB_UNUSED
1660	SW	DDB_UNUSED_1660	DDB_UNUSED
1661	SW	DDB_UNUSED_1661	DDB_UNUSED
1662	SW	DDB_UNUSED_1662	DDB_UNUSED
1663	SW	DDB_UNUSED_1663	DDB_UNUSED
1664	SW	DDB_UNUSED_1664	DDB_UNUSED
1665	SW	DDB_UNUSED_1665	DDB_UNUSED
1666	SW	DDB_UNUSED_1666	DDB_UNUSED
1667	SW	DDB_UNUSED_1667	DDB_UNUSED
1668	SW	DDB_UNUSED_1668	DDB_UNUSED
1669	SW	DDB_UNUSED_1669	DDB_UNUSED
1670	SW	DDB_UNUSED_1670	DDB_UNUSED
1671	SW	DDB_UNUSED_1671	DDB_UNUSED
1672	SW	DDB_UNUSED_1672	DDB_UNUSED
1673	SW	DDB_UNUSED_1673	DDB_UNUSED
1674	SW	DDB_UNUSED_1674	DDB_UNUSED
1675	SW	DDB_UNUSED_1675	DDB_UNUSED
1676	SW	DDB_UNUSED_1676	DDB_UNUSED
1677	SW	DDB_UNUSED_1677	DDB_UNUSED
1678	SW	DDB_UNUSED_1678	DDB_UNUSED
1679	SW	DDB_UNUSED_1679	DDB_UNUSED
1680	SW	DDB_UNUSED_1680	DDB_UNUSED
1681	SW	DDB_UNUSED_1681	DDB_UNUSED
1682	SW	DDB_UNUSED_1682	DDB_UNUSED
1683	SW	DDB_UNUSED_1683	DDB_UNUSED
1684	SW	DDB_UNUSED_1684	DDB_UNUSED
1685	SW	DDB_UNUSED_1685	DDB_UNUSED
1686	SW	DDB_UNUSED_1686	DDB_UNUSED
1687	SW	DDB_UNUSED_1687	DDB_UNUSED
1688	SW	DDB_UNUSED_1688	DDB_UNUSED
1689	SW	DDB_UNUSED_1689	DDB_UNUSED
1690	SW	DDB_UNUSED_1690	DDB_UNUSED

DDB No	Source	Description	English Text
1691	SW	DDB_UNUSED_1691	DDB_UNUSED
1692	SW	DDB_UNUSED_1692	DDB_UNUSED
1693	SW	DDB_UNUSED_1693	DDB_UNUSED
1694	SW	DDB_UNUSED_1694	DDB_UNUSED
1695	SW	DDB_UNUSED_1695	DDB_UNUSED
1696	SW	DDB_UNUSED_1696	DDB_UNUSED
1697	SW	DDB_UNUSED_1697	DDB_UNUSED
1698	SW	DDB_UNUSED_1698	DDB_UNUSED
1699	SW	DDB_UNUSED_1699	DDB_UNUSED
1700	SW	DDB_UNUSED_1700	DDB_UNUSED
1701	SW	DDB_UNUSED_1701	DDB_UNUSED
1702	SW	DDB_UNUSED_1702	DDB_UNUSED
1703	SW	DDB_UNUSED_1703	DDB_UNUSED
1704	SW	DDB_UNUSED_1704	DDB_UNUSED
1705	SW	DDB_UNUSED_1705	DDB_UNUSED
1706	SW	DDB_UNUSED_1706	DDB_UNUSED
1707	SW	DDB_UNUSED_1707	DDB_UNUSED
1708	SW	DDB_UNUSED_1708	DDB_UNUSED
1709	SW	DDB_UNUSED_1709	DDB_UNUSED
1710	SW	DDB_UNUSED_1710	DDB_UNUSED
1711	SW	DDB_UNUSED_1711	DDB_UNUSED
1712	SW	DDB_UNUSED_1712	DDB_UNUSED
1713	SW	DDB_UNUSED_1713	DDB_UNUSED
1714	SW	DDB_UNUSED_1714	DDB_UNUSED
1715	SW	DDB_UNUSED_1715	DDB_UNUSED
1716	SW	DDB_UNUSED_1716	DDB_UNUSED
1717	SW	DDB_UNUSED_1717	DDB_UNUSED
1718	SW	DDB_UNUSED_1718	DDB_UNUSED
1719	SW	DDB_UNUSED_1719	DDB_UNUSED
1720	SW	DDB_UNUSED_1720	DDB_UNUSED
1721	SW	DDB_UNUSED_1721	DDB_UNUSED
1722	SW	DDB_UNUSED_1722	DDB_UNUSED
1723	SW	DDB_UNUSED_1723	DDB_UNUSED
1724	SW	DDB_UNUSED_1724	DDB_UNUSED
1725	SW	DDB_UNUSED_1725	DDB_UNUSED
1726	SW	DDB_UNUSED_1726	DDB_UNUSED
1727	SW	DDB_UNUSED_1727	DDB_UNUSED
1728	SW	DDB_UNUSED_1728	DDB_UNUSED
1729	SW	DDB_UNUSED_1729	DDB_UNUSED
1730	SW	DDB_UNUSED_1730	DDB_UNUSED
1731	SW	DDB_UNUSED_1731	DDB_UNUSED
1732	SW	DDB_UNUSED_1732	DDB_UNUSED
1733	SW	DDB_UNUSED_1733	DDB_UNUSED
1734	SW	DDB_UNUSED_1734	DDB_UNUSED
1735	SW	DDB_UNUSED_1735	DDB_UNUSED
1736	SW	DDB_UNUSED_1736	DDB_UNUSED
1737	SW	DDB_UNUSED_1737	DDB_UNUSED
1738	SW	DDB_UNUSED_1738	DDB_UNUSED
1739	SW	DDB_UNUSED_1739	DDB_UNUSED
1740	SW	DDB_UNUSED_1740	DDB_UNUSED
1741	SW	DDB_UNUSED_1741	DDB_UNUSED
1742	SW	DDB_UNUSED_1742	DDB_UNUSED
1743	SW	DDB_UNUSED_1743	DDB_UNUSED
1744	SW	DDB_UNUSED_1744	DDB_UNUSED
1745	SW	DDB_UNUSED_1745	DDB_UNUSED

DDB No	Source	Description	English Text
1746	SW	DDB_UNUSED_1746	DDB_UNUSED
1747	SW	DDB_UNUSED_1747	DDB_UNUSED
1748	SW	DDB_UNUSED_1748	DDB_UNUSED
1749	SW	DDB_UNUSED_1749	DDB_UNUSED
1750	SW	DDB_UNUSED_1750	DDB_UNUSED
1751	SW	DDB_UNUSED_1751	DDB_UNUSED
1752	SW	DDB_UNUSED_1752	DDB_UNUSED
1753	SW	DDB_UNUSED_1753	DDB_UNUSED
1754	SW	DDB_UNUSED_1754	DDB_UNUSED
1755	SW	DDB_UNUSED_1755	DDB_UNUSED
1756	SW	DDB_UNUSED_1756	DDB_UNUSED
1757	SW	DDB_UNUSED_1757	DDB_UNUSED
1758	SW	DDB_UNUSED_1758	DDB_UNUSED
1759	SW	DDB_UNUSED_1759	DDB_UNUSED
1760	SW	DDB_UNUSED_1760	DDB_UNUSED
1761	SW	DDB_UNUSED_1761	DDB_UNUSED
1762	SW	DDB_UNUSED_1762	DDB_UNUSED
1763	SW	DDB_UNUSED_1763	DDB_UNUSED
1764	SW	DDB_UNUSED_1764	DDB_UNUSED
1765	SW	DDB_UNUSED_1765	DDB_UNUSED
1766	SW	DDB_UNUSED_1766	DDB_UNUSED
1767	SW	DDB_UNUSED_1767	DDB_UNUSED
1768	SW	DDB_UNUSED_1768	DDB_UNUSED
1769	SW	DDB_UNUSED_1769	DDB_UNUSED
1770	SW	DDB_UNUSED_1770	DDB_UNUSED
1771	SW	DDB_UNUSED_1771	DDB_UNUSED
1772	SW	DDB_UNUSED_1772	DDB_UNUSED
1773	SW	DDB_UNUSED_1773	DDB_UNUSED
1774	SW	DDB_UNUSED_1774	DDB_UNUSED
1775	SW	DDB_UNUSED_1775	DDB_UNUSED
1776	SW	DDB_UNUSED_1776	DDB_UNUSED
1777	SW	DDB_UNUSED_1777	DDB_UNUSED
1778	SW	DDB_UNUSED_1778	DDB_UNUSED
1779	SW	DDB_UNUSED_1779	DDB_UNUSED
1780	SW	DDB_UNUSED_1780	DDB_UNUSED
1781	SW	DDB_UNUSED_1781	DDB_UNUSED
1782	SW	DDB_UNUSED_1782	DDB_UNUSED
1783	SW	DDB_UNUSED_1783	DDB_UNUSED
1784	SW	DDB_UNUSED_1784	DDB_UNUSED
1785	SW	DDB_UNUSED_1785	DDB_UNUSED
1786	SW	DDB_UNUSED_1786	DDB_UNUSED
1787	SW	DDB_UNUSED_1787	DDB_UNUSED
1788	SW	DDB_UNUSED_1788	DDB_UNUSED
1789	SW	DDB_UNUSED_1789	DDB_UNUSED
1790	SW	DDB_UNUSED_1790	DDB_UNUSED
1791	SW	DDB_UNUSED_1791	DDB_UNUSED
1792	SW	DDB_UNUSED_1792	DDB_UNUSED
1793	SW	DDB_UNUSED_1793	DDB_UNUSED
1794	SW	DDB_UNUSED_1794	DDB_UNUSED
1795	SW	DDB_UNUSED_1795	DDB_UNUSED
1796	SW	DDB_UNUSED_1796	DDB_UNUSED
1797	SW	DDB_UNUSED_1797	DDB_UNUSED
1798	SW	DDB_UNUSED_1798	DDB_UNUSED
1799	SW	DDB_UNUSED_1799	DDB_UNUSED
1800	SW	DDB_UNUSED_1800	DDB_UNUSED

DDB No	Source	Description	English Text
1801	SW	DDB_UNUSED_1801	DDB_UNUSED
1802	SW	DDB_UNUSED_1802	DDB_UNUSED
1803	SW	DDB_UNUSED_1803	DDB_UNUSED
1804	SW	DDB_UNUSED_1804	DDB_UNUSED
1805	SW	DDB_UNUSED_1805	DDB_UNUSED
1806	SW	DDB_UNUSED_1806	DDB_UNUSED
1807	SW	DDB_UNUSED_1807	DDB_UNUSED
1808	SW	DDB_UNUSED_1808	DDB_UNUSED
1809	SW	DDB_UNUSED_1809	DDB_UNUSED
1810	SW	DDB_UNUSED_1810	DDB_UNUSED
1811	SW	DDB_UNUSED_1811	DDB_UNUSED
1812	SW	DDB_UNUSED_1812	DDB_UNUSED
1813	SW	DDB_UNUSED_1813	DDB_UNUSED
1814	SW	DDB_UNUSED_1814	DDB_UNUSED
1815	SW	DDB_UNUSED_1815	DDB_UNUSED
1816	SW	DDB_UNUSED_1816	DDB_UNUSED
1817	SW	DDB_UNUSED_1817	DDB_UNUSED
1818	SW	DDB_UNUSED_1818	DDB_UNUSED
1819	SW	DDB_UNUSED_1819	DDB_UNUSED
1820	SW	DDB_UNUSED_1820	DDB_UNUSED
1821	SW	DDB_UNUSED_1821	DDB_UNUSED
1822	SW	DDB_UNUSED_1822	DDB_UNUSED
1823	SW	DDB_UNUSED_1823	DDB_UNUSED
1824	SW	DDB_UNUSED_1824	DDB_UNUSED
1825	SW	DDB_UNUSED_1825	DDB_UNUSED
1826	SW	DDB_UNUSED_1826	DDB_UNUSED
1827	SW	DDB_UNUSED_1827	DDB_UNUSED
1828	SW	DDB_UNUSED_1828	DDB_UNUSED
1829	SW	DDB_UNUSED_1829	DDB_UNUSED
1830	SW	DDB_UNUSED_1830	DDB_UNUSED
1831	SW	DDB_UNUSED_1831	DDB_UNUSED
1832	SW	DDB_UNUSED_1832	DDB_UNUSED
1833	SW	DDB_UNUSED_1833	DDB_UNUSED
1834	SW	DDB_UNUSED_1834	DDB_UNUSED
1835	SW	DDB_UNUSED_1835	DDB_UNUSED
1836	SW	DDB_UNUSED_1836	DDB_UNUSED
1837	SW	DDB_UNUSED_1837	DDB_UNUSED
1838	SW	DDB_UNUSED_1838	DDB_UNUSED
1839	SW	DDB_UNUSED_1839	DDB_UNUSED
1840	SW	DDB_UNUSED_1840	DDB_UNUSED
1841	SW	DDB_UNUSED_1841	DDB_UNUSED
1842	SW	DDB_UNUSED_1842	DDB_UNUSED
1843	SW	DDB_UNUSED_1843	DDB_UNUSED
1844	SW	DDB_UNUSED_1844	DDB_UNUSED
1845	SW	DDB_UNUSED_1845	DDB_UNUSED
1846	SW	DDB_UNUSED_1846	DDB_UNUSED
1847	SW	DDB_UNUSED_1847	DDB_UNUSED
1848	SW	DDB_UNUSED_1848	DDB_UNUSED
1849	SW	DDB_UNUSED_1849	DDB_UNUSED
1850	SW	DDB_UNUSED_1850	DDB_UNUSED
1851	SW	DDB_UNUSED_1851	DDB_UNUSED
1852	SW	DDB_UNUSED_1852	DDB_UNUSED
1853	SW	DDB_UNUSED_1853	DDB_UNUSED
1854	SW	DDB_UNUSED_1854	DDB_UNUSED
1855	SW	DDB_UNUSED_1855	DDB_UNUSED

DDB No	Source	Description	English Text
1856	SW	DDB_UNUSED_1856	DDB_UNUSED
1857	SW	DDB_UNUSED_1857	DDB_UNUSED
1858	SW	DDB_UNUSED_1858	DDB_UNUSED
1859	SW	DDB_UNUSED_1859	DDB_UNUSED
1860	SW	DDB_UNUSED_1860	DDB_UNUSED
1861	SW	DDB_UNUSED_1861	DDB_UNUSED
1862	SW	DDB_UNUSED_1862	DDB_UNUSED
1863	SW	DDB_UNUSED_1863	DDB_UNUSED
1864	SW	DDB_UNUSED_1864	DDB_UNUSED
1865	SW	DDB_UNUSED_1865	DDB_UNUSED
1866	SW	DDB_UNUSED_1866	DDB_UNUSED
1867	SW	DDB_UNUSED_1867	DDB_UNUSED
1868	SW	DDB_UNUSED_1868	DDB_UNUSED
1869	SW	DDB_UNUSED_1869	DDB_UNUSED
1870	SW	DDB_UNUSED_1870	DDB_UNUSED
1871	SW	DDB_UNUSED_1871	DDB_UNUSED
1872	SW	DDB_UNUSED_1872	DDB_UNUSED
1873	SW	DDB_UNUSED_1873	DDB_UNUSED
1874	SW	DDB_UNUSED_1874	DDB_UNUSED
1875	SW	DDB_UNUSED_1875	DDB_UNUSED
1876	SW	DDB_UNUSED_1876	DDB_UNUSED
1877	SW	DDB_UNUSED_1877	DDB_UNUSED
1878	SW	DDB_UNUSED_1878	DDB_UNUSED
1879	SW	DDB_UNUSED_1879	DDB_UNUSED
1880	SW	DDB_UNUSED_1880	DDB_UNUSED
1881	SW	DDB_UNUSED_1881	DDB_UNUSED
1882	SW	DDB_UNUSED_1882	DDB_UNUSED
1883	SW	DDB_UNUSED_1883	DDB_UNUSED
1884	SW	DDB_UNUSED_1884	DDB_UNUSED
1885	SW	DDB_UNUSED_1885	DDB_UNUSED
1886	SW	DDB_UNUSED_1886	DDB_UNUSED
1887	SW	DDB_UNUSED_1887	DDB_UNUSED
1888	SW	DDB_UNUSED_1888	DDB_UNUSED
1889	SW	DDB_UNUSED_1889	DDB_UNUSED
1890	SW	DDB_UNUSED_1890	DDB_UNUSED
1891	SW	DDB_UNUSED_1891	DDB_UNUSED
1892	SW	DDB_UNUSED_1892	DDB_UNUSED
1893	SW	DDB_UNUSED_1893	DDB_UNUSED
1894	SW	DDB_UNUSED_1894	DDB_UNUSED
1895	SW	DDB_UNUSED_1895	DDB_UNUSED
1896	SW	DDB_UNUSED_1896	DDB_UNUSED
1897	SW	DDB_UNUSED_1897	DDB_UNUSED
1898	SW	DDB_UNUSED_1898	DDB_UNUSED
1899	SW	DDB_UNUSED_1899	DDB_UNUSED
1900	SW	DDB_UNUSED_1900	DDB_UNUSED
1901	SW	DDB_UNUSED_1901	DDB_UNUSED
1902	SW	DDB_UNUSED_1902	DDB_UNUSED
1903	SW	DDB_UNUSED_1903	DDB_UNUSED
1904	SW	DDB_UNUSED_1904	DDB_UNUSED
1905	SW	DDB_UNUSED_1905	DDB_UNUSED
1906	SW	DDB_UNUSED_1906	DDB_UNUSED
1907	SW	DDB_UNUSED_1907	DDB_UNUSED
1908	SW	DDB_UNUSED_1908	DDB_UNUSED
1909	SW	DDB_UNUSED_1909	DDB_UNUSED
1910	SW	DDB_UNUSED_1910	DDB_UNUSED

DDB No	Source	Description	English Text
1911	SW	DDB_UNUSED_1911	DDB_UNUSED
1912	SW	DDB_UNUSED_1912	DDB_UNUSED
1913	SW	DDB_UNUSED_1913	DDB_UNUSED
1914	SW	DDB_UNUSED_1914	DDB_UNUSED
1915	SW	DDB_UNUSED_1915	DDB_UNUSED
1916	SW	DDB_UNUSED_1916	DDB_UNUSED
1917	SW	DDB_UNUSED_1917	DDB_UNUSED
1918	SW	DDB_UNUSED_1918	DDB_UNUSED
1919	SW	DDB_UNUSED_1919	DDB_UNUSED
1920	SW	DDB_UNUSED_1920	DDB_UNUSED
1921	SW	DDB_UNUSED_1921	DDB_UNUSED
1922	SW	DDB_UNUSED_1922	DDB_UNUSED
1923	SW	DDB_UNUSED_1923	DDB_UNUSED
1924	SW	DDB_UNUSED_1924	DDB_UNUSED
1925	SW	DDB_UNUSED_1925	DDB_UNUSED
1926	SW	DDB_UNUSED_1926	DDB_UNUSED
1927	SW	DDB_UNUSED_1927	DDB_UNUSED
1928	SW	DDB_UNUSED_1928	DDB_UNUSED
1929	SW	DDB_UNUSED_1929	DDB_UNUSED
1930	SW	DDB_UNUSED_1930	DDB_UNUSED
1931	SW	DDB_UNUSED_1931	DDB_UNUSED
1932	SW	DDB_UNUSED_1932	DDB_UNUSED
1933	SW	DDB_UNUSED_1933	DDB_UNUSED
1934	SW	DDB_UNUSED_1934	DDB_UNUSED
1935	SW	DDB_UNUSED_1935	DDB_UNUSED
1936	SW	DDB_UNUSED_1936	DDB_UNUSED
1937	SW	DDB_UNUSED_1937	DDB_UNUSED
1938	SW	DDB_UNUSED_1938	DDB_UNUSED
1939	SW	DDB_UNUSED_1939	DDB_UNUSED
1940	SW	DDB_UNUSED_1940	DDB_UNUSED
1941	SW	DDB_UNUSED_1941	DDB_UNUSED
1942	SW	DDB_UNUSED_1942	DDB_UNUSED
1943	SW	DDB_UNUSED_1943	DDB_UNUSED
1944	SW	DDB_UNUSED_1944	DDB_UNUSED
1945	SW	DDB_UNUSED_1945	DDB_UNUSED
1946	SW	DDB_UNUSED_1946	DDB_UNUSED
1947	SW	DDB_UNUSED_1947	DDB_UNUSED
1948	SW	DDB_UNUSED_1948	DDB_UNUSED
1949	SW	DDB_UNUSED_1949	DDB_UNUSED
1950	SW	DDB_UNUSED_1950	DDB_UNUSED
1951	SW	DDB_UNUSED_1951	DDB_UNUSED
1952	SW	DDB_UNUSED_1952	DDB_UNUSED
1953	SW	DDB_UNUSED_1953	DDB_UNUSED
1954	SW	DDB_UNUSED_1954	DDB_UNUSED
1955	SW	DDB_UNUSED_1955	DDB_UNUSED
1956	SW	DDB_UNUSED_1956	DDB_UNUSED
1957	SW	DDB_UNUSED_1957	DDB_UNUSED
1958	SW	DDB_UNUSED_1958	DDB_UNUSED
1959	SW	DDB_UNUSED_1959	DDB_UNUSED
1960	SW	DDB_UNUSED_1960	DDB_UNUSED
1961	SW	DDB_UNUSED_1961	DDB_UNUSED
1962	SW	DDB_UNUSED_1962	DDB_UNUSED
1963	SW	DDB_UNUSED_1963	DDB_UNUSED
1964	SW	DDB_UNUSED_1964	DDB_UNUSED
1965	SW	DDB_UNUSED_1965	DDB_UNUSED

DDB No	Source	Description	English Text
1966	SW	DDB_UNUSED_1966	DDB_UNUSED
1967	SW	DDB_UNUSED_1967	DDB_UNUSED
1968	SW	DDB_UNUSED_1968	DDB_UNUSED
1969	SW	DDB_UNUSED_1969	DDB_UNUSED
1970	SW	DDB_UNUSED_1970	DDB_UNUSED
1971	SW	DDB_UNUSED_1971	DDB_UNUSED
1972	SW	DDB_UNUSED_1972	DDB_UNUSED
1973	SW	DDB_UNUSED_1973	DDB_UNUSED
1974	SW	DDB_UNUSED_1974	DDB_UNUSED
1975	SW	DDB_UNUSED_1975	DDB_UNUSED
1976	SW	DDB_UNUSED_1976	DDB_UNUSED
1977	SW	DDB_UNUSED_1977	DDB_UNUSED
1978	SW	DDB_UNUSED_1978	DDB_UNUSED
1979	SW	DDB_UNUSED_1979	DDB_UNUSED
1980	SW	DDB_UNUSED_1980	DDB_UNUSED
1981	SW	DDB_UNUSED_1981	DDB_UNUSED
1982	SW	DDB_UNUSED_1982	DDB_UNUSED
1983	SW	DDB_UNUSED_1983	DDB_UNUSED
1984	SW	DDB_UNUSED_1984	DDB_UNUSED
1985	SW	DDB_UNUSED_1985	DDB_UNUSED
1986	SW	DDB_UNUSED_1986	DDB_UNUSED
1987	SW	DDB_UNUSED_1987	DDB_UNUSED
1988	SW	DDB_UNUSED_1988	DDB_UNUSED
1989	SW	DDB_UNUSED_1989	DDB_UNUSED
1990	SW	DDB_UNUSED_1990	DDB_UNUSED
1991	SW	DDB_UNUSED_1991	DDB_UNUSED
1992	SW	DDB_UNUSED_1992	DDB_UNUSED
1993	SW	DDB_UNUSED_1993	DDB_UNUSED
1994	SW	DDB_UNUSED_1994	DDB_UNUSED
1995	SW	DDB_UNUSED_1995	DDB_UNUSED
1996	SW	DDB_UNUSED_1996	DDB_UNUSED
1997	SW	DDB_UNUSED_1997	DDB_UNUSED
1998	SW	DDB_UNUSED_1998	DDB_UNUSED
1999	SW	DDB_UNUSED_1999	DDB_UNUSED
2000	SW	DDB_UNUSED_2000	DDB_UNUSED
2001	SW	DDB_UNUSED_2001	DDB_UNUSED
2002	SW	DDB_UNUSED_2002	DDB_UNUSED
2003	SW	DDB_UNUSED_2003	DDB_UNUSED
2004	SW	DDB_UNUSED_2004	DDB_UNUSED
2005	SW	DDB_UNUSED_2005	DDB_UNUSED
2006	SW	DDB_UNUSED_2006	DDB_UNUSED
2007	SW	DDB_UNUSED_2007	DDB_UNUSED
2008	SW	DDB_UNUSED_2008	DDB_UNUSED
2009	SW	DDB_UNUSED_2009	DDB_UNUSED
2010	SW	DDB_UNUSED_2010	DDB_UNUSED
2011	SW	DDB_UNUSED_2011	DDB_UNUSED
2012	SW	DDB_UNUSED_2012	DDB_UNUSED
2013	SW	DDB_UNUSED_2013	DDB_UNUSED
2014	SW	DDB_UNUSED_2014	DDB_UNUSED
2015	SW	DDB_UNUSED_2015	DDB_UNUSED
2016	SW	DDB_UNUSED_2016	DDB_UNUSED
2017	SW	DDB_UNUSED_2017	DDB_UNUSED
2018	SW	DDB_UNUSED_2018	DDB_UNUSED
2019	SW	DDB_UNUSED_2019	DDB_UNUSED
2020	SW	DDB_UNUSED_2020	DDB_UNUSED

DDB No	Source	Description	English Text
2021	SW	DDB_UNUSED_2021	DDB_UNUSED
2022	SW	DDB_UNUSED_2022	DDB_UNUSED
2023	SW	DDB_UNUSED_2023	DDB_UNUSED
2024	SW	DDB_UNUSED_2024	DDB_UNUSED
2025	SW	DDB_UNUSED_2025	DDB_UNUSED
2026	SW	DDB_UNUSED_2026	DDB_UNUSED
2027	SW	DDB_UNUSED_2027	DDB_UNUSED
2028	SW	DDB_UNUSED_2028	DDB_UNUSED
2029	SW	DDB_UNUSED_2029	DDB_UNUSED
2030	SW	DDB_UNUSED_2030	DDB_UNUSED
2031	SW	DDB_UNUSED_2031	DDB_UNUSED
2032	SW	DDB_UNUSED_2032	DDB_UNUSED
2033	SW	DDB_UNUSED_2033	DDB_UNUSED
2034	SW	DDB_UNUSED_2034	DDB_UNUSED
2035	SW	DDB_UNUSED_2035	DDB_UNUSED
2036	SW	DDB_UNUSED_2036	DDB_UNUSED
2037	SW	DDB_UNUSED_2037	DDB_UNUSED
2038	SW	DDB_UNUSED_2038	DDB_UNUSED
2039	SW	DDB_UNUSED_2039	DDB_UNUSED
2040	SW	DDB_UNUSED_2040	DDB_UNUSED
2041	SW	DDB_UNUSED_2041	DDB_UNUSED
2042	SW	DDB_UNUSED_2042	DDB_UNUSED
2043	SW	DDB_UNUSED_2043	DDB_UNUSED
2044	SW	DDB_UNUSED_2044	DDB_UNUSED
2045	SW	DDB_UNUSED_2045	DDB_UNUSED
2046	SW	DDB_UNUSED_2046	DDB_UNUSED
2047	SW	DDB_UNUSED_2047	DDB_UNUSED

Table 1 – Digital database point list sorted by DDB number

3 FACTORY DEFAULT PROGRAMMABLE SCHEME LOGIC

The following table details the default settings of the PSL.

The MiCOM P849 models are as follows:

Model	Logic Inputs	Relay Outputs		
		Total	relays	High break relays
P849xxxA	32	16	16	--
P849xxxB	48	24	24	--
P849xxxC	32	30	14	16
P849xxxD	16	60	60	--
P849xxxE	64	16	16	--
P849xxxF	32	46	46	--

Table 2 – Model numbers, inputs and outputs

4 VIEWING AND PRINTING DEFAULT PSL DIAGRAMS

4.1 Typical Mappings

It is possible to view and print the default PSL diagrams for the device. Typically, these diagrams allow you to see these mappings:

- Opto Input Mappings
- Output Relay Mappings
- LED Mappings
- Start Indications
- Phase Trip Mappings
- System Check Mapping

4.2 Download, Extract and Print PSL Diagrams

To Download PSL diagrams to the Device:

1. Select the device in Easergy Studio (MiCOM S1 Studio)
2. Right-click on the device name and select the Send link.
3. In the Send To dialog box, select the PSL file you wish to send to which group, then click the Send button.

To Extract PSL diagrams from the Device:

1. Select the device in Easergy Studio (MiCOM S1 Studio)
2. Right click on the PSL folder
3. Click Extract
4. Select the groupt number to extract
5. The extracted file will automatically be given the next sequential number

To view/print PSL diagrams

1. Select the device in Easergy Studio (MiCOM S1 Studio)
2. Click the + button to expand the options for the device, then click the + button next to the PSL folder
3. Double click required file to open it. This will launch the PSL Editor
4. In the PSL Editor select File/Print to print the PSL

5 PROGRAMMABLE SCHEME LOGIC

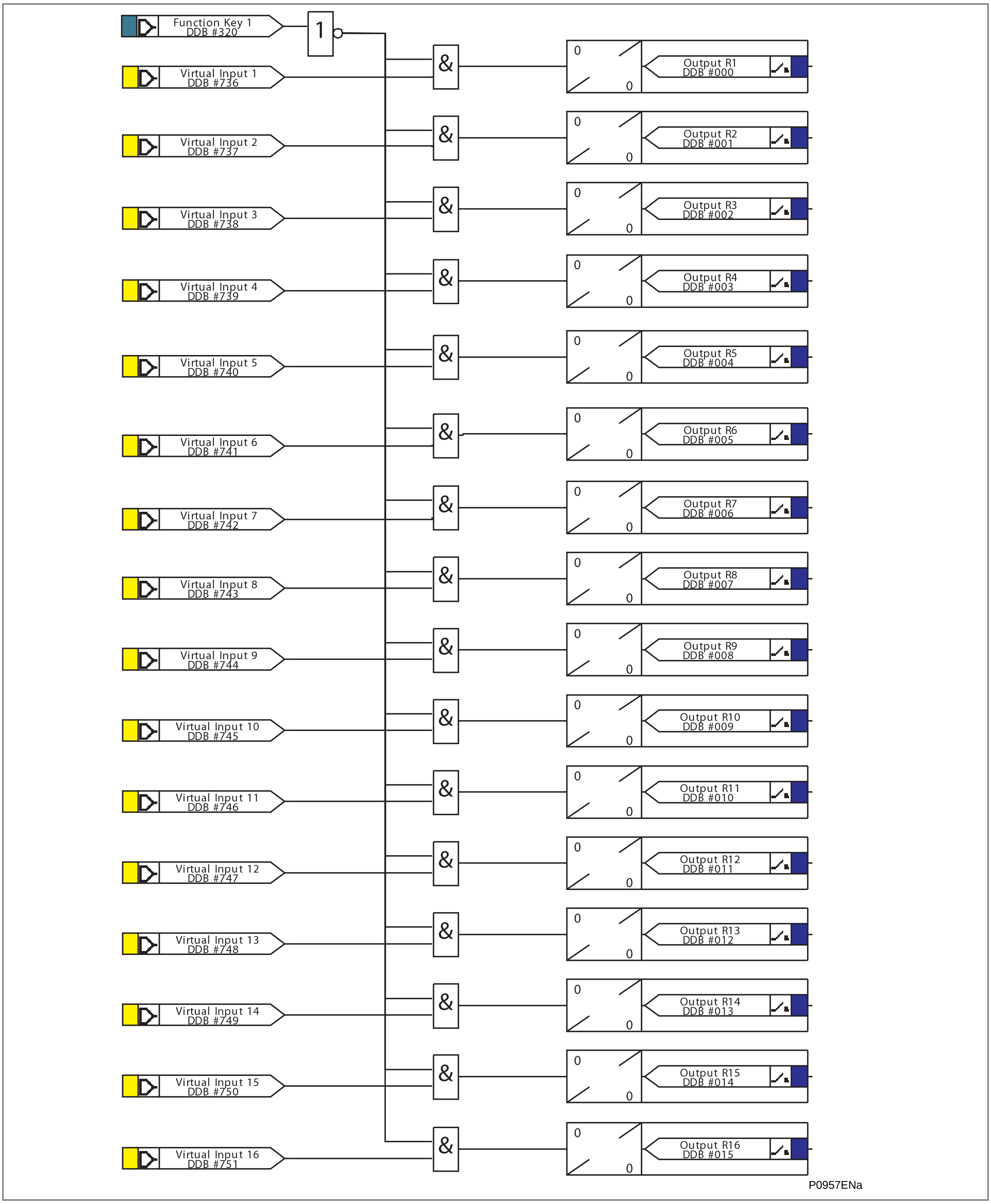


Figure 1 – Virtual inputs / relay outputs

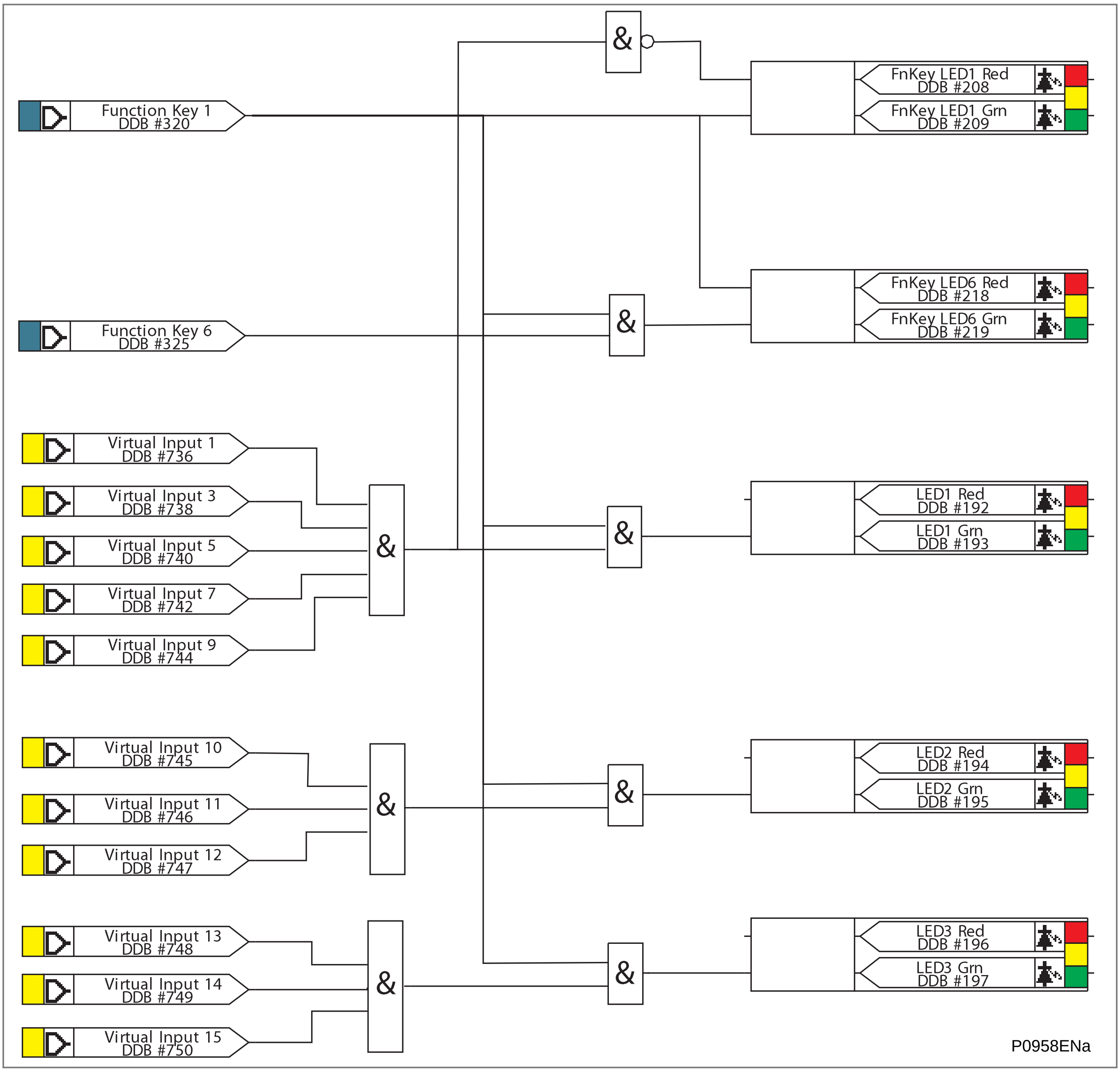


Figure 2 – Goose testing mode

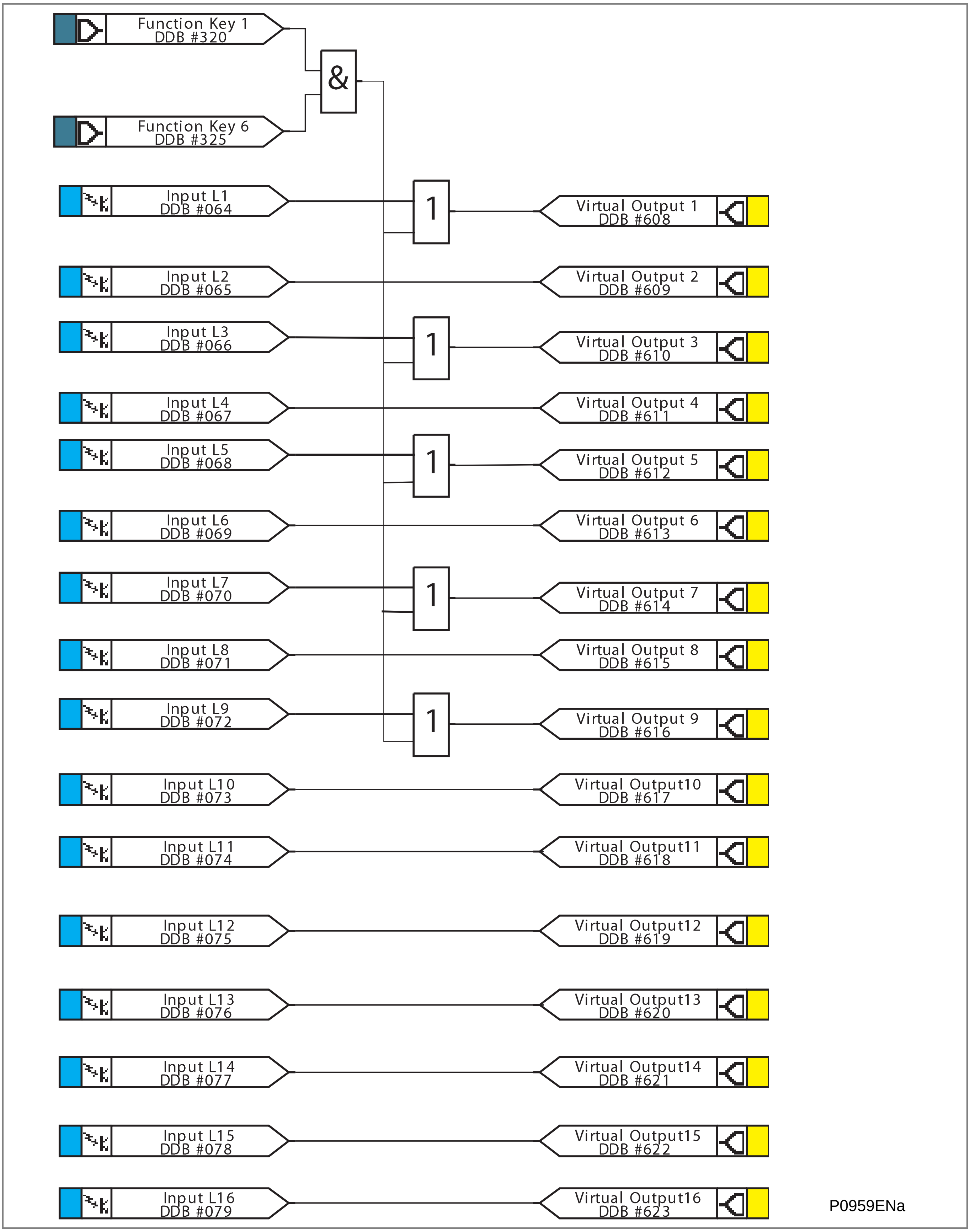


Figure 3 – Opto inputs / virtual outputs

MEASUREMENTS AND RECORDING

CHAPTER 9

Date:	12/2017
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.
Hardware Suffix:	M
Software Version:	B2
Connection Diagrams:	10P849xx (xx = 01 to 06)

CONTENTS

TABLES

Notes:

1 RECORDING

1.1 Introduction

The relay is equipped with integral measurements, event, fault and disturbance recording facilities suitable for analysis of complex system disturbances.

The relay is flexible enough to allow for the programming of these facilities to specific user application requirements. These requirements are discussed in the sections which follow.

Important	***The MiCOM P849 does not produce measurements.***

1.2 Standard Event Recorder

The relay records and time tags up to 250 or 512 events (only up to 250 events in the P24x and P44x) and stores them in non-volatile (battery-backed up) memory. This lets the system operator establish the sequence of events that occurred in the relay following a particular power system condition or switching sequence. When the available space is used up, the oldest event is automatically overwritten by the new one (i.e. first in, first out).

The relay’s real-time clock provides the time tag to each event, to a resolution of 1 ms.

The event records can be viewed either from the front plate LCD or remotely using the communications ports (using any available protocols, such as Courier or MODBUS).

For local viewing on the LCD of event, fault and maintenance records, select the **VIEW RECORDS** menu column.

For extraction from a remote source using communications, see the *SCADA Communications* chapter or the MiCOM S1 Studio instructions.

For a full list of all the event types and the meaning of their values, see the Menu Database document.

VIEW RECORDS	
LCD Reference	**Description**
Select Event	Setting range from 0 to 511. This selects the required event record from the possible 512 that may be stored. A value of 0 corresponds to the latest event and so on.
Menu Cell Ref	Self reset alarm active. Self reset alarm inactive. Relay event. Opto event. Protection event. Platform event. Fault logged event. Maintenance Record logged event.
Time & Date	Time & Date Stamp for the event given by the internal Real Time Clock.
Record Text	Up to 32 Character description of the Event (refer to following sections).
Record Value	Up to 32 Bit Binary Flag or integer representative of the Event (refer to following sections).
Select Maint	Setting range from 0 to 4. This selects the required maintenance record from the possible 5 that may be stored. A value of 0 corresponds to the latest event and so on.
Maint Text Maint Type Maint Data	The following cells show all the starts etc. associated with the event.

VIEW RECORDS	
LCD Reference	**Description**
Reset Indication	Either Yes or No. This serves to reset the trip LED indications provided that the relevant element has reset, to reset all LED and relays latched in the PSL, and to reset the latched alarms.

Table 1 – View records

1.2.1.1 Types of Event

An event may be a change of state of a control input or output relay, an alarm condition, or a setting change. The following sections show the various items that constitute an event:

1.2.1.2 Change of State of Opto-Isolated Inputs

If one or more of the opto (logic) inputs has changed state since the last time the protection algorithm ran, the new status is logged as an event. When this event is selected to be viewed on the LCD, three cells appear, as in shown here:

```
Time & date of event
“LOGIC INPUTS1”
“Event Value 0101010101010101”
```

The Event Value is a multi-bit word (see note) showing the status of the opto inputs, where the least significant bit (extreme right) corresponds to opto input 1. The same information is present if the event is extracted and viewed using a PC.

Note	*For P24x or P44x the Event Value is an 8 or 16 bit word.* *For P34x or P64x it is an 8, 12, 16, 24 or 32-bit word.* *For P445 it is an 8, 12 or 16-bit word.* *For P44y, P54x, P547 or P841, it is an 8, 12, 16 or 24-bit word.* *For P74x it is a 12, 16, 24 or 32-bit word.* *For P746 or P849 it is a 32-bit word.*

1.2.1.3 Change of State of One or More Output Relay Contacts

If one or more of the output relay contacts have changed state since the last time the protection algorithm ran, the new status is logged as an event. When this event is selected to be viewed on the LCD, three cells appear, as shown here:

```
Time and Date of Event
Output Contacts
Event Value 010101010101010101010
```

The Event Value is a multi-bit word (see Note) showing the status of the output contacts, where the least significant bit (extreme right) corresponds to output contact 1, etc. The same information is present if the event is extracted and viewed using a PC.

Note	*For P24x the Event Value is is a 7 or 16-bit word.* *For P34x or P64x it is an 7, 11, 14, 15, 16, 22, 24 or 32-bit word.* *For P445 it is an 8, 12 or 16-bit word.* *For P44x it is a 7, 14 or 21 bit word.* *For P44y, P54x, P547 or P841, it is an 8, 12, 16, 24 or 32 bit word.* *For P74x it is a 12, 16, 24 or 32 bit word.* *For P746 or P849 it is a 24-bit word.*

1.2.1.4 Device Alarm Conditions

Any alarm conditions generated by the relays are logged as individual events. This table shows examples of some of the alarm conditions and how they appear in the event list:

Alarm Condition	Event Text (‘System Data / Alarms Status 1” menu)	Event Value
Setting group via optos invalid	SG-opto Invalid	Bit position 3 in 32 bit field

Alarm Condition	Event Text (‘System Data / Alarms Status 1” menu)	Event Value
Protection disabled	Prot'n Disabled	Bit position 4 in 32 bit field

Table 2 – Examples of alarm conditions

The previous table shows the abbreviated description given to the various alarm conditions and a corresponding value between 0 and 31. This value is appended to each alarm event in a similar way to the input and output events described previously. It is used by the event extraction software, such as MiCOM S1 Studio, to identify the alarm and is therefore invisible if the event is viewed on the LCD. ON or OFF is shown after the description to signify whether the particular condition has become operated or has reset.

Alarm Status 1			Alarm Status 2			Alarm Status 3	
Bit	**Text**		**Bit**	**Text**		**Bit**	**Text**
1	Unused		1 to 4	Unused		1	Battery Fail
2	Unused		5 to 14	SR User Alarm 8 tp 17		2	Field Volt Fail
3	SG-opto Invalid		15 to 32	MR User Alarm 18 to 35		3	Comm2 H/W FAIL
4	Prot'n Disabled					4	GOOSE IED Absent
5 to 25	Unused					5	NIC Not Fitted
26 to 32	SR User Alarm 1 (to 7)					6	NIC No Response
						8	NIC Soft. Reload
						9	Bad TCP/IP Config.
						10	Bad OSI Config.
						12	NIC SW Mis-Match
						13	IP Addr Conflict
						14	IM Loopback
						15	IM Message Fail
						16	IM Data CD Fail
						17	IM Channel Fail
						18	Backup Setting
						19	Bad DNP Setting
						20	Unused
						21	Unused
						22	Invalid DNPoE IP
						23	Invalid Config.
						24	Test Mode
						25	Contacts Block
						26	NIC Hardware Mismatch
						27	NIC Application Mismatch
						28	Simulation GOOSE
						29 to 32	Unused

Table 3 – Alarm status

1.2.1.5 General Events

A number of events come under the heading of 'General Events'. The following list items are stored as events.

- Recognition of change of state of logic (optically isolated) inputs
- Recognition of change of state of output relays
- Alarms
- Maintenance records
- Settings changes (local and remote)

A complete list of the 'General Events' is given in the Relay Menu Database (P849/EN MD), which is a separate document.

1.2.1.6 Setting Changes

Changes to any setting within the device are logged as an event.

Note	*Control/Support settings are settings which are not duplicated within the four setting groups. When any of these settings are changed, the event record is created simultaneously. However, changes to precise or standard event recorder settings will only generate an event once the settings have been confirmed at the 'setting trap'.*

1.2.2 Resetting of Precise Event Records

To delete the event, fault or maintenance reports, use the **RECORD CONTROL** column.

1.2.3 Viewing Event Records via MiCOM S1 Studio

When the event records are extracted and viewed on a PC they look slightly different than when viewed on the LCD.

The first line gives the description and time stamp for the event, while the additional information displayed below may be collapsed using the +/– symbol.

For further information regarding events and their specific meaning, refer to the *Relay Menu Database* document. This standalone document not included in this manual.

1.2.4 Event Filtering

Event reporting can be disabled from all interfaces that support setting changes. The settings that control the various types of events are in the RECORD CONTROL column. The effect of setting each to disabled is in shown in the following table:

Note	*Some occurrences can result in more than one type of event, e.g. a battery failure will produce an alarm event and a maintenance record event.*

If the Protection Event setting is Enabled, a further set of settings is revealed which allow the event generation by individual DDB signals to be enabled or disabled.

For further information on events and their specific meaning, see the *Relay Menu Database* document.

The following changes are stored as events:

- change of state logic (opto-isolated) inputs
- change of state of output relays
- Alarms
- Maintenance records
- Settings changes (local and remote)

The effect of setting each to disabled is as follows:

Menu text	Action
Clear Events	To clear the existing event log. An event will be generated indicating that the events have been erased
Clear Maint	To erase the existing maintenance.
Alarm Event	Disabled = all the occurrences that produce an alarm will result in no event being generated.
Relay O/P Event	Disabled = no event generated for any change in logic input state.
Opto Input Event	Disabled = no event generated for any change in logic input state.
General Event	Disabled = no General Events generated
Maint. Rec Event	Disabled = no event generated for any occurrence that produces a maintenance record.
Clear Dist Recs	To clear the existing records. An event will be generated indicating that the records have been erased.

Table 4 – Menu text and actions

2 DISTURBANCE RECORDER

The integral enhanced disturbance recorder has an area of memory specifically set aside for record storage. The number of records that may be stored by the relay is dependent on the selected recording duration and the installed software release.

The relay can typically store a pre-set minimum number of records, each of a pre-set duration. These may vary between different MiCOM products.

Disturbance records continue to be recorded until the available memory is exhausted, at which time the oldest record(s) are overwritten to make space for the newest one.

The recorder stores actual samples that are taken at a rate of pre-defined number of samples per cycle. Again, this may vary between different MiCOM products.

Each disturbance record consists of a number of analog data channels and digital data channels.

The relevant CT and VT ratios for the analog channels are also extracted to enable scaling to primary quantities. If a CT ratio is set less than unity, the relay will choose a scaling factor of zero for the appropriate channel.

This device can typically store a minimum of 50 records, each of 1.5 seconds duration.

Each disturbance record consists of up to 32 digital data channels.

Menu Text	Action
Duration	This sets the overall recording time
Trigger Position	This sets the trigger point as a percentage of the duration
Trigger Mode	Sets Single or Extended trigger mode.
Digital input xx (with xx = 1 to 32)	Any relay output digital channel, any Opto-isolated inputs or Internal digital signals can be assigned to this channel. The digital channel will trigger the precise event recorder when the corresponding assigned event will occur.
Digital trigger xx (with xx = 1 to 32)	When “Trigger L/H” is selected, the channel will trigger the precise event recorder when changing from ‘0’ (low Level) to ‘1’ (High level). If “Trigger H/L” is selected, it will trigger when changing from ‘1’ (high level) to ‘0’ (low level).

Table 5 – Menu text and actions

The pre and post fault recording times are set by a combination of the **Duration** and **Trigger Position** cells. **Duration** sets the overall recording time and the **Trigger Position** sets the trigger point as a percentage of the duration.

- For example, the default settings show that the overall recording time is set to 1.5 s with the trigger point being at 33.3% of this, giving 0.5 s pre-fault and 1 s post-fault recording times.

If a further trigger occurs while a recording is taking place, the recorder ignores the trigger if the **Trigger Mode** is set to **Single**. However, if this is set to **Extended**, the post-trigger timer is reset to zero, extending the recording time.

As can be seen from the menu, each of the analog channels is selectable from the available analog inputs to the relay. The digital channels may be mapped to any of the opto isolated inputs or output contacts, in addition to several internal relay digital signals, such as protection starts and LEDs. The complete list of these signals may be found by viewing the available settings in the relay menu or using a setting file in MiCOM S1 Studio. Any of the digital channels may be selected to trigger the disturbance recorder on either a low-to-high or a high-to-low transition, using the **Input Trigger** cell. The default trigger settings are that any dedicated trip output contacts, such as relay 3, trigger the recorder.

It is not possible to view the disturbance records locally using the LCD; they must be extracted using suitable software such as MiCOM S1 Studio. This process is fully explained in the *SCADA Communications* chapter.

3 MEASUREMENTS

The MiCOM P849 device does not acquire any analogue value. The "Measurements SETUP" (when visible) does not display measurements.

Notes:

PRODUCT DESIGN

CHAPTER 10

Date:	12/2017
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.
Hardware Suffix:	M
Software Version:	B2
Connection Diagrams:	10P849xx (xx = 01 to 06)

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FIGURES

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1 RELAY SYSTEM OVERVIEW

1.1 Hardware Overview

The relay is based on a modular hardware design where each module performs a separate function. This section describes the functional operation of the various hardware modules. Some modules are essential while others are optional depending on the user's requirements (see *Product Specific Options* and *Hardware Communications Options*).

All modules are connected by a parallel data and address bus which allows the processor board to send and receive information to and from the other modules as required.

There is also a separate serial data bus for transferring sample data from the input module to the processor. See the *Relay modules* diagram.

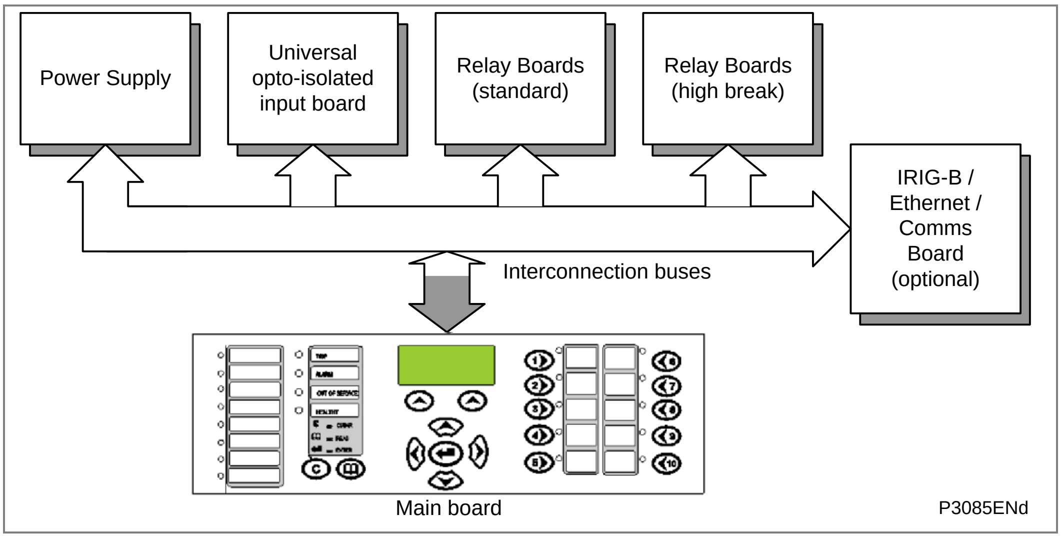

Figure 1 - Relay modules and information flow

1.2 Mechanical Layout

The relay case is pre-finished steel with a conductive covering of aluminum and zinc. This provides good earthing at all joints with a low impedance path to earth that is essential for shielding from external noise. The boards and modules use multi-point grounding (earthing) to improve immunity to external noise and minimize the effect of circuit noise. Ground planes are used on boards to reduce impedance paths and spring clips are used to ground the module metalwork.

Heavy duty terminal blocks are used at the rear of the relay for the current and voltage signal connections. Medium duty terminal blocks are used for the digital logic input signals, output relay contacts, power supply and rear communication port. A BNC connector is used for the optional IRIG-B signal. 9-pin and 25-pin female D-connectors are used at the front of the relay for data communication.

Inside the relay the boards plug into the connector blocks at the rear, and can be removed from the front of the relay only. The connector blocks to the relay's CT inputs have internal shorting links inside the relay. These automatically short the current transformer circuits before they are broken when the board is removed.

The front panel consists of a membrane keypad with tactile dome keys, an LCD and 12 or 22 LEDs (depending on the model) mounted on an aluminum backing plate.

1.3 Processor Board

The processor board performs all calculations for the relay and controls the operation of all other modules in the relay. The processor board also contains and controls the user interfaces (LCD, LEDs, keypad and communication interfaces).

The relay is based around a TMS320VC33-150MHz (peak speed), floating-point, 32-bit Digital Signal Processor (DSP) operating at a clock frequency of half this speed. This processor performs all of the calculations for the relay, including the protection functions, control of the data communication and user interfaces including the operation of the LCD, keypad and LEDs.

The processor board is directly behind the relay’s front panel. This allows the LCD and LEDs and front panel communication ports to be mounted on the processor board. These ports are:

- The 9-pin D-connector for EIA(RS)232 serial communications used for MiCOM S1 Studio and Courier communications.
- The 25-pin D-connector relay test port for parallel communication.

All serial communication is handled using a Field Programmable Gate Array (FPGA).

The main processor board has:

- 2 MB SRAM for the working area. This is fast access (zero wait state) volatile memory used to temporarily store and execute the processor software.
- 4 MB flash ROM to store the software code, text, configuration data, default settings, and present settings.
- 4 MB battery-backed SRAM to store disturbance, event, fault and maintenance records.

Note	*With hardware revisions L and M, the SRAM size has changed from 2MB to 8MB; and the Flash size has changed from 4MB to 8MB.*

1.4 Internal Communication Buses

The relay has two internal buses for the communication of data between different modules. The main bus is a parallel link that is part of a 64-way ribbon cable. The ribbon cable carries the data and address bus signals in addition to control signals and all power supply lines. Operation of the bus is driven by the main processor board that operates as a master while all other modules in the relay are slaves.

The second bus is a serial link that is used exclusively for communicating the digital sample values from the input module to the main processor board. The DSP has a built-in serial port that is used to read the sample data from the serial bus. The serial bus is also carried on the 64-way ribbon cable.

1.5 Input Module

The input module provides the interface between the processor board and the digital signals coming into the device.

As shown in the *Main input board* diagram, the input board provides the circuitry for the digital input signals. The digital input signals are opto isolated on this board to prevent excessive voltages on these inputs causing damage to the device's internal circuitry.

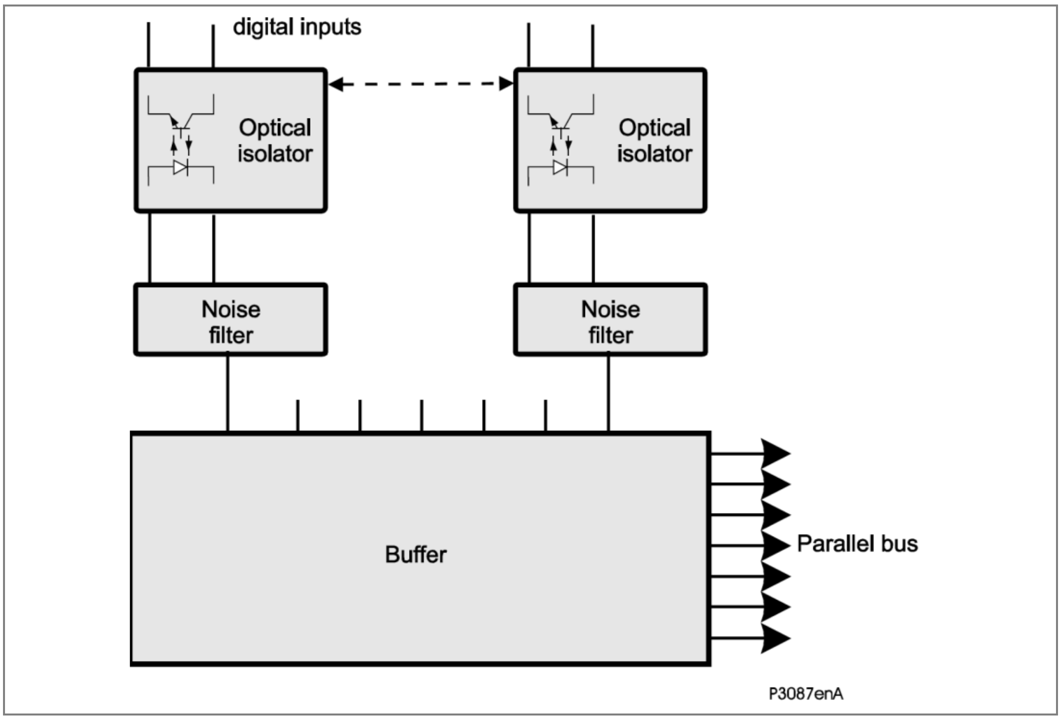

Figure 2 - Main input board

The other function of the input board is to read the state of the signals present on the digital inputs and present this to the parallel data bus for processing. The input board holds eight optical isolators for the connection of up to eight digital input signals. The opto-isolators are used with the digital signals for the same reason as the transformers with the analogue signals; to isolate the relay's electronics from the power system environment. The input board provides some hardware filtering of the digital signals to remove unwanted noise before buffering the signals for reading on the parallel data bus.

1.5.1 Universal Opto Isolated Logic Inputs

The standard opto-isolated input module consists of a main input board which provides isolated digital inputs.

This series of relays have universal opto-isolated logic inputs that can be programmed for the nominal battery voltage of the circuit of which they are a part. This allows different voltages for different circuits such as signaling and tripping. They can also be programmed as Standard 60% - 80% or 50% - 70% to satisfy different operating constraints.

Threshold levels are shown in this table:

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
OPTO CONFIG.				
Global Nominal V	48/54V	24/27V, 30/34V, 48/54V, 110/125V, 220/250V, Custom		
Opto Input x	48/54V	24/27V, 30/34V, 48/54V, 110/125V, 220/250V, Custom		

Table 1 – Setting ranges

This lower value eliminates fleeting pickups that may occur during a battery earth fault, when stray capacitance may present up to 50% of battery voltage across an input. Each input has filtering of 7ms. This renders the input immune to induced noise on the wiring: although this method is secure it can be slow.

In the Opto Config. menu the nominal battery voltage can be selected for all opto inputs by selecting one of the five standard ratings in the Global Nominal V settings. If Custom is selected then each opto input can individually be set to a nominal voltage value.

1.6 Power Supply Module (including Output Devices)

The power supply module contains two boards, one for the power supply unit and the other for the output relays. It provides power to all of the other modules in the relay, as well as the EIA(RS)485 electrical connection for the rear communication port. The second board of the power supply module contains the relays that provide the output contacts.

1.6.1 Power Supply Board (including EIA(RS)485 Communication Interface)

One of three different configurations of the power supply board can be fitted to the relay. This will be specified at the time of order and depends on the nature of the supply voltage that will be connected to the relay. The options are shown in the following table:

Nominal dc range	Nominal ac range
24 - 32 V dc	dc only
48 - 110 V dc	dc only
110 - 250 V dc	100 - 240 V ac rms

Table 2 - Power supply options

The output from all versions of the power supply module are used to provide isolated power supply rails to all of the other modules in the relay. Three voltage levels are used in the relay: 5.1 V for all of the digital circuits, ±16 V for the analog electronics such as on the input board, and 22 V for driving the output relay coils. All power supply voltages including the 0 V earth line are distributed around the relay through the 64-way ribbon cable. The power supply board also provides the 48 V field voltage. This is brought out to terminals on the back of the relay so that it can be used to drive the optically-isolated digital inputs.

The two other functions provided by the power supply board are the EIA(RS)485 communications interface and the watchdog contacts for the relay. The EIA(RS)485 interface is used with the relay’s rear communication port to provide communication using one of either Courier, MODBUS, IEC60870-5-103, or DNP3.0 protocols. The EIA(RS)485 hardware supports half-duplex communication and provides optical isolation of the serial data that is transmitted and received. All internal communication of data from the power supply board is through the output relay board connected to the parallel bus.

The watchdog facility has two output relay contacts, one Normally Open (N/O)and one Normally Closed (N/C). These are driven by the main processor board and indicate that the relay is in a healthy state.

The power supply board incorporates inrush current limiting. This limits the peak inrush current, during energization, to approximately 10 A.

1.6.2 Auxiliary Power Supply

In the relay the power supply module contains a main power supply and an auxiliary power supply. The auxiliary power supply adds power on the 22 V rail for up to seven communication boards within the relay.

The three input voltage options are the same as for main supply. The relay board is provided as a standalone board.

1.6.3 Output Relay Board

The output relay board has eight relays, six normally open contacts and two changeover contacts.

The relays are driven from the 22 V power supply line. The relays’ state is written to or read from using the parallel data bus.

1.6.4 High Break Relay Board

The output relay board holds four relays, all normally open. The relays are driven from the 22V power supply line. The relays’ state is written to or read from using the parallel data bus.

This board uses a hybrid of MOSFET Solid State Devices (SSD) in parallel with high capacity relay output contacts. The MOSFET has a varistor across it to provide protection which is required when switching off inductive loads because the stored energy in the inductor causes a reverse high voltage which could damage the MOSFET.

When there is a control input command to operate an output contact, the miniature relay is operated at the same time as the SSD. The miniature relay contact closes in nominally 3.5 ms and is used to carry the continuous load current; the SSD operates in <0.2 ms and is switched off after 7.5 ms. When the control input resets to open the contacts, the SSD is again turned on for 7.5 ms. The miniature relay resets in nominally 3.5 ms before the SSD so the SSD is used to break the load. The SSD absorbs the energy when breaking inductive loads and so limits the resulting voltage surge. This contact arrangement is for switching dc circuits only. As the SSD comes on very fast (<0.2 ms) these high break output contacts have the added advantage of being very fast operating. See the *High break contact operation* diagram below:

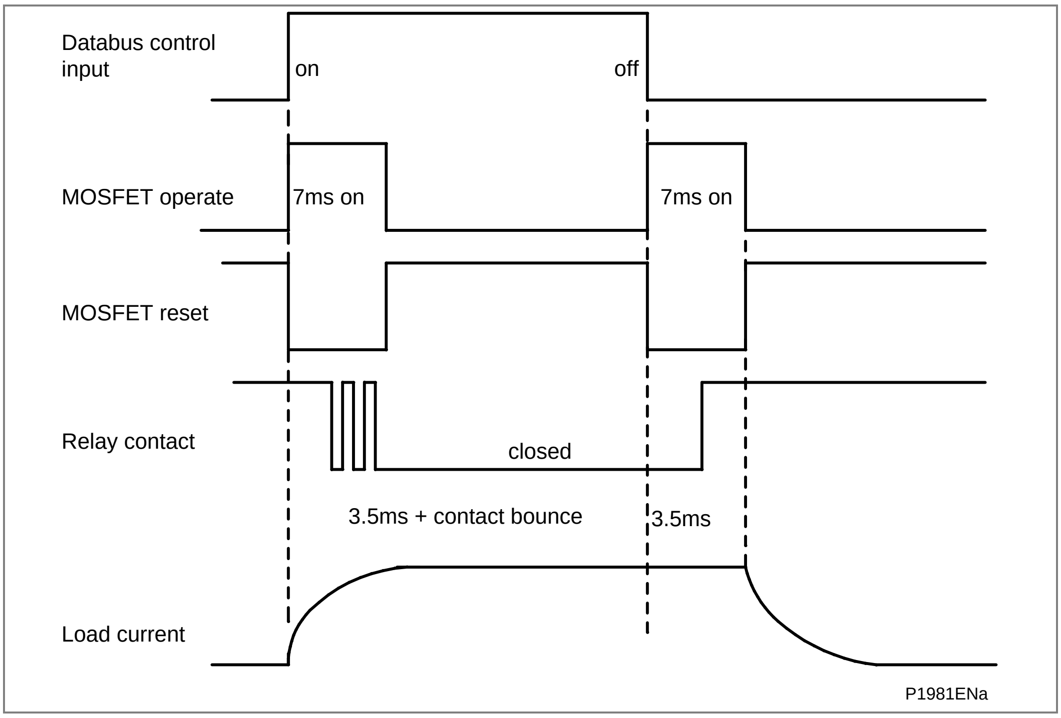

Figure 3 - High break contact operation

1.7 Product Specific Options

Product Specific Options may mean that an additional board may be present if it was specified when the relay was ordered. The product specific options commonly allow a choice of IRIG-B, different numbers of Optos, Relays (including High Break relays). These options are shown in the *Ordering Options* section in *Chapter 1 – Introduction*.

1.8 IRIG-B Modulated or Unmodulated Board (Optional)

The optional IRIG-B board is an order option that can be fitted to provide an accurate timing reference for the relay. This can be used wherever an IRIG-B signal is available. The IRIG-B signal is connected to the board with a BNC connector on the back of the relay. The timing information is used to synchronize the relay's internal real-time clock to an accuracy of 1 ms. The internal clock is then used for the time tagging of the event, fault maintenance and disturbance records. The IRIG-B board can also be specified with a fiber optic or Ethernet rear communication port.

The modulated or unmodulated IRIG-B board, which is optional, can be used where an IRIG-B signal is available to provide an accurate time reference for the device. There is also an option on this board to specify:

- a fibre optic rear communication port, for use with IEC60870 communication only.
- a second rear port designed typically for dial-up modem access by engineers/operators (see the *Second Rear Comms and InterMiCOM Board Board (Optional)* section).

All modules are connected by a parallel data and address bus which allows the processor board to send and receive information to and from the other modules as required. There is also a separate serial data bus for conveying data from the input module to the processor. The *Software Overview* section shows the modules of the device and the flow of information between them.

The IRIG-B board is controlled by the main board.

1.9 Second Rear Comms and InterMiCOM Board Board (Optional)

The optional second rear port is designed typically for dial-up modem access by engineers/operators, when the main port is reserved for SCADA traffic. Communication is via one of three physical links; K-Bus, EIA(RS)485 or EIA(RS)232. The port supports full local or remote control access by MiCOM S1 V2 or MiCOM S1 Studio software. The second rear port is also available with an on board IRIG-B input.

The optional board also houses port “SK5”, the InterMiCOM teleprotection port. InterMiCOM permits end-to-end signalling with a remote device. Port SK5 has an EIA(RS)232 connection, allowing connection to a MODEM, or compatible multiplexers.

1.10 Second Rear Communications

On ordering this board within a relay, both 2nd rear communications and InterMiCOM will become connection and setting options. The user may then enable either one, or both, as demanded by the installation.

For relays with the Courier protocol on the first rear communications port there is the hardware option of a second rear communications port (which also runs the Courier language). This can be used over one of three physical links: twisted pair K-BUS (non-polarity sensitive), twisted pair EIA(RS)485 (connection polarity sensitive) or EIA(RS)232.

The second rear comms. board, Ethernet and IRIG-B boards are mutually exclusive since they use the same hardware slot. For this reason two versions of second rear comms. and Ethernet boards are available; one with an IRIG-B input and one without. The second rear comms. board is shown in the following diagram.

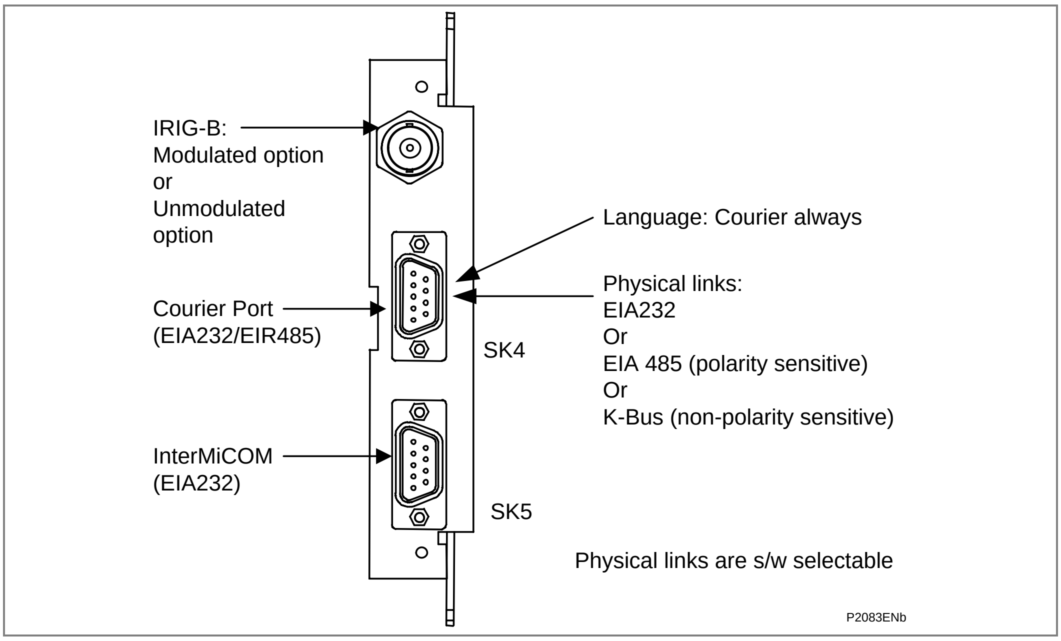

Figure 4 - Rear comms. port

1.11 Ethernet and Redundant Ethernet Boards

This is a mandatory board for IEC 61850 enabled relays. It provides network connectivity through either copper or fiber media at rates of 10Mb/s (copper only) or 100Mb/s. There is also an option on this board to specify IRIG-B board port (modulated and/or un-modulated). This board, the IRIG-B board mentioned in the Hardware Communications Options section and second rear comms. board mentioned in the IRIG-B Board section are mutually exclusive as they all use slot A within the relay case.

All modules are connected by a parallel data and address bus that allows the processor board to send and receive information to and from the other modules as required. There is also a separate serial data bus for conveying sample data from the input module to the processor. The relay modules and information flow diagram shows the modules of the relay and the flow of information between them.

This optional board is required for providing network connectivity using IEC 61850. There are a variety of different boards which provide Ethernet connectivity.

Important	**The choice of communication board options varies according to the Hardware Suffix and the Software Version of the MiCOM product. These are shown in the *Ordering Options* section in *Chapter 1 – Introduction*.**

By way of example, the board options may include:

- single-port Ethernet boards (which use 10/100 Mbits/s Copper and modulated/unmodulated IRIG-B connectivity)
- single-port Ethernet boards (which use 100MBits/s optical fibre connectivity)
- Redundant Ethernet Self-Healing Ring with one or more multi-mode fibre optic ports and modulated/unmodulated IRIG-B connectivity
- Redundant Ethernet RSTP with one or more multi-mode fibre optic ports and modulated/unmodulated IRIG-B connectivity
- Redundant Ethernet Dual Homing Star with one or more multi-mode fibre optic ports and modulated/unmodulated IRIG-B connectivity
- Redundant Ethernet Parallel Redundancy Protocol (PRP) with one or more multi-mode fibre optic ports and modulated/unmodulated IRIG-B connectivity
- Redundant Ethernet with PRP/HSR/Dual IP and a mixture of LC/RJ45 ports and modulated/unmodulated IRIG-B connectivity

These options are mutually exclusive as they all use slot A in the relay case.

Note	*Each Ethernet board has a unique MAC address used for each Ethernet communication interface. The MAC address is printed on the rear of the board, next to the Ethernet sockets.*

Note	*The 100 Mbits/s Fiber Optic ports use ST/LC type connectors and are suitable for 1310 nm multi-mode fiber type.*

Copper ports use RJ45 type connectors. When using copper Ethernet, it is important to use Shielded Twisted Pair (STP) or Foil Twisted Pair (FTP) cables, to shield the IEC 61850 communications against electromagnetic interference. The RJ45 connector at each end of the cable must be shielded, and the cable shield must be connected to this RJ45 connector shield, so that the shield is grounded to the relay case. Both the cable and the RJ45 connector at each end of the cable must be Category 5 minimum, as specified by the IEC 61850 standard.

It is recommended that each copper Ethernet cable is limited to a maximum length of 3 m and confined to one bay or cubicle.

When using IEC 61850 communications through the Ethernet board, the rear EIA(RS)485 and front EIA(RS)232 ports are also available for simultaneous use, both using the Courier protocol.

One example of an Ethernet board is shown in this *Ethernet board connectors* diagram:

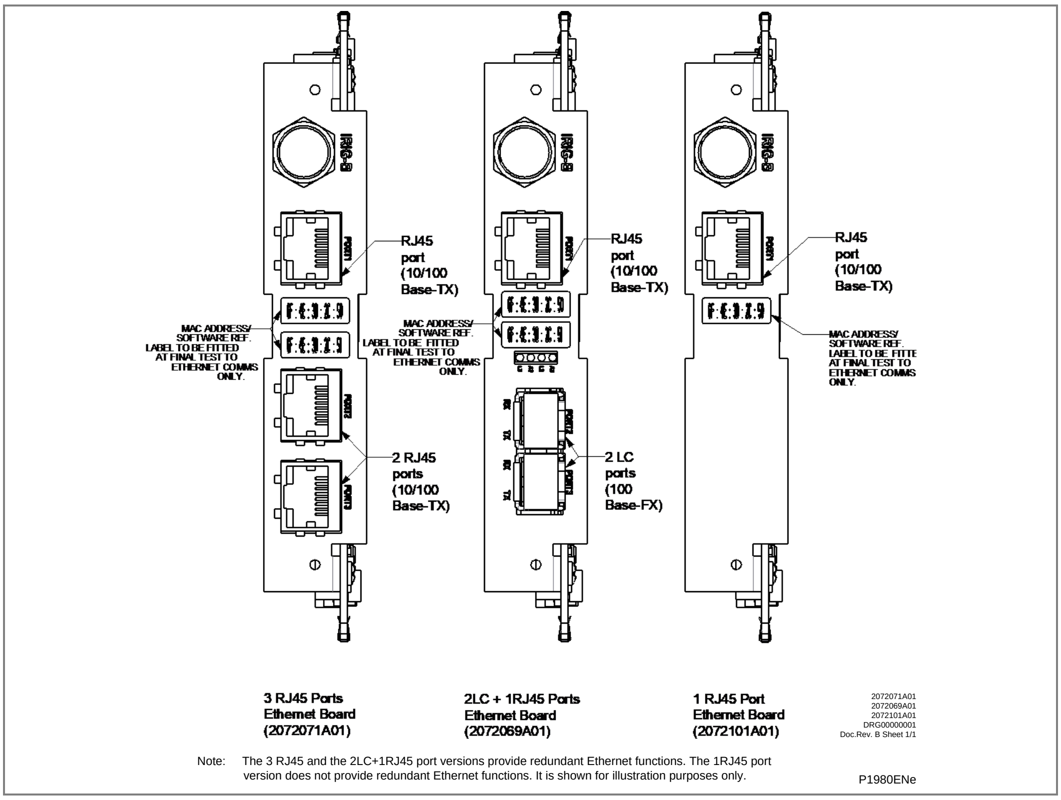

Figure 5 - Ethernet board connectors (3 RJ45 or 2 LC + RJ45 or 1 RJ45)

1.11.1 Input and Output Boards

Model	Opto-inputs	Device outputs
P849xxxA	32 x UNI (1)	16 (12 N/O, 4 C/O)
P849xxxB	48 x UNI (1)	24 (18 N/O, 6 C/O)
P849xxxC	32 x UNI (1)	14 (6 N/O, 8 C/O) + 16 high break devices
P849xxxD	16 x UNI (1)	60 (36 N/O, 24 C/O)
P849xxxE	64 x UNI (1)	16 (12 N/O, 4 C/O)
P849xxxF	32 x UNI (1)	46 (30 N/O, 16 C/O)
(1) Universal voltage range opto inputs	N/O – normally open	C/O – change over

Table 3 - Input and output boards

1.11.2 Power Supply Module

The power supply module provides a power supply to all of the other modules in the relay, at three different voltage levels.

The power supply board also provides the EIA(RS)485 electrical connection for the rear communication port.

On a second board, the power supply module contains:

- relays which provide the output contacts (P742 and P743),
- an auxiliary power supply (P741).

The power supply module also provides a 48V external field supply output to drive the opto isolated digital inputs (or the substation battery may be used to drive the optos).

2 RELAY SOFTWARE

The relay software was introduced in the overview of the relay at the start of this chapter. The software can be considered to be made up of these sections:

- The real-time operating system
- The system services software
- The platform software
- The protection and control software

These four elements are all processed by the same processor board.This section describes in detail the ***platform software*** and the ***protection and control software***, which between them control the functional behavior of the relay. The following *Relay software structure* diagram shows the structure of the relay software.

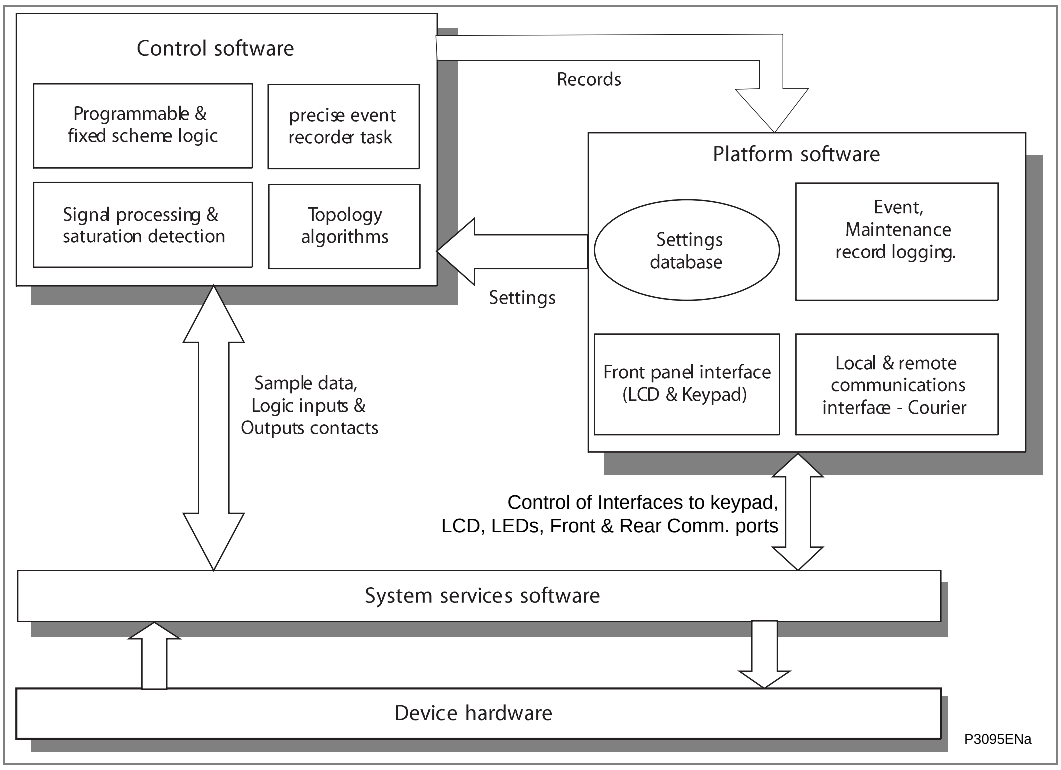

Figure 6 – Relay software structure

2.1 Real-Time Operating System

The real-time operating system provides a framework for the different parts of the relay's software to operate in.

The software is split into tasks; the real-time operating system is used to schedule the processing of the tasks to ensure that they are processed in the time available and in the desired order of priority. The operating system is also responsible in part for controlling the communication between the software tasks through the use of operating system messages.

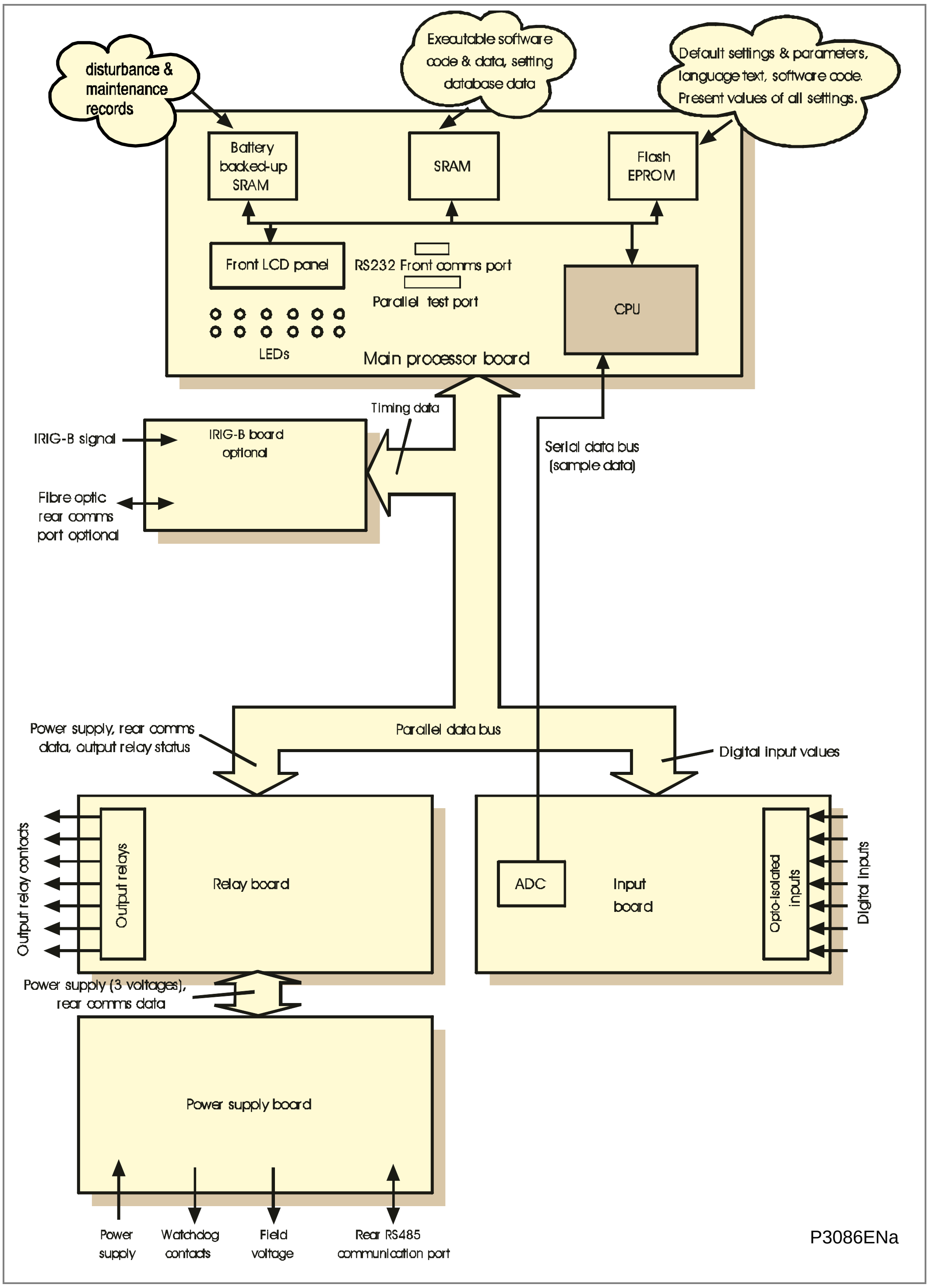

Figure 7 - Device modules and information flow

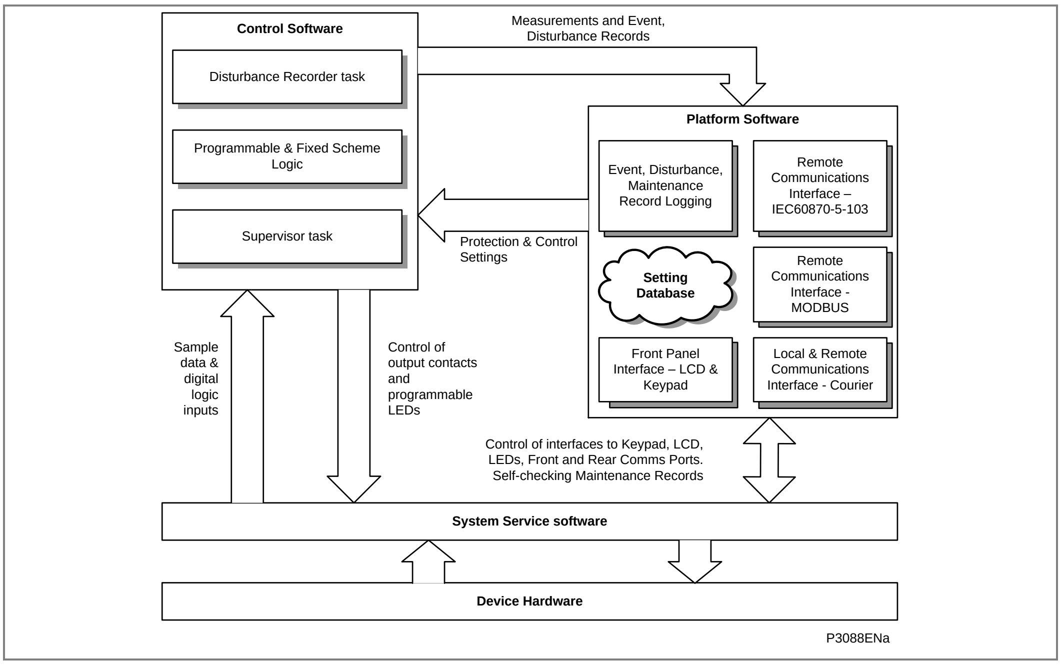

Figure 8 - Device software structure

2.2 Real-Time Operating System

The real-time operating system provides a framework for the different parts of the relay's software to operate in.

The software is split into tasks; the real-time operating system is used to schedule the processing of the tasks to ensure that they are processed in the time available and in the desired order of priority. The operating system is also responsible in part for controlling the communication between the software tasks through the use of operating system messages.

As explained in the hardware overview, each relay contains one main board and one coprocessor board. These two boards use two different operating systems:

- For main board software: a real time operating system provides a framework for the different parts of the relay's software to operate within. To this end, the software is split into tasks. The real-time operating system is responsible for scheduling the processing of these tasks such that they are carried out in the time available and in the desired order of priority.
- For coprocessor board software: a sequencer manages all the functions implemented on the coprocessor board. Each function is executed at a fixed frequency. Consequently the CPU load of the coprocessor is fixed and independent of the network's frequency.

The real-time operating system is responsible for scheduling the processing of these tasks such that they are carried out in the time available and in the desired order of priority. The operating system is also responsible for the exchange of information between tasks, in the form of messages.

2.3 System Services Software

As shown in the above *Relay software structure* diagram, the system services software provides the low-level control of the relay hardware. It also provides the interface between the relay's hardware and the higher-level functionality of the platform software and the protection and control software.

For example, the system services software provides drivers for items such as the LCD display, the keypad and the remote communication ports. It also controls the boot of the processor and downloading of the processor code into SRAM from non-volatile flash EPROM at power up.

2.4 Platform Software

The platform software has these main functions:

- To deal with the management of the relay settings.
- To control the logging of all records that are generated by the protection software, including alarms and event, fault, disturbance and maintenance records.
- To store and maintain a database of all of the relay's settings in non-volatile memory.
- To provide the internal interface between the settings database and each of the relay's user interfaces. These interfaces are the front panel interface and the front and rear communication ports, using whichever communication protocol has been specified (Courier, MODBUS, IEC60870-5-103 and DNP3.0). The platform software converts the information from the database into the format required.

The platform software notifies the protection and control software of all settings changes and logs data as specified by the protection and control software.

2.4.1 Record Logging

The logging function is provided to store all alarms, events, faults and maintenance records. The records for all of these incidents are logged in battery backed-up SRAM in order to provide a non-volatile log of what has happened. The relay maintains four logs: one each for up to 32 alarms, 512 event records, 5 fault records and 5 maintenance records. The logs are maintained such that the oldest record is overwritten with the newest record.

The logging function can be initiated from the protection software or the platform software, and is responsible for logging of a maintenance record in the event of a relay failure. This includes errors that have been detected by the platform software itself or error that are detected by either the system services or the protection software functions. See also the section on *Self-Testing and Diagnostics* later in this section.

2.4.2 Settings Database

The settings database contains all of the settings and data for the relay, including the protection, disturbance recorder and control and support settings. The settings are maintained in non-volatile memory. The platform software's management of the settings database make sure that only one user interface modifies the database settings at any one time. This feature is used to avoid confusion between different parts of the software during a setting change. For changes to protection settings and disturbance recorder settings, the platform software operates a 'scratchpad' in SRAM memory. This allows a number of setting changes to be made in any order but applied to the protection elements, disturbance recorder and saved in the database in non-volatile memory, at the same time. If a setting change affects the protection and control task, the database advises it of the new values.

The database is directly compatible with Courier communications.

2.4.3 Database Interface

The other function of the platform software is to implement the relay's internal interface between the database and each of the relay's user interfaces. The database of settings and measurements must be accessible from all of the relay's user interfaces to allow read and modify operations. The platform software presents the data in the appropriate format for each user interface.

2.5 Protection and Control Software

The protection and control software interfaces with the platform software for settings changes and logging of records, and with the system services software for acquisition of sample data and access to output relays and digital opto-isolated inputs. It also performs the calculations for all of the protection algorithms of the relay. This includes digital signal processing such as Fourier filtering and ancillary tasks such as the disturbance recorder.
The protection and control software task processes all of the protection elements and measurement functions of the relay. It has to communicate with both the system services software and the platform software, and organize its own operations. The protection software has the highest priority of any of the software tasks in the relay, to provide the fastest possible protection response. It also has a supervisor task that controls the start-up of the task and deals with the exchange of messages between the task and the platform software.

2.5.1 Signal Processing

The sampling function filters the digital input signals from the opto-isolators and tracks the frequency of the analog signals. The digital inputs are checked against their previous value over a period of half a cycle. Therefore a change in the state of one of the inputs must be maintained over at least half a cycle before it is registered with the protection and control software.

2.5.2 Programmable Scheme Logic (PSL)

The Programmable Scheme Logic (PSL) allows the relay user to configure an individual protection scheme to suit their own particular application. This is done with programmable logic gates and delay timers.

The input to the PSL is any combination of the status of the digital input signals from the opto-isolators on the input board, the outputs of the protection elements such as protection starts and trips, and the outputs of the fixed PSL. The fixed PSL provides the relay's standard protection schemes. The PSL consists of software logic gates and timers. The logic gates can be programmed to perform a range of different logic functions and can accept any number of inputs. The timers are used either to create a programmable delay or to condition the logic outputs, such as to create a pulse of fixed duration on the output, regardless of the length of the pulse on the input. The outputs of the PSL are the LEDs on the front panel of the relay and the output contacts at the rear.

The execution of the PSL logic is event driven: the logic is processed whenever any of its inputs change, for example as a result of a change in one of the digital input signals or a trip output from a protection element. Also, only the part of the PSL logic that is affected by the particular input change that has occurred is processed. This reduces the amount of processing time that is used by the PSL. The protection and control software updates the logic delay timers and checks for a change in the PSL input signals every time it runs.

This system provides flexibility for the user to create their own scheme logic design. However, it also means that the PSL can be configured into a very complex system, and because of this setting of the PSL is implemented through the PC support package MiCOM S1 Studio.

2.5.3 Function Key Interface

The ten function keys interface directly into the PSL as digital input signals and are processed based on the PSLs event-driven execution. However, a change of state is only recognized when a key press is executed, on average for longer than 200 ms. The time to register a change of state depends on whether the function key press is executed at the start or the end of a protection task cycle, with the additional hardware and software scan time included. A function key press can provide a latched (toggled mode) or output on key press only (normal mode) depending on how it is programmed and can be configured to individual protection scheme requirements. The latched state signal for each function key is written to non-volatile memory and read from non-volatile memory during relay power up, allowing the function key state to be reinstated after power-up if the relay power is lost.

2.5.4 Event and Maintenance Recording

A change in any digital input signal or protection element output signal is used to indicate that an event has taken place. When this happens, the protection and control task sends a message to the supervisor task to show that an event is available to be processed. The protection and control task writes the event data to a fast buffer in SRAM that is controlled by the supervisor task. When the supervisor task receives either an event or fault record message, it instructs the platform software to create the appropriate log in battery backed-up SRAM. The supervisor's buffer is faster than battery backed-up SRAM, therefore the protection software is not delayed waiting for the records to be logged by the platform software. However, if a large number of records to be logged are created in a short time, some may be lost if the supervisor's buffer is full before the platform software is able to create a new log in battery backed-up SRAM. If this occurs, an event is logged to indicate this loss of information.

2.5.5 Precise Event Recorder

The analog values and logic signals are routed from the protection and control software to the disturbance recorder software. The platform software interfaces with the disturbance recorder to allow the stored records to be extracted.

The disturbance recorder operates as a separate task from the protection and control task. It can record the waveforms for up to 8 analogue channels and the values of up to 32 digital signals. For peripheral unit the recording time is user selectable up to a maximum of 10 seconds and for central unit the record duration is fixed to 600ms. The disturbance recorder is supplied with data by the protection and control task once per cycle. The disturbance recorder collates the data that it receives into the required length disturbance record. It attempts to limit the demands it places on memory space by saving the analogue data in compressed format whenever possible. This is done by detecting changes in the analogue input signals and compressing the recording of the waveform when it is in a steady-state condition. The disturbance records can be extracted by MiCOM S1 that can also store the data in COMTRADE format, thus allowing the use of other packages to view the recorded data.

3 SELF-TESTING AND DIAGNOSTICS

The relay includes several self-monitoring functions to check the operation of its hardware and software when it is in service. These are included so that if an error or fault occurs in the relay's hardware or software, the relay is able to detect and report the problem and attempt to resolve it by performing a reboot. The relay must therefore be out of service for a short time, during which the **Healthy** LED on the front of the relay is OFF and, the watchdog contact at the rear is ON. If the reboot fails to resolve the problem, the relay takes itself permanently out of service; the **Healthy** LED stays OFF and watchdog contact stays ON.

If a problem is detected by the self-monitoring functions, the relay stores a maintenance record in battery backed-up SRAM.

The self-monitoring is implemented in two stages:

- firstly a thorough diagnostic check that is performed when the relay is booted-up
- secondly a continuous self-checking operation that checks the operation of the relay's critical functions while it is in service.

3.1 Start-Up Self-Testing

The self-testing that is carried out when the relay is started takes a few seconds to complete, during which time the relay's protection is unavailable. This is shown by the **Healthy** LED on the front of the relay which is ON when the relay has passed all tests and entered operation. If the tests detect a problem, the relay remains out of service until it is manually restored to working order.

The operations that are performed at start-up are:

- System Boot
- Initialization Software
- Platform Software Initialization and Monitoring

3.1.1 System Boot

The integrity of the flash memory is verified using a checksum before the program code and data are copied into SRAM and executed by the processor. When the copy is complete the data then held in SRAM is checked against that in flash memory to ensure they are the same and that no errors have occurred in the transfer of data from flash memory to SRAM. The entry point of the software code in SRAM is then called which is the relay initialization code.

3.1.2 Initialization Software

In the initialization process the relay checks the following.

- The status of the battery
- The integrity of the battery backed-up SRAM that stores event, fault and disturbance records
- The voltage level of the field voltage supply that drives the opto-isolated inputs
- The operation of the LCD controller
- The watchdog operation

When the initialization software routine is complete, the supervisor task starts the platform software.

3.1.3 Platform Software Initialization and Monitoring

In starting the platform software, the relay checks the integrity of the data held in non-volatile memory with a checksum, the operation of the real-time clock, and the IRIG-B board if fitted. The final test that is made concerns the input and output of data; the presence and healthy condition of the input board is checked and the analog data acquisition system is checked through sampling the reference voltage.

At the successful conclusion of all of these tests the relay is entered into service and the protection started-up.

3.2 Continuous Self-Testing

When the relay is in service, it continually checks the operation of the critical parts of its hardware and software. The checking is carried out by the system services software (see section on relay software earlier in this section) and the results reported to the platform software.

The functions that are checked are as follows:

- The flash EPROM containing all program code and language text is verified by a checksum
- The code and constant data held in SRAM is checked against the corresponding data in flash EPROM to check for data corruption
- The SRAM containing all data other than the code and constant data is verified with a checksum
- The non-volatile memory containing setting values is verified by a checksum, whenever its data is accessed
- The battery status
- The level of the field voltage
- The integrity of the digital signal I/O data from the opto-isolated inputs and the relay contacts, is checked by the data acquisition function every time it is executed. The operation of the analog data acquisition system is checked by the acquisition function every time it is executed. This is done by sampling the reference voltage on a spare multiplexed channel
- The operation of the IRIG-B board is checked, where it is fitted, by the software that reads the time and date from the board

If the Ethernet board is fitted, it is checked by the software on the main processor board. If the Ethernet board fails to respond, an alarm is raised and the board is reset in an attempt to resolve the problem

In the unlikely event that one of the checks detects an error in the relay's subsystems, the platform software is notified and it will attempt to log a maintenance record in battery backed-up SRAM. If the problem is with the battery status or the IRIG-B board, the relay continues in operation. However, for problems detected in any other area the relay shuts down and reboots. This result in a period of up to 5 seconds when protection is unavailable, but the complete restart of the relay including all initializations should clear most problems that could occur. An integral part of the start-up procedure is a thorough diagnostic self-check. If this detects the same problem that caused the relay to restart, the restart has not cleared the problem and the relay takes itself permanently out of service. This is indicated by the **Healthy** LED on the front of the relay which goes OFF, and the watchdog contact that goes ON.

Notes:

COMMISSIONING

CHAPTER 11

Date:	12/2017
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.
Hardware Suffix:	M
Software Version:	B2
Connection Diagrams:	10P849xx (xx = 01 to 06)

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1 INTRODUCTION

About MiCOM Range

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

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

The components within MiCOM are:

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

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

For up-to-date information, please see:

www.schneider-electric.com

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

The MiCOM P40 range of products includes various devices which have different functions. This chapter includes information related to the Commissioning of one or more of these devices. Many, although not all, of the commissioning tasks are common to these products.

This chapter applies to the MiCOM P40 products shown on the second page of this chapter. Where a particular section or paragraph relates only to one of more of the products, this is stated in the heading or at the beginning of the paragraph or section. If this states “Applicability: All”, this means the following information relates to all the products in shown on the second page of this chapter. Otherwise the Applicability statement will list the MiCOM P40 products which the information covers.

When using this chapter, you (i.e. in your role as the Commissioning Engineer), need to be aware of:

- The MiCOM product number you are commissioning
- The features associated with that MiCOM product number
- The subset of features which have been enabled for the specific piece of equipment you are commissioning
- Any work instructions which determine how the equipment should be installed and which of its functions have been enabled and how they should relate to other equipment
- You will then be able to select which of the following sections/subsections you need to follow. Some of these sections will not be relevant for the particular commissioning tasks you are performing. By way of example, if the MiCOM device you are commissioning has an Auto-Reclose function you need to refer to the sections which cover Auto-Reclose, otherwise you can ignore them.

- You should start using this chapter at the beginning and work your way through to the end. At key points in the chapter, you will have to know what technical functions have been enabled, as you will be asked to omit certains sections of this chapter if they are not relevant for your current commissioning task.

MiCOM P40 relays are fully numerical in their design, implementing all protection and non-protection functions in software. The relays use a high degree of self-checking and give an alarm in the unlikely event of a failure. Therefore, the commissioning tests do not need to be as extensive as with non-numeric electronic or electro-mechanical relays.

To commission numeric relays, it is only necessary to verify that the hardware is functioning correctly and the application-specific software settings have been applied to the relay. It is considered unnecessary to test every function of the relay if the settings have been verified by one of the following methods:

- Extracting the settings applied to the relay using appropriate setting software (preferred method)
- Using the operator interface

To confirm that the product is operating correctly once the application-specific settings have been applied, perform a test on a single protection element.

Unless previously agreed to the contrary, the customer is responsible for determining the application-specific settings to be applied to the relay and for testing any scheme logic applied by external wiring or configuration of the relay’s internal programmable scheme logic.

Blank commissioning test and setting records are provided within this manual for completion as required.

As the relay’s menu language is user-selectable, the Commissioning Engineer can change it to allow accurate testing as long as the menu is restored to the customer’s preferred language on completion.

To simplify the specifying of menu cell locations in these Commissioning Instructions, they are given in the form [courier reference: COLUMN HEADING, Cell Text]. For example, the cell for selecting the menu language (first cell under the column heading) is in the System Data column (column 00) so it is given as [0001: SYSTEM DATA, Language].

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

Caution	**The relay must not be disassembled in any way during commissioning.**

2 SETTING FAMILIARISATION

When first commissioning a relay, allow sufficient time to become familiar with how to apply the settings.

The *Relay Menu Database document* and the *Introduction* or *Settings* chapters contain a detailed description of the menu structure of Schneider Electric relays. The relay menu database is a separate document which can be downloaded from our website:

www.schneider-electric.com

With the secondary front cover in place, all keys except the ↵ key are accessible. All menu cells can be read. LEDs and alarms can be reset. However, no protection or configuration settings can be changed, or fault and event records cleared.

Removing the secondary front cover allows access to all keys so that settings can be changed, LEDs and alarms reset, and fault and event records cleared. However, to make changes to menu cells, the appropriate user role and password is needed.

Alternatively, if a portable PC with suitable setting software is available (such as MiCOM S1 Studio), the menu can be viewed one page at a time, to display a full column of data and text. This PC software also allows settings to be entered more easily, saved to a file for future reference, or printed to produce a settings record. Refer to the PC software user manual for details. If the software is being used for the first time, allow sufficient time to become familiar with its operation.

3 EQUIPMENT REQUIRED FOR COMMISSIONING

3.1 Minimum Equipment Required

The minimum equipment needed varies slightly, depending on the features provided by each type of MiCOM product. The list of minimum equipment is given below:

- A portable PC, with an RS232 port as well as appropriate software
- Multifunctional dynamic current and voltage injection test set
- Multimeter with suitable ac current range, and ac and dc voltage ranges of 0 - 440V and 0 - 250V respectively
- Continuity tester (if not included in multimeter)
- Phase angle meter
- Phase rotation meter

Note	*Modern test equipment may contain many of the above features in one unit.*

3.2 Optional Equipment

- Fiber optic power meter (and fibre optic test leads may be required depending upon application).
- Multi-finger test plug type Easergy test plug (if Easergy test block type is installed)
- An electronic or brushless insulation tester with a dc output not exceeding 500 V (for insulation resistance testing when required)
- K-Bus to EIA(RS)232 protocol converter (if the first rear EIA(RS)485 K-Bus port or second rear port configured for K-Bus is being tested and one is not already installed)
- EIA(RS)485 to EIA(RS)232 converter (if first rear EIA(RS)485 port or second rear port configured for EIA(RS)485 is being tested)
- A printer, for printing a setting record from the portable PC

4 PRODUCT CHECKS

These product checks cover all aspects of the relay that need to be checked to ensure:

- that it has not been physically damaged before commissioning
- that it is functioning correctly and
- that all input quantity measurements are within the stated tolerances

If the application-specific settings have been applied to the relay before commissioning, it is advisable to make a copy of the settings to allow their restoration later.

If Programmable Scheme Logic (PSL) (other than the default settings with which the relay was supplied) has been applied, the default settings should be restored before commissioning. This can be done by:

- Obtaining a setting file from the customer. This requires a portable PC with appropriate setting software for transferring the settings from the PC to the relay.
- Extracting the settings from the relay itself. This requires a portable PC with appropriate setting software.
- Manually creating a setting record. This could be done by stepping through the front panel menu using the front panel user interface.

If password protection is enabled, and the customer has changed password 2 that prevents unauthorized changes to some of the settings, either the revised password 2 should be provided, or the customer should restore the original password before testing is started.

Note	*If the password has been lost, a recovery password can be obtained from Schneider Electric by quoting the serial number of the relay. The recovery password is unique to that relay and will not work on any other relay.*

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

4.1 With the Device De-Energised

The following group of tests should be carried out without the auxiliary supply applied to the relay and with the trip circuit isolated.

Before inserting the test plug, refer to the scheme diagram to ensure this will not cause damage or a safety hazard. For example, the test block may be associated with protection current transformer circuits. Before the test plug is inserted into the test block, make sure the sockets in the test plug which correspond to the current transformer secondary windings are linked.

Warning	**The current and voltage transformer connections must be isolated from the relay for these checks. If a MiCOM P991 or an Easergy test block is provided, insert the Easergy or MiCOM P992 test plug, which open-circuits all wiring routed through the test block.**

Danger	**Never open-circuit the secondary circuit of a current transformer because the high voltage produced may be lethal. It could also damage insulation.**

If a test block is not provided, isolate the voltage transformer supply to the relay using the panel links or connecting blocks. Short-circuit and disconnect the line current transformers from the relay terminals. Where means of isolating the auxiliary supply and trip circuit (such as isolation links, fuses and MCB) are provided, these should be used. If this is impossible, the wiring to these circuits must be disconnected and the exposed ends suitably terminated to prevent them from being a safety hazard.

4.1.1 Visual Inspection

Caution	**Check the rating information under the top access cover on the front of the relay. Check that the relay being tested is correct for the protected line or circuit. Ensure that the circuit reference and system details are entered onto the setting record sheet. Double-check the CT secondary current rating, and be sure to record the actual CT tap which is in use.**

Carefully examine the relay to see that no physical damage has occurred since installation.

Ensure that the case earthing connections, at the bottom left-hand corner at the rear of the relay case, are used to connect the relay to a local earth bar using an adequate conductor.

4.1.2 Insulation

Insulation resistance tests are only necessary during commissioning if it is required for them to be done and they have not been performed during installation.

Isolate all wiring from the earth and test the insulation with an electronic or brushless insulation tester at a dc voltage not exceeding 500V. Terminals of the same circuits should be temporarily connected together.

The main groups of device terminals are:

a) Auxiliary voltage supply
b) Field voltage output and opto-isolated control inputs
c) Device contacts
d) Case earth

The insulation resistance should be greater than 100MΩ at 500V.

On completion of the insulation resistance tests, ensure all external wiring is correctly reconnected to the device.

4.1.3 External Wiring

Caution	**Check that the external wiring is correct to the relevant relay diagram and scheme diagram. Ensure as far as practical that phasing/phase rotation appears to be as expected. The relay diagram number appears on the rating label under the top access cover on the front of the relay. Schneider Electric supply the corresponding connection diagram with the order acknowledgement for the relay.**

If a MiCOM P991 or an Easergy test block is provided, check the connections against the wiring diagram. It is recommended that the supply connections are to the live side of the test block (colored orange with the odd numbered terminals 1, 3, 5, 7, and so on). The auxiliary supply is normally routed through terminals 13 (supply positive) and 15 (supply negative), with terminals 14 and 16 connected to the relay's positive and negative auxiliary supply terminals respectively. However, check the wiring against the schematic diagram for the installation to ensure compliance with the customer's normal practice.

4.1.4 Watchdog Contacts

Using a continuity tester, check that the watchdog contacts are in the states shown in the *Watchdog contact status* table for a de-energized relay.

Terminals		Contact State	
		Relay De-energized	Relay Energized
N11 – N12		Closed	Open
N13 – N14		Open	Closed

Table 1 - Watchdog contact status

4.1.5 Auxiliary Supply

Caution	The relay can be operated from either a dc only or an ac/dc auxiliary supply depending on the relay's nominal supply rating. The incoming voltage must be within the operating range specified in the following table.

Without energizing the relay, measure the auxiliary supply to ensure it is within the operating range.

Note	*The relay can withstand an ac ripple of up to 12% of the upper rated voltage on the dc auxiliary supply.*

Nominal Supply Rating		Operating Ranges	
dc	ac	dc	ac
24 - 32V dc	-	19 - 38V dc	-
48 - 110V dc	-	37 - 150V dc	-
110 - 250V dc	100 - 240V ac rms	87 - 300V dc	80 - 265V ac

Table 2 - Operational range of auxiliary supply VX

Caution	Do not energize the relay using the battery charger with the battery disconnected as this can irreparably damage the relay's power supply circuitry.

Caution	Energize the relay only if the auxiliary supply is within the operating range. If a test block is provided, it may be necessary to link across the front of the test plug to connect the auxiliary supply to the relay.

4.2 With the Device Energised

The following group of tests verify that the relay hardware and software is functioning correctly and should be carried out with the auxiliary supply applied to the relay.

4.2.1 Watchdog Contacts

Using a continuity tester, check that the watchdog contacts are in the states shown in the *Watchdog contact status* table for an energized relay.

4.2.2 Date and Time

Before setting the date and time, ensure that the factory-fitted battery isolation strip that prevents battery drain during transportation and storage has been removed. With the lower access cover open, the presence of the battery isolation strip can be checked by a red tab protruding from the positive side of the battery compartment. Lightly pressing the battery to prevent it falling out of the battery compartment, pull the red tab to remove the isolation strip.

The data and time should now be set to the correct values. The method of setting depends on whether accuracy is being maintained through the optional Inter-Range Instrumentation Group standard B (IRIG-B) port on the rear of the relay or by using SNTP via Ethernet.

4.2.2.1 With an IRIG-B Signal

Note	*For P741 the IRIG-B signal may apply to the Central Unit only.*

If a satellite time clock signal conforming to IRIG-B is provided and the relay has the optional IRIG-B port fitted, the satellite clock equipment should be energized.

To allow the relay's time and date to be maintained from an external IRIG-B source cell [DATE and TIME, IRIG-B Sync.] must be set to **Enabled**.

Ensure the relay is receiving the IRIG-B signal by checking that cell [DATE and TIME, IRIG-B Status] reads **Active**.

Once the IRIG-B signal is active, adjust the time offset of the universal coordinated time (satellite clock time) on the satellite clock equipment so that local time is displayed.

Check the time, date and month are correct in cell [0801: DATE and TIME, Date/Time]. The IRIG-B signal does not contain the current year so needs to be set manually in this cell.

If the auxiliary supply fails, with a battery fitted in the compartment behind the bottom access cover, the time and date is maintained. Therefore, when the auxiliary supply is restored, the time and date are correct and need not be set again.

To test this, remove the IRIG-B signal, then remove the auxiliary supply from the relay. Leave the relay de-energized for approximately 30 seconds. On re-energization, the time in cell [DATE and TIME, Date/Time] should be correct. Then reconnect the IRIG-B signal.

4.2.2.2 Without an IRIG-B Signal

Note	*For P741 the IRIG-B signal may not apply to the Central Unit only. For the P742/P743 it may apply to the Peripheral Unit only.*

If the time and date is not being maintained by an IRIG-B signal, ensure that cell [0804: DATE and TIME, IRIG-B Sync.] is set to **Disabled**.

Set the date and time to the correct local time and date using cell [0801: DATE and TIME, Date/Time].

If the auxiliary supply fails, with a battery fitted in the compartment behind the bottom access cover, the time and date are maintained. Therefore when the auxiliary supply is restored, the time and date are correct and need not be set again.

To test this, remove the auxiliary supply from the relay for approximately 30 seconds. On re-energization, the time in cell [0801: DATE and TIME, Date/Time] should be correct.

4.2.3 Light Emitting Diodes (LEDs)

On power-up, the green LED should switch on and stay on, indicating that the relay is healthy. The relay has non-volatile memory which stores the state (on or off) of the alarm, trip and, if configured to latch, user-programmable LED indicators when the relay was last energized from an auxiliary supply. Therefore, these indicators may also switch on when the auxiliary supply is applied.

If any of these LEDs are on, reset them before proceeding with further testing. If the LED successfully resets (the LED switches off), there is no testing required for that LED because it is known to be operational.

Note	*It is likely that alarms related to the communications channels will not reset at this stage.*

4.2.3.1 Testing the Alarm and Out Of Service LEDs

The alarm and out of service LEDs can be tested using the **COMMISSIONING TESTS** menu column. Set cell [0F0D: COMMISSIONING TESTS, Test Mode] to **Contacts Blocked**. Check that the out of service LED is on continuously and the alarm LED flashes.

It is not necessary to return cell [0F0D: COMMISSIONING TESTS, Test Mode] to **Disabled** at this stage because the test mode will be required for later tests.

4.2.3.2 Testing the Trip LED

The trip LED can be tested by initiating a manual circuit breaker trip from the relay. However, the trip LED will operate during the setting checks performed later. Therefore, no further testing of the trip LED is required at this stage.

4.2.3.3 Testing the User-Programmable LEDs

To test the user-programmable LEDs set cell [0F10: COMMISSIONING TESTS, Test LEDs] to **Apply Test**. Check that all the programmable LEDs on the relay switch on.

In the MiCOM P741, P743, P746 & P849:

- The ‘Red LED Status’ cell is an 18-bit binary string that indicates which of the user-programmable LEDs on the device are illuminated when accessing the device from a remote location, a ‘1’ indicating a particular Red LED is lit.
- The ‘Green LED Status’ cell is an 18-bit binary string that indicates which of the user-programmable LEDs on the device are illuminated when accessing the device from a remote location, a ‘1’ indicating a particular Green LED is lit.
- If a ‘Red LED Status’ cell AND the same ‘Green LED Status’ cell are at ‘1’ the particular LED is lit Orange
- If a ‘Red LED Status’ cell AND the same ‘Green LED Status’ cell are at ‘0’ the particular LED is not lit.

4.2.4 Field Voltage Supply

The relay generates a field voltage of nominally 48 V that can be used to energize the opto-isolated inputs (alternatively the substation battery may be used).

Measure the field voltage across terminals 7 and 9 on the terminal block shown in the following table. Check that the field voltage is in the range 40 V to 60 V when no load is connected and that the polarity is correct.

Repeat for terminals 8 and 10

Supply Rail	Terminals
+ve	N7 & N8
–ve	N9 & N10

Table 3 - Field voltage terminals

4.2.5 Input Opto-Isolators

This test checks that all the opto-isolated inputs on the relay are functioning correctly.

The opto-isolated inputs should be energised one at a time, see the *Connection Diagrams* chapter for terminal numbers. Ensuring correct polarity, connect the field supply voltage to the appropriate terminals for the input being tested.

Note	*The opto-isolated inputs may be energised from an external dc auxiliary supply (e.g. the station battery) in some installations. Check that this is not the case before connecting the field voltage otherwise damage to the relay may result.*

The status of each opto-isolated input can be viewed using either cell [SYSTEM DATA, Opto I/P Status] or [COMMISSION TESTS, Opto I/P Status], a '1' indicating an energised input and a '0' indicating a de-energised input. When each opto-isolated input is energised one of the characters on the bottom line of the display will change to indicate the new state of the inputs.

4.2.6 Output Relays

This test checks that all the output relays are functioning correctly.

See external Connection Diagrams Chapter (P849/EN IN) for terminal numbers.

Ensure that the cell [xxxx: COMMISSIONING TESTS, Test Mode] is set to **Contacts Blocked**. (xxxx = 0F0E for P44x/P44y, 0F0D for P14x, P24x, P34x, P341, P54x, P547, P64x or P841).

The output relays should be energized one at a time. To select output relay 1 for testing, set cell [xxxx: COMMISSIONING TESTS, Test Pattern] to 00000000000000000000000000000001. (xxxx = 0F0F for P44x/P44y, 0F0E for P14x, P24x, P34x, P341, P445, P54x, P547, P64x or P841).

Connect a continuity tester across the terminals corresponding to output relay 1 as shown in the relevant external connection diagram in the *Installation* chapter.

To operate the output relay, set cell [xxxx: COMMISSIONING TESTS, Contact Test] to **Apply Test**. Operation is confirmed by the continuity tester operating for a normally open contact and ceasing to operate for a normally closed contact. Measure the resistance of the contacts in the closed state. (xxxx = 0F11 for P44x, 0F0F for P14x, P24x, P34x, P341, P44y, P445, P54x, P547, P64x or P841).

Reset the output relay by setting cell [xxxx: COMMISSIONING TESTS, Contact Test] to **Remove Test**. (xxxx = 0F11 for P44x, 0F0F for P14x, P24x, P34x, P341, P44y, P445, P54x, P547 or P64x).

Note	*Ensure that the thermal ratings of anything connected to the output relays during the contact test procedure are not exceeded by the associated output relay being operated for too long. Keep the time between application and removal of contact test to a minimum.*

Repeat the test for the rest of the relays (the numbers depend on the model).

Return the relay to service by setting cell [0F0D: COMMISSIONING TESTS, Test Mode] to **Disabled**.

4.2.7 Rear Communications Port

This test should only be performed where the relay is to be accessed from a remote location and varies depending on the communications standard adopted.

It is not the intention of the test to verify the operation of the complete system from the relay to the remote location, just the relay's rear communications port and any protocol converter necessary.

A variety of communications protocols may be available. For further details, please see whichever of these sections are relevant for the device you are commissioning:

4.2.7.1 Courier Communications

If a K-Bus to EIA(RS)232 KITZ protocol converter is installed, connect a portable PC running the appropriate software (such as MiCOM S1 Studio or PAS&T) to the incoming (remote from relay) side of the protocol converter.

If a KITZ protocol converter is not installed, it may not be possible to connect the PC to the relay installed. In this case a KITZ protocol converter and portable PC running appropriate software should be temporarily connected to the relay's first rear K-Bus port. The terminal numbers for the relay's first rear K-Bus port are shown in the following table. However, as the installed protocol converter is not being used in the test, only the correct operation of the relay's K-Bus port will be confirmed.

Ensure that the communications baud rate and parity settings in the application software are set the same as those on the protocol converter (usually a KITZ but could be a SCADA RTU). The relays courier address in cell [COMMUNICATIONS, Remote Access] must be set to a value between 6 (P741) and 34. Check that communications can be established with this relay using the portable PC.

Check that, using the Master Station, communications with the relay can be established.

Note:	*The first rear communication port (terminal N17-18) can be either K-Bus or EIA(RS)485.*

4.2.8 Second Rear Communications Port

This test should only be performed where the relay is to be accessed from a remote location and varies depending on the communications standard being adopted.

It is not the intention of the test to verify the operation of the complete system from the relay to the remote location, just the relay's rear communications port and any protocol converter necessary.

A variety of communications protocols may be available. For further details, please see whichever of these sections are relevant for the device you are commissioning:

4.2.8.1 K-Bus Configuration

If a K-Bus to EIA(RS)232 KITZ protocol converter is installed, connect a portable PC running the appropriate software (MiCOM S1 Studio or PAS&T) to the incoming (remote from relay) side of the protocol converter.

If a KITZ protocol converter is not installed, it may not be possible to connect the PC to the relay installed. In this case a KITZ protocol converter and portable PC running appropriate software should be temporarily connected to the relay's second rear communications port configured for K-Bus. The terminal numbers for the relay's K-Bus port are shown in the following table. However, as the installed protocol converter is not being used in the test, only the correct operation of the relay's K-Bus port is confirmed.

Pin*	Connection
4	EIA(RS)485 - 1 (+ ve)
7	EIA(RS)485 - 2 (- ve)
* All other pins unconnected.	

Table 4 - Second rear communications port K-Bus terminals

Ensure that the communications baud rate and parity settings in the application software are set the same as those on the protocol converter (usually a KITZ but could be a SCADA RTU). The relay's Courier address in cell [0E90: COMMUNICATIONS, RP2 Address] must be set to a value between 1 and 254. The second rear communication's port configuration [0E88: COMMUNICATIONS RP2 Port Config.] must be set to K-Bus.

Check that communications can be established with this relay using the portable PC.

4.2.8.2 EIA(RS)485 Configuration

If an EIA(RS)485 to EIA(RS)232 converter (Schneider Electric CK222) is installed, connect a portable PC running the appropriate software (Easergy Studio/MiCOM S1 Studio) to the EIA(RS)232 side of the converter and the second rear communications port of the relay to the EIA(RS)485 side of the converter.

The terminal numbers for the relay's EIA(RS)485 port are shown in the *Second rear communications port EIA(RS)232 terminals* table.

Ensure that the communications baud rate and parity settings in the application software are the same as those in the relay. The relay's Courier address in cell [0E90: COMMUNICATIONS, RP2 Address] must be set to a value between 1 and 254. The second rear communications port's configuration [0E88: COMMUNICATIONS RP2 Port Config.] must be set to EIA(RS)485.

Check that communications can be established with this relay using the portable PC.

4.2.8.3 EIA(RS)232 Configuration

Connect a portable PC running the appropriate software (MiCOM S1 Studio) to the rear EIA(RS)232 port of the relay. This port is actually compliant with EIA(RS)574; the 9-pin version of EIA(RS)232, see www.tiaonline.org.

The second rear communications port connects using the 9-way female D-type connector (SK4). The connection is compliant with EIA(RS)574.

Pin	Connection
1	No Connection
2	RxD
3	TxD
4	DTR#
5	Ground
6	No Connection
7	RTS#
8	CTS#
9	No Connection
# These pins are control lines for use with a modem.	

Table 5 - Second rear communications port EIA(RS)232 terminals

Connections to the second rear port configured for EIA(RS)232 operation can be made using a screened multi-core communication cable up to 15 m long, or a total capacitance of 2500 pF. Terminate the cable at the relay end with a 9-way, metal-shelled, D-type male plug. The terminal numbers for the relay's EIA(RS)232 port are shown in the previous table.

Ensure that the communications baud rate and parity settings in the application software are set the same as those in the relay. The relay's Courier address in cell [0E90: COMMUNICATIONS, RP2 Address] must be set to a value between 1 and 254. The second rear communication's port configuration [0E88: COMMUNICATIONS RP2 Port Config] must be set to EIA(RS)232.

Check that communications can be established with this relay using the portable PC.

5 COMMISSIONING TOOLS

To help minimize the time needed to test MiCOM relays the relay provides several test facilities under the '**COMMISSION TESTS**' menu heading. There are menu cells which allow the status of the opto-isolated inputs, output relay contacts, internal Digital Data Bus (DDB) signals and user-programmable LEDs to be monitored. Additionally there are cells to test the operation of the output contacts, user-programmable LEDs and, where available, the auto-reclose cycles.

The following table shows the relay menu of commissioning tests, including the available setting ranges and factory defaults. Each of the main menu tests are described in more detail in the following sections.

COMMISSION TESTS for P849		
Menu Text	**Default Setting**	**Settings**
Opto I/P Status	-	-
Relay O/P Status	-	-
Test Port Status	-	-
LED Status	-	-
Monitor Bit 1	256 - (LED 1)	0 to 2047
Monitor Bit 2	258 - (LED 2)	0 to 2047
Monitor Bit 3	260 - (LED 3)	0 to 2047
Monitor Bit 4	262 - (LED 4)	0 to 2047
Monitor Bit 5	264 - (LED 5)	0 to 2047
Monitor Bit 6	266 - (LED 6)	0 to 2047
Monitor Bit 7	268 - (LED 7)	0 to 2047
Monitor Bit 8	270 - (LED 8)	0 to 2047
Test Mode	Disabled	Disabled, Test Mode, Contacts Blocked
Test Pattern	All bits set to 0	0 = Not Operated, 1 = Operated
Contact Test	No Operation	No Operation, Apply Test, Remove Test
Test LEDs	No Operation	No Operation, Apply Test
Test Auto-reclose	No Operation	No Operation, 3 Pole Test
Red LED Status	-	-
Green LED Status	-	-
Note *See Relay Menu Database for details of DDB signals*		

Table 6 - Commission Tests

5.1 Opto I/P Status

This menu cell displays the status of the relay's opto-isolated inputs as a binary string, a '**1**' indicating an energized opto-isolated input and a '**0**' a de-energized one. If the cursor is moved along the binary numbers the corresponding label text will be displayed for each logic input.

It can be used during commissioning or routine testing to monitor the status of the opto-isolated inputs whilst they are sequentially energized with a suitable dc voltage.

5.2 Relay O/P Status

This menu cell displays the status of the Digital Data Bus (DDB) signals that result in energization of the output relays as a binary string, a '**1**' indicating an operated state and '**0**' a non-operated state. If the cursor is moved along the binary numbers the corresponding label text will be displayed for each relay output.

The information displayed can be used during commissioning or routine testing to indicate the status of the output relays when the relay is '**in service**'. Additionally fault finding for output relay damage can be performed by comparing the status of the output contact under investigation with it's associated bit.

> *Note* *When the '**Test Mode**' cell is set to '**Enabled**' this cell will continue to indicate which contacts would operate if the relay was in-service, it does not show the actual status of the output relays.*

5.3 Test Port Status

This menu cell displays the status of the eight Digital Data Bus (DDB) signals that have been allocated in the '**Monitor Bit**' cells. If the cursor is moved along the binary numbers the corresponding DDB signal text string will be displayed for each monitor bit.

By using this cell with suitable monitor bit settings, the state of the DDB signals can be displayed as various operating conditions or sequences are applied to the relay. Thus the Programmable Scheme Logic (PSL) can be tested.

As an alternative to using this cell, the optional monitor/download port test box can be plugged into the monitor/download port located behind the bottom access cover. Details of the monitor/download port test box can be found in the *Using a Monitor/Download Port Test Box* section of this chapter.

5.4 LED Status

The '**LED Status**' is an eight bit binary strings that indicate which of the user-programmable LEDs on the relay are illuminated when accessing the relay from a remote location, a '**1**' indicating a particular LED is lit and a '**0**' not lit.

5.5 Monitor Bits 1 to 8

The eight '**Monitor Bit**' cells allow the user to select the status of which digital data bus signals can be observed in the '**Test Port Status**' cell or via the monitor/download port.

Each '**Monitor Bit**' is set by entering the required Digital Data Bus (DDB) signal number from the list of available DDB signals in the Programmable Logic chapter. The pins of the monitor/download port used for monitor bits are given in the following table. The signal ground is available on pins 18, 19, 22 and 25.

Monitor bit	1	2	3	4	5	6	7	8
Monitor/download port pin	11	12	15	13	20	21	23	24

The required DDB signal numbers are 0 – 2047.

Table 7 - Monitor bit pins

> **Warning** **The monitor/download port is not electrically isolated against induced voltages on the communications channel. It should therefore only be used for local communications.**

5.6 Test Mode

The **Test Mode** menu cell (in the **COMMISSION TESTS** column) is used to allow secondary injection testing to be performed on the relay.

To select test mode set the Test Mode menu cell to '**Test Mode**'. It causes an alarm condition to be recorded, the yellow ALARM LED to light and an alarm message '**Test Mode Alm**' to be generated.

Test Mode freezes any information stored in the **CB CONDITION** column and (in IEC60870-5-103 builds) changes the Cause Of Transmission (COT) to Test Mode. For relays supporting IEC 61850 Edition 2, the test bit for data quality attribute shall set to TRUE, and the Logical Device Mode will set to test.

Test mode can also be enabled by energizing an opto mapped to the **Test Mode** signal.

To enable testing of output contacts set the **Test Mode** cell to **Contacts Blocked**. It causes an alarm condition to be recorded, the yellow ALARM LED to light and an alarm message '**Contacts Blk Alm**' to be generated.

In **Contact Blocked** mode, the protection function still works but the contacts will not operate. Also the **test pattern** and contact test functions are visible, which can be used to manually operate the output contacts. For relays supporting IEC 61850 Edition 2, the test bit for data quality attribute shall set to TRUE, and the Logical Device Mode will set to test/blocked.

Contacts Blocked can also be enabled by energizing an opto mapped to the **Contacts Blocked** signal.

Once testing is complete the cell must be set back to '**Disabled**' to restore the relay back to service.

WARNING	**If you use or enable Test Mode, you must disable Test Mode before putting the relay back into active service. IT IS POTENTIALLY EXTREMELY UNSAFE TO ATTEMPT TO USE ANY RELAY WHICH IS STILL IN TEST MODE IN ACTIVE SERVICE.**

5.7 Test Pattern

The '**Test Pattern**' cell is used to select the output relay contacts that will be tested when the '**Contact Test**' cell is set to '**Apply Test**'. The cell has a binary string with one bit for each user-configurable output contact which can be set to '**1**' to operate the output under test conditions and '**0**' to not operate it.

5.8 Contact Test

When the '**Apply Test**' command in this cell is issued the contacts set for operation (set to '**1**') in the '**Test Pattern**' cell change state. After the test has been applied the command text on the LCD will change to '**No Operation**' and the contacts will remain in the Test State until reset issuing the '**Remove Test**' command. The command text on the LCD will again revert to '**No Operation**' after the '**Remove Test**' command has been issued.

Note	*When the '**Test Mode**' cell is set to '**Enabled**' the '**Relay O/P Status**' cell does not show the current status of the output relays and hence can not be used to confirm operation of the output relays. Therefore it will be necessary to monitor the state of each contact in turn.*

5.9 Test LEDs

When the '**Apply Test**' command in this cell is issued the eight/eighteen user-programmable LEDs will illuminate for approximately 2 seconds before they extinguish and the command text on the LCD reverts to '**No Operation**'.

5.10 Test Auto-Reclose

Where the relay provides an auto-reclose function, this cell will be available for testing the sequence of circuit breaker trip and auto-reclose cycles with the settings applied.

Issuing the command '**3 Pole Trip**' will cause the relay to perform the first three-phase trip/reclose cycle so that associated output contacts can be checked for operation at the correct times during the cycle. Once the trip output has operated the command text will revert to '**No Operation**' whilst the rest of the auto-reclose cycle is performed. To test subsequent three-phase auto-reclose cycles repeat the '**3 Pole Trip**' command.

Note	*The factory settings for the relay's Programmable Scheme Logic (PSL) has the '**AR Trip Test**' signal mapped to relay 3. If the PSL has been changed, it is essential that this signal remains mapped to relay 3 for the '**Test Auto-reclose**' facility to work.*

5.11 Red LED Status and Green LED Status

The **Red LED Status** and **Green LED Status** cells are 18-bit binary strings that show which of the user-programmable LEDs on the relay are ON when accessing the relay from a remote location. **1** indicates a particular LED is ON and a **0** OFF. When the status of a particular LED in both cells is **1**, this means the LED is yellow.

5.12 Using a Monitor/Download Port Test Box

A monitor/download port test box containing 8 LEDs and a switchable audible indicator is available from Schneider Electric, or one of their regional sales offices. It is housed in a small plastic box with a 25-pin male D-connector that plugs directly into the relay's monitor/download port. There is also a 25-pin female D-connector which allows other connections to be made to the monitor/download port whilst the monitor/download port test box is in place.

Each LED corresponds to one of the monitor bit pins on the monitor/download port with '**Monitor Bit 1**' being on the left hand side when viewing from the front of the relay. The audible indicator can either be selected to sound if a voltage appears on any of the eight monitor pins or remain silent so that indication of state is by LED alone.

6 SETTING CHECKS

The setting checks ensure that all of the application-specific relay settings (both the relay's function and Programmable Scheme Logic (PSL) settings) for the particular installation have been correctly applied to the relay.

Caution	**The trip circuit should remain isolated during these checks to prevent accidental operation of the associated circuit breaker.**

6.1 Apply Application-Specific Settings

There are different methods of applying the settings:

- Transferring settings from a pre-prepared setting file to the relay using a laptop PC running the appropriate software (such as Easergy/MiCOM S1 Studio). Use the front EIA(RS)232 port (under the bottom access cover), or the first rear communications port (Courier protocol with a protocol converter connected), or the second rear communications port. This is the preferred method for transferring function settings as it is much faster and there is less margin for error. If PSL other than the default settings with which the relay is supplied is used, this is the only way of changing the settings.

  If a setting file has been created for the particular application and provided on a memory device, the commissioning time is further reduced, especially if application-specific PSL is applied to the relay.
- Enter the settings manually using the relay's operator interface. This method is not suitable for changing the PSL.

Caution	**When the installation needs application-specific Programmable Scheme Logic (PSL), it is essential that the appropriate .psl file is downloaded (sent) to the relay, for each setting group that will be used. If the user fails to download the required .psl file to any setting group that may be brought into service, the factory default PSL will still be resident. This may have severe operational and safety consequences.**

6.2 Check Application Settings

Carefully check applied settings against the required application-specific settings to ensure they have been entered correctly. However, this is not considered essential if a customer-prepared setting file on a memory device has been transferred to the relay using a portable PC.

There are two methods of checking the settings:

- Extract the settings from the relay using a portable PC running the appropriate software (MiCOM S1 Studio) using the front EIA(RS)232 port, under the bottom access cover, or the first rear communications port (Courier protocol with a KITZ protocol converter connected), or the second rear communications port. Compare the settings transferred from the relay with the original written application-specific setting record (for cases where the customer has only provided a printed copy of the required settings but a portable PC is available).
- Step through the settings using the relay's operator interface and compare them with the original application-specific setting record.

Unless previously agreed to the contrary, the application-specific PSL is not checked as part of the commissioning tests.

Due to the versatility and possible complexity of the PSL, it is beyond the scope of these commissioning instructions to detail suitable test procedures. Therefore, when PSL tests must be performed, written tests that satisfactorily demonstrate the correct operation of the application-specific scheme logic should be devised by the engineer who created it. These tests should be provided to the Commissioning Engineer with the memory device containing the PSL setting file.

7 FINAL CHECKS

The tests are now complete.

Caution	***Remove all test or temporary shorting leads. If it has been necessary to disconnect any of the external wiring from the relay to perform the wiring verification tests, make sure all connections are replaced according to the relevant external connection or scheme diagram.***

Ensure that the relay is restored to service by checking that cell [0Fxx: COMMISSIONING TESTS, Test Mode] and [0F12: COMMISSION TESTS, Static Test] are set to '**Disabled**' (0F0D for P14x/P24x/P34x/P341/P44y/P54x/P841, otherwise 0F0F).

If the menu language was changed to allow accurate testing, it must now be restored to the customer's preferred language.

If a MiCOM P991 or Easergy test block is installed, remove the MiCOM P992 or Easergy test plug and replace the test block cover so that the protection is put into service.

Ensure that all event records, fault records, disturbance records, alarms and LEDs have been reset before leaving the relay.

If applicable, replace the secondary front cover on the relay.

Notes:

TEST AND SETTINGS RECORDS

CHAPTER 12

Date:	12/2017
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.
Hardware Suffix:	M
Software Version:	B2
Connection Diagrams:	10P849xx (xx = 01 to 06)

CONTENTS

Notes:

1 TEST RECORD

1.1 Date

Date:		Engineer:	
Station:		Circuit:	
		System Frequency:	……… Hz
VT Ratio:	……… / ……… V	CT Ratio (tap in use):	……… /A

1.2 Front Plate Information

Relay type	MiCOM P…………
Model number	
Serial number	
Rated current In	
Rated voltage Vn	
Auxiliary voltage Vx	

1.3 Test Equipment Used

This section should be completed to allow future identification of protective devices that have been commissioned using equipment that is later found to be defective or incompatible but may not be detected during the commissioning procedure.

Overcurrent test set	Model: Serial No:	
Injection test set	Model: Serial No:	
Phase angle meter	Model: Serial No:	
Phase rotation meter	Model: Serial No:	
Optical power meter	Model: Serial No:	
Insulation tester	Model: Serial No:	
Setting software:	Type: Version:	

1.4 Checklist

Have all relevant safety instructions been followed?	Yes ☐ No ☐

In the following Complete or delete as appropriate (na = Not Applicable, nm = Not Measured).
Refer to the Connection Diagrams chapter for "Normally open" and "Change over" output relays location

5. PRODUCT CHECKS

5.1 With the relay de-energized

5.1.1	Visual inspection	
	Relay damaged?	Yes ☐ No ☐
	Rating information correct for installation?	Yes ☐ No ☐
	Case earth installed?	Yes ☐ No ☐
5.1.2	Current transformer shorting contacts close?	Yes ☐ No ☐ Not checked ☐
5.1.3	Insulation resistance >100 MΩ at 500 V dc	Yes ☐ No ☐ Not tested ☐
5.1.4	External wiring	
	Wiring checked against diagram?	Yes ☐ No ☐
	Test block connections checked?	Yes ☐ No ☐ N/A ☐
5.1.5	Watchdog contacts (auxiliary supply off)	
	Terminals 11 and 12 Contact closed?	Yes ☐ No ☐
	Contact resistance	Ω Not measured ☐
	Terminals 13 and 14 Contact open?	Yes ☐ No ☐
5.1.6	Measured auxiliary supply	V ac/dc

5.2 With the relay energized

5.2.1	Watchdog contacts (auxiliary supply on)	
	Terminals 11 and 12 Contact open?	Yes ☐ No ☐
	Terminals 13 and 14 Contact closed?	Yes ☐ No ☐
	Contact resistance	Ω Not measured ☐
5.2.2	LCD front panel display	
	LCD contrast setting used	
5.2.3	Date and time	
	Clock set to local time?	Yes ☐ No ☐
	Time maintained when auxiliary supply removed?	Yes ☐ No ☐
5.2.4	Light emitting diodes	
	Relay healthy (green) LED working?	Yes ☐ No ☐
	Alarm (yellow) LED working?	Yes ☐ No ☐
	Out of service (yellow) LED working?	Yes ☐ No ☐
	Trip (red) LED working?	Yes ☐ No ☐
	All programmable LEDs working? (may be 8 or 18 depending on the model)	Yes ☐ No ☐
5.2.5	Field supply voltage	
	Value measured between terminals 7 and 9	V dc
	Value measured between terminals 8 and 10	V dc

5.2.6 Input opto-isolators (numbers vary depending on the product)

Opto input 1	working?	Yes	☐	No	☐		
Opto input 2	working?	Yes	☐	No	☐		
Opto input 3	working?	Yes	☐	No	☐		
Opto input 4	working?	Yes	☐	No	☐		
Opto input 5	working?	Yes	☐	No	☐		
Opto input 6	working?	Yes	☐	No	☐		
Opto input 7	working?	Yes	☐	No	☐		
Opto input 8	working?	Yes	☐	No	☐		
Opto input 9	working?	Yes	☐	No	☐		
Opto input 10	working?	Yes	☐	No	☐		
Opto input 11	working?	Yes	☐	No	☐		
Opto input 12	working?	Yes	☐	No	☐		
Opto input 13	working?	Yes	☐	No	☐		
Opto input 14	working?	Yes	☐	No	☐		
Opto input 15	working?	Yes	☐	No	☐		
Opto input 16	working?	Yes	☐	No	☐		
Opto input 17	working?	Yes	☐	No	☐	N/A	☐
Opto input 18	working?	Yes	☐	No	☐	N/A	☐
Opto input 19	working?	Yes	☐	No	☐	N/A	☐
Opto input 20	working?	Yes	☐	No	☐	N/A	☐
Opto input 21	working?	Yes	☐	No	☐	N/A	☐
Opto input 22	working?	Yes	☐	No	☐	N/A	☐
Opto input 23	working?	Yes	☐	No	☐	N/A	☐
Opto input 24	working?	Yes	☐	No	☐	N/A	☐

Opto input 25	working?	Yes	☐	No	☐	N/A	☐
Opto input 26	working?	Yes	☐	No	☐	N/A	☐
Opto input 27	working?	Yes	☐	No	☐	N/A	☐
Opto input 28	working?	Yes	☐	No	☐	N/A	☐
Opto input 29	working?	Yes	☐	No	☐	N/A	☐
Opto input 30	working?	Yes	☐	No	☐	N/A	☐
Opto input 31	working?	Yes	☐	No	☐	N/A	☐
Opto input 32	working?	Yes	☐	No	☐	N/A	☐
Opto input 33	working?	Yes	☐	No	☐	N/A	☐
Opto input 34	working?	Yes	☐	No	☐	N/A	☐
Opto input 35	working?	Yes	☐	No	☐	N/A	☐
Opto input 36	working?	Yes	☐	No	☐	N/A	☐
Opto input 37	working?	Yes	☐	No	☐	N/A	☐
Opto input 38	working?	Yes	☐	No	☐	N/A	☐
Opto input 39	working?	Yes	☐	No	☐	N/A	☐
Opto input 40	working?	Yes	☐	No	☐	N/A	☐
Opto input 41	working?	Yes	☐	No	☐	N/A	☐
Opto input 42	working?	Yes	☐	No	☐	N/A	☐
Opto input 43	working?	Yes	☐	No	☐	N/A	☐
Opto input 44	working?	Yes	☐	No	☐	N/A	☐
Opto input 45	working?	Yes	☐	No	☐	N/A	☐
Opto input 46	working?	Yes	☐	No	☐	N/A	☐
Opto input 47	working?	Yes	☐	No	☐	N/A	☐
Opto input 48	working?	Yes	☐	No	☐	N/A	☐

Opto input 49	working?	Yes ☐ No ☐ N/A ☐
Opto input 50	working?	Yes ☐ No ☐ N/A ☐
Opto input 51	working?	Yes ☐ No ☐ N/A ☐
Opto input 52	working?	Yes ☐ No ☐ N/A ☐
Opto input 53	working?	Yes ☐ No ☐ N/A ☐
Opto input 54	working?	Yes ☐ No ☐ N/A ☐
Opto input 55	working?	Yes ☐ No ☐ N/A ☐
Opto input 56	working?	Yes ☐ No ☐ N/A ☐
Opto input 57	working?	Yes ☐ No ☐ N/A ☐
Opto input 58	working?	Yes ☐ No ☐ N/A ☐
Opto input 59	working?	Yes ☐ No ☐ N/A ☐
Opto input 60	working?	Yes ☐ No ☐ N/A ☐
Opto input 61	working?	Yes ☐ No ☐ N/A ☐
Opto input 62	working?	Yes ☐ No ☐ N/A ☐
Opto input 63	working?	Yes ☐ No ☐ N/A ☐
Opto input 64	working?	Yes ☐ No ☐ N/A ☐

5.2.7 Output relays

Relay 1	working?		Yes ☐ No ☐
	Contact resistance		Ω ☐ Not measured ☐
Relay 2	working?		Yes ☐ No ☐
	Contact resistance		Ω ☐ Not measured ☐
Relay 3	working?		Yes ☐ No ☐
	Contact resistance		Ω ☐ Not measured ☐
Relay 4	working?		Yes ☐ No ☐
	Contact resistance	(N/C)	Ω ☐ Not measured ☐
		(N/O)	Ω ☐ Not measured ☐
Relay 5	working?		Yes ☐ No ☐
	Contact resistance	(N/C)	Ω ☐ Not measured ☐
		(N/O)	Ω ☐ Not measured ☐
Relay 6	working?		Yes ☐ No ☐
	Contact resistance	(N/C)	Ω ☐ Not measured ☐
		(N/O)	Ω ☐ Not measured ☐
Relay 7	working?		Yes ☐ No ☐
	Contact resistance	(N/C)	Ω ☐ Not measured ☐
		(N/O)	Ω ☐ Not measured ☐
Relay 8	working?		Yes ☐ No ☐ N/A ☐
	Contact resistance	(N/C)	Ω ☐ Not measured ☐
		(N/O)	Ω ☐ Not measured ☐

Relay 9	working?		Yes ☐ No ☐ N/A ☐
	Contact resistance		Ω ☐ Not measured ☐
Relay 10	working?		Yes ☐ No ☐ N/A ☐
	Contact resistance		Ω ☐ Not measured ☐
Relay 11	working?		Yes ☐ No ☐ N/A ☐
	Contact resistance	(N/C)	Ω ☐ Not measured ☐
		(N/O)	Ω ☐ Not measured ☐
Relay 12	working?		Yes ☐ No ☐ N/A ☐
	Contact resistance	(N/C)	Ω ☐ Not measured ☐
		(N/O)	Ω ☐ Not measured ☐
Relay 13	working?		Yes ☐ No ☐ N/A ☐
	Contact resistance	(N/C)	Ω ☐ Not measured ☐
		(N/O)	Ω ☐ Not measured ☐
Relay 14	working?		Yes ☐ No ☐ N/A ☐
	Contact resistance	(N/C)	Ω ☐ Not measured ☐
		(N/O)	Ω ☐ Not measured ☐

Next output relays are only present in the models with with options A, B, D, E and F

Relay 15	working?		Yes ☐	No ☐	N/A ☐
	Contact resistance	(N/C)	Ω ☐	Not measured ☐	
		(N/O)	Ω ☐	Not measured ☐	
Relay 16	working?		Yes ☐	No ☐	N/A ☐
	Contact resistance	(N/C)	Ω ☐	Not measured ☐	
		(N/O)	Ω ☐	Not measured ☐	

Next output relays are only present in the models with options B, D and F

Relay 17	working?		Yes ☐	No ☐	N/A ☐
	Contact resistance		Ω ☐	Not measured ☐	
Relay 18	working?		Yes ☐	No ☐	N/A ☐
	Contact resistance	(N/C)	Ω ☐	Not measured ☐	
		(N/O)	Ω ☐	Not measured ☐	
Relay 19	working?		Yes ☐	No ☐	N/A ☐
	Contact resistance	(N/C)	Ω ☐	Not measured ☐	
		(N/O)	Ω ☐	Not measured ☐	
Relay 20	working?		Yes ☐	No ☐	N/A ☐
	Contact resistance	(N/C)	Ω ☐	Not measured ☐	
		(N/O)	Ω ☐	Not measured ☐	
Relay 21	working?		Yes ☐	No ☐	N/A ☐
	Contact resistance	(N/C)	Ω ☐	Not measured ☐	
		(N/O)	Ω ☐	Not measured ☐	
Relay 22	working?		Yes ☐	No ☐	N/A ☐
	Contact resistance	(N/C)	Ω ☐	Not measured ☐	
		(N/O)	Ω ☐	Not measured ☐	
Relay 23	working?		Yes ☐	No ☐	N/A ☐
	Contact resistance	(N/C)	Ω ☐	Not measured ☐	
		(N/O)	Ω ☐	Not measured ☐	
Relay 24	working?		Yes ☐	No ☐	N/A ☐
	Contact resistance	(N/C)	Ω ☐	Not measured ☐	
		(N/O)	Ω ☐	Not measured ☐	

Next output relays are only present in the models with options D and F

Relay 25	working?		Yes ☐	No ☐	N/A ☐
	Contact resistance	(N/C)	Ω ☐	Not measured ☐	
		(N/O)	Ω ☐	Not measured ☐	
Relay 26	working?		Yes ☐	No ☐	N/A ☐
	Contact resistance	(N/C)	Ω ☐	Not measured ☐	
		(N/O)	Ω ☐	Not measured ☐	
Relay 27	working?		Yes ☐	No ☐	N/A ☐
	Contact resistance	(N/C)	Ω ☐	Not measured ☐	
		(N/O)	Ω ☐	Not measured ☐	
Relay 28	working?		Yes ☐	No ☐	N/A ☐
	Contact resistance	(N/C)	Ω ☐	Not measured ☐	
		(N/O)	Ω ☐	Not measured ☐	
Relay 29	working?		Yes ☐	No ☐	N/A ☐
	Contact resistance	(N/C)	Ω ☐	Not measured ☐	
		(N/O)	Ω ☐	Not measured ☐	
Relay 30	working?		Yes ☐	No ☐	N/A ☐
	Contact resistance	(N/C)	Ω ☐	Not measured ☐	
		(N/O)	Ω ☐	Not measured ☐	

Relay 31	working?		Yes ☐	No ☐	
	Contact resistance		Ω ☐	Not measured ☐	
Relay 32	working?		Yes ☐	No ☐	
	Contact resistance		Ω ☐	Not measured ☐	
Relay 33	working?		Yes ☐	No ☐	
	Contact resistance		Ω ☐	Not measured ☐	
Relay 34	working?		Yes ☐	No ☐	
	Contact resistance		Ω ☐	Not measured ☐	
Relay 35	working?		Yes ☐	No ☐	N/A ☐
	Contact resistance	(N/C)	Ω ☐	Not measured ☐	
		(N/O)	Ω ☐	Not measured ☐	
Relay 36	working?		Yes ☐	No ☐	N/A ☐
	Contact resistance	(N/C)	Ω ☐	Not measured ☐	
		(N/O)	Ω ☐	Not measured ☐	
Relay 37	working?		Yes ☐	No ☐	N/A ☐
	Contact resistance	(N/C)	Ω ☐	Not measured ☐	
		(N/O)	Ω ☐	Not measured ☐	
Relay 38	working?		Yes ☐	No ☐	N/A ☐
	Contact resistance	(N/C)	Ω ☐	Not measured ☐	
		(N/O)	Ω ☐	Not measured ☐	

Relay 39	working?		Yes ☐	No ☐	
	Contact resistance		Ω ☐	Not measured ☐	
Relay 40	working?		Yes ☐	No ☐	
	Contact resistance		Ω ☐	Not measured ☐	
Relay 41	working?		Yes ☐	No ☐	
	Contact resistance		Ω ☐	Not measured ☐	
Relay 42	working?		Yes ☐	No ☐	
	Contact resistance		Ω ☐	Not measured ☐	
Relay 43	working?		Yes ☐	No ☐	N/A ☐
	Contact resistance	(N/C)	Ω ☐	Not measured ☐	
		(N/O)	Ω ☐	Not measured ☐	
Relay 44	working?		Yes ☐	No ☐	N/A ☐
	Contact resistance	(N/C)	Ω ☐	Not measured ☐	
		(N/O)	Ω ☐	Not measured ☐	
Relay 45	working?		Yes ☐	No ☐	N/A ☐
	Contact resistance	(N/C)	Ω ☐	Not measured ☐	
		(N/O)	Ω ☐	Not measured ☐	
Relay 46	working?		Yes ☐	No ☐	N/A ☐
	Contact resistance	(N/C)	Ω ☐	Not measured ☐	
		(N/O)	Ω ☐	Not measured ☐	

Next output relays are only present in the model with option D.

Relay 47	working?		Yes ☐	No ☐	
	Contact resistance		Ω ☐	Not measured ☐	
Relay 48	working?		Yes ☐	No ☐	
	Contact resistance		Ω ☐	Not measured ☐	
Relay 49	working?		Yes ☐	No ☐	
	Contact resistance		Ω ☐	Not measured ☐	
Relay 50	working?		Yes ☐	No ☐	
	Contact resistance		Ω ☐	Not measured ☐	
Relay 51	working?		Yes ☐	No ☐	N/A ☐
	Contact resistance	(N/C)	Ω ☐	Not measured ☐	
		(N/O)	Ω ☐	Not measured ☐	
Relay 52	working?		Yes ☐	No ☐	N/A ☐
	Contact resistance	(N/C)	Ω ☐	Not measured ☐	
		(N/O)	Ω ☐	Not measured ☐	

Relay 53	working?		Yes	☐	No	☐		
	Contact resistance			Ω ☐	Not measured	☐		
Relay 54	working?		Yes	☐	No	☐		
	Contact resistance			Ω ☐	Not measured	☐		
Relay 55	working?		Yes	☐	No	☐		
	Contact resistance			Ω ☐	Not measured	☐		
Relay 56	working?		Yes	☐	No	☐		
	Contact resistance			Ω ☐	Not measured	☐		
Relay 57	working?		Yes	☐	No	☐		
	Contact resistance			Ω ☐	Not measured	☐		
Relay 58	working?		Yes	☐	No	☐		
	Contact resistance			Ω ☐	Not measured	☐		
Relay 59	working?		Yes	☐	No	☐	N/A ☐	
	Contact resistance	(N/C)		Ω ☐	Not measured	☐		
		(N/O)		Ω ☐	Not measured	☐		
Relay 60	working?		Yes	☐	No	☐	N/A ☐	
	Contact resistance	(N/C)		Ω ☐	Not measured	☐		
		(N/O)		Ω ☐	Not measured	☐		

1.5 Engineer Details

Commissioning Engineer	Customer Witness
Date:	Date:

2 CREATING A SETTING RECORD

You often need to create a record of what settings have been applied to a device. In the past, you could have used paper printouts of all the available settings, and mark up the ones you had used. Keeping such a paper-based Settings Records can be time-consuming and prone to error (e.g. due to being settings written down incorrectly).

The Easergy Studio software lets you read/write MiCOM devices.

- **Extract** lets you download all the settings from a MiCOM Px40 device. A summary is given in Extract Settings from a MiCOM Px40 Device below.
- **Send** lets you send the settings you currently have open in the Easergy Studio software. A summary is given in Send Settings to a MiCOM Px40 Device below.

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

In most cases, it will be quicker and less error prone to extract settings electronically and store them in a settings file on a memory stick. In this way, there will be a digital record which is certain to be accurate. It is also possible to archive these settings files in a repository; so they can be used again or adapted for another use.

Full details of how to do these tasks is provided in the Easergy Studio help.

A quick summary of the main steps is given below.

In each case you need to make sure that:

- Your computer includes the Easergy Studio software.
- Your computer and the MiCOM device are powered on.
- You have used a suitable cable to connect your computer to the MiCOM device (Front Port, Rear Port, Ethernet port or Modem as available).

2.1 Extract Settings from a MiCOM Px40 Device

Full details of how to do this is provided in the Easergy Studio help.

As a quick guide, you need to do the following:

1. In Easergy Studio, click the Quick Connect… button.
2. Select the relevant Device Type in the Quick Connect dialog box.
3. Click the relevant port in the Port Selection dialog box.
4. Enter the relevant connection parameters in the Connection Parameters dialog box and click the Finish button
5. Easergy Studio will try to communicate with the Px40 device. It will display a connected message if the connection attempt is successful.
6. The device will appear in the Studio Explorer pane on the top-left of the interface.
7. Click the + button to expand the options for the device, then click on the Settings folder.
8. Right-click on Settings and select the Extract Settings link to read the settings on the device and store them on your computer or a memory stick.
9. After retrieving the settings file, close the dialog box by clicking the Close button.

2.2 Send Settings to a MiCOM Px40 Device

Full details of how to do this is provided in the Easergy Studio help.

As a quick guide, you need to do the following:

1. In Easergy Studio, click the Quick Connect… button.
2. Select the relevant Device Type in the Quick Connect dialog box.
3. Click the relevant port in the Port Selection dialog box.
4. Enter the relevant connection parameters in the Connection Parameters dialog box and click the Finish button
5. Easergy Studio will try to communicate with the Px40 device. It will display a connected message if the connection attempt is successful.
6. The device will appear in the Studio Explorer pane on the top-left hand side of the interface.
7. Click the + button to expand the options for the device and then right-click on the Settings link.
8. To add an existing file, right-click the settings folder and choose Add Existing File.
9. To create a new file, right-click the settings folder and select Add. A file with the next sequential number will be created. Double-click the file to edit.
10. Right-click on the device name and select the Send link.

Note	*When you send settings to a MiCOM Px40 device, the data is stored in a temporary location at first. This temporary data is tested to make sure it is complete. If the temporary data is complete, it will be programmed into the MiCOM Px40 device. This avoids the risk of a device being programmed with incomplete or corrupt settings.*

11. In the Send To dialog box, select the settings file(s) you wish to send, then click the Send button.
12. Close the Send To dialog box by clicking the Close button.

Notes:

MAINTENANCE

CHAPTER 13

Date:	07/2016	
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.	
Hardware suffix:	All MiCOM Px4x products	
Software version:	All MiCOM Px4x products	
Connection diagrams:	P14x (P141, P142, P143 & P145): 10P141xx (xx = 01 to 02) 10P142xx (xx = 01 to 05) 10P143xx (xx = 01 to 11) 10P145xx (xx = 01 to 11) P24x (P241, P242 & P243): 10P241xx (xx = 01 to 02) 10P242xx (xx = 01) 10P243xx (xx = 01) P34x (P342, P343, P344, P345 & P391): 10P342xx (xx = 01 to 17) 10P343xx (xx = 01 to 19) 10P344xx (xx = 01 to 12) 10P345xx (xx = 01 to 07) 10P391xx (xx = 01 to 02) P445: 10P445xx (xx = 01 to 04) P44x (P441, P442 & P444): 10P44101 (SH 1 & 2) 10P44201 (SH 1 & 2) 10P44202 (SH 1) 10P44203 (SH 1 & 2) 10P44401 (SH 1) 10P44402 (SH 1) 10P44403 (SH 1 & 2) 10P44404 (SH 1) 10P44405 (SH 1) 10P44407 (SH 1 & 2) P44y (P443 & P446): 10P44303 (SH 01 and 03) 10P44304 (SH 01 and 03) 10P44305 (SH 01 and 03) 10P44306 (SH 01 and 03) 10P44600 10P44601 (SH 1 to 2) 10P44602 (SH 1 to 2) 10P44603 (SH 1 to 2)	P54x (P543, P544, P545 & P546): 10P54302 (SH 1 to 2) 10P54303 (SH 1 to 2) 10P54400 10P54404 (SH 1 to 2) 10P54405 (SH 1 to 2) 10P54502 (SH 1 to 2) 10P54503 (SH 1 to 2) 10P54600 10P54604 (SH 1 to 2) 10P54605 (SH 1 to 2) 10P54606 (SH 1 to 2) P547: 10P54702xx (xx = 01 to 02) 10P54703xx (xx = 01 to 02) 10P54704xx (xx = 01 to 02) 10P54705xx (xx = 01 to 02) P64x (P642, P643 & P645): 10P642xx (xx = 1 to 10) 10P643xx (xx = 1 to 6) 10P645xx (xx = 1 to 9) P74x (P741, P742 & P743): 10P740xx (xx = 01 to 07) P746: 10P746xx (xx = 00 to 21) P841: 10P84100 10P84101 (SH 1 to 2) 10P84102 (SH 1 to 2) 10P84103 (SH 1 to 2) 10P84104 (SH 1 to 2) 10P84105 (SH 1 to 2) P849: 10P849xx (xx = 01 to 06)

CONTENTS

Notes:

1 MAINTENANCE PERIOD

Warning	**Before inspecting any wiring, performing any tests or carrying out any work on the equipment, you should be familiar with the contents of the Safety Information and Technical Data sections and the information on the equipment's rating label.**

It is recommended that products supplied by Schneider Electric receive periodic monitoring after installation. In view of the critical nature of protective and control equipment, and their infrequent operation, it is desirable to confirm that they are operating correctly at regular intervals.

Schneider Electric protection and control equipment is designed for a life in excess of 20 years.

MiCOM relays are self-supervising and so require less maintenance than earlier designs. Most problems will result in an alarm so that remedial action can be taken. However, some periodic tests should be done to ensure that the equipment is functioning correctly and the external wiring is intact.

If the customer's organization has a preventative maintenance policy, the recommended product checks should be included in the regular program. Maintenance periods depend on many factors, such as:

- The operating environment
- The accessibility of the site
- The amount of available manpower
- The importance of the installation in the power system
- The consequences of failure

2 MAINTENANCE CHECKS

Although some functionality checks can be performed from a remote location by using the communications ability of the equipment, these are predominantly restricted to checking that the equipment, is measuring the applied currents and voltages accurately, and checking the circuit breaker maintenance counters. Therefore it is recommended that maintenance checks are performed locally (i.e. at the equipment itself).

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

Warning **If a P391 is used, you should also be familiar with the ratings and warning statements in the P391 technical manual.**

2.1 Alarms

The alarm status LED should first be checked to identify if any alarm conditions exist. If so, press the read key (⊜) repeatedly to step through the alarms.

Clear the alarms to extinguish the LED.

2.2 Opto-Isolators

The opto-isolated inputs can be checked to ensure that the equipment responds to energization by repeating the commissioning test detailed in the Commissioning chapter.

2.3 Output Relays

The output relays can be checked to ensure that they operate by repeating the commissioning test detailed in the Commissioning chapter.

2.4 Measurement Accuracy

If the power system is energized, the values measured by the equipment can be compared with known system values to check that they are in the approximate range that is expected. If they are, the analog/digital conversion and calculations are being performed correctly by the relay. Suitable test methods can be found in the Commissioning chapter.

Alternatively, the values measured by the equipment can be checked against known values injected via the test block, if fitted, or injected directly into the equipment terminals. Suitable test methods can be found in the Commissioning chapter. These tests will prove the calibration accuracy is being maintained.

3 METHOD OF REPAIR

If the equipment should develop a fault whilst in service, depending on the nature of the fault, the watchdog contacts will change state and an alarm condition will be flagged. Due to the extensive use of surface-mount components, faulty Printed Circuit Boards (PCBs) should be replaced, as it is not possible to perform repairs on damaged PCBs. Therefore either the complete equipment module or just the faulty PCB (as identified by the in-built diagnostic software), can be replaced. Advice about identifying the faulty PCB can be found in the Troubleshooting chapter.

The preferred method is to replace the complete equipment module as it ensures that the internal circuitry is protected against electrostatic discharge and physical damage at all times and overcomes the possibility of incompatibility between replacement PCBs. However, it may be difficult to remove installed equipment due to limited access in the back of the cubicle and the rigidity of the scheme wiring.

Replacing PCBs can reduce transport costs but requires clean, dry conditions on site and higher skills from the person performing the repair. If the repair is not performed by an approved service center, the warranty will be invalidated.

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

This should ensure that no damage is caused by incorrect handling of the electronic components.

3.1 Replacing the Complete Equipment IED/Relay

The case and rear terminal blocks have been designed to facilitate removal of the IED/relay should replacement or repair become necessary without having to disconnect the scheme wiring.

Warning	**Before working at the rear of the equipment, isolate all voltage and current supplies to the equipment.**

Note	*The MiCOM range has integral current transformer shorting switches which will close when the heavy duty terminal block is removed.*

1. Disconnect the equipment's earth, IRIG-B and fiber optic connections, as appropriate, from the rear of the device.

   There are two types of terminal block used on the equipment, medium and heavy duty, which are fastened to the rear panel using Pozidriv or PZ1 screws. The P24x/P43x/P64x ranges also includes an RTD/CLIO terminal block option. These block types are shown in the ***Commissioning*** chapter.

Important	*The use of a magnetic bladed screwdriver is recommended to minimize the risk of the screws being left in the terminal block or lost.*

2. Without exerting excessive force or damaging the scheme wiring, pull the terminal blocks away from their internal connectors.
3. Remove the screws used to fasten the equipment to the panel, rack, etc. These are the screws with the larger diameter heads that are accessible when the access covers are fitted and open.

Warning	**If the top and bottom access covers have been removed, do not remove the screws with the smaller diameter heads which are accessible. These screws secure the front panel to the equipment.**

4. Withdraw the equipment carefully from the panel, rack, etc. because it will be heavy due to the internal transformers.

To reinstall the repaired or replacement equipment, follow the above instructions in reverse, ensuring that each terminal block is relocated in the correct position and the case earth, IRIG-B and fiber optic connections are replaced. To facilitate easy identification of each terminal block, they are labeled alphabetically with 'A' on the left-hand side when viewed from the rear.

Once reinstallation is complete, the equipment should be re-commissioned using the instructions in the Commissioning chapter.

3.2 Replacing a PCB

Replacing PCBs and other internal components must be undertaken only by Service Centers approved by Schneider Electric. Failure to obtain the authorization of Schneider Electric after sales engineers prior to commencing work may invalidate the product warranty.

Warning **Before removing the front panel to replace a PCB, remove the auxiliary supply and wait <u>at least 30 seconds</u> for the capacitors to discharge.**
We strongly recommend that the voltage and current transformer connections and trip circuit are isolated.

Schneider Electric support teams are available world-wide. We strongly recommend that any repairs be entrusted to those trained personnel. For this reason, details on product disassembly and re-assembly are not included here.

4 RE-CALIBRATION

Re-calibration is not required when a PCB is replaced **unless it happens to be one of the boards in the input module;** the replacement of either directly affects the calibration.

Warning	**Although it is possible to carry out re-calibration on site, this requires test equipment with suitable accuracy and a special calibration program to run on a PC. It is therefore recommended that the work be carried out by the manufacturer, or entrusted to an approved service center.**

5 CHANGING THE BATTERY

Each relay/IED has a battery to maintain status data and the correct time when the auxiliary supply voltage fails. The data maintained includes event, fault and disturbance records and the thermal state at the time of failure.

This battery will periodically need changing, although an alarm will be given as part of the relay's/IED's continuous self-monitoring in the event of a low battery condition.

If the battery-backed facilities are not required to be maintained during an interruption of the auxiliary supply, the steps below can be followed to remove the battery, but do not replace with a new battery.

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

5.1 Instructions for Replacing the Battery

1. Open the bottom access cover on the front of the equipment.
2. Gently extract the battery from its socket. If necessary, use a small, insulated screwdriver to prize the battery free.
3. Ensure that the metal terminals in the battery socket are free from corrosion, grease and dust.
4. The replacement battery should be removed from its packaging and placed into the battery holder, taking care to ensure that the polarity markings on the battery agree with those adjacent to the socket.

Note	*Only use a type ½AA Lithium battery with a nominal voltage of 3.6 V and safety approvals such as UL (Underwriters Laboratory), CSA (Canadian Standards Association) or VDE (Vereinigung Deutscher Elektrizitätswerke).*

5. Ensure that the battery is securely held in its socket and that the battery terminals are making good contact with the metal terminals of the socket.
6. Close the bottom access cover.

5.2 Post Modification Tests

To ensure that the replacement battery will maintain the time and status data if the auxiliary supply fails, check cell [0806: DATE and TIME, Battery Status] reads 'Healthy'. If further confirmation that the replacement battery is installed correctly is required, the commissioning test is described in the Commissioning chapter, 'Date and Time', can be performed.

5.3 Battery Disposal

The battery that has been removed should be disposed of in accordance with the disposal procedure for Lithium batteries in the country in which the equipment is installed.

6 CLEANING

Warning	**Before cleaning the equipment ensure that all ac and dc supplies, current transformer and voltage transformer connections are isolated to prevent any chance of an electric shock whilst cleaning.**

The equipment may be cleaned using a lint-free cloth moistened with clean water. The use of detergents, solvents or abrasive cleaners is not recommended as they may damage the relay's surface and leave a conductive residue.

TROUBLESHOOTING

CHAPTER 14

<table>
<tr><td>Date:</td><td colspan="2">07/2016</td></tr>
<tr><td>Products covered by this chapter:</td><td colspan="2">This chapter covers the specific versions of the MiCOM products listed below. This includes only the following combinations of Software Version and Hardware Suffix.</td></tr>
<tr><td>Hardware Suffix:</td><td colspan="2">All MiCOM Px4x products</td></tr>
<tr><td>Software Version:</td><td colspan="2">All MiCOM Px4x products</td></tr>
<tr><td>Connection Diagrams:</td><td>P14x (P141, P142, P143 & P145):
10P141xx (xx = 01 to 02)
10P142xx (xx = 01 to 05)
10P143xx (xx = 01 to 11)
10P145xx (xx = 01 to 11)
P24x (P241, P242 & P243):
10P241xx (xx = 01 to 02)
10P242xx (xx = 01)
10P243xx (xx = 01)
P34x (P342, P343, P344, P345 & P391):
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10P343xx (xx = 01 to 19)
10P344xx (xx = 01 to 12)
10P345xx (xx = 01 to 07)
10P391xx (xx = 01 to 02)
P445:
10P445xx (xx = 01 to 04)
P44x(P442 & P444):
10P44101 (SH 1 & 2)
10P44201 (SH 1 & 2)
10P44202 (SH 1)
10P44203 (SH 1 & 2)
10P44401 (SH 1)
10P44402 (SH 1)
10P44403 (SH 1 & 2)
10P44404 (SH 1)
10P44405 (SH 1)
10P44407 (SH 1 & 2)
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10P44304 (SH 01 and 03)
10P44305 (SH 01 and 03)
10P44306 (SH 01 and 03)
10P44600
10P44601 (SH 1 to 2)
10P44602 (SH 1 to 2)
10P44603 (SH 1 to 2)</td><td>P54x (P543, P544, P545 & P546):
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10P54303 (SH 1 to 2)
10P54400
10P54404 (SH 1 to 2)
10P54405 (SH 1 to 2)
10P54502 (SH 1 to 2)
10P54503 (SH 1 to 2)
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10P54604 (SH 1 to 2)
10P54605 (SH 1 to 2)
10P54606 (SH 1 to 2)
P547:
10P54702xx (xx = 01 to 02)
10P54703xx (xx = 01 to 02)
10P54704xx (xx = 01 to 02)
10P54705xx (xx = 01 to 02)
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10P643xx (xx = 1 to 6)
10P645xx (xx = 1 to 9)
P74x (P741, P742 & P743):
10P740xx (xx = 01 to 07)
P746:
10P746xx (xx = 00 to 21)
P841:
10P84100
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10P84103 (SH 1 to 2)
10P84104 (SH 1 to 2)
10P84105 (SH 1 to 2)
P849:
10P849xx (xx = 01 to 06)</td></tr>
</table>

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TABLES

Notes:

1 INTRODUCTION

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

The purpose of this chapter of the service manual is to allow an error condition on the relay to be identified so that appropriate corrective action can be taken.

If the relay has developed a fault, it should be possible in most cases to identify which relay module requires attention. The *Maintenance* chapter advises on the recommended method of repair where faulty modules need replacing. It is not possible to perform an on-site repair to a faulted module.

In cases where a faulty relay/module is being returned to the manufacturer or one of their approved service centers, completed copy of the Repair/Modification Return Authorization Form located at the end of this chapter should be included.

2 INITIAL PROBLEM IDENTIFICATION

Consult the following table to find the description that best matches the problem experienced, then consult the section referenced to perform a more detailed analysis of the problem.

Symptom	Refer To
Relay fails to power up	Power-Up Errors section
Relay powers up - but indicates error and halts during power-up sequence	Error Message/Code On Power-Up section
Relay Powers up but Out of Service LED is illuminated	Out of Service LED illuminated on Power Up section
Error during normal operation	Error Code During Operation section
Mal-operation of the relay during testing	Mal-Operation of the Relay during Testing section

Table 1 - Problem identification

3 POWER UP ERRORS

If the relay does not appear to power up then the following procedure can be used to determine whether the fault is in the external wiring, auxiliary fuse, power supply module of the relay or the relay front panel.

Test	Check	Action
1	Measure auxiliary voltage on terminals 1 and 2; verify voltage level and polarity against rating the label on front. Terminal 1 is –dc, 2 is +dc	If auxiliary voltage is present and correct, then proceed to test 2. Otherwise the wiring/fuses in auxiliary supply should be checked.
2	Do LEDs/and LCD backlight illuminate on power-up, also check the N/O watchdog contact for closing.	If they illuminate or the contact closes and no error code is displayed then error is probably in the main processor board (front panel). If they do not illuminate and the contact does not close then proceed to test 3.
3	Check Field voltage output (nominally 48V DC)	If field voltage is not present then the fault is probably in the relay power supply module.

Table 2 - Failure of relay to power up

4 ERROR MESSAGE/CODE ON POWER-UP

During the power-up sequence of the relay self-testing is performed as indicated by the messages displayed on the LCD. If an error is detected by the relay during these self-tests, an error message will be displayed and the power-up sequence will be halted. If the error occurs when the relay application software is executing, a maintenance record will be created and the relay will reboot.

Test	Check	Action
1	Is an error message or code permanently displayed during power up?	If relay locks up and displays an error code permanently then proceed to Test 2. If the relay prompts for input by the user proceed to Test 4. If the relay re-boots automatically then proceed to Test 5.
2	Record displayed error, then remove and re-apply relay auxiliary supply.	Record whether the same error code is displayed when the relay is rebooted. If no error code is displayed then contact the local service center stating the error code and relay information. If the same code is displayed proceed to Test 3.
3	Error code Identification Following text messages (in English) will be displayed if a fundamental problem is detected preventing the system from booting: Bus Fail address lines SRAM Fail data lines FLASH Fail format error FLASH Fail checksum Code Verify Fail These hex error codes relate to errors detected in specific relay modules:	These messages indicate that a problem has been detected on the main processor board of the relay (located in the front panel).
	0c140005/0c0d0000	Input Module (inc. Opto-isolated inputs)
	0c140006/0c0e0000	Output Relay Cards
	Last 4 digits provide details on the actual error.	Other error codes relate to problems within the main processor board hardware or software. It will be necessary to contact Schneider Electric with details of the problem for a full analysis.
4	Relay displays message for corrupt settings and prompts for restoration of defaults to the affected settings.	The power up tests have detected corrupted relay settings, it is possible to restore defaults to allow the power-up to be completed. It will then be necessary to re-apply the application-specific settings.
5	Relay resets on completion of power up - record error code displayed	Error 0x0E080000, Programmable Scheme Logic (PSL) error due to excessive execution time. Restore default settings by performing a power up with ⇦ and ⇨ keys depressed, confirm restoration of defaults at prompt using (↵) key. If relay powers up successfully, check PSL for feedback paths. Other error codes will relate to software errors on the main processor board, contact Schneider Electric.

Table 3 - Power-up self-test error

5 OUT OF SERVICE LED ILLUMINATED ON POWER UP

Test	Check	Action	
1	Using the relay menu confirm whether the Commission Test/Test Mode setting is Contact Blocked. Otherwise proceed to test 2.	If the setting is Contact Blocked then disable the test mode and, verify that the Out of Service LED is extinguished.	
2	Select and view the last maintenance record from the menu (in the View Records).	Check for H/W Verify Fail this indicates a discrepancy between the relay model number and the hardware; examine the "**Maint. Data**", this indicates the causes of the failure using bit fields:	
		Bit	**Meaning**
		0	The application type field in the model number does not match the software ID
		1	The application field in the model number does not match the software ID
		2	The variant 1 field in the model number does not match the software ID
		3	The variant 2 field in the model number does not match the software ID
		4	The protocol field in the model number does not match the software ID
		5	The language field in the model number does not match the software ID
		6	The VT type field in the model number is incorrect (110V VTs fitted)
		7	The VT type field in the model number is incorrect (440V VTs fitted)
		8	The VT type field in the model number is incorrect (no VTs fitted)

Table 4 - Out of service LED illuminated

6 ERROR CODE DURING OPERATION

The relay performs continuous self-checking, if an error is detected then an error message will be displayed, a maintenance record will be logged and the relay will reset (after a 1.6 second delay). A permanent problem (for example due to a hardware fault) will generally be detected on the power up sequence, following which the relay will display an error code and halt. If the problem was transient in nature then the relay should reboot correctly and continue in operation. The nature of the detected fault can be determined by examination of the maintenance record logged.

There are also two cases where a maintenance record will be logged due to a detected error where the relay will not reset. These are detection of a failure of either the field voltage or the lithium battery, in these cases the failure is indicated by an alarm message, however the relay will continue to operate.

If the field voltage is detected to have failed (the voltage level has dropped below threshold), then a scheme logic signal is also set. This allows the scheme logic to be adapted in the case of this failure (for example if a blocking scheme is being used).

In the case of a battery failure it is possible to prevent the relay from issuing an alarm using the setting under the Date and Time section of the menu. This setting '**Battery Alarm**' can be set to '**Disabled**' to allow the relay to be used without a battery, without an alarm message being displayed.

In the case of an RTD board failure, an alarm "RTD board fail" message is displayed, the RTD protection is disabled, but the operation of the rest of the relay functionality is unaffected.

7 MAL-OPERATION OF THE RELAY DURING TESTING

7.1 Failure of Output Contacts

An apparent failure of the relay output contacts may be caused by the relay configuration; the following tests should be performed to identify the real cause of the failure.

Note	*The relay self-tests verify that the coil of the contact has been energized, an error will be displayed if there is a fault in the output relay board.*

Test	Check	Action
1	Is the Out of Service LED illuminated?	Illumination of this LED may indicate that the relay is Contact Blocked or that the protection has been disabled due to a hardware verify error (see the *Out of service LED illuminated* table..
2	Examine the Contact status in the Commissioning section of the menu.	If the relevant bits of the contact status are operated, proceed to test 4, if not proceed to test 3.
3	Verify by examination of the fault record or by using the test port whether the protection element is operating correctly.	If the protection element does not operate verify whether the test is being correctly applied. If the protection element does operate, it will be necessary to check the PSL to ensure that the mapping of the protection element to the contacts is correct.
4	Using the Commissioning/Test mode function apply a test pattern to the relevant relay output contacts and verify whether they operate (note the correct external connection diagram should be consulted). A continuity tester can be used at the rear of the relay for this purpose.	If the output relay does operate, the problem must be in the external wiring to the relay. If the output relay does not operate this could indicate a failure of the output relay contacts (note that the self-tests verify that the relay coil is being energized). Ensure that the closed resistance is not too high for the continuity tester to detect.

Table 5 - Failure of output contacts

7.2 Failure of Opto-Isolated Inputs

The opto-isolated inputs are mapped onto the relay internal signals using the PSL. If an input does not appear to be recognized by the relay scheme logic the Commission Tests/Opto Status menu option can be used to verify whether the problem is in the opto-isolated input itself or the mapping of its signal to the scheme logic functions. If the opto-isolated input does appear to be read correctly then it will be necessary to examine its mapping within the PSL.

Ensure the voltage rating for the opto inputs has been configured correctly with applied voltage. If the opto-isolated input state is not being correctly read by the relay the applied signal should be tested. Verify the connections to the opto-isolated input using the correct wiring diagram and the correct nominal voltage settings in any standard or custom menu settings. Next, using a voltmeter verify that 80% opto setting voltage is present on the terminals of the opto-isolated input in the energized state. If the signal is being correctly applied to the relay then the failure may be on the input card itself. Depending on which opto-isolated input has failed this may require replacement of either the complete analog input module (the board within this module cannot be individually replaced without re-calibration of the relay) or a separate opto board.

7.3 Incorrect Analog Signals

The measurements may be configured in primary or secondary to assist. If it is suspected that the analog quantities being measured by the relay are not correct then the measurement function of the relay can be used to verify the nature of the problem. The measured values displayed by the relay should be compared with the actual magnitudes at the relay terminals. Verify that the correct terminals are being used (in particular the dual rated CT inputs) and that the CT and VT ratios set on the relay are correct. The correct 120 degree displacement of the phase measurements should be used to confirm that the inputs have been correctly connected.

7.4 PSL Editor Troubleshooting

A failure to open a connection could be because of one or more of the following:

- The relay address is not valid (note: this address is always 1 for the front port).
- Password is not valid
- Communication Set-up - COM port, Baud rate, or Framing - is not correct
- Transaction values are not suitable for the relay and/or the type of connection
- Modem configuration is not valid. Changes may be necessary when using a modem
- The connection cable is not wired correctly or broken. See MiCOM S1 connection configurations
- The option switches on any KITZ101/102 that is in use may be incorrectly set

7.4.1 Diagram Reconstruction after Recover from Relay

Although the extraction of a scheme from a relay is supported, the facility is provided as a way of recovering a scheme in the event that the original file is unobtainable.

The recovered scheme will be logically correct, but much of the original graphical information is lost. Many signals will be drawn in a vertical line down the left side of the canvas. Links are drawn orthogonally using the shortest path from A to B.

Any annotation added to the original diagram (titles, notes, etc.) are lost.

Sometimes a gate type may not be what was expected, e.g. a 1-input AND gate in the original scheme will appear as an OR gate when uploaded. Programmable gates with an inputs-to-trigger value of 1 will also appear as OR gates.

7.4.2 PSL Version Check

The PSL is saved with a version reference, time stamp and CRC check. This gives a visual check whether the default PSL is in place or whether a new application has been downloaded.

8 REPAIR AND MODIFICATION PROCEDURE

Please follow these steps to return an Automation product to us:

1. Get the Repair and Modification Authorization Form (RMA).

   A copy of the RMA form is shown at the end of this section.

2. Fill in the RMA form.

   Fill in only the white part of the form.

   Please ensure that all fields marked **(M)** are completed such as:

   Equipment model

   Model No. and Serial No.

   Description of failure or modification required (please be specific)

   Value for customs (in case the product requires export)

   Delivery and invoice addresses

   Contact details

3. Receive from local service contact, the information required to ship the product.

   Your local service contact will provide you with all the information:

   Pricing details

   RMA No

   Repair center address

   If required, an acceptance of the quote must be delivered before going to next stage.

4. Send the product to the repair center.

   Address the shipment to the repair center specified by your local contact.

   Ensure all items are protected by appropriate packaging: anti-static bag and foam protection.

   Ensure a copy of the import invoice is attached with the unit being returned.

   Ensure a copy of the RMA form is attached with the unit being returned.

   E-mail or fax a copy of the import invoice and airway bill document to your local contact.

Notes:

REPAIR/MODIFICATION RETURN AUTHORIZATION FORM

FIELDS IN GREY TO BE FILLED IN BY SCHNEIDER ELECTRIC PERSONNEL ONLY

Reference **RMA:**		Date:
Repair Center Address (for shipping)	**Service Type** ☐ Retrofit ☐ Warranty ☐ Paid service ☐ Under repair contract ☐ Wrong supply	LSC PO No.:
Schneider Electric - Local Contact Details Name: Telephone No.: Fax No.: E-mail:		

IDENTIFICATION OF UNIT

Fields marked (M) are mandatory, delays in return will occur if not completed.

Model No./Part No.: **(M)**	Site Name/Project:
Manufacturer Reference: **(M)**	Commissioning Date:
Serial No.: **(M)**	Under Warranty: ☐ Yes ☐ No
Software Version:	Additional Information:
Quantity:	Customer P.O (if paid):

FAULT INFORMATION

Type of Failure	**Found Defective**
Hardware fail ☐	During FAT/inspection ☐
Mechanical fail/visible defect ☐	On receipt ☐
Software fail ☐	During installation/commissioning ☐
Other:	During operation ☐
	Other:
Fault Reproducibility	
Fault persists after removing, checking on test bench ☐	
Fault persists after re-energization ☐	
Intermittent fault ☐	

Description of Failure Observed or Modification Required - *Please be specific* **(M)**

FOR REPAIRS ONLY

Would you like us to install an updated firmware version after repair?	☐	Yes	☐	No

CUSTOMS & INVOICING INFORMATION

Required to allow return of repaired items

Value for Customs (M)	
Customer Invoice Address ((M) if paid)	**Customer Return Delivery Address** **(full street address) (M)** Part shipment accepted ☐ Yes ☐ No **OR** Full shipment required ☐ Yes ☐ No
Contact Name: Telephone No.: Fax No.: E-mail:	Contact Name: Telephone No.: Fax No.: E-mail:

REPAIR TERMS

1. **Please ensure that a copy of the import invoice is attached with the returned unit, together with the airway bill document.** Please fax/e-mail a copy of the appropriate documentation **(M)**.
2. Please ensure the Purchase Order is released, for paid service, to allow the unit to be shipped.
3. Submission of equipment to Schneider Electric is deemed as authorization to repair and acceptance of quote.
4. Please ensure all items returned are marked as Returned for 'Repair/Modification' and **protected by appropriate packaging** (anti-static bag for each board and foam protection).

SCADA COMMUNICATIONS

CHAPTER 15

Date:	12/2017
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.
Hardware Suffix:	M
Software Version:	B2
Connection Diagrams:	10P849xx (xx = 01 to 06)

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FIGURES

TABLES

Notes:

1 INTRODUCTION

This chapter describes the remote interfaces of the MiCOM relay in enough detail to allow integration in a substation communication network. The relay supports a choice of one of a number of protocols through the rear 2-wire EIA(RS)485 communication interface, selected using the model number when ordering. This is in addition to the front serial interface and second rear communications port, which supports the Courier protocol only. According to the protocol and hardware options selected, the interface may alternatively be presented over an optical fiber interface, or via an Ethernet connection.

The supported protocols include:

- Courier
- IEC-60870-5-103
- DNP3.0
- MODBUS
- IEC 61850 Ethernet Interface

The implementation of both Courier and IEC 60870-5-103 on RP1 can also, optionally, be presented over fiber as well as EIA(RS)485.

The DNP3.0 implementation is available via the EIA(RS)485 port.

The rear EIA(RS)-485 interface is isolated and is suitable for permanent connection whichever protocol is selected. The advantage of this type of connection is that up to 32 relays can be daisy-chained together using a simple twisted-pair electrical connection.

Note	*The second rear Courier port and the fiber optic interface are mutually exclusive as they occupy the same physical slot.*

An outline of the connection details for each of the communications ports is provided here. The ports are configurable using settings - a description of the configuration follows the connections part. Details of the protocol characteristics are also shown.

For each of the protocol options, the supported functions and commands are listed with the database definition. The operation of standard procedures such as extraction of event, fault and disturbance records, or setting changes is also described.

The descriptions in this chapter do not aim to fully describe the protocol in detail. Refer to the relevant documentation protocol for this information. This chapter describes the specific implementation of the protocol in the relay.

1.1 Read Only Mode (Command Blocking)

A Read Only mode is available for the rear communication ports of the Px40 relays. When Read Only mode is enabled for a port, all setting changes and most commands/control actions are blocked (not accepted by the relay). The full functionality is described below. It is similar to the ‘Command Blocking’ setting of Px30 relays.

Read Only mode can be enabled/disabled for the following rear ports:

- Rear Port 1 – IEC 60870-5-103 and Courier protocols
- Rear Port 2 (if fitted) – Courier protocol
- Ethernet Port (if fitted) – Courier protocol (“tunnelled”)

Read Only mode is not currently required for IEC 61850, as there are no settings or controls implemented.

Read Only mode does not apply to the Front Port, that is intended for local connection only.

The following settings enable and disable the Read Only Mode:

- [09FB: CONFIGURATION, RP1 Read Only]
- [09FC: CONFIGURATION, RP2 Read Only]
- [09FD: CONFIGURATION, NIC Read Only]

Read Only mode can only be disabled from either the front panel User Interface or via the Front Port.

Read Only mode can be enabled/disabled in the PSL by using the DDB signals ‘RP1 Read Only’, ‘RP2 Read Only’, ‘NIC Read Only’.

When Read Only mode is enabled, the commands that are blocked (not accepted by the relay) and the commands that are allowed (accepted by the relay) are as follows.

(1) IEC 60870-5-103 Protocol

Blocked:

INF16 auto-recloser on/off (ASDU20)
INF17 teleprotection on/off (ASDU20)
INF18 protection on/off (ASDU20)
INF19 LED reset (ASDU20)
private INFs e.g CB open/close, Control Inputs (ASDU20)

Allowed:

Poll Class 1 (read spontaneous events)
Poll Class 2 (read measurands)
General Interrogation (GI) sequence
Transmission of Disturbance Records sequence
Time Synchronisation (ASDU6)
INF23 activate characteristic 1 (ASDU20)
INF24 activate characteristic 2 (ASDU20)
INF25 activate characteristic 3 (ASDU20)
INF26 activate characteristic 4 (ASDU20)

(2) Courier Protocol

Blocked:

- All setting changes
- Reset Indication (Trip LED) command
- Operate Control Input commands
- CB operation commands
- Auto-reclose operation commands
- Reset demands / thermal etc... command
- Clear event / fault / maintenance / disturbance record commands
- Test LEDs & contacts commands

Allowed:

- Read settings, statuses, measurands
- Read records (event, fault, disturbance)
- Time Synchronization command
- Change active setting group command

2 CONNECTIONS TO THE COMMUNICATIONS PORTS

2.1 Front Port

The front communications port is not intended for permanent connection. The front communications port supports the Courier protocol and is implemented on an EIA(RS)232 connection. A 9-pin connector type, as described in the ‘Getting Started’ (GS) chapter of this manual, is used, and the cabling requirements are detailed in the ‘Connection Diagrams’ (CD) chapter of this manual.

2.2 Rear Communication Port - EIA(RS)-485

The rear EIA(RS)-485 communication port is provided by a 3-terminal screw connector on the back of the relay. See the Connection Diagrams chapter for details of the connection terminals. The rear port provides K-Bus/EIA(RS)-485 serial data communication and is intended for use with a permanently-wired connection to a remote control center. Of the three connections, two are for the signal connection, and the other is for the earth shield of the cable.

If the IEC60870-5-103, or the DNP3.0 protocols are specified as the interface for the rear port, then connections conform entirely to the EIA(RS)485 standards outline below. If, however, the Courier protocol is specified as the rear port protocol, then the interface can be set either to EIA(RS)485 or K-Bus. The configuration of the port as either EIA(RS)485 or K-Bus is described later together with K-Bus details, but as connection to the port is affected by this choice, the following points should be noted:

- Connection to an EIA(RS)485 device is polarity sensitive, whereas K-Bus connection is not.
- Whilst connection to between an EIA(RS)485 port and an EIA(RS)232 port on, say, a PC might be implemented using a general purpose EIA(RS)485 to EIA(RS)232 converter, connection between an EIA(RS)232 port and K-Bus requires a KITZ101, KITZ102 or KITZ201

If the IEC60870-5-103, or the DNP3.0 protocols are specified as the interface for the rear port, then connections conform entirely to the EIA(RS)485 standards outline below. If, however, the Courier protocol is specified as the rear port protocol, the interface can be set either to EIA(RS)485 or K-Bus. The configuration of the port as either EIA(RS)485 or K-Bus is described later together with K-Bus details, but as connection to the port is affected by this choice, you should note these points:

- Connection to an EIA(RS)485 device is polarity sensitive, whereas K-Bus connection is not. In all other respects (bus wiring, topology, connection, biasing, and termination) K-Bus can be considered the same as EIA(RS)485.
- Whilst connection to or between an EIA(RS)485 port and an EIA(RS)232 port on a PC can be implemented using a general purpose EIA(RS)485 to EIA(RS)232 converter. However, connection between an EIA(RS)232 port and K-Bus requires a KITZ101, KITZ102 or KITZ201.

The protocol provided by the relay is indicated in the relay menu in the **Communications** column. Using the keypad and LCD, first check that the **Comms. settings** cell in the **Configuration** column is set to **Visible**, then move to the **Communications** column. The first cell down the column shows the communication protocol that is being used by the rear port.

Note	*Unless the K-Bus option is chosen for the rear port, correct polarity must be observed for the signal connections. In all other respects (bus wiring, topology, connection, biasing and termination) K-Bus can be considered the same as EIA(RS)485.*

2.3 Second Rear Communication Port (RP2 (Courier))

Relays with Courier, MODBUS, IEC60870-5-103 or DNP3.0 protocol on the first rear communications port have the option of a second rear port, running the Courier language. The second port is intended typically for dial-up modem access by protection engineers or operators, when the main port is reserved for SCADA communication traffic. Communication is through one of three physical links: K-Bus, EIA(RS)-485 or EIA(RS)-232. The port supports full local or remote protection and control access using MiCOM S1 Studio.

When changing the port configuration between K-Bus, EIA(RS)-485 and EIA(RS)-232, reboot the relay to update the hardware configuration of the second rear port.

The EIA(RS)-485 and EIA(RS)-232 protocols can be configured to operate with a modem, using an IEC60870 10-bit frame.

If both rear communications ports are connected to the same bus, make sure their address settings are not the same to avoid message conflicts.

Port Configuration	Valid Communication Protocol
K-Bus	K-Bus
EIA(RS)-232	IEC60870 FT1.2, 11-bit frame IEC60870, 10-bit frame
EIA(RS)-485	IEC60870 FT1.2, 11-bit frame IEC60870, 10-bit frame

Table 1 - Port configurations and communication protocols

2.3.1 Courier Protocol

The second rear communications port is functionally the same as described in the previous section for a Courier rear communications port, with the following exceptions:

2.3.1.1 Event Extraction

Automatic event extraction is not supported when the first rear port protocol is Courier, MODBUS or CS103. It is supported when the first rear port protocol is DNP3.0.

2.3.1.2 Disturbance Record Extraction

Automatic disturbance record extraction is not supported when the first rear port protocol is Courier, MODBUS or CS103. It is supported when the first rear port protocol is DNP3.0.

2.3.2 Connection to the Second Rear Port

The second rear Courier port connects using the 9-way female D-type connector (SK4) in the middle of the card end plate (between the IRIG-B connector and lower D-type). The connection complies with EIA(RS)-574.

For IEC60870-5-2 over EIA(RS)-232			For K-bus or IEC60870-5-2 over EIA(RS)-485	
Pin	Connection		Pin*	Connection
1	No Connection			
2	RxD			
3	TxD			
4	DTR#		4	EIA(RS)-485 - 1 (+ ve)
5	Ground			
6	No Connection			
7	RTS#		7	EIA(RS)-485 - 2 (- ve)
8	CTS#			
9	No Connection			
# - These pins are control lines for use with a modem.			* - All other pins unconnected.	

Notes *Connector pins 4 and 7 are used by both the EIA(RS)-232and EIA(RS)-485 physical layers, but for different purposes. Therefore, the cables should be removed during configuration switches.*
When using the EIA(RS)-485 protocol, an EIA(RS)-485 to EIA(RS)-232 converter is needed to connect the relay to a modem or PC running MiCOM S1 Studio. A Schneider Electric CK222 is recommended.
EIA(RS)-485 is polarity sensitive, with pin 4 positive (+) and pin 7 negative (-).
The K-Bus protocol can be connected to a PC using a KITZ101 or 102.

Table 2 - Pin connections over EIA(RS)-232 and EIS(RS)-485

2.4 EIA(RS)-485 Bus

The EIA(RS)-485 two-wire connection provides a half-duplex fully isolated serial connection to the product. The connection is polarized and while the product's connection diagrams show the polarization of the connection terminals, there is no agreed definition of which terminal is which. If the master is unable to communicate with the product and the communication parameters match, make sure the two-wire connection is not reversed.

EIA(RS)-485 provides the capability to connect multiple devices to the same two-wire bus. MODBUS is a master-slave protocol, so one device is the master, and the remaining devices are slaves. It is not possible to connect two masters to the same bus, unless they negotiate bus access.

2.4.1 Bus Termination

The EIA(RS)-485 bus must have 120 Ω (Ohm) ½ Watt terminating resistors fitted at either end across the signal wires, see the *EIA(RS)-485 bus connection arrangements* diagram below. Some devices may be able to provide the bus terminating resistors by different connection or configuration arrangements, in which case separate external components are not needed. However, this product does not provide such a facility, so if it is located at the bus terminus, an external termination resistor is needed.

2.4.2 Bus Connections & Topologies

The EIA(RS)-485 standard requires each device to be directly connected to the physical cable that is the communications bus. Stubs and tees are expressly forbidden, as are star topologies. Loop bus topologies are not part of the EIA(RS)-485 standard and are forbidden by it.

Two-core screened cable is recommended. The specification of the cable depends on the application, although a multi-strand 0.5 mm^2 per core is normally adequate. Total cable length must not exceed 1000 m. The screen must be continuous and connected at one end, normally at the master connection point. It is important to avoid circulating currents, especially when the cable runs between buildings, for both safety and noise reasons.

This product does not provide a signal ground connection. If the bus cable has a signal ground connection, it must be ignored. However, the signal ground must have continuity for the benefit of other devices connected to the bus. For both safety and noise reasons, the signal ground must never be connected to the cable's screen or to the product's chassis.

2.4.3 Biasing

It may also be necessary to bias the signal wires to prevent jabber. Jabber occurs when the signal level has an indeterminate state because the bus is not being actively driven. This can occur when all the slaves are in receive mode and the master is slow to switch from receive mode to transmit mode. This may be because the master purposefully waits in receive mode, or even in a high impedance state, until it has something to transmit. Jabber causes the receiving device(s) to miss the first bits of the first character in the packet, which results in the slave rejecting the message and consequentially not responding. Symptoms of this are poor response times (due to retries), increasing message error counters, erratic communications, and even a complete failure to communicate.

Biasing requires that the signal lines are weakly pulled to a defined voltage level of about 1 V. There should only be one bias point on the bus, which is best situated at the master connection point. The DC source used for the bias must be clean, otherwise noise is injected. Some devices may (optionally) be able to provide the bus bias, in which case external components are not required.

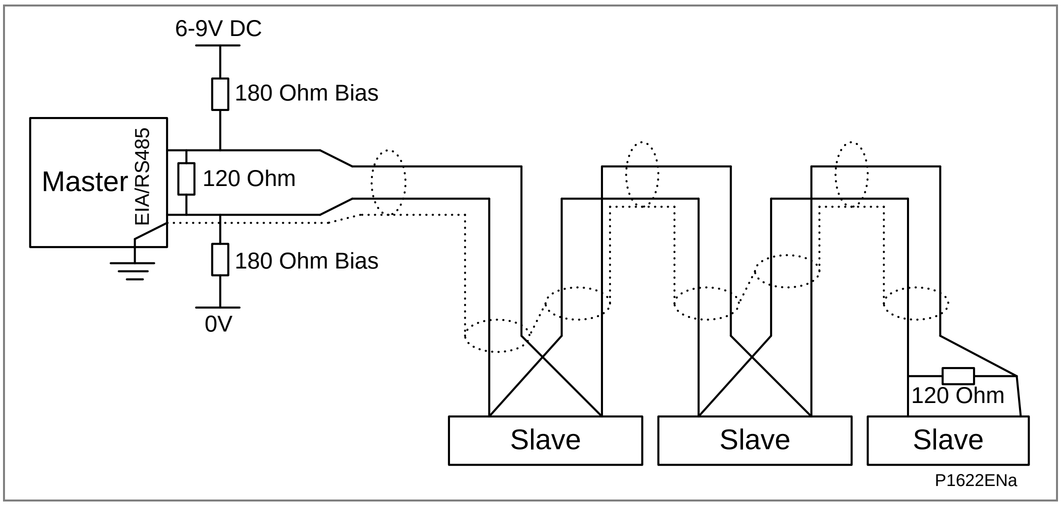


Figure 1 - EIA(RS)-485 bus connection arrangements

It is possible to use the product's field voltage output (48 V DC) to bias the bus using values of 2.2 k Ω (½W) as bias resistors instead of the 180 Ω resistors shown in the *EIA(RS)-485 bus connection arrangements* diagram. Note these warnings apply:

Warnings	**It is extremely important that the 120 Ω termination resistors are fitted. Otherwise the bias voltage may be excessive and may damage the devices connected to the bus.** **As the field voltage is much higher than that required, Schneider Electric cannot assume responsibility for any damage that may occur to a device connected to the network as a result of incorrect application of this voltage.** **Ensure the field voltage is not used for other purposes, such as powering logic inputs, because noise may be passed to the communication network.**

2.4.4 Courier Communication

Courier is the communication language developed to allow remote interrogation of its range of protection relays. Courier uses a master and slave. EIA(RS)-232 on the front panel allows only one slave but EIA(RS)-485 on the back panel allows up to 32 daisy-chained slaves. Each slave unit has a database of information and responds with information from its database when requested by the master unit.

The relay is a slave unit that is designed to be used with a Courier master unit such as MiCOM S1 Studio, MiCOM S10, PAS&T or a SCADA system. MiCOM S1 Studio is compatible is specifically designed for setting changes with the relay.

To use the rear port to communicate with a PC-based master station using Courier, a KITZ K-Bus to EIA(RS)-232 protocol converter is needed. This unit (and information on how to use it) is available from Schneider Electric. A typical connection arrangement is shown in the *K-bus remote communication connection arrangements* diagram below. For more detailed information on other possible connection arrangements, refer to the manual for the Courier master station software and the manual for the KITZ protocol converter. Each spur of the K-Bus twisted pair wiring can be up to 1000 m in length and have up to 32 relays connected to it.

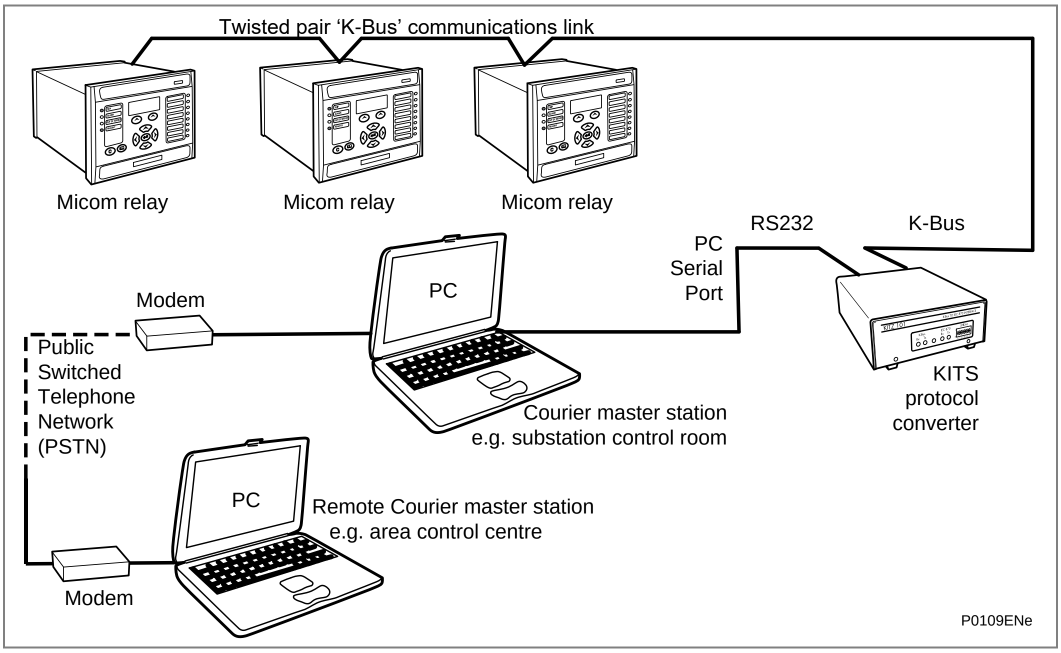


Figure 2 – K-bus remote communication connection arrangements

Once the physical connection is made to the relay, configure the relay's communication settings using the keypad and LCD user interface.

2.4.5 MODBUS Communication

Important	**MODBUS is not available for all MiCOM products. MODBUS availability is shown in the *Supported Protocols* table.**

MODBUS is a master/slave communication protocol that can be used for network control. In a similar way to Courier, the master device initiates all actions and the slave devices (the relays) respond to the master by supplying the requested data or by taking the requested action. MODBUS communication uses a twisted pair connection to the rear port and can be used over a distance of 1000 m with up to 32 slave devices.

To use the rear port with MODBUS communication, configure the relay's communication settings using the keypad and LCD user interface.

2.4.6 IEC 60870-5 CS 103 Communication

The IEC specification IEC 60870-5-103: Telecontrol Equipment and Systems, Part 5: Transmission Protocols Section 103 defines the use of standards IEC 60870-5-1 to IEC 60870-5-5 to perform communication with protection equipment. The standard configuration for the IEC 60870-5-103 protocol is to use a twisted pair connection over distances up to 1000 m. As an option for IEC 60870-5-103, the rear port can be specified to use a fiber optic connection for direct connection to a master station. The relay operates as a slave in the system, responding to commands from a master station. The method of communication uses standardized messages which are based on the VDEW communication protocol.

To use the rear port with IEC 60870-5-103 communication, configure the relay's communication settings using the keypad and LCD user interface.

There are three settings associated with this cell; these are:

- **Disabled**
  No blocking selected.
- **Monitor Blocking**
  When the monitor blocking DDB Signal is active high, either by energizing an opto input or control input, reading of the status information and disturbance records is not permitted. When in this mode the relay returns a “Termination of general interrogation” message to the master station.
- **Command Blocking**
  When the command blocking DDB signal is active high, either by energizing an opto input or control input, all remote commands are ignored, such as CB Trip/Close or change setting group. When in this mode the relay returns a **negative acknowledgement of command** message to the master station.

2.4.7 DNP3.0 Communication

Important	**DNP3.0 is not available for all MiCOM products. DNP3.0 availability is shown in the Supported Protocols table.**

The DNP3.0 protocol is defined and administered by the DNP User Group. Information about the user group, DNP3.0 in general and protocol specifications can be found on their website: www.dnp.org

The relay operates as a DNP3.0 slave and supports subset level 2 of the protocol plus some of the features from level 3. DNP3.0 communication is achieved using a twisted pair connection to the rear port and can be used over a distance of 1000 m with up to 32 slave devices.

2.5 SK5 Port Connection

The lower 9-way D-type connector (SK5) is currently unsupported.
Do not connect to this port.

3 CONFIGURING THE COMMUNICATIONS PORTS

3.1 Introduction

Courier works on a master/slave basis where the slave units contain information in the form of a database, and respond with information from the database when it is requested by a master unit.

The relay is a slave unit that is designed to be used with a Courier master unit such as MiCOM S1 Studio, PAS&T or a SCADA system.

3.2 Configuring the Front Courier Port

The front EIA(RS)232 9-pin port supports the Courier protocol for one-to-one communication. It is designed for use during installation, commissioning and maintenance and is not suitable for permanent connection. Since this interface is not intended to link the relay to a substation communication system, not all of the features of the Courier interface are supported; the port is not configurable and the following parameters apply:

- Physical presentation EIA(RS)232 via 9-pin connector
- Frame format IEC60870-5 FT1.2 = 11-bit (8 Even 1)
- Address 1
- Baud rate 19200 bps

Note	*As part of the limited implementation of Courier on the front port, neither automatic extraction of event and disturbance records, nor busy response are supported.)*

3.3 Configuring the First Rear Courier Port (RP1)

Once the physical connection is made to the relay, configure the relay's communication settings using the keypad and LCD user interface.

1. In the relay menu, select the **Configuration** column, then check that the **Comms. settings** cell is set to **Visible**.
2. Select the **Communications** column. Only two settings apply to the rear port using Courier, the relay's address and the inactivity timer. Synchronous communication uses a fixed baud rate of 64 kbits/s.
3. Move down the **Communications** column from the column heading to the first cell down. This shows the communication protocol.

```
Protocol
Courier
```

4. The next cell down the column controls the address of the relay. As up to 32 relays can be connected to one K-Bus spur, each relay must have a unique address so messages from the master control station are accepted by one relay only. Courier uses an integer (from 0 to 254) for the relay address that is set with this cell. Important: no two relays should have the same Courier address. The master station uses the Courier address to communicate with the relay.

```
Address
1
```

5. The next cell down controls the inactivity timer.

```
Inactiv timer
10.00 mins.
```

The inactivity timer controls how long the relay waits without receiving any messages on the rear port before it reverts to its default state, including revoking any password access that was enabled. For the rear port this can be set between 1 and 30 minutes.

Note	*Protection and disturbance recorder settings that are modified using an on-line editor such as PAS&T must be confirmed with a write to the 'Save changes' cell of the 'Configuration' column. Off-line editors such as MiCOM S1 Studio do not require this action for the setting changes to take effect.*

The next cell down controls the physical media used for the communication.

```
Physical link
Copper
```

The default setting is to select the electrical (copper) connection. If the optional fiber optic interface is fitted to the relay, then this setting can be changed to '**Fiber optic**'. This cell is invisible if a second rear communications port or an Ethernet card is fitted, as they are mutually exclusive and occupy the same physical location.

6. If the Physical link selection is copper, the next cell down becomes visible to further define the configuration:

```
Port Config
KBus
```

The setting choice is between K-Bus and EIA(RS)485. Selecting K-Bus allows connection with K-series devices, but means that a KITZ converter must be used to make a connection. If the EIA(RS)485 selection is made, direct connections can be made to proprietary equipment such as MODEMs. If the EIA(RS)485 selection is made, then two further cells become visible to control the frame format and the communication speed:

7. The frame format is selected in the RP1 Comms mode setting:

```
Comms Mode
IEC60870 FT1.2
```

The standard default is the IEC 60870-FT1.2. This is an 11-bit framing. Alternatively, a 10-bit framing may be selected for use with MODEMs that do not support 11-bit framing.

8. The final RP1 cell controls the communication speed or baud rate:

```
Baud Rate
19200 bits/s
```

Courier communications is asynchronous and three baud rate selections are available to allow the relay communication rate to be matched to that of the connected equipment. Three baud rates are supported by the relay, '9600 bits/s', '19200 bits/s' and '38400 bits/s'.

Important	**If you modify protection and disturbance recorder settings using an on-line editor such as PAS&T, you must confirm them. To do this, from the Configuration column select the Save changes cell. Off-line editors such as MiCOM S1 Studio do not need this action for the setting changes to take effect.**

3.4 Configuring the MODBUS Communication

Important	MODBUS is not available for all MiCOM products. MODBUS availability is shown in the *Supported Protocols* table.

MODBUS is a master/slave communication protocol that can be used for network control. In a similar way to Courier, the master device initiates all actions and the slave devices (the relays) respond to the master by supplying the requested data or by taking the requested action. MODBUS communication uses a twisted pair connection to the rear port and can be used over a distance of 1000 m with up to 32 slave devices.

To use the rear port with MODBUS communication, configure the relay's communication settings using the keypad and LCD user interface.

1. In the relay menu firstly check that the '**Comms. settings**' cell in the '**Configuration**' column is set to '**Visible**'.
2. Select the '**Communications**' column. Four settings apply to the rear port using MODBUS, which are described below.
3. Move down the **Communications** column from the column heading to the first cell down which indicates the communication protocol.

```
Protocol
MODBUS
```

4. The next cell down controls the MODBUS address of the relay:

```
MODBUS address
23
```

   Up to 32 relays can be connected to one MODBUS spur, and therefore it is necessary for each relay to have a unique address so that messages from the master control station are accepted by one relay only. MODBUS uses an integer number between 1 and 247 for the relay address. It is important that no two relays have the same MODBUS address. The MODBUS address is then used by the master station to communicate with the relay.
5. The next cell down controls the inactivity timer:

```
Inactivity timer
10.00 mins.
```

   The inactivity timer controls how long the relay will wait without receiving any messages on the rear port before it reverts to its default state, including revoking any password access that was enabled. For the rear port this can be set between 1 and 30 minutes.
6. The next cell down the column controls the baud rate to be used:

```
Baud rate
9600 bits/s
```

7. MODBUS communication is asynchronous. Three baud rates are supported by the relay, '**9600 bits/s**', '**19200 bits/s**' and '**38400 bits/s**'. It is important that whatever baud rate is selected on the relay is the same as that set on the MODBUS master station.
8. The next cell down controls the parity format used in the data frames:

```
Parity
None
```

   The parity can be set to be one of '**None**', '**Odd**' or '**Even**'. It is important that whatever parity format is selected on the relay is the same as that set on the MODBUS master station.
9. The next cell down controls the IEC time format used in the data frames:

```
MODBUS IEC time
Standard
```

10. The MODBUS IEC time can be set to ‘**Standard**’ or ‘**Reverse**’. For a complete definition see the Relay Menu Database (P14x/EN MD), datatype G12.

The format can be selected as either **Standard** (as for IEC60870-5-4 ‘Binary Time 2a’) which is the default, or to **Reverse** for compatibility with MICOM Px20 and Px30 product ranges. For more information see the *Date and Time Format* section.

3.5 Configuring the IEC 60870-5 CS 103 Rear Port, RP1

The IEC specification IEC 60870-5-103: Telecontrol Equipment and Systems, Part 5: Transmission Protocols Section 103 defines the use of standards IEC 60870-5-1 to IEC 60870-5-5 to perform communication with protection equipment. The standard configuration for the IEC 60870-5-103 protocol is to use a twisted pair connection over distances up to 1000 m. As an option for IEC 60870-5-103, the rear port can be specified to use a fiber optic connection for direct connection to a master station. The relay operates as a slave in the system, responding to commands from a master station. The method of communication uses standardized messages which are based on the VDEW communication protocol.

To use the rear port with IEC 60870-5-103 communication, configure the relay's communication settings using the keypad and LCD user interface.

1. In the relay menu, select the **Configuration** column, then check that the **Comms. settings** cell is set to **Visible**.
2. Select the **Communications** column. Four settings apply to the rear port using IEC 60870-5-103 that are described below.

   Move down the 'COMMUNICATIONS' column from the column heading to the first cell to confirm the communication protocol:

   ```
   Protocol
   IEC60870-5-103
   ```

3. The next cell sets the address of the relay on the IEC 60870-5-103 network:

   ```
   Remote Address
   162
   ```

   Up to 32 relays can be connected to one IEC 60870-5-103 spur, and therefore it is necessary for each relay to have a unique address so that messages from the master control station are accepted by one relay only. IEC 60870-5-103 uses an integer number between 0 and 254 for the relay address. It is important that no two relays have the same address. The address is then used by the master station to communicate with the relay.
4. The next cell down the column controls the baud rate to be used:

   ```
   Baud rate
   9600 bits/s
   ```

   IEC 60870-5-103 communication is asynchronous. Two baud rates are supported by the relay, '9600 bits/s' and '19200 bits/s'. It is important that whatever baud rate is selected on the relay is the same as that set on the IEC 60870-5-103 master station.
5. The next cell down controls the period between IEC 60870-5-103 measurements:

   ```
   Measure't period
   30.00 s
   ```

   The IEC 60870-5-103 protocol allows the relay to supply measurements at regular intervals. The interval between measurements is controlled by this cell, and can be set between 1 and 60 seconds.
6. An optional fiber optic card is available in the relay to allow optical connection to the IEC 60870-5-103 communication to be made over an optical connection. When fitted, it converts between EIA(RS)485 signals and fiber optic signals and the following cell is visible in the menu column:

   ```
   Physical link
   Copper
   ```

The default setting is to select the electrical (copper) connection. If the optional fiber optic interface is fitted to the relay, then this setting can be changed to 'Fiber optic'. This cell is invisible if a second rear communications port or an Ethernet card is fitted, as they are mutually exclusive and occupy the same physical location.

7. The following cell which may be displayed, is not currently used but is available for future expansion.

```
InactivTimer
```

8. The next cell down can be used for monitor or command blocking:

```
CS103 Blocking
```

There are three settings associated with this cell; these are:

- **Disabled**
  No blocking selected.
- **Monitor Blocking**
  When the monitor blocking DDB Signal is active high, either by energizing an opto input or control input, reading of the status information and disturbance records is not permitted. When in this mode the relay returns a "Termination of general interrogation" message to the master station.
- **Command Blocking**
  When the command blocking DDB signal is active high, either by energizing an opto input or control input, all remote commands are ignored, such as CB Trip/Close or change setting group. When in this mode the relay returns a **negative acknowledgement of command** message to the master station.

3.6 Configuring the DNP3.0 Rear Port, RP1 and Optional DNP3.0 over Ethernet

Important	**DNP3.0 is not available for all MiCOM products. DNP3.0 availability is shown in the Supported Protocols table.**

The DNP3.0 protocol is defined and administered by the DNP User Group. Information about the user group, DNP3.0 in general and protocol specifications can be found on their website: www.dnp.org

The DNP3.0 implementation in the MiCOM P841 can be presented on an EIA(RS)485 physical layer, and/or on an Ethernet connection according to the options selected.

The relay operates as a DNP3.0 slave and supports subset Level 2 of the protocol plus some of the features from Level 3.

The settings applicable to the EIA(RS)485 implementation are described in section 3.7.

The settings applicable to the Ethernet implementation are described in section 5 - MODBUS Interface.

3.7 Configuring the DNP3.0 Communication Rear Port, RP1

The DNP3.0 protocol is defined and administered by the DNP User Group. Information about the user group, DNP3.0 in general and protocol specifications can be found on their website: www.dnp.org

The relay operates as a DNP3.0 slave and supports subset level 2 of the protocol plus some of the features from level 3. DNP3.0 communication is achieved using a twisted pair connection to the rear port and can be used over a distance of 1000 m with up to 32 slave devices.

1. To use the rear port with DNP3.0 communication, configure the relay's communication settings using the keypad and LCD user interface.
2. In the relay menu, select the **Configuration** column, then check that the **Comms. settings** cell is set to **Visible**.
3. Four settings apply to the rear port using DNP 3.0 that are described below.
4. Move down the 'COMMUNICATIONS' column from the column heading to the first cell that indicates the communications protocol:

```
Protocol
DNP 3.0
```

5. The next cell sets the device address on the DNP3.0 network:

```
DNP 3.0 Address
232
```

   Up to 32 devices can be connected to one DNP3.0 spur, and therefore it is necessary for each device to have a unique address so that messages from the master control station are accepted by only one device. DNP3.0 uses a decimal number between 1 and 65519 for the device address. It is important that no two devices have the same address. The address is then used by the DNP3.0 master station to communicate with the relay.
6. The next cell sets the baud rate to be used:

```
Baud Rate
9600 bits/s
```

   DNP3.0 communication is asynchronous. Six baud rates are supported by the relay '1200bits/s', '2400bits/s', '4800bits/s', '9600bits/s', '19200bits/s' and '38400bits/s'. It is important that whatever baud rate is selected on the relay is the same as that set on the DNP3.0 master station.
7. The next cell controls the parity format used in the data frames:

```
Parity
None
```

   The parity can be set to be one of **None**, **Odd** or **Even.** It is important that whatever parity format is selected on the relay is the same as that set on the DNP3.0 master station.

   An optional fiber optic card is available in the relay to allow optical connection to the IEC 60870-5-103 communication to be made over an optical connection. When fitted, it converts between EIA(RS)485 signals and fiber optic signals and the following cell is visible in the menu column.
8. The next cell down the column controls the physical media used for the communication.

```
Physical link
Copper
```

The default setting is to select the electrical (copper) connection. If the optional fiber optic interface is fitted to the relay, then this setting can be changed to **Fiber optic**. This cell is invisible if a second rear communications port or an Ethernet card is fitted, as they are mutually exclusive and occupy the same physical location.

9. The next cell down the column sets the time synchronization request from the master by the relay:

```
Time Sync.
Enabled
```

The time synchronization can be set to either enabled or disabled. If enabled it allows the DNP3.0 master to synchronize the time.

10. Analogue values can be set to be reported in terms of primary, secondary or normalized (with respect to the CT/VT ratio setting) values:

```
Meas Scaling
Primary
```

11. A message gap setting is provided:

```
Message Gap
ϕ
```

This allows a gap between message frames to be set to enable compatibility with different master stations.

The setting for enabling/disabling DNP3.0 time synchronization is described above. When DNP3.0 time sync is enabled, the required rate of synchronization, known as the “need time”, needs to be set.

12. A setting allows different “need time” to be set with setting range from 1 - 30 minutes, step of 1 minute and default at 10 minutes:

```
DNP Need Time
10mins
```

The transmitted application fragment size can be set to ensure that a Master Station cannot be held too long before a complete reply is received and allow it to move on to next IED in a token ring polling setup.

13. The maximum overall response message length can be configured:

```
DNP App Fragment
2048
```

A single fragment size is 249. Depending on circumstances, a user may set the fragment size as a multiple of 249 in order to optimize segment packing efficiency in fragments. However it can also be useful to allow "odd" sizes for users to choose under specific circumstances, such as if sending data inside SMS frames, through packet radios, etc. In such cases it can be useful to select the fragment size such that each packet occupies a single "transmission media frame".

In some cases, communication to the outstation is made over slow, packet-switched networks which can add seconds to the communication latency.

14. A setting is provided to allow the application layer timeout to be set:

```
DNP App Timeout
2s
```

15. Select Before Operate (SBO) timeouts can be set.
If the DNP3.0 “Select a trip command” causes the relay’s internal logic to block automatic tripping, then a corruption of the DNP3.0 “Operate” message could delay the trip. The delay of tripping can be set:

```
DNP SBO Timeout
10s
```

16. The DNP link timeout can be set:

```
DNP Link Timeout
10s
```

3.8 Configuring the Second Rear Communication Port (RP2)

For relays with Courier, MODBUS, IEC60870-5-103 or DNP3.0 protocol on the first rear communications port there is the hardware option of a second rear communications port, which will run the Courier language. This can be used over one of three physical links: twisted pair K-Bus (non-polarity sensitive), twisted pair EIA(RS)485 (connection polarity sensitive) or EIA(RS)232.
The settings for this port are located immediately below the ones for the first port as described in the *Introduction* chapter.

1. Move down the settings until the following sub heading is displayed.

```
Rear Port 2 (RP2)
```

2. The next cell defines the protocol, which is fixed at Courier for RP2.

```
RP2 protocol
Courier
```

3. The following cell indicates the status of the hardware.

```
RP2 card status
EIA(RS)232 OK
```

4. The following cell allows for selection of the port configuration.

```
RP2 port config.
EIA(RS)232
```

5. The port can be configured for EIA(RS)232, EIA(RS)485 or K-Bus.
As in the case of the first rear Courier port, if K-Bus is not selected certain other cells to control the communication mode and speed become visible. If either EIA(RS)232 or EIA(RS)485 is selected for the port configuration, the next cell is visible and selects the communication mode.

```
RP2 comms.  Mode
IEC60870 FT1.2
```

6. The standard default is the IEC 60870 FT1.2 for normal operation with 11-bit modems. Alternatively, a 10-bit framing with no parity bit can be selected for special cases.
7. The next cell down sets the communications port address.

```
RP2 address
255
```

Since up to 32 devices can be connected to one K-bus spur, it is necessary for each device to have a unique address so that messages from the master control station are accepted by one device only. Courier uses an integer number between 0 and 254 for the device address that is set with this cell. It is important that no two devices have the same Courier address. The Courier address is then used by the master station to communicate with the device. The default value is 255 and must be changed to a value in the range 0 to 254 before use.

8. The following cell controls the inactivity timer.

```
RP2 InactivTimer
15 mins.
```

9. The inactivity timer controls how long the relay will wait without receiving any messages on the rear port before it reverts to its default state. This includes revoking any password access that was enabled. The inactivity timer can be set between 1 and 30 minutes.
10. In the case of EIA(RS)232 and EIA(RS)485 the next cell down controls the baud rate. For K-Bus the baud rate is fixed at 64kbit/second between the relay and the KITZ interface at the end of the relay spur.

```
RP2 baud rate
19200
```

Courier communications is asynchronous and three selections are available to allow the relay communication rate to be matched to that of the connected equipment. The three baud rates supported by the relay are: ‘9600 bits/s’, ‘19200 bits/s’ and ‘38400 bits/s’.

3.9 Fiber Optic Converter (option)

An optional fiber optic card is available in this product. This converts the EIA(RS)485 protocols into a fiber optic output. This communication card is available for use on Courier, MODBUS (for products listed in the *Supported Protocols* table), IEC60870-5-103 and DNP3.0 it adds the following setting to the communication column.

This controls the physical media used for the communication:

```
Physical link
Copper
```

The default setting is to select the electrical EIA(RS)485 connection. If the optional fiber optic connectors are fitted to the relay, then this setting can be changed to ‘**Fiber optic**’. This cell is also invisible if a second rear comms. port, or Ethernet card is fitted, as it is mutually exclusive with the fiber optic connectors, and occupies the same physical location.

Where this is used, connection should be made using either 50/125µm or 62.5/125µm multi-mode optical fibers terminated with BFOC/2.5 (ST) connectors.

3.10 Second Rear Port K-Bus Application

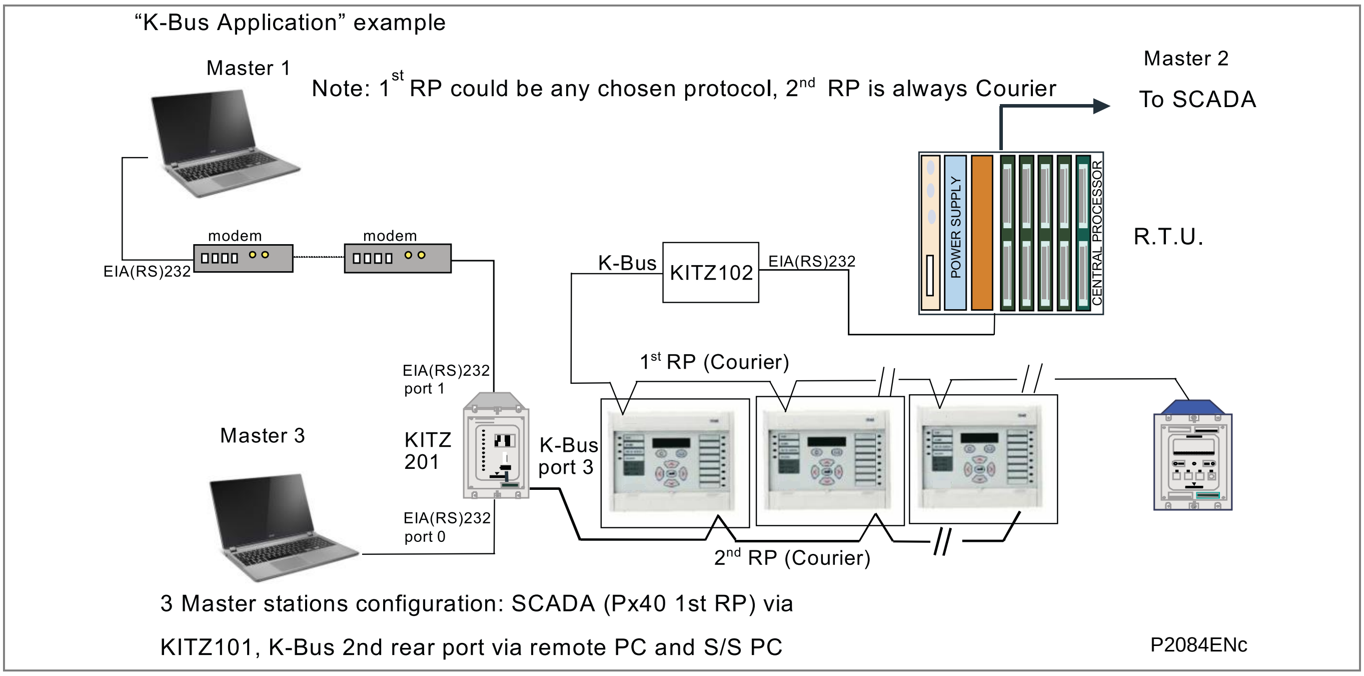


Figure 3 - Second rear port K-Bus application

3.11 Second Rear Port EIA(RS)485 Example

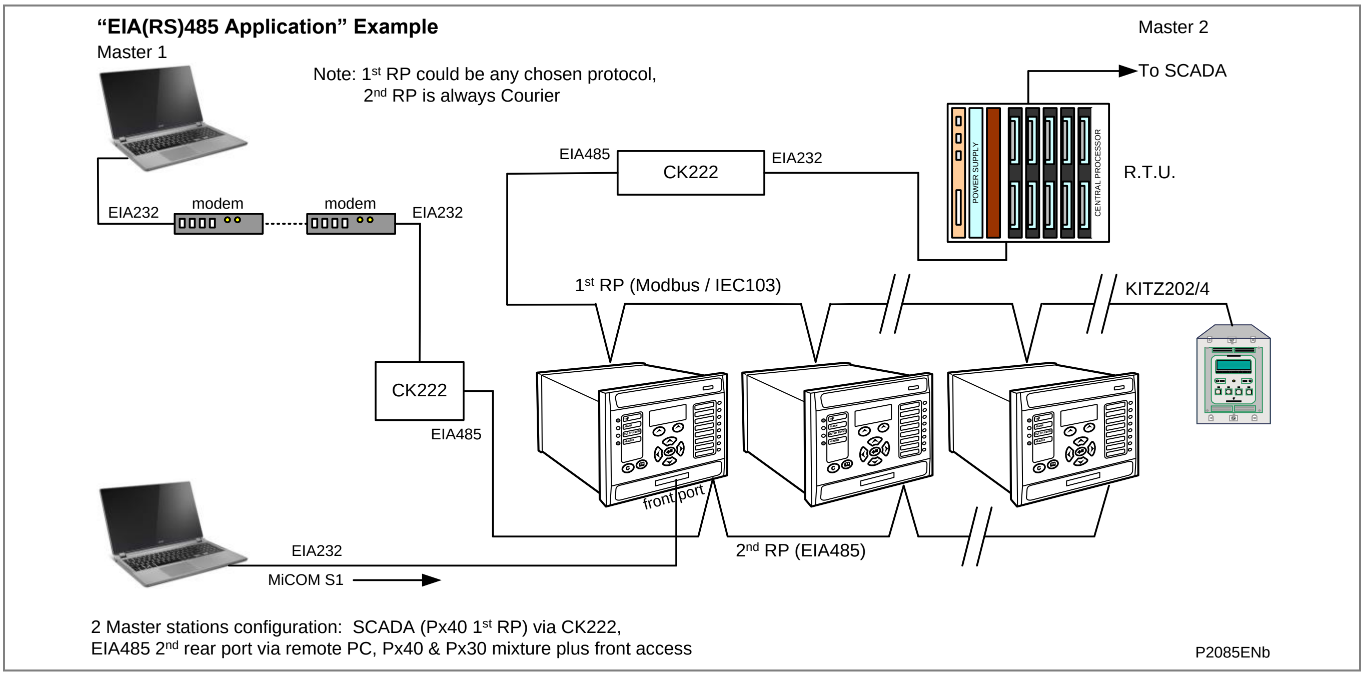


Figure 4 - Second rear port EIA(RS)485 example

3.12 Second Rear Port EIA(RS)232 Example

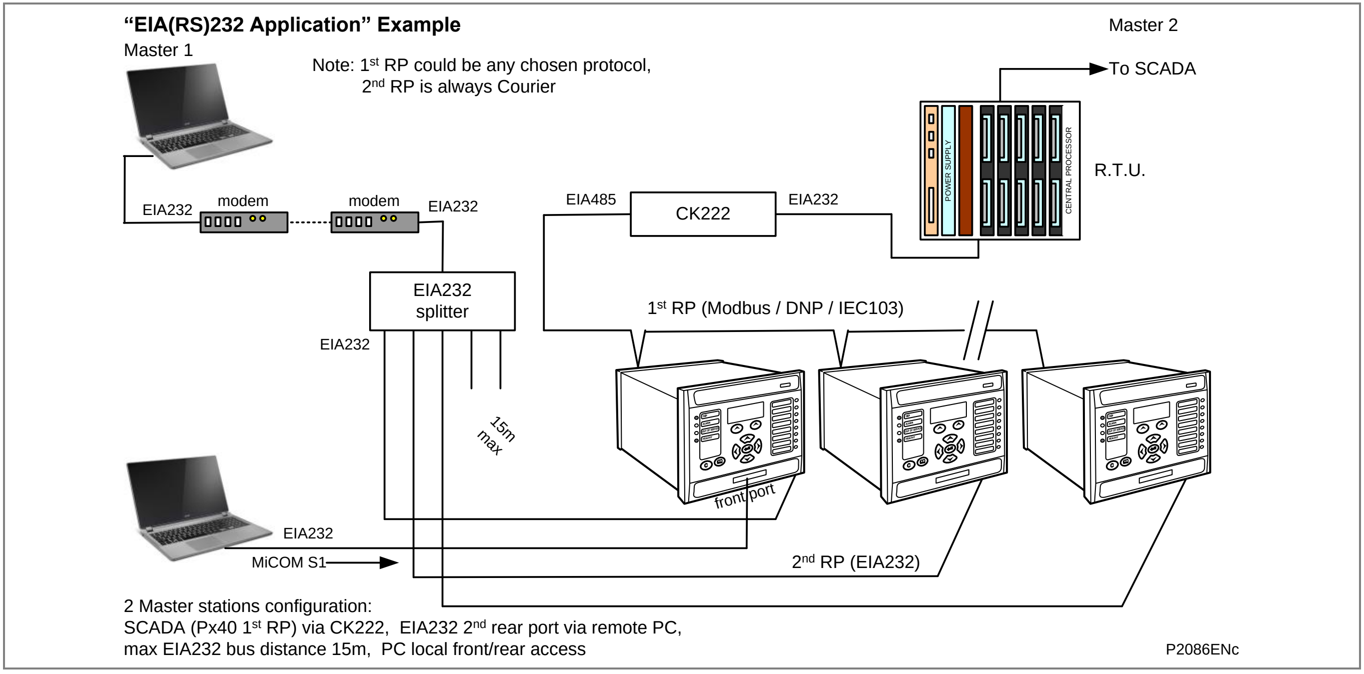


Figure 5 - Second rear port EIA(RS)232 example

3.13 SK5 Port Connection

The lower 9-way D-type connector (SK5) is the InterMiCOM port, which is based on the EIA232 standard.

3.14 Configuring the Ethernet Communication (option)

It is possible to communicate through an Ethernet network using a Schneider Electric I4XS4UE (refer to Px4x/EN REB user guide for Redundant Ethernet board connections).

Connection for Ethernet communication can be made either by standard RJ45 electrical connections or by multi-mode optical fibers suitable for 1310 nm transmission and terminated with BFOC/2.5 (ST) connectors.

For the P746 or P849 product, it is also possible to use the IEC 61850-8.1 protocol.

3.14.1 Legacy Protocols

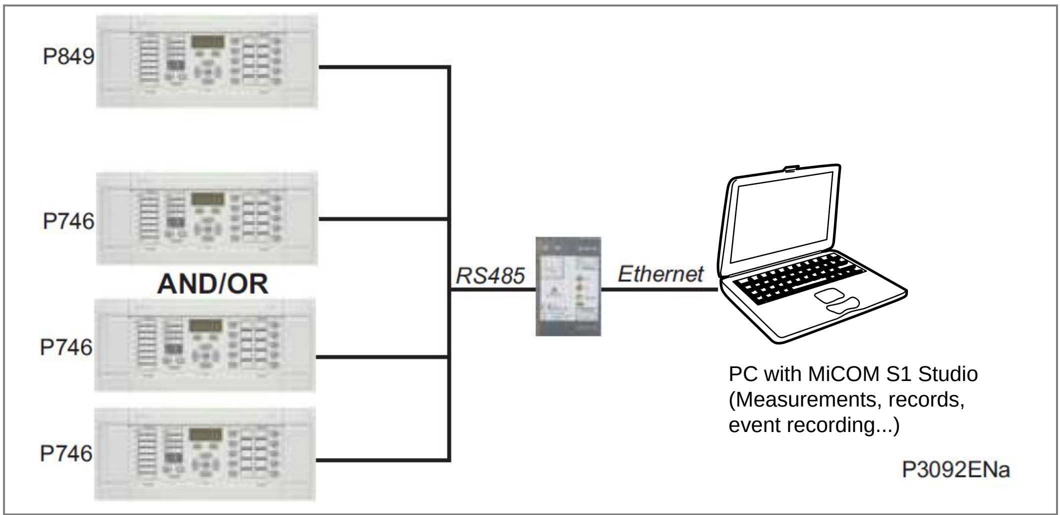


Figure 6 – Ethernet connection example

3.14.2 IEC 61850 Protocol

Using Ethernet hardware options, high-speed communication exchanges are possible through an Ethernet network.

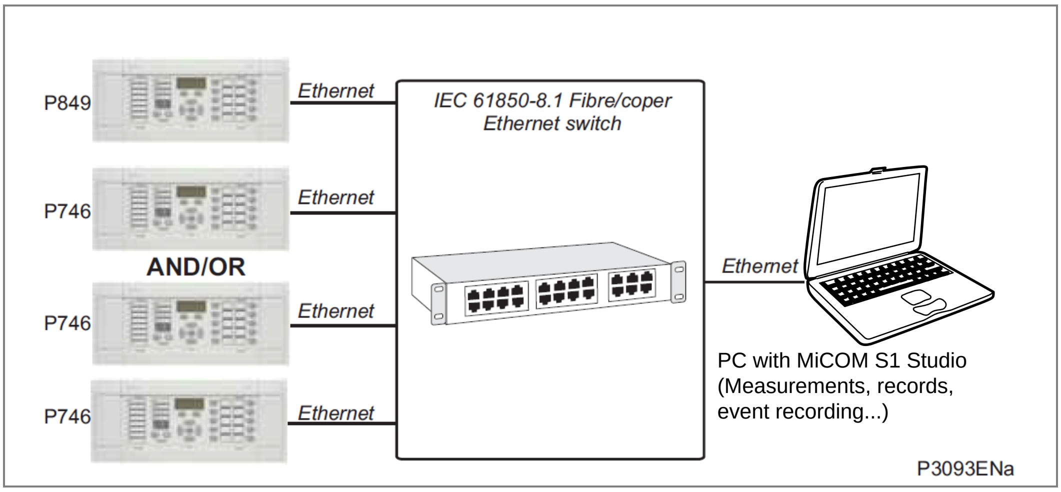


Figure 7 – Ethernet connection example

3.14.3 Redundant Ethernet Protocol

Redundant Ethernet connections are performed with Redundant Ethernet (Self Healing, Dual homing or Rapid Spanning Tree Protocol) options (refer to Px4x/EN REB user guide).

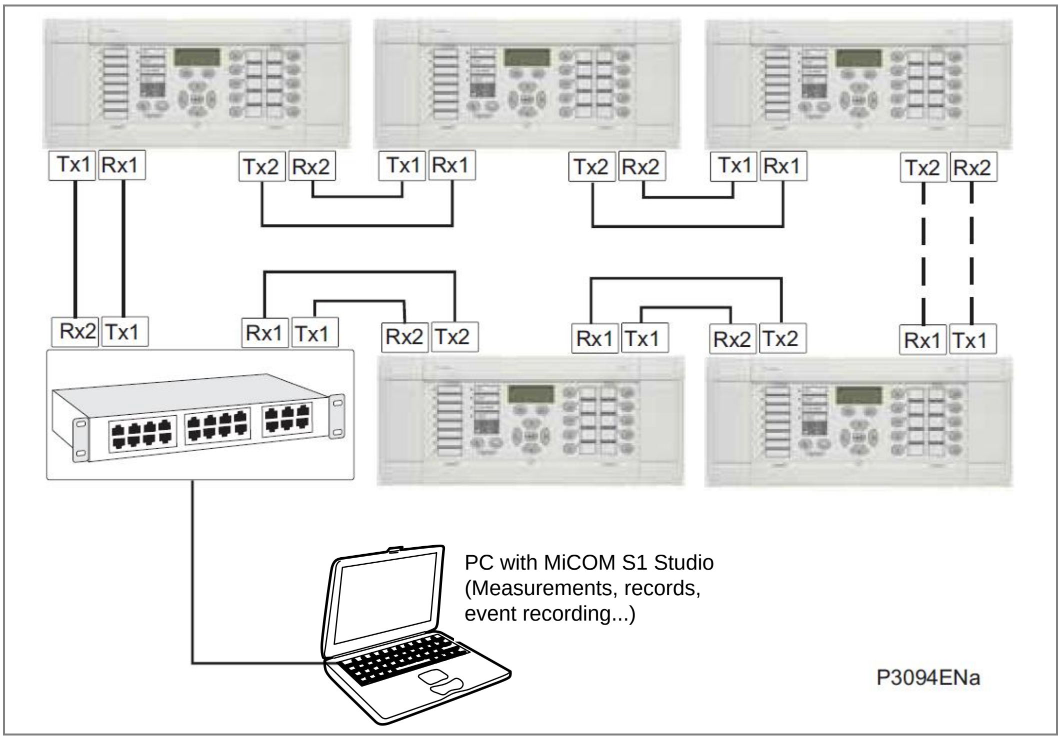


Figure 8 – Redundant ethernet board connection

4 COURIER INTERFACE

4.1 Courier Protocol

Courier is a Schneider Electric communication protocol. The concept of the protocol is that a standard set of commands is used to access a database of settings and data in the relay. This allows a generic master to be able to communicate with different slave devices. The application-specific aspects are contained in the database rather than the commands used to interrogate it, so the master station does not need to be preconfigured.

The same protocol can be used through two physical links K-Bus or EIA(RS)-232.

K-Bus is based on EIA(RS)-485 voltage levels with HDLC FM0 encoded synchronous signaling and its own frame format. The K-Bus twisted pair connection is unpolarized, whereas the EIA(RS)-485 and EIA(RS)-232 interfaces are polarized.

The EIA(RS)-232 interface uses the IEC60870-5 FT1.2 frame format.

The relay supports an IEC60870-5 FT1.2 connection on the front-port. This is intended for temporary local connection and is not suitable for permanent connection. This interface uses a fixed baud rate, 11-bit frame, and a fixed device address.

The rear interface is used to provide a permanent connection for K-Bus and allows multi-drop connection. Although K-Bus is based on EIA(RS)-485 voltage levels, it is a synchronous HDLC protocol using FM0 encoding. It is not possible to use a standard EIA(RS)-232 to EIA(RS)-485 converter to convert IEC60870-5 FT1.2 frames to K-Bus. Also it is not possible to connect K-Bus to an EIA(RS)-485 computer port. A protocol converter, such as the KITZ101, should be used for this purpose.

For a detailed description of the Courier protocol, command-set and link description, see the following documentation:

R6509	K-Bus Interface Guide
R6510	IEC60870 Interface Guide
R6511	Courier Protocol
R6512	Courier User Guide

Alternatively for direct connections, the fiber optic converter card may be used to convert the rear EIA(RS)485 port into a fiber optic (ST) port. See the *Fiber Optic Converter (option)* section for more information.

4.2 Front Courier Port

The front EIA(RS)-232 9 pin port supports the Courier protocol for one-to-one communication. This port complies with EIA(RS)-574; the 9-pin version of EIA(RS)-232, see www.tiaonline.org. It is designed for use during installation and commissioning/maintenance and is not suitable for permanent connection. Since this interface is not used to link the relay to a substation communication system, some of the features of Courier are not implemented. These are as follows:

- Automatic extraction of Event Records:
  - Courier Status byte does not support the Event flag.
  - Send Event/Accept Event commands are not implemented.
- Automatic extraction of Disturbance records:
  - Courier Status byte does not support the Disturbance flag.
- Busy Response Layer:
  - Courier Status byte does not support the Busy flag, the only response to a request is the final data.
- Fixed Address:
  - The address of the front Courier port is always 1; the Change Device address command is not supported.
- Fixed Baud Rate:
  - 19200 bps.
  - Although automatic extraction of event and disturbance records is not supported, it is possible to manually access this data through the front port.

4.3 Supported Command Set

The following Courier commands are supported by the relay:

Protocol Layer:

- Reset Remote Link
- Poll Status
- Poll Buffer*

Setting Changes:

- Enter Setting Mode
- Preload Setting
- Abort Setting
- Execute Setting
- Reset Menu Cell
- Set Value

Low Level Commands:

- Send Event*
- Accept Event*
- Send Block
- Store Block Identifier
- Store Block Footer

Control Commands:

- Select Setting Group
- Change Device Address*
- Set Real Time

Menu Browsing:

- Get Column Headings
- Get Column Text
- Get Column Values
- Get Strings
- Get Text
- Get Value
- Get Column Setting Limits

Note *Commands marked with an asterisk (*) are not supported through the front Courier port.*

4.4 Courier Database

The Courier database is two-dimensional. Each cell in the database is referenced by a row and column address. Both the column and the row can take a range from 0 to 255. Addresses in the database are specified as hexadecimal values, for example, 0A02 is column 0A (10 decimal) row 02. Associated settings or data are part of the same column. Row zero of the column has a text string to identify the contents of the column and to act as a column heading.

The *Relay Menu Database document* contains the complete database definition for the relay. For each cell location the following information is stated:

- Cell Text
- Cell Data type
- Cell value
- Whether the cell is settable, if so
    - Minimum value
    - Maximum value
    - Step size
- Password Level required to allow setting changes
- String information (for Indexed String or Binary flag cells)

4.5 Setting Changes

(See R6512, Courier User Guide - Chapter 9)
Courier provides two mechanisms for making setting changes, both of these are supported by the relay. Either method can be used for editing any of the settings in the relay database.

4.5.1 Method 1

This uses a combination of three commands to perform a settings change:

Enter Setting Mode	Checks that the cell is settable and returns the limits.
Preload Setting	Places a new value to the cell. This value is echoed to ensure that setting corruption has not taken place. The validity of the setting is not checked by this action.
Execute Setting	Confirms the setting change. If the change is valid, a positive response is returned. If the setting change fails, an error response is returned.
Abort Setting	This command can be used to abandon the setting change.

This is the most secure method. It is ideally suited to on-line editors because the setting limits are taken from the relay before the setting change is made. However, this method can be slow if many settings are being changed because three commands are required for each change.

4.5.2 Method 2

The **Set Value** command can be used to directly change a setting, the response to this command is either a positive confirm or an error code to indicate the nature of a failure. This command can be used to implement a setting more rapidly than the previous method, however the limits are not extracted from the relay. This method is most suitable for off-line setting editors such as MiCOM S1 Studio, or for issuing preconfigured (SCADA) control commands.

4.5.3 Relay Settings

There are three categories of settings in the relay database:

- Control and support
- Disturbance recorder
- Protection settings group

Setting changes made to the control and support settings are implemented immediately and stored in non-volatile memory. Changes made to either the Disturbance recorder settings or the Protection Settings Groups are stored in a ‘scratchpad’ memory and are not immediately implemented by the relay.

To action setting changes stored in the scratchpad the Save **Changes cell** in the **Configuration** column must be written to. This allows the changes to either be confirmed and stored in non-volatile memory, or the setting changes to be aborted.

4.5.4 Setting Transfer Mode

If it is necessary to transfer all of the relay settings to or from the relay, a cell in the **Communication System Data** column can be used. This cell (location BF03) when set to 1 makes all of the relay settings visible. Any setting changes made with the relay set in this mode are stored in scratchpad memory, including control and support settings. When the value of BF03 is set back to 0, any setting changes are verified and stored in non-volatile memory.

4.6 Event Extraction

Events can be extracted either automatically (rear port only) or manually (either Courier port). For automatic extraction all events are extracted in sequential order using the standard Courier event mechanism, this includes fault/maintenance data if appropriate. The manual approach allows the user to select events, faults, or maintenance data at random from the stored records.

4.6.1 Automatic Event Extraction

(See Chapter 7 Courier User Guide, publication R6512).

This method is intended for continuous extraction of event and fault information as it is produced. It is only supported through the rear Courier port.

When new event information is created, the Event bit is set in the Status byte. This indicates to the Master device that event information is available. The oldest, unextracted event can be extracted from the relay using the Send Event command. The relay responds with the event data, which is either a Courier Type 0 or Type 3 event. The Type 3 event is used for fault records and maintenance records.

Once an event has been extracted from the relay, the Accept Event can be used to confirm that the event has been successfully extracted. If all events have been extracted, the event bit is reset. If there are more events still to be extracted, the next event can be accessed using the **Send Event** command as before.

4.6.2 Event Types

Events are created by the relay under these circumstances:

- Change of state of output contact
- Change of state of opto input
- Protection element operation
- Alarm condition
- Setting change
- Password entered/timed-out
- Fault record (Type 3 Courier Event)
- Maintenance record (Type 3 Courier Event)

4.6.3 Event Format

The Send Event command results in these fields being returned by the relay:

- Cell reference
- Time stamp
- Cell text
- Cell value

The *Relay Menu Database* document for the relevant product, contains a table of the events created by the relay and indicates how the contents of the above fields are interpreted. Fault records and Maintenance records return a Courier Type 3 event, which contains the above fields with two additional fields:

- Event extraction column
- Event number

These events contain additional information that is extracted from the relay using the referenced extraction column. Row 01 of the extraction column contains a setting that allows the fault/maintenance record to be selected. This setting should be set to the event number value returned in the record. The extended data can be extracted from the relay by uploading the text and data from the column.

4.6.4 Manual Event Record Extraction

Column 01 of the database can be used for manual viewing of event, fault, and maintenance records. The contents of this column depend on the nature of the record selected. It is possible to select events by event number and to directly select a fault record or maintenance record by number.

Event Record selection (Row 01)

> This cell can be set to a value between 0 to 511 to select from 512 stored events. 0 selects the most recent record and 511 the oldest stored record. For simple event records, (Type 0) cells 0102 to 0105 contain the event details. A single cell is used to represent each of the event fields. If the event selected is a fault or maintenance record (Type 3), the remainder of the column contains the additional information.

Maintenance Record Selection (Row F0)

> This cell can be used to select a maintenance record using a value between 0 and 4. This cell operates in a similar way to the fault record selection.

If this column is used to extract event information from the relay, the number associated with a particular record changes when a new event or fault occurs.

4.7 Disturbance Record Extraction

The stored disturbance records in the relay are accessible in a compressed format through the Courier interface. The records are extracted using column B4. Cells required for extraction of uncompressed disturbance records are not supported.

Select Record Number (Row 01)

> This cell can be used to select the record to be extracted. Record 0 is the oldest unextracted record, already extracted older records are assigned positive values, and negative values are used for more recent records. To help automatic extraction through the rear port, the Disturbance bit of the Status byte is set by the relay whenever there are unextracted disturbance records.

Once a record has been selected, using the above cell, the time and date of the record can be read from cell 02. The disturbance record can be extracted using the block transfer mechanism from cell B00B. The file extracted from the relay is in a compressed format. Use MiCOM S1 Studio to decompress this file and save the disturbance record in the COMTRADE format.

As has been stated, the rear Courier port can be used to extract disturbance records automatically as they occur. This operates using the standard Courier mechanism, see *Chapter 8 of the Courier User Guide*. The front Courier port does not support automatic extraction although disturbance record data can be extracted manually from this port.

4.8 Programmable Scheme Logic (PSL) Settings

The Programmable Scheme Logic (PSL) settings can be uploaded from and downloaded to the relay using the block transfer mechanism defined in the Courier User Guide.

These cells are used to perform the extraction:

- B204 Domain — Used to select either PSL settings (upload or download) or PSL configuration data (upload only)
- B208 Sub-Domain — Used to select the Protection Setting Group to be uploaded or downloaded.
- B20C Version — Used on a download to check the compatibility of the file to be downloaded with the relay.
- B21C Transfer Mode — Used to set up the transfer process.
- B120 Data Transfer Cell — Used to perform upload or download.

The PSL settings can be uploaded and downloaded to and from the relay using this mechanism. If it is necessary to edit the settings, MiCOM S1 Studio must be used because the data is compressed. MiCOM S1 Studio also performs checks on the validity of the settings before they are downloaded to the relay.

5 MODBUS INTERFACE

The MODBUS interface is a master/slave protocol and is defined by: www.modbus.org

MODBUS Serial Protocol Reference Guide: PI-MBUS-300 Rev. E

5.1 Serial Interface

The MODBUS interface uses the first rear EIA(RS)-485 (RS485) two-wire port “RP1” (or converted fiber optic port). The port is designated “EIA(RS)-485/K-Bus Port” on the external connection diagrams.
The interface uses the MODBUS RTU communication mode rather than the ASCII mode since it provides for more efficient use of the communication bandwidth and is in widespread use. This communication mode is defined by the MODBUS standard.

5.1.1 Character Framing

The character framing is 1 start bit, 8 data bits, either 1 parity bit and 1 stop bit, or 2 stop bits. This gives 11 bits per character.

5.1.2 Maximum MODBUS Query and Response Frame Size

The maximum query and response frame size is limited to 260 bytes in total. (This includes the frame header and CRC footer, as defined by the MODBUS protocol.).

5.1.3 User Configurable Communications Parameters

The following parameters can be configured for this port using the product’s front panel user interface (in the communications sub-menu):

- Baud rate: 9600, 19200, 38400 bps
- Device address: 1 - 247
- Parity: Odd, even, none.
- Inactivity time: 1 - 30 minutes

Note	*The inactivity timer is started (or restarted) whenever the active password level is reduced when a valid password is entered, or when a change is made to the setting scratchpad. When the timer expires, the password level is restored to its default level and any pending (uncommitted) setting changes on the scratch pad are discarded. The inactivity timer is disabled when the password level is at its default value and there are no settings pending on the scratchpad. See the Setting Changes section.*

The MODBUS interface communication parameters are not part of the product’s setting file and cannot be configured with MiCOM S1 Studio.

5.2 Supported MODBUS Query Functions

The MODBUS protocol provides numerous query functions, of which the product supports the subset in the following table. The product responds with exception code 01 if any other query function is received by it.

Query Function Code	MODBUS Query Name	Application / Interpretation
01	Read Coil Status	Read status of output contacts (0x addresses)
02	Read Input Status	Read status of opto-isolated status inputs (1x addresses)
03	Read Holding Registers	Read setting values (4x addresses)
04	Read Input Registers	Read measurement values (3x addresses)
06	Preset Single Register	Write single setting value (4x addresses)
07	Read Exception Status	Read relay status, same value as register 3x1
08	Diagnostics	Application defined by the MODBUS protocol specification
11	Fetch Communication Event Counter	
12	Fetch Communication Event Log	
16	Preset Multiple Registers (127 max)	Write multiple setting values (4x addresses)

Table 3 - MODBUS query functions supported by the product

5.3 MODBUS Response Code Interpretation

Code	MODBUS response name	Product interpretation
01	Illegal Function Code	The function code transmitted is not supported.
02	Illegal Data Address	The start data address in the request is not an allowable value. If any of the addresses in the range cannot be accessed due to password protection, all changes in the request are discarded and this error response is returned. Note If the start address is correct but the range includes non-implemented addresses, this response is not produced.
03	Illegal Value	A value referenced in the data field transmitted by the master is not in range. Other values transmitted in the same packet are executed if they are in the range.
04	Slave Device Failure	An exception arose during the processing of the received query that is not covered by any of the other exception codes in this table.
05	Acknowledge	Not used.
06	Slave Device Busy	The write command cannot be implemented due to the product's internal database being locked by another interface. This response is also produced if the product is busy executing a previous request.

Table 4 - MODBUS response code interpretation

5.4 Maximum Query and Response Parameters

The following table shows the maximum amount of data that the product can process for each of the supported query functions (see the Supported MODBUS Query Functions section) and the maximum amount of data that can be sent in a corresponding response frame. The principal constraint is the maximum query and response frame size, as noted in the *Maximum MODBUS Query and Response Frame Size* section. Maximum MODBUS query and response frame size.

Query function code	MODBUS query name	Maximum query data request size	Maximum response data size
01	Read Coil Status	32 coils	32 coils
02	Read Input Status	32 inputs	32 inputs
03	Read Holding Registers	127 registers	127 registers
04	Read Input Registers	127 registers	127 registers
06	Preset Single Register	1 register	1 register
07	Read Exception Status	-	8 coils
08	Diagnostics	-	-
11	Fetch Communication Event Counter	-	-
12	Fetch Communication Event Log	-	70 bytes
16	Preset Multiple Registers	127 registers	127 registers

Table 5 - Maximum query and response parameters for supported queries

5.5 Register Mapping

5.5.1 Conventions

5.5.1.1 Memory Pages

The MODBUS specification associates a specific register address space to each query that has a data address field. The address spaces are often called memory pages because they are analogous to separate memory devices. A simplistic view of the queries in MODBUS is that a specified location in a specified memory device is being read from or written to. However, the product's implementation of such queries is not as a memory access but as a translation to an internal database query (see Note).

Note	*One consequence of this is that the granularity of the register address space (in the 3x and 4x memory pages) is governed by the size of the data item being requested from the internal database. Since this is often more than the 16 bits of an individual register, not all register addresses are valid. See the Register Data Types section for more details.*

Each MODBUS memory page has a name and an ID. The *MODBUS "memory" pages reference and application* table provides a summary of the memory pages, their Ids, and their application in the product.

It is common practice to prefix a decimal register address with the page ID and generally this is the style used in this document.

Memory page ID	MODBUS memory page name	Product application
0xxxx	Coil Status	Read and write access of the Output Relays.
1xxxx	Input Status	Read only access of the Opto-Isolated Status Inputs.
3xxxx	Input Registers	Read-only data access, such as measurements and records.
4xxxx	Holding Registers	Read and write data access, such as product configurations settings and control commands.
6xxxx	Extended Memory File	Not used or supported.
Note	*xxxx represents the addresses available in the page (0 to 9999).*	

Table 6 - MODBUS "memory" pages reference and application

5.5.1.2 MODBUS Register Identification

The MODBUS convention is to document register identifiers with ordinal values (first, second, third…) whereas the actual protocol uses memory-page based register addresses that begin with address zero. Therefore the first register in a memory page is register address zero, the second register is register address 1 and so on. In general, one must be subtracted from a register’s identifier to find its equivalent address. The page number notation is not part of the address.

Example:

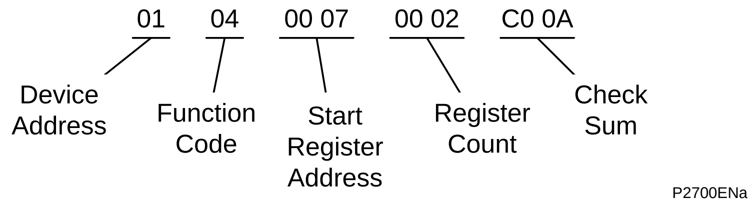
Task:

Obtain the status of the output contacts from the Schneider Electric MiCOM Pxxx device at address 1.

The output contact status is a 32-bit binary string held in input registers 3x8 and 3x9 (see the *Binary Status Information* section).

Select MODBUS function code 4 “Read input registers” and request two registers starting at input register address 7. Note the register address is one less than the required register ordinal.

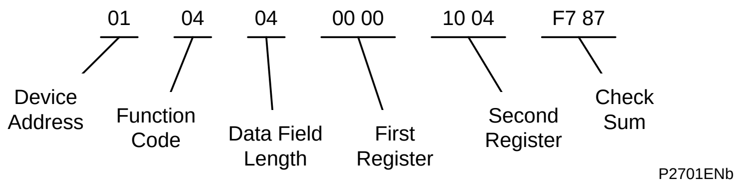
The MODBUS query frame is:



Note that the following frame data is shown in hexadecimal 8-bit bytes.

The frame is transmitted from left to right by the master device. The start register address, register count and check sum are all 16-bit numbers that are transmitted in a high byte - low byte order.

The query may elicit the following response: [4]



The frame was transmitted from left to right by the slave device. The response frame is valid because the eighth bit of the function code field is not set. The data field length is 4 bytes since the query was a read from two 16-bit registers. The data field consists of two pairs of bytes in a high byte - low byte order with the first requested register’s data coming first. Therefore the request for the 32-bit output contact status starting at register 3x8 is 00001004h (1000000000100b), which shows that outputs 3 and 13 are energized and the remaining outputs are de-energized.

5.6 Register Map

For a complete map of the MODBUS addresses supported by the product, see the *Relay Menu Database document*.

The register map tables in this document include an Equivalent Courier Cell column. The cell identifiers relate to the product’s internal Courier database and may be used in cross-reference with the Courier Protocol documentation or the product’s front panel user interface documentation.

The Data Format column specifies the format of the data presented by the associated MODBUS register or registers. The *Register Data Types* section describes the formats used.

The right-hand columns in the tables show whether the register is used in a particular product model. An asterisk indicates that the model uses the register.

5.7 Event Extraction

The product can store up to 512 event records in battery backed-up memory. An event record consists of a time stamp, a record type, and a set of information fields. The record type and the information fields record the event that occurred at the time captured by the time stamp.

The product has several classes of event record:

- Alarm events
- Opto-isolated status input events
- Relay contact output events
- Protection/DDB operation events
- Fault data capture events
- General events

The *Relay Menu Database document* specifies the available events. The product provides an “event filtering” feature that may be used to prevent specific events from being logged. The event filter is configured in the **Record Control** section of the product’s menu database in the MiCOM S1 Studio configuration tool.

The product supports two methods of event extraction providing either automatic or manual extraction of the stored event, fault, and maintenance records.

The product stores event, fault, and maintenance records in three separate queues. As entries are added to the fault and maintenance queues, a corresponding event is added to the event queue. Each queue is of different length and each queue may be individually cleared – see the *Event Record Delection* section. It is therefore possible to have a fault event or a maintenance event entry in the event queue with no corresponding entry in the associated queue because it has been overwritten or deleted.

The manual extraction procedure (see the *Manual Extraction Procedure section*) allows each of these three queues to be read independently.

The automatic extraction procedure (sss the *Automatic Extraction Procedure section*) reads records from the event queue. If the event record is a fault or a maintenance record, the record’s extended data is read also, if it is available from their queues.

Note	*Version 31 of the product introduced a new set of 3x registers for the presentation of the event and fault record data. These registers are used throughout the text of the following sub-sections. For legacy compatibility, the original registers are still provided. These are described as previous MODBUS addresses in the Relay Menu Database document. They should not be used for new installations. See the* ***Legacy Event Record Support*** *section for additional information.*

5.7.1 Manual Extraction Procedure

There are three registers used to manually select stored records. For each of these registers, zero represents the most-recent stored record. For example:

- 4x00100 - Select Event, 0 to 511
- 4x00101 - Select Fault, 0 to 4
- 4x00102 - Select Maintenance Record, 0 to 4

These registers can be read to indicate the numbers of the various types of record stored.

- 30100 - Number of stored records
- 30101 - Number of stored fault records
- 30102 - Number of stored maintenance records

Each fault or maintenance record logged causes an event record to be created by the relay. If this event record is selected the additional registers allowing the fault or maintenance record details will also become populated.

5.7.2 Automatic Extraction Procedure

Automatic event-record extraction allows records to be extracted as they occur. Event records are extracted in sequential order, including any fault or maintenance data that may be associated with an event.

The MODBUS master can determine whether the product has any events stored that have not yet been extracted. This is done by reading the product's status register 3x00001 (G26 data type). If the event bit of this register is set, the product contains event records that have not yet been extracted.

To select the next event for sequential extraction, the master station writes a value of one to the record selection register 4x00400 (G18 data type). The event data, plus any fault or maintenance data, can be read from the registers specified in the *Record Data* section. Once the data has been read, the event record is marked. This is done by writing a value of 2 to register 4x00400. The G18 data type consists of bit fields. Therefore it is also possible to both mark the current record as read and automatically select the next unread record. This is done by writing a value of 3 to the register.

When the last (most recent) record is accepted, the event flag in the status register (3x00001) resets. If the last record is accepted by writing a value of 3 to the record selection register (4x00400), a dummy record appears in the event-record registers with an "Event Type" value of 255. Selecting another record when none are available gives a MODBUS exception code 3, "Invalid value" (see the *MODBUS Response Code Interpretation* section).

One possible event record extraction procedure is shown in the following *Automatic event extraction procedure* diagram.

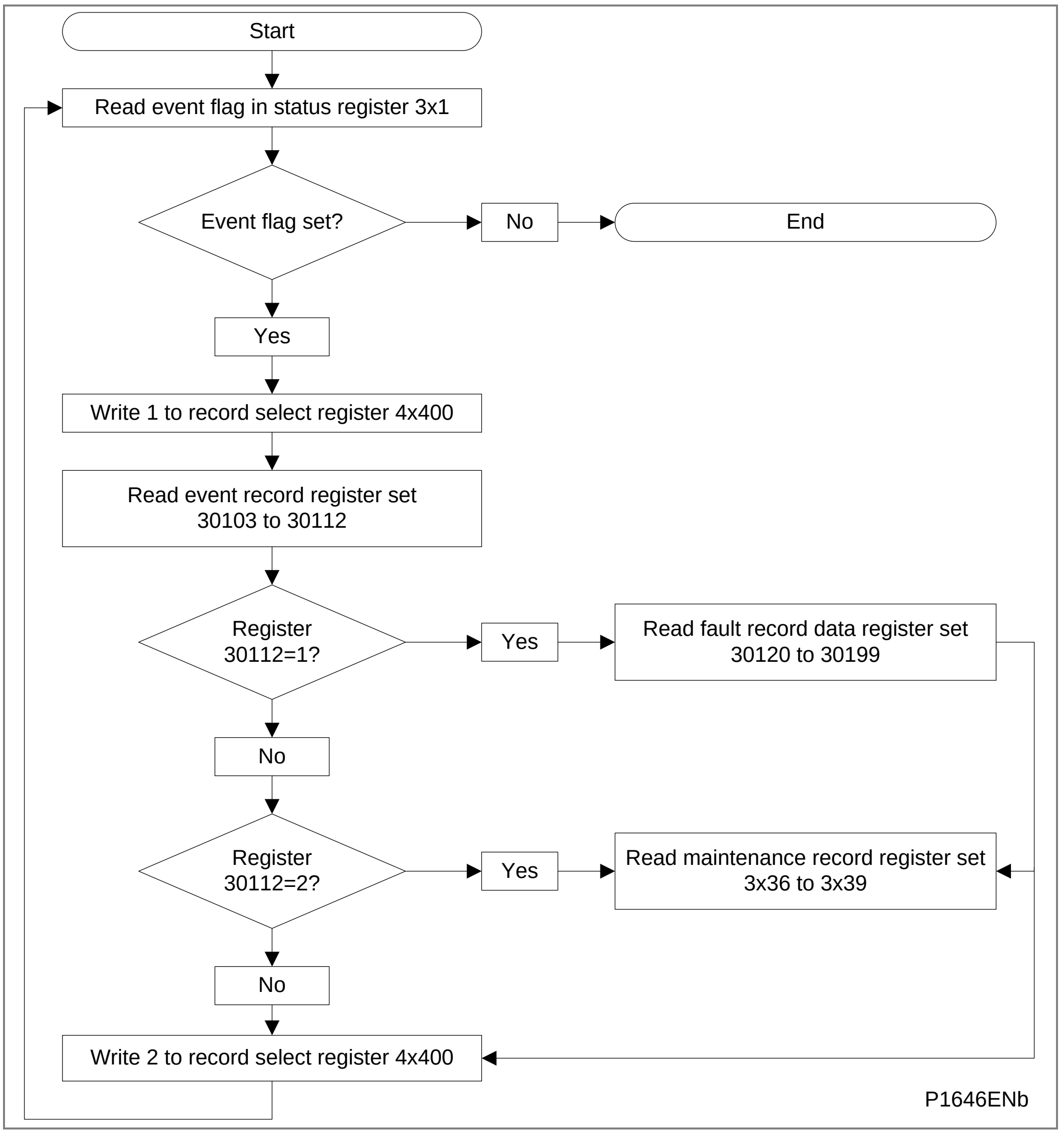


Figure 9 - Automatic event extraction procedure

5.7.3 Record Data

The location and format of the registers used to access the record data is the same whether they have been selected using manual or automatic extraction mechanisms, see the *Manual Extraction Procedure* and *Automatic Extraction Procedure* sections.

Event Description	MODBUS Address	Length (registers)	Comments
Time Stamp	30103	4	See G12 data type in the Relay Menu Database document.
Event Type	30107	1	Indicates the type of the event record. See G13 data type in the Relay Menu Database document (a value of 255 indicates that the end of the event log has been reached).
Event Value	30108	2	Contains the associated status register value as a string of binary flags for relay-contact, opto-input, alarm, and protection events. Otherwise it has a value of zero. When a status value is supplied, the value represents the recorded value of the event types associated register pair, as indicated by the Event Origin value (see Note 1).
Event Origin	30110	1	The Event Original value indicates the MODBUS Register pair where the change occurred (see Note 2). Possible values are: 30011: Alarm Status 1 event 30013: Alarm Status 2 event 30015: Alarm Status 3 event 30723: Relay contact event (2 registers: DDB 0-31 status) 30725: Status input event (2 registers: DDB 32-63 status) 30727 to 30785: Protection events (Indicates the 32-bit DDB status word that was the origin of the event) For General events, Fault events, and Maintenance events, a value of zero is returned.
Event Index	30111	1	The Event Index value is used to distinguish between events with the same Event Type and Event Origin. The registers value depends on the type of the event: For protection events, the value is the ID of the DDB that caused the event. For alarm events, the value is the ID of the alarm that caused the event. In both cases, the value includes the direction of the state transition in the Most Significant Bit. This direction bit is 1 for a 0-1 (low to high) change, and 0 for a 1-0 (high to low) change. For all other types of events, it has a value of zero.
Additional Data Present	30112	1	Indicates whether the record has additional data. 0: Indicates that there is no additional data. 1: Indicates that fault record data can be read from 3x10020 to 3x10999 (see Note 3). 2: Indicates that maintenance record data can be read from registers 3x36 to 3x39.

Note 1 *The protection-event status information is the value of the DDB status word that contains the protection DDB that caused the event.*

Note 2 *Subtracting 3000 from the Event Origin value results in the MODBUS 3x memory-page register ID, subtracting one from this results in the MODBUS register address - see section 5.5.1.2. The resultant register address can be used in a function code 4 MODBUS query.*

Note 3 *The exact number of fault record registers depends on the individual product - see Relay Menu Database.*

Table 7 – MODBUS Event record extraction registers

If a fault record or maintenance record is directly selected using the manual mechanism then the data can be read from the register ranges specified above. The event record data in registers 30103 to 30111 will not be available.

It is possible using register 40401(G6 data type) to clear independently the stored relay event/fault and maintenance records. This register also provides an option to reset the relay indications, which has the same effect on the relay as pressing the clear key within the alarm viewer using the front panel menu.

Event types 4 **Relay Contact Output Events** and 5 **Opto-Isolated Status Input Events** only provide the value of the input or output status register (as indicated by the Event Origin value) when the event occurred. If event transition information for each input or output is required, it must be deduced by comparing the event value with the previous event value (for identically-typed events records).

Event type 7 **General Event** events are solely identified by their **Event Value**.

Event types 8 **Fault Record** and 9 **Maintenance Record** require additional registers to be read when the associated additional data is available (see Note). The Fault record registers in the range 30120 to 30199 (the exact number of registers depends on the individual product) are documented in the 3x register-map in the *Relay Menu Database document*. The two additional 32-bit maintenance record register-pairs consist of a maintenance record type (register pair 3x36/7) and a type-specific error code (register pair 3x38/9). The *Maintenance record types* table lists the different types of maintenance record available from the product.

Note	*As noted at the beginning of the Event Extraction section, it should not be assumed that the additional data is available for fault and maintenance record events.*

Maintenance record	Front panel text	Record type 3x00036
Power on test errors (non-fatal)		
Watchdog 1 failure (fast)	Fast W'Dog Error	0
Battery fail	Battery Failure	1
Battery-backed RAM failure	BBRAM Failure	2
Field voltage failure	Field Volt Fail	3
Ribbon bus check failure	Bus Reset Error	4
Watchdog 2 failure (slow)	Slow W'Dog Error	5
Continuous self-test errors		
SRAM bus failure	SRAM Failure Bus	6
SRAM cell failure	SRAM Failure Blk.	7
Flash EPROM checksum failure	FLASH Failure	8
Program code verify failure	Code Verify Fail	9
Battery-backed RAM failure	BBRAM Failure	10
Battery fail	Battery Failure	11
Field Voltage failure	Field Volt Fail	12
EEPROM failure	EEPROM Failure	13
Fatal software exception	Software Failure	14
Incorrect hardware configuration	H/W Verify Fail	15
Software exception (typically non-fatal)	Non Standard	16
Analog module failure	Ana. Sample Fail	17
Ethernet card error	NIC Soft Error	18

Table 8 - Maintenance record types

5.7.4 Event Record Deletion

It is possible to independently delete ("clear") the stored event, fault, and maintenance record queues. This is done by writing a value of 1, 2, or 3 to register 4x401 (G6 data type), respectively.

Register 4x401 also provides an option to reset the product's front panel indications, which has the same effect as pressing the front panel "Clear" key when viewing alarm indications using the front panel user interface. This is done by writing a value of 4 to register 4x401.

See also the *Disturbance Record Deletion* section for details about deleting disturbance records.

5.7.5 Legacy Event Record Support

Version 57 of P24x and Version 31 of P34x product introduced a new set of 3x registers for the presentation of the event and fault record data. For legacy compatibility, the original registers are supported and are described in this section. They should not be used for new installations and they are correspondingly described as previous MODBUS address in the 3x-register table in the *Relay Menu Database document*.

The *Correspondence of obsolete event record 3x registers with their counterparts* table provides a mapping between the obsolete event record 3x-registers and the registers used in the event record discussions in the previous sub-sections.

The obsolete fault record data between registers 3x113 and 3x199, and 3x490 and 3x499, now exists between registers 3x10020 and 3x10999. In comparison with the obsolete fault record data, the data between registers 3x10020 and 3x10999 is ordered slightly differently and it contains new data values. These new values are not available in the obsolete fault-record register sets.

The maintenance-record registers 3x36 to 3x39 remain unaffected by this evolution.

Description	Obsolete register	Length (registers)	Corresponds to register
Number of stored event records	3x00100	1	3x10100
Number of stored fault records	3x00101	1	3x10101
Number of stored maintenance records	3x00102	1	3x10102
Time Stamp	3x00103	4	3x10103
Event Type	3x00107	1	3x10107
Event Value	3x00108	2	3x10108
Event Origin	3x00110	1	3x10110
Event Index	3x00111	1	3x10111
Additional Data Present	3x00112	1	3x10112

Table 9 – Correspondence of obsolete event record 3x registers with their counterparts record types

5.8 Disturbance Record Extraction

The product provides facilities for both manual and automatic extraction of disturbance records. The two methods differ only in the mechanism for selecting a disturbance record; the method for extracting the data and the format of the data are identical.

Records extracted are presented in IEEE COMTRADE format. This involves extracting two files: an ASCII text configuration file, and a binary data file.

Each file is extracted by repeatedly reading a data-page until all of the file's data has been transferred. The data-page is made up of 127 registers; providing a maximum of 254 bytes for each register block request.

5.8.1 Interface Registers

The following set of registers is presented to the master station to support the extraction of uncompressed disturbance records:

MODBUS Register	Name	Description
3x00001	Status register	Provides the status of the product as bit flags: b0 Out of service b1 Minor self test failure b2 Event b3 Time synchronization b4 Disturbance b5 Fault b6 Trip b7 Alarm b8 to b15 Unused A ‘1’ in bit “b4” indicates the presence of one or more disturbance records.
3x00800	Number of stored disturbances	Indicates the total number of disturbance records currently stored in the product, both extracted and unextracted.
3x00801	Unique identifier of the oldest disturbance record	Indicates the unique identifier value for the oldest disturbance record stored in the product. This is an integer value used with the **Number of stored disturbances** value to calculate a value for manually selecting records.
4x00250	Manual disturbance record selection register	This register is used to manually select disturbance records. The values written to this cell are an offset of the unique identifier value for the oldest record. The offset value, which ranges from 0 to the Nº of stored disturbances - 1, is added to the identifier of the oldest record to generate the identifier of the required record.
4x00400	Record selection command register	This register is used during the extraction process and has several commands. These are: b0 Select next event b1 Accept event b2 Select next disturbance record b3 Accept disturbance record b4 Select next page of disturbance data b5 Select data file
3x00930 to 3x00933	Record time stamp	These registers return the timestamp of the disturbance record.
3x00802	Number of registers in data page	This register informs the master station of the number of registers in the data page that are populated.
3x00803 to 3x00929	Data page registers	These 127 registers are used to transfer data from the product to the master station.
3x00934	Disturbance record status register	The disturbance record status register is used during the extraction process to indicate to the master station when data is ready for extraction. See Table 13.
4x00251	Data file format selection	This is used to select the required data file format. This is reserved for future use.
Note		*Register addresses are provided in reference code + address format. E.g. 4x00001 is reference code 4x, address 1 (which is specified as function code 03, address 0x0000 in the MODBUS specification).*

Table 10 - Disturbance record extraction registers

The Disturbance Record status register reports one of these values:

State		Description
Idle		This is the state reported when no record is selected; such as after power-on or after a record has been marked as extracted.
Busy		The product is currently processing data.
Page ready		The data page has been populated and the master can now safely read the data.
Configuration complete		All of the configuration data has been read without error.
Record complete	4	All of the disturbance data has been extracted.

State		Description
Disturbance overwritten	5	An error occurred during the extraction process where the disturbance being extracted was overwritten by a new record.
No unextracted disturbances	6	An attempt was made by the master station to automatically select the next oldest unextracted disturbance when all records have been extracted.
Not a valid disturbance	7	An attempt was made by the master station to manually select a record that did not exist in the product.
Command out of sequence	8	The master station issued a command to the product that was not expected during the extraction process.

Table 11 - Disturbance record status register (3x934) values

5.8.2 Extraction Procedure

The following procedure must be used to extract disturbance records from the product. The procedure is split into four sections:

1. Selection of a disturbance, either manually or automatically.
2. Extraction of the configuration file.
3. Extraction of the data file.
4. Accepting the extracted record (automatic extraction only).

5.8.2.1 Manual Extraction Procedure

The procedure used to extract a disturbance manually is shown in the following *Manual selection of a disturbance record* diagram. The manual method of extraction does not allow for the acceptance of disturbance records.

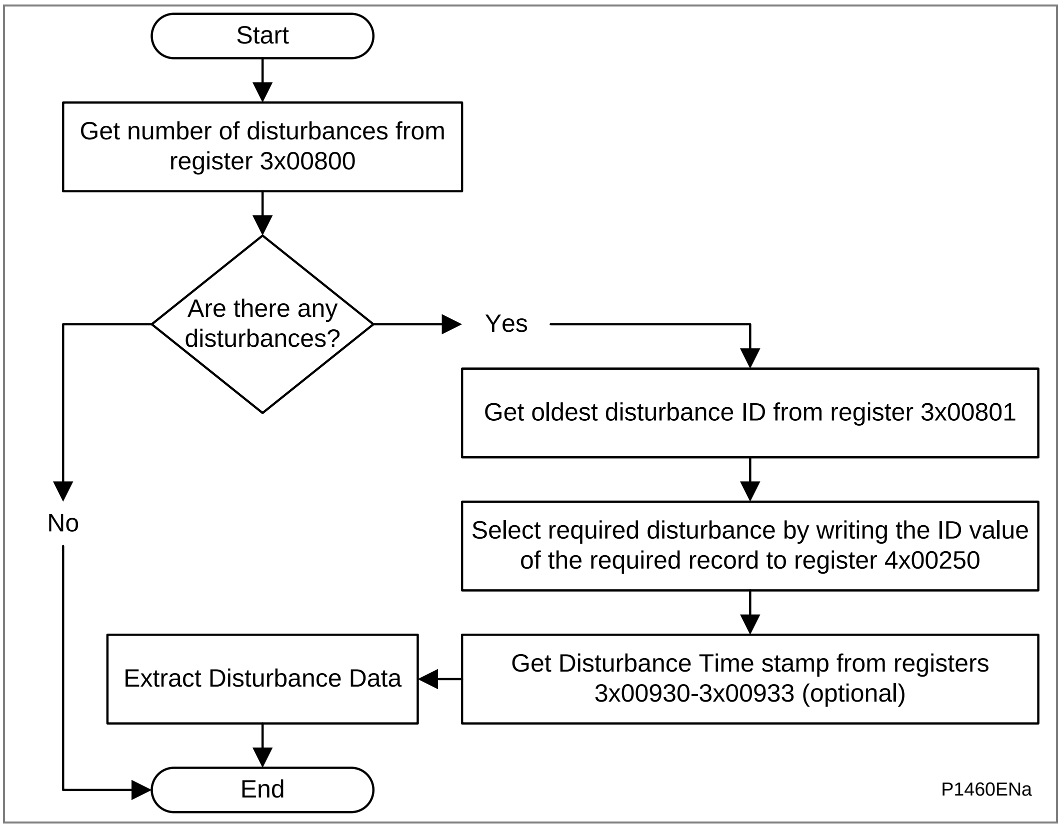


Figure 10 - Manual selection of a disturbance record

5.8.2.2 Automatic Extraction Procedure - Option 1

There are two methods that can be used for automatically extracting disturbances. The procedure for the first method is shown in the *Automatic selection of a disturbance - option 1* diagram. This also shows the acceptance of the disturbance record once the extraction is complete.

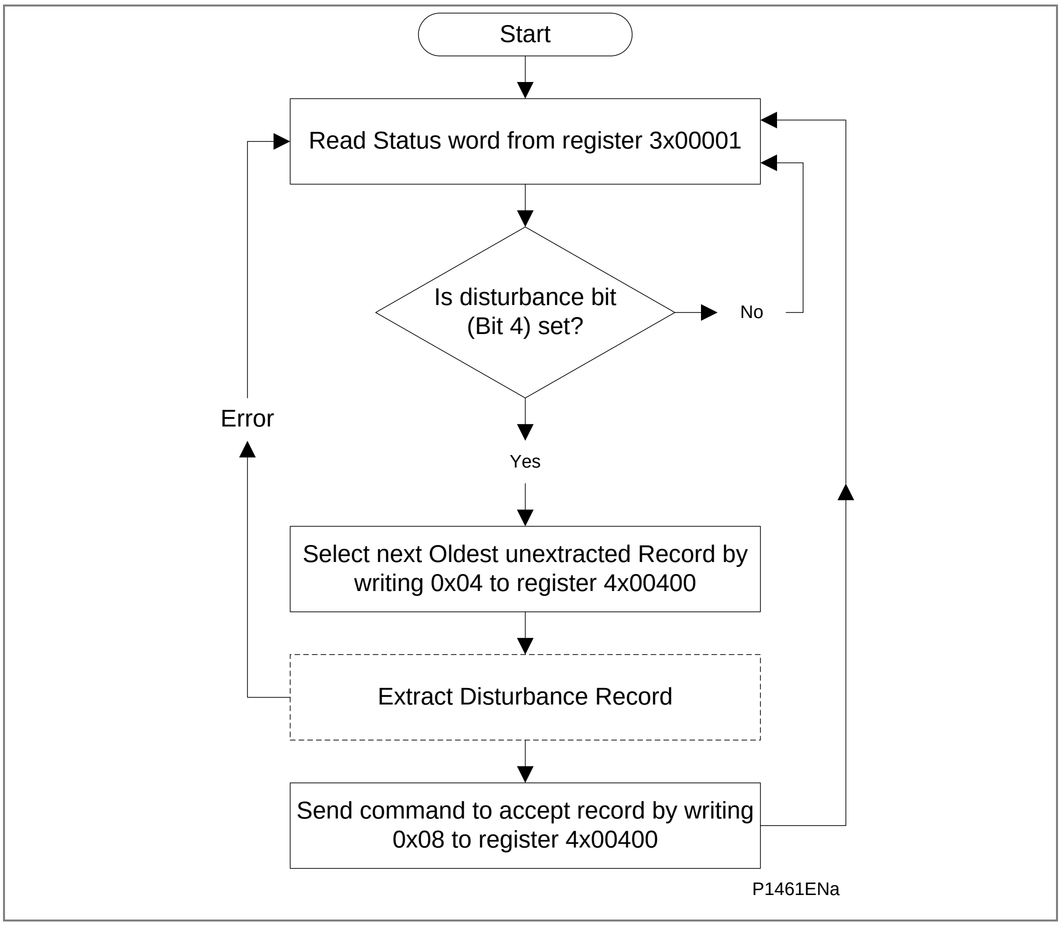


Figure 11 - Automatic selection of a disturbance - option 1

5.8.2.3 Automatic Extraction Procedure - Option 2

The second method that can be used for automatic extraction is shown in the *Automatic selection of a disturbance - option 2* diagram. This also shows the acceptance of the disturbance record once the extraction is complete.

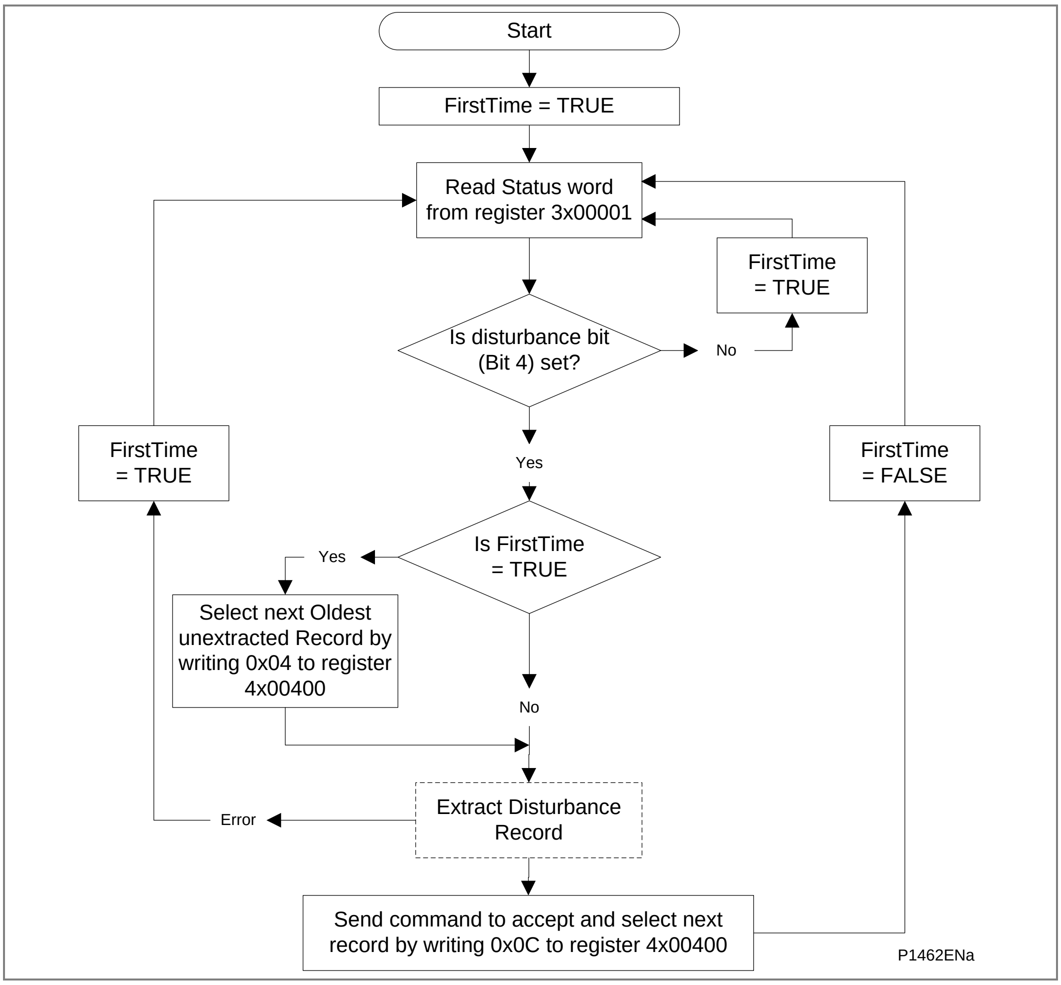


Figure 12 - Automatic selection of a disturbance - option 2

5.8.2.4 Extracting the Disturbance Data

Extraction of a selected disturbance record is a two-stage process. This involves first reading the configuration file, then the data file. The *Extracting the COMTRADE configuration file* diagram shows how the configuration file is read and *the Extracting the COMTRADE binary data file* diagram shows how the data file is extracted.

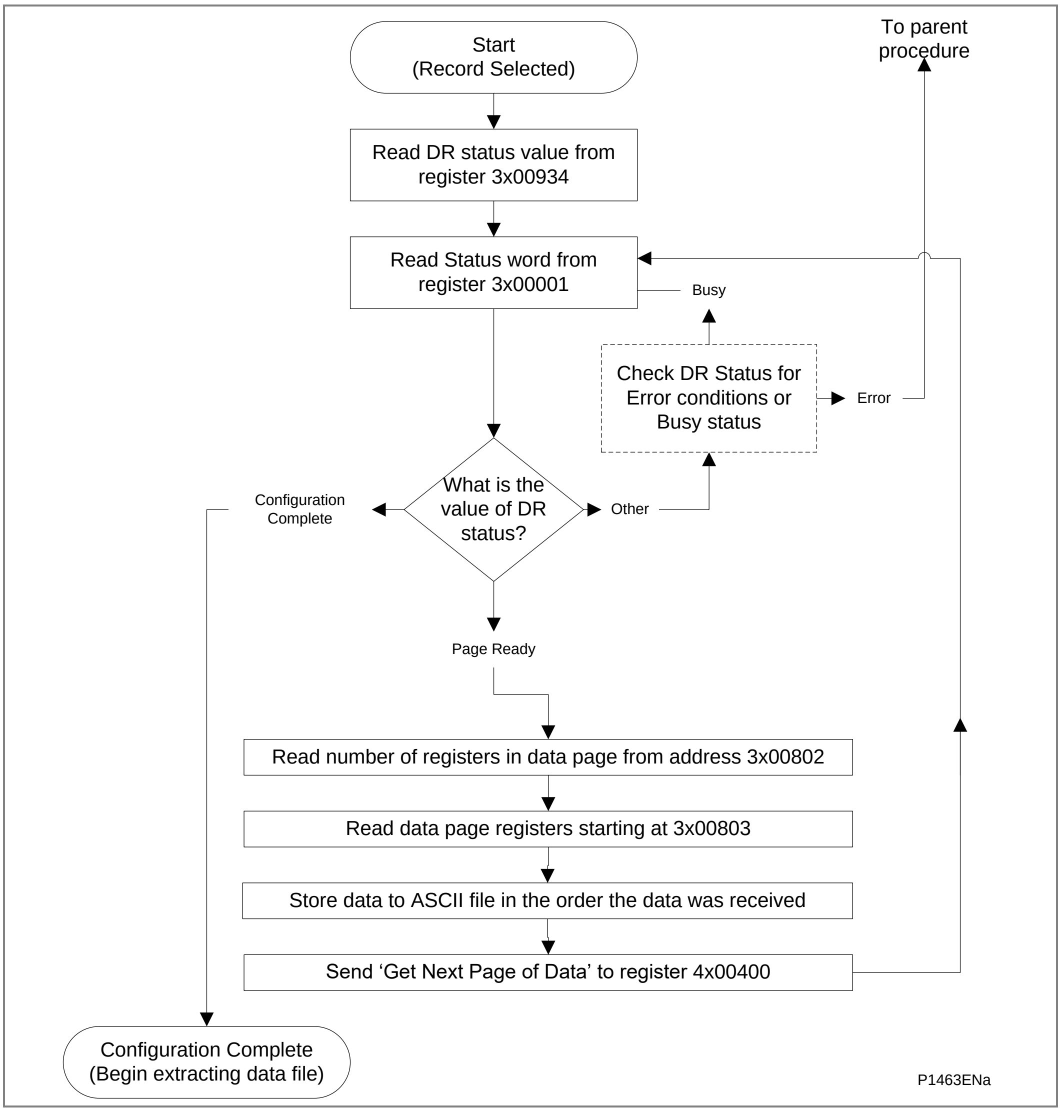


Figure 13 - Extracting the COMTRADE configuration file

The following figure shows how the data file is extracted:

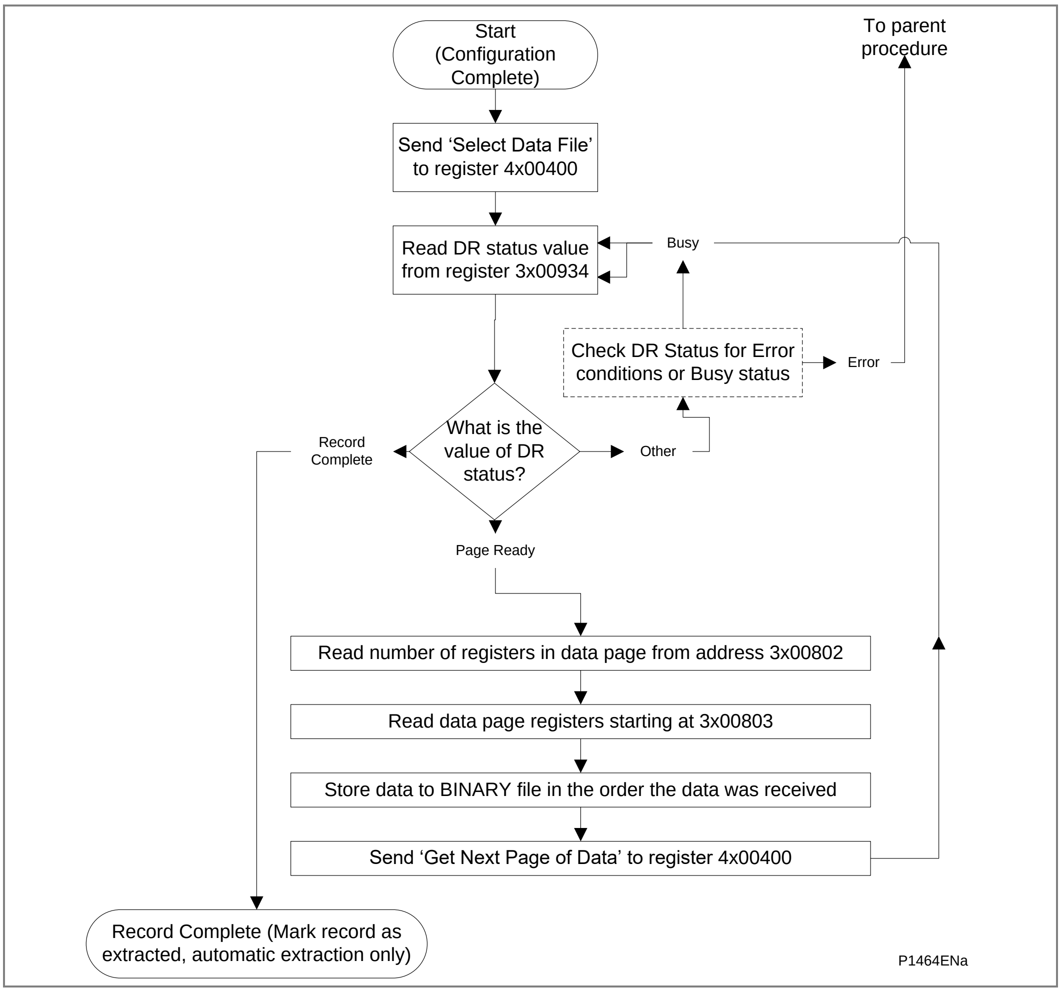


Figure 14 - Extracting the COMTRADE binary data file

During the extraction of a COMTRADE file, an error may occur that is reported in the disturbance record status register, 3x934. This can be caused by the product overwriting the record that is being extracted. It can also be caused by the master issuing a command that is not in the bounds of the extraction procedure.

5.8.3 Storage of Extracted Data

The extracted data needs to be written to two separate files. The first is the configuration file, which is in ASCII text format, and the second is the data file, which is in a binary format.

5.8.3.1 Storing the Configuration File

As the configuration data is extracted from the product, it should be stored to an ASCII text file with a '.cfg' file extension. Each register in the page is a G1 format 16-bit unsigned integer that is transmitted in big-endian byte order. The master must write the configuration file page-data to the file in ascending register order with <u>each register's high order byte written before its low order byte</u>, until all the pages have been processed.

5.8.3.2 Storing the Binary Data File

As the binary data is extracted from the product, it should be stored to a binary file with the same name as the configuration file, but with a '.dat' file extension instead of the '.cfg' extension. Each register in the page is a G1-format 16-bit unsigned integer that is transmitted in big-endian byte order. The master must write the page data to a file in ascending register order with <u>each register's high order byte written before its low order byte</u> until all the pages have been processed.

5.8.4 Disturbance Record Deletion

All of the disturbance records stored in the product can be deleted (“cleared”) by writing 5 to the record control register 4x401 (G6 data type). See the *Event Record Deletion* section for details on event record deletion.

5.9 Setting Changes

The relay settings can be split into two categories:

- Control and support settings
- Disturbance record settings and protection setting groups

Changes to settings in the control and support area are executed immediately. Changes to the protection setting groups or the disturbance recorder settings are stored in a temporary ‘scratchpad’ area and must be confirmed before they are implemented. All the product settings are 4xxxx page registers; see the *Relay Menu Database document*. The following points should be noted when changing settings:

- Settings implemented using multiple registers must be written to using a multi-register write operation. The product does not support write access to sub-parts of multi-register data types.
- The first address for a multi-register write must be a valid address. If there are unmapped addresses in the range that is written to, the data associated with these addresses are discarded.
- If a write operation is performed with values that are out of range, an “illegal data” response code is produced. Valid setting values in the same write operation are executed.
- If a write operation is performed attempting to change registers that require a higher level of password access than is currently enabled, all setting changes in the write operation are discarded.

5.9.1 Authentication and Password Protection

Access to the product’s settings is subject to authentication of a user who has the correct role. The authentication needed to change a setting is shown in the 4x register-map table in the *Relay Menu Database document, P64x/EN MD*.

5.9.2 Control and Support Settings

Control and support settings are committed immediately when a value is written to such a register. The MODBUS registers in this category are:

- 4x00000-4x00599
- 4x00700-4x00999
- 4x02049 to 4x02052
- 4x10000-4x10999

5.9.2.1 Time Synchronization

The value of the product’s real time clock can be set by writing the desired time (see the *Date and Time Format (Data Type G12)* section) to registers 4x02049 through 4x02052. These registers are standard to Schneider Electric MiCOM products, which makes it easier to broadcast a time synchronization packet, being a block write to the time setting registers sent to slave address zero.

When the product’s time has been set using these registers, the Time Synchronized flag in the MODBUS Status Register (3x1: type G26) is set. The product automatically clears this flag if more than five minutes has elapsed since these registers were last written to.

A “Time synchronization” event is logged if the new time value is more than two seconds different to the current value.

5.9.3 Protection and Disturbance Recorder Settings

Protection configuration-settings are written to a scratchpad memory area. A confirmation procedure is required to commit the contents of the scratchpad to the product's protection functions, which ensures that their configuration is consistent at all times. The contents of the scratchpad memory can be discarded with the abort procedure. The scratchpad confirmation and abort procedures are described in the *Scratchpad Management* section.

The product supports four groups of protection settings. One protection-group is active and the other three are either dormant or disabled. The active protection-group can be selected by writing to register 4x00404. An illegal data response is returned if an attempt is made to set the active group to one that has been disabled.

Group 1	41000 - 42999
Group 2	43000 - 44999
Group 3	45000 - 46999
Group 4	47000 - 48999

5.9.4 Scratchpad Management

In addition to the basic editing of the protection setting groups, the following functions are provided:

- Default values can be restored to a setting group or to all of the relay settings by writing to register 40402.
- It is possible to copy the contents of one setting group to another by writing the source group to register 40406 and the target group to 40407.

It should be noted that the setting changes performed by either of the two operations defined above are made to the scratchpad area. These changes must be confirmed by writing to register 40405.

The active protection setting groups can be selected by writing to register 40404. An illegal data response will be returned if an attempt is made to set the active group to one that has been disabled.

5.10 Register Data Types

The product maps one or more MODBUS registers to data-typed information contained in an internal database. These data-types are referred to as G-Types since they have a 'G' prefixed identifier. The *Relay Menu Database document* gives a complete definition of the all of the G-Types used in the product.

Generally the data types are transmitted in high byte to low byte order, also known as "Big Endian format". This may require the MODBUS master to reorder the received bytes into a format that complies with its byte order and register order (for multi-register G-Types) conventions. Most MODBUS masters provide byte-swap and register-swap device (or data point) configuration to cope with the wide range of implementations.

The product's data types cannot be broken into smaller parts. Therefore multi-register data types cannot be read from or written to on an individual register basis. All of the registers for a multi-register data-typed item must be read from or written to with a single block read or write command. The following subsections provide some additional notes for a few of the more complex G-Types.

5.11 Numeric Setting (Data Types G2 & G35)

Numeric settings are integer representations of real (non-integer) values. The register value is the number of setting increments (or steps) that the real value is away from the real minimum value. This is expressed by this formula:

$S_{real} = S_{min.} + (S_{inc.} \times S_{numeric})$

Where:

S_{real}	Setting real value
$S_{min.}$	Setting real minimum value
$S_{inc.}$	Setting real increment (step) value
$S_{numeric}$	Setting numeric (register) value

For example, a setting with a real value setting range of 0.01 to 10 in steps of 0.01 would have the following numeric setting values:

Real value (S_{real})	Numeric value ($S_{numeric}$)
0.01	0
0.02	1
1.00	99

Table 12 – Numeric settings

The G2 numeric data type uses 1 register as an unsigned 16-bit integer, whereas the G35 numeric data type uses 2 registers as an unsigned 32-bit integer. The G2 data type therefore provides a maximum setting range of $2^{16} \times S_{inc}$. Similarly the G35 data type provides a maximum setting range of $2^{32} \times S_{inc}$.

5.12 Date and Time Format (Data Type G12)

The date-time data type G12 allows real date and time information to be conveyed down to a resolution of 1 ms. The data-type is used for record time-stamps and for time synchronization (see the *Time Synchronization* section).

The structure of the data type is shown in the following table and complies with the IEC60870-5-4 Binary Time 2a format.

Byte	Bit Position							
	7	6	5	4	3	2	1	0
1	m^7	m^6	m^5	m^4	m^3	m^2	m^1	m^0
2	m^{15}	m^{14}	m^{13}	m^{12}	m^{11}	m^{10}	m^9	m^8
3	IV	R	I^5	I^4	I^3	I^2	I^1	I^0
4	SU	R	R	H^4	H^3	H^2	H^1	H^0
5	W^2	W^1	W^0	D^4	D^3	D^2	D^1	D^0
6	R	R	R	R	M^3	M^2	M^1	M^0
7	R	Y^6	Y^5	Y^4	Y^3	Y^2	Y^1	Y^0

Where:

m	=	0…59,999ms	Y	=	0…99 Years (year of century)
I	=	0…59 minutes	R	=	Reserved bit = 0
H	=	0…23 Hours	SU	=	Summertime: 0=standard time, 1=summer time
W	=	1…7 Day of week; Monday to Sunday, 0 for not calculated	IV	=	Invalid value: 0=valid, 1=invalid
D	=	1…31 Day of Month			
M	=	1…12 Month of year; January to December	range	=	0ms…99 years

Table 13 - G12 date & time data type structure

The seven bytes of the structure are packed into four 16-bit registers. Two packing formats are provided: standard and reverse. The prevailing format is selected by the G238 setting in the **Date and Time** menu column or by register 4x306 (Modbus IEC Time).

The standard packing format is the default and complies with the IEC60870-5-4 requirement that byte 1 is transmitted first. This is followed by byte 2 through to byte 7, followed by a null (zero) byte to make eight bytes in total. Since register data is usually transmitted in big-endian format (high-order byte followed by low-order byte), byte 1 is in the high-order byte position followed by byte 2 in the low-order position for the first register. The last register contains just byte 7 in the high-order position and the low-order byte has a value of zero.

The reverse packing format is the exact byte transmission order reverse of the standard format. The null (zero) byte is sent as the high-order byte of the first register and byte 7 as the register's low-order byte. The second register's high-order byte contains byte 6 and byte 5 in its low order byte.

Both packing formats are fully documented in the *Relay Menu Database document* for the G12 type.

The principal application of the reverse format is for date-time packet format consistency when a mixture of MiCOM Px20, Px30, and Px40 series products are being used. This is especially true when there is a requirement for broadcast time synchronization with a mixture of such MiCOM products.

The data type provides only the value for the year of the century. The century must be deduced. The century could be imposed as 20 for applications not dealing with dates stored in this format from the previous (20th) century. Alternatively, the century can be calculated as the one that produces the nearest time value to the current date. For example: 30-12-99 is 30-12-1999 when received in 1999 & 2000, but is 30-12-2099 when received in 2050. This technique allows 2-digit years to be accurately converted to 4 digits in a ±50 year window around the current datum.

The invalid bit has two applications:

- It can indicate that the date-time information is considered inaccurate, but is the best information available.
- Date-time information is not available.

The summertime bit is used to indicate that summertime (day light saving) is being used and, more importantly, to resolve the alias and time discontinuity which occurs when summertime starts and ends. This is important for the correct time correlation of time stamped records.

Note	*The value of the summertime bit does not affect the time displayed by the product.*

The day of the week field is optional and if not calculated is set to zero.

This data type (and therefore the product) does not cater for time zones so the end user must determine the time zone used by the product. UTC (universal co-ordinated time) is commonly used and avoids the complications of daylight saving timestamps.

5.13 Power and Energy Measurement Data Formats (G29 & G125)

The power and energy measurements are available in two data formats, G29 integer format and G125 IEEE754 floating point format. The G125 format is preferred over the older G29 format.

5.13.1 Data Type G29

Data type G29 consists of three registers. The first register is the per-unit power or energy measurement and is of type G28, which is a signed 16-bit quantity. The second and third registers contain a multiplier to convert the per-unit value to a real value.

The multiplier is of type G27, which is an unsigned 32-bit quantity. Therefore the overall value conveyed by the G29 data type must be calculated as G29 = G28 × G27.

The product calculates the G28 per unit power or energy value as

G28 = ((measured secondary quantity) / (CT secondary) × (110 V / (VT secondary)).

Since data type G28 is a signed 16-bit integer, its dynamic range is constrained to ±32768. This limitation should be borne in mind for the energy measurements, as the G29 value saturates a long time before the equivalent G125.

The associated G27 multiplier is calculated as

G27 = (CT primary) × (VT primary / 110 V)
when primary value measurements are selected,
and as
G27 = (CT secondary) × (VT secondary / 110 V)
when secondary value measurements are selected.

Due to the required truncations from floating point values to integer values in the calculations of the G29 component parts and its limited dynamic range, the use of the G29 values is only recommended when the MODBUS master cannot deal with the G125 IEEE754 floating point equivalents.

Note	*The G29 values must be read in whole multiples of three registers. It is not possible to read the G28 and G27 parts with separate read commands.*

Example:

For A-Phase Power (Watts) (registers 3x00300 - 3x00302) for a 110 V nominal,
In = 1 A, VT ratio = 110 V:110 V and CT ratio = 1 A : 1 A.

Applying A-phase 1A @ 63.51V

A-phase Watts = ((63.51 V × 1 A) / In=1 A) × (110/Vn=110 V) = 63.51 Watts

The G28 part of the value is the truncated per unit quantity, which is equal to 64 (40h).

The multiplier is derived from the VT and CT ratios set in the product, with the equation ((CT Primary) × (VT Primary) / 110 V)). Therefore the G27 part of the value equals 1 and the overall value of the G29 register set is 64×1 = 64 W.

The registers would contain:
3x00300 - 0040h
3x00301 - 0000h
3x00302 - 0001h

Using the previous example with a VT ratio = 110,000 V:110 V and CT ratio = 10,000 A : 1 A the G27 multiplier would be 10,000 A × 110,000 V / 110 = 10,000,000. The overall value of the G29 register set is 64 × 10,000,000 = 640 MW. (Note that there is an actual error of 49 MW in this calculation due to loss of resolution).

The registers would contain:
3x00300 - 0040h
3x00301 - 0098h
3x00302 - 9680h

5.13.2 Data Type G125

Data type G125 is a short float IEEE754 floating point format, which occupies 32 bits in two consecutive registers. The most significant 16 bits of the format are in the first (low order) register and the least significant 16 bits in the second register.

The value of the G125 measurement is as accurate as the product’s ability to resolve the measurement after it has applied the secondary or primary scaling factors as required. It does not suffer from the truncation errors or dynamic range limitations associated with the G29 data format.

6 IEC60870-5-103 INTERFACE

The IEC60870-5-103 interface is a master/slave interface with the relay as the slave device. The relay conforms to compatibility level 2; compatibility level 3 is not supported.

These IEC60870-5-103 facilities are supported by this interface:

- Initialization (Reset)
- Time Synchronization
- Event Record Extraction
- General Interrogation
- Cyclic Measurements
- General Commands
- Disturbance Record Extraction
- Private Codes

6.1 Physical Connection and Link Layer

Two connection options are available for IEC60870-5-103, either the rear EIA(RS)-485 port or an optional rear fiber optic port. If the fiber optic port is fitted, the active port can be selected using the front panel menu or the front Courier port. However the selection is only effective following the next relay power up.

For either of the two connection modes, both the relay address and baud rate can be selected using the front panel menu or the front Courier port. Following a change to either of these two settings a reset command is required to re-establish communications, see the description of the reset command in the *Initialization* section.

6.2 Initialization

Whenever the relay has been powered up, or if the communication parameters have been changed, a reset command is required to initialize the communications. The relay responds to either of the two reset commands (Reset CU or Reset FCB). However, the Reset CU clears any unsent messages in the relay’s transmit buffer.

The relay responds to the reset command with an identification message ASDU 5. The Cause Of Transmission (COT) of this response is either Reset CU or Reset FCB depending on the nature of the reset command. For information on the content of ASDU 5 see *section IEC60870-5-103 in the Relay Menu Database document*.

In addition to the ASDU 5 identification message, if the relay has been powered up it also produces a power-up event.

6.3 Time Synchronization

The relay time and date can be set using the time synchronization feature of the IEC60870-5-103 protocol. The relay corrects for the transmission delay as specified in IEC60870-5-103. If the time synchronization message is sent as a send / confirm message, the relay responds with a confirm. Whether the time-synchronization message is sent as a send / confirm or a broadcast (send / no reply) message, a time synchronization Class 1 event is generated.

If the relay clock is synchronised using the IRIG-B input, it is not possible to set the relay time using the IEC60870-5-103 interface. If the time is set using the interface, the relay creates an event using the current date and time from the internal clock, which is synchronised to IRIG-B.

6.4 Spontaneous Events

Events are categorized using the following information:

- Function Type
- Information Number

The IEC60870-5-103 profile in the *Relay Menu Database document*, contains a complete listing of all events produced by the relay.

6.5 General Interrogation (GI)

The General Interrogation (GI) request can be used to read the status of the relay, the function numbers, and information numbers that are returned during the GI cycle. See the IEC60870-5-103 profile in the *Relay Menu Database document*.

6.6 Cyclic Measurements

The relay produces measured values using ASDU 9 cyclically. This can be read from the relay using a Class 2 poll (note ADSU 3 is not used). The rate at which the relay produces new measured values can be controlled using the Measurement Period setting. This setting can be edited from the front panel menu or the front Courier port and is active immediately following a change.

The measurands transmitted by the relay are sent as a proportion of 2.4 times the rated value of the analog value.

6.7 Commands

A list of the supported commands is contained in the *Relay Menu Database document*. The relay responds to other commands with an ASDU 1, with a Cause of Transmission (COT) indicating 'negative acknowledgement'.

6.8 Test Mode

Using either the front panel menu or the front Courier port, it is possible to disable the relay output contacts to allow secondary injection testing to be performed. This is interpreted as 'test mode' by the IEC60870-5-103 standard. An event is produced to indicate both entry to and exit from test mode. Spontaneous events and cyclic measured data transmitted while the relay is in test mode has a COT of 'test mode'.

6.9 Disturbance Records

For Software Releases prior to B0 (i.e. 57 and earlier):

The disturbance records are stored in uncompressed format and can be extracted using the standard mechanisms described in IEC60870-5-103.

Note	*IEC60870-5-103 only supports up to 8 records.*

For Software Release B0 - A & B:

The disturbance records are stored in uncompressed format and can be extracted using the standard mechanisms described in IEC60870-5-103. The Enhanced Disturbance Recorder software releases mean the relay can store a minimum of 15 records, each of 1.5 seconds duration.

Using relays with IEC 60870-5 CS 103 communication means they can store the same total record length. However, the IEC 60870-5 CS 103 communication protocol dictates that only 8 records (of 3 seconds duration) can be extracted via the rear port.

For Other Software Releases:

The disturbance records are stored in uncompressed format and can be extracted using the standard mechanisms described in IEC60870-5-103.

Where available, the Enhanced Disturbance Recorder software releases mean the relay can store a minimum of 15 records, each of 3.0 seconds duration.

Using relays with IEC 60870-5 CS 103 communication means they can store the same total record length. However, the IEC 60870-5 CS 103 communication protocol dictates that only 8 records (of 3 seconds duration) can be extracted via the rear port.

6.10 Blocking of Monitor Direction

The relay supports a facility to block messages in the Monitor direction and in the Command direction. Messages can be blocked in the Monitor and Command directions using the menu commands, Communications - CS103 Blocking -
Disabled / Monitor Blocking / Command Blocking or DDB signals Monitor Blocked and Command Blocked.

6.11 Setting Changes through IEC103 Protocol

The IEC 870-5-103 Standard suggests using the generic services for read/write operations on the proprietary data of different manufacture protection equipments, the directory structure specified by the standard for accessing the generic data is the same as the Px40 setting structure. With the generic services selected in the Platform Software full access to the relay's database is possible over the first rear communications port using the IEC608070-5-103 protocol with Level 3 compatibility.

Each cell in the database has an attribute that defines whether it is included in the list of cells that are subject to a General Interrogation of Generic data.

The following Group 1,2,3 and 4 settings will be included in the GGI:

- Overcurrent, Neg Seq O/C, Broken Conductor, Earth Fault 1 and 2,
- SEF/REF Prot'n, Residual O/V NVD, Thermal Overload, NEG Sequence O/V,
- Cold Load Pickup, Selective Logic, Admit Protection, Power Protection,
- Volt Protection, Freq Protection, CB FAIL & I<, Supervision,
- Fault Locator, System Checks, Autoreclose, ADV.Frequency.

7 DNP3.0 INTERFACE

7.1 DNP3.0 Protocol

The DNP3.0 protocol is defined and administered by the DNP Users Group. For information on the user group, DNP3.0 in general and the protocol specifications, see www.dnp.org

The descriptions given there are intended to accompany the device profile document that is included in the *Relay Menu Database document.* The DNP3.0 protocol is not described here, please refer to the documentation available from the user group. The device profile document specifies the full details of the DNP3.0 implementation for the relay. This is the standard format DNP3.0 document that specifies which objects; variations and qualifiers are supported. The device profile document also specifies what data is available from the relay using DNP3.0. The relay operates as a DNP3.0 slave and supports subset level 2 of the protocol, plus some of the features from level 3.

DNP3.0 communication uses the EIA(RS)-485 communication port at the rear of the relay. The data format is 1 start bit, 8 data bits, an optional parity bit and 1 stop bit. Parity is configurable (see menu settings below).

7.2 DNP3.0 Menu Setting

The following settings are in the DNP3.0 menu in the ***Communications*** column.

Settings	Range	Description
Remote Address	0 - 65519	DNP3.0 address of relay (decimal)
Baud Rate	1200, 2400, 4800, 9600, 19200, 38400	Selectable baud rate for DNP3.0 serial communication
Parity	None, Odd, Even	Parity setting
DNP Time Sync	Disabled, Enabled	If set to ‘Enabled’ the DNP3.0 master station can be used to synchronize the time on the IED. If set to ‘Disabled’ either the internet free running clock, or IRIG-B input are used.
Meas Scaling	Primary, Secondary or Normalised	Setting to report analog values in terms of primary, secondary or normalized (with respect to the CT/VT ratio setting) values.
Message Gap (ms)	0-50	DNP3.0 versions only. This setting allows the master station to have an interframe gap.
DNP Need Time	1 - 30 mins	The length of time waited before requesting another time sync from the master.
DNP App Fragment	100 - 2048 bytes	The maximum message length (application fragment size) transmitted by the relay.
DNP App Timeout	1 - 120 s	The length of time waited after sending a message fragment and waiting for a confirmation from the master.
DNP SBO Timeout	1 - 10 s	The length of time waited after receiving a select command and waiting for an operate confirmation from the master.
DNP Link Timeout	0 - 120 s	The length of time the relay waits for a Data Link Confirm from the master. A value of 0 means data link support disabled and 1 to 120 seconds is the timeout setting.

Table 14 - DNP3.0 Menu Settings

7.3 Object 1 Binary Inputs

Object 1, binary inputs, contains information describing the state of signals in the relay, which mostly form part of the Digital Data Bus (DDB). In general, these include the state of the output contacts and input optos, alarm signals and protection start and trip signals. The ‘DDB number’ column in the device profile document provides the DDB numbers for the DNP3.0 point data. These can be used to cross-reference to the DDB definition list. See the *Relay Menu Database document*. The binary input points can also be read as change events using object 2 and object 60 for class 1-3 event data.

7.4 Object 10 Binary Outputs

Object 10, binary outputs, contains commands that can be operated using DNP3.0. Therefore the points accept commands of type pulse on [null, trip, close] and latch on/off as detailed in the device profile in the *Relay Menu Database document* and execute the command once for either command. The other fields are ignored (queue, clear, trip/close, in time and off time).

There is an additional image of the control inputs. Described as alias control inputs, they reflect the state of the control input, but with a dynamic nature.

- If the Control Input DDB signal is already SET and a new DNP SET command is sent to the Control Input, the Control Input DDB signal goes momentarily to RESET and then back to SET.
- If the Control Input DDB signal is already RESET and a new DNP RESET command is sent to the Control Input, the Control Input DDB signal goes momentarily to SET and then back to RESET.

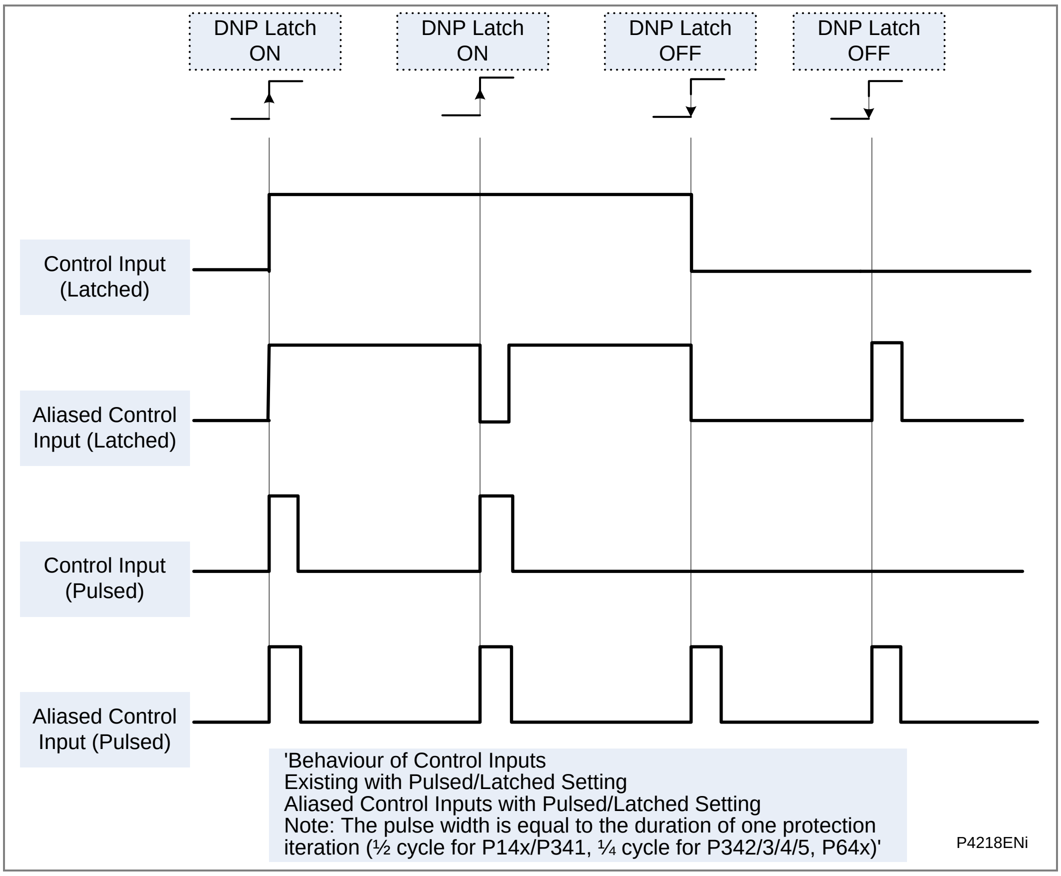


Figure 15 - Behavior when control input is set to pulsed or latched

Many of the relay's functions are configurable so some of the object 10 commands described in the following sections may not be available. A read from object 10 reports the point as off-line and an operate command to object 12 generates an error response.

Examples of object 10 points that maybe reported as off-line are:

- Activate setting groups — Ensure setting groups are enabled
- CB trip/close — Ensure remote CB control is enabled
- Reset NPS thermal — Ensure NPS thermal protection is enabled
- Reset thermal O/L — Ensure thermal overload protection is enabled
- Reset RTD flags — Ensure RTD Inputs is enabled
- Control inputs — Ensure control inputs are enabled

7.5 Object 20 Binary Counters

Object 20, binary counters, contains cumulative counters and measurements. The binary counters can be read as their present 'running' value from object 20, or as a 'frozen' value from object 21. The running counters of object 20 accept the read, freeze and clear functions. The freeze function takes the current value of the object 20 running counter and stores it in the corresponding object 21 frozen counter. The freeze and clear function resets the object 20 running counter to zero after freezing its value.

Binary counter and frozen counter change event values are available for reporting from object 22 and object 23 respectively. Counter change events (object 22) only report the most recent change, so the maximum number of events supported is the same as the total number of counters. Frozen counter change events (object 23) are generated whenever a freeze operation is performed and a change has occurred since the previous freeze command. The frozen counter event queues store the points for up to two freeze operations.

7.6 Object 30 Analog Input

Object 30, analog inputs, contains information from the relay's measurements columns in the menu. All Object 30 points can be reported as 16 or 32-bit integer values with flag, 16 or 32-bit integer values without flag, as well as short floating point values.

Analogue values can be reported to the master station as primary, secondary or normalized values (which takes into account the relay's CT and VT ratios) and this is settable in the DNP3.0 Communications Column in the relay. Corresponding deadband settings can be displayed in terms of a primary, secondary or normalized value. Deadband point values can be reported and written using Object 34 variations.

The deadband is the setting used to determine whether a change event should be generated for each point. The change events can be read using Object 32 or Object 60. These events are generated for any point which has a value changed by more than the deadband setting since the last time the data value was reported.

Any analog measurement that is unavailable when it is read is reported as offline. For example, the frequency when the current and voltage frequency is outside the tracking range of the relay or the thermal state when the thermal protection is disabled in the configuration column. All Object 30 points are reported as secondary values in DNP3.0 (with respect to CT and VT ratios).

The following fault data can be mapped in DNP3.0 protocol in serial and Ethernet connections:

- Fault voltages
- Fault currents
- Fault location
- Operating time of relay
- Operating time of breaker
- Fault time
- Fault date

The latest fault records only will be retrieved over DNP3.0.

7.7 Object 40 Analog Output

The conversion to fixed-point format requires the use of a scaling factor, which is configurable for the various types of data within the relay such as current, voltage, and phase angle. All Object 40 points report the integer scaling values and Object 41 is available to configure integer scaling quantities.

7.8 DNP3.0 Configuration using Easergy Studio

A PC support package for DNP3.0 is available as part of Easergy Studio to allow configuration of the relay's DNP3.0 response. The PC is connected to the relay using a serial cable to the 9-pin connector on the front of the relay, see the *Introduction* chapter.

The configuration data is uploaded from the relay to the PC in a block of compressed format data and downloaded to the relay in a similar manner after modification. The new DNP3.0 configuration takes effect in the relay after the download is complete. To restore the default configuration at any time, from the **Configuration** column, select the **Restore Defaults** cell then select **All Settings**.

In Easergy Studio, the DNP3.0 data is shown in four main folders, one folder each for the point configuration, integer scaling, default variation (data format) and DNP over Ethernet. The point configuration also includes screens for binary inputs, binary outputs, counters and analogue input configuration. Note that if the DNP3.0 over Ethernet plus IEC61850 option is chosen, DNP over Ethernet configuration will be used to configure DNP3.0 over Ethernet, and this part of configuration will be ignored by DNP3.0 serial.

For the IP configuration of DNP over Ethernet, please refer to the *DNP3.0 over Ethernet runs concurrently with IEC61850* section.

Please refer to the DNP3.0 Configurator Tool User guide (S1V2DNP/EN HI/A11) for details regarding the configuration of binary points, analogues and reporting format.

DNP3.0 over Ethernet includes support for unsolicited responses. For the Unsolicited Responses configuration of DNP over Ethernet, please refer to this table:

Setting Name	Explanation
unsolAllowed	Determines whether unsolicited responses are allowed. If unsolAllowed is set to disabled, no unsolicited responses will be generated. Requests to enable or disable unsolicited responses will fail and the master station will reply indicating bad function information. If it is configured to allow unsolicited mode (enabled), the relay will be able to send event data in an unsolicited response after it receives a request from the master station containing function code ENABLE_UNSOLICITED(0x14) that enables some or all points to initiate unsolicited responses.
unsolMaxRetries	Specify the maximum number of unsolicited retries before changing to the 'offline' retry period (30 seconds).
unsolRetryDelay	Specifies the time, in seconds, to delay after an unsolicited confirm timeout before retrying the unsolicited response.
unsolClass1MaxDelay	If unsolicited responses are enabled, unsolClassXMaxDelay specifies the maximum amount of time in seconds after an event in the corresponding class is received before an unsolicited response will be generated. A configured value of 0 indicates that responses are not delayed.
unsolClass2MaxDelay	
unsolClass3MaxDelay	
unsolClass1MaxEvents	If unsolicited responses are enabled, unsolClassXMaxEvents specifies the maximum number of events in the corresponding class to be allowed before an unsolicited response will be generated.
unsolClass2MaxEvents	
unsolClass3MaxEvents	

Important ***At most 8 clients are supported to connect to device at the same time in DNP3.0 over Ethernet protocol.***

7.8.1 Object 1

For every point included in the device profile document there is a check box for membership of class 0 and radio buttons for class 1, 2 or 3 membership. Any point that is in class 0 must be a member of one of the change event classes 1, 2 or 3.

Points that are configured out of class 0 are by default not capable of generating change events. Furthermore, points that are not part of class 0 are effectively removed from the DNP3.0 response by renumbering the points that are in class 0 into a contiguous list starting at point number 0. The renumbered point numbers are shown at the left-hand side of the screen in S1 and can be printed out to form a revised device profile for the relay. This mechanism allows best use of available bandwidth by only reporting the data points required by the user when a poll for all points is made.

7.8.2 Object 20

The running counter value of object 20 points can be configured to be in or out of class 0. Any running counter that is in class 0 can have its frozen value selected to be in or out of the DNP3.0 response, but a frozen counter cannot be included without the corresponding running counter. As with object 1, the class 0 response will be renumbered into a contiguous list of points based on the selection of running counters. The frozen counters will also be renumbered based on the selection; note that if some of the counters that are selected as running are not also selected as frozen then the renumbering will result in the frozen counters having different point numbers to their running counterparts. For example, object 20 point 3 (running counter) might have its frozen value reported as object 21 point 1.

7.8.3 Object 30

For the analog inputs, object 30, the same selection options for classes 0, 1, 2 and 3 are available as for object 1. In addition to these options, which behave in exactly the same way as for object 1, it is possible to change the deadband setting for each point. The minimum and maximum values and the resolution of the deadband settings are defined in the device profile document; MiCOM S1 will allow the deadband to be set to any value within these constraints.

7.8.4 DNP3.0 over Ethernet runs concurrently with IEC61850

DNP3.0 over Ethernet can run concurrently with IEC61850 if DNP3.0 over Ethernet plus IEC61850 option is chosen. Below table describes the different cases of the usage of DNP3.0 over Ethernet service and IEC61850 service. IEC61850 service will always run under this situation, but DNPoE service only runs when certain requirements are met.

Board Type	Dual or PRP/HSR	Configuration file	Interface 1		Interface 2		Invalid DNPoE IP Alarm
			IP address	DNP3oE	IP address	DNP3oE	
Q or R	Doesn't matter	Default IEC61850 configuration No DNP setting or IP_DNP is 0.0.0.0	DEF_IP_1	Disabled	DEF_IP_2	Disabled	No
	Dual	Default IEC61850 configuration Customized DNP setting with valid IP_DNP	IP_DNP	Run	DEF_IP_2	N/A	No
	PRP/HSR		DEF_IP_1	N/A	IP_DNP	Run	No
	Doesn't matter	Customized IEC61850 configuration No DNPoE setting or IP_DNP is 0.0.0.0	IP_1	Disabled	IP_2	Disabled	No
	Doesn't matter	Customized IEC61850 configuration Customized DNPoE setting where IP_DNP = IP_1	IP_1	Run	IP_2	N/A	No
	Doesn't matter	Customized IEC61850 configuration Customized DNPoE setting where IP_DNP = IP_2	IP_1	N/A	IP_2	Run	No
	Doesn't matter	Customized IEC61850 configuration Customized DNPoE setting where IP_DNP ≠ IP_1 and IP_DNP ≠ IP_2	IP_1	Disabled	IP_2	Disabled	Yes
S	N/A	Default IEC61850 configuration No DNPoE setting or IP_DNP is 0.0.0.0	DEF_IP_1	Disabled	N/A	N/A	No
	N/A	Default IEC61850 configuration Customized DNPoE setting with valid IP_DNP	IP_DNP	Run	N/A	N/A	No
	N/A	Customized IEC61850 configuration No DNPoE setting or IP_DNP is 0.0.0.0	IP_1	Disabled	N/A	N/A	No
	N/A	Customized IEC61850 configuration Customized DNPoE setting where IP_DNP = IP_1	IP_1	Run	N/A	N/A	No
	N/A	Customized IEC61850 configuration Customized DNPoE setting where IP_DNP ≠ IP_1	IP_1	Disabled	N/A	N/A	Yes

Note *For detailed information about different interfaces please refer to the* ***Dual IP in MiCOM*** *section in the Dual Redundant Ethernet Board (DREB) chapter.*

Table 15 - Protocol running options for different board types

For these IP abbreviations please refer to this table:

Abbreviation	Description
DEF_IP_1	Default IP of interface 1 with default IEC61850 configuration
DEF_IP_2	Default IP of interface 2 with default IEC61850 configuration
IP_1	IP of interface 1 configured in a IEC61850 configuration file
IP_2	IP of interface 2 configured in a IEC61850 configuration file
IP_DNP	IP configured in DNP over Ethernet setting

Table 16 – Abbreviations of Different IP

Note	*Running DNP3.0 serial and DNP3.0 over Ethernet concurrently is not recommended.*

8 IEC 61850 ETHERNET INTERFACE

8.1 Introduction

IEC 61850 is the international standard for Ethernet-based communication in substations. It enables integration of all protection, control, measurement and monitoring functions in a substation, and provides the means for interlocking and inter-tripping. It combines the convenience of Ethernet with the security which is essential in substations today.

The MiCOM protection relays can integrate with the PACiS substation control systems, to complete Schneider Electric's offer of a full IEC 61850 solution for the substation. The majority of MiCOM Px3x and Px4x relay types can be supplied with Ethernet, in addition to traditional serial protocols. Relays which have already been delivered with UCA2.0 on Ethernet can be easily upgraded to IEC 61850.

8.2 What is IEC 61850?

IEC 61850 is a 14-part international standard, which defines a communication architecture for substations. It is more than just a protocol and provides:

- Standardized models for IEDs and other equipment in the substation
- Standardized communication services (the methods used to access and exchange data)
- Standardized formats for configuration files
- Peer-to-peer (for example, relay to relay) communication

The standard includes mapping of data onto Ethernet. Using Ethernet in the substation offers many advantages, most significantly including:

- High-speed data rates (currently 100 Mbits/s, rather than tens of kbits/s or less used by most serial protocols)
- Multiple masters (called “clients”)
- Ethernet is an open standard in every-day use

Schneider Electric has been involved in the Working Groups which formed the standard, building on experience gained with UCA2.0, the predecessor of IEC 61850.

8.2.1 Interoperability

A major benefit of IEC 61850 is interoperability. IEC 61850 standardizes the data model of substation IEDs which simplifies integration of different vendors’ products. Data is accessed in the same way in all IEDs, regardless of the vendor, even though the protection algorithms of different vendors’ relays may be different.

IEC 61850-compliant devices are not interchangeable, you cannot replace one device with another (although they are interoperable). However, the terminology is predefined and anyone with knowledge of IEC 61850 can quickly integrate a new device without mapping all of the new data. IEC 61850 improves substation communications and interoperability at a lower cost to the end user.

8.2.2 Data Model

To ease understanding, the data model of any IEC 61850 IED can be viewed as a hierarchy of information. The categories and naming of this information is standardized in the IEC 61850 specification.

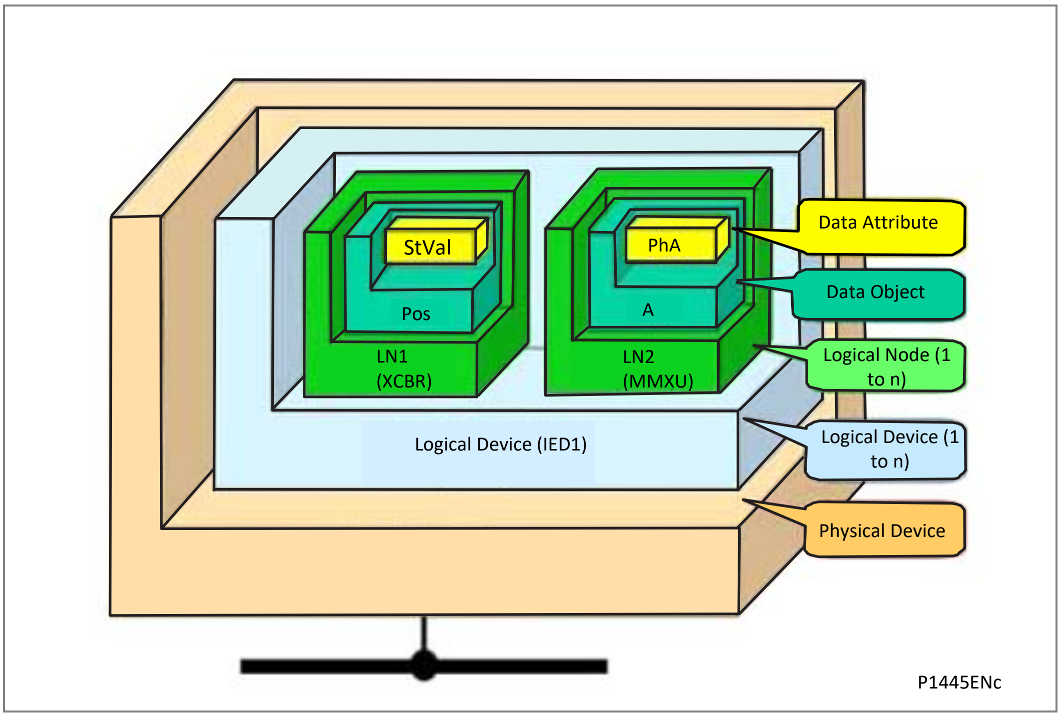


Figure 16 - Data model layers in IEC 61850

The levels of this hierarchy can be described as follows:

- Physical Device — Identifies the actual IED in a system. Typically the device's name or IP address can be used (for example **Feeder_1** or **10.0.0.2**).
- Logical Device — Identifies groups of related Logical Nodes inthe Physical Device. For the MiCOM relays, five Logical Devices exist: **Control, Measurements, Protection, Records, System**.
- Wrapper/Logical Node Instance — Identifies the major functional areas in the IEC 61850 data model. Either 3 or 6 characters are used as a prefix to define the functional group (wrapper) while the actual functionality is identified by a 4 character Logical Node name, suffixed by an instance number. For example, XCBR1 (circuit breaker), MMXU1 (measurements), FrqPTOF2 (overfrequency protection, stage 2).
- Data Object — This next layer is used to identify the type of data presented. For example, **Pos** (position) of Logical Node type **XCBR**.
- Data Attribute — This is the actual data (such as measurement value, status, and description). For example, **stVal** (status value) indicates the actual position of the circuit breaker for Data Object type **Pos** of Logical Node type **XCBR**.

8.3 IEC 61850 in MiCOM Relays

IEC 61850 is implemented in MiCOM relays by use of a separate Ethernet card. This card manages the majority of the IEC 61850 implementation and data transfer to avoid any impact on the performance of the protection.

To communicate with an IEC 61850 IED on Ethernet, it is necessary only to know its IP address. This can then be configured into either:

- An IEC 61850 **client** (or **master**), for example a PACiS computer (MiCOM C264) or HMI, or
- An **MMS browser**, with which the full data model can be retrieved from the IED, without any prior knowledge

8.3.1 Capability

The IEC 61850 interface provides these capabilities:

- Read access to measurements

  All measurands are presented using the measurement Logical Nodes, in the **Measurements** Logical Device. Reported measurement values are refreshed by the relay once per second, in line with the relay user interface.

The following fault data have been mapped in LN RFLO1 of LD Records of IEC61850 data model:

- Fault voltages, Fault currents and Fault location
- Operating time of relay and Operating time of breaker
- Fault time, Fault date, etc…

Only the latest fault record can be retrieved over IEC61850.

- Generation of unbuffered reports on change of status/measurement

  Unbuffered reports, when enabled, report any change of state in statuses and measurements (according to deadband settings).
- Support for time synchronization over an Ethernet link

  Time synchronization is supported using SNTP (Simple Network Time Protocol). This protocol is used to synchronize the internal real time clock of the relays.
- GOOSE peer-to-peer communication
  GOOSE communications of statuses are included as part of the IEC 61850 implementation. See *Peer-to-Peer (GSE) Communications* for more details.
- Disturbance record extraction
  Disturbance records can be extracted from MiCOM relays by file transfer, as ASCII format COMTRADE files.
- Controls
  The following control services are available:
  - Direct Control
  - Direct Control with enhanced security
  - Select Before Operate (SBO) with enhanced security
  - Controls are applied to open and close circuit breakers using XCBR.Pos and DDB signals ‘Control Trip’ and ‘Control Close’.
  - System/LLN0. LLN0.LEDRs are used to reset any trip LED indications.

Setting changes (e.g. of protection settings) are not supported in the current IEC 61850 implementation. To keep this process as simple as possible, such setting changes are done using Easergy Studio settings & records program. This can be done as previously using the front port serial connection of the relay, or now optionally over the Ethernet link if preferred (this is known as “tunneling”).

- Reports
  Reports only include data objects that have changed and not the complete dataset. The exceptions to this are a General Interrogation request and integrity reports.
- Buffered Reports
  Eight Buffered Report Control Blocks, (BRCB), are provided in SYSTEM/LLN0 in Logical Device ‘System’.
  Buffered reports are configurable to use any configurable dataset located in the same Logical device as the BRCB (SYSTEM/LLN0).
- Unbuffered Reports
  Sixteen Unbuffered Report Control Blocks (URCB) are provided in SYSTEM/LLN0 in Logical Device ‘System’.
  Unbuffered reports are configurable to use any configurable dataset located in the same Logical device as the URCB (SYSTEM/LLN0).
- Configurable Data Sets
  It is possible to create and configure datasets in any Logical Node using the IED Configurator. The maximum number of datasets will be specified in an IED’s ICD file. An IED is capable of handling 100 datasets.
- Published GOOSE message
  Eight GOCBs are provided in SYSTEM/LLN0.
- Uniqueness of control
  The Uniqueness of control mechanism is implemented to be consistent with the PACiS mechanism. This requires the relay to subscribe to the OrdRun signal from all devices in the system and be able to publish such a signal in a GOOSE message.
- Select Active Setting Group
  Functional protection groups can be enabled or disabled using private mod/beh attributes in the Protection/LLN0.OcpMod object. Setting groups are selectable using the Setting Group Control Block class, (SGCB). The Active Setting Group can be selected using the System/LLN0.SP.SGCB.ActSG data attribute in Logical Device ‘System’.
- Quality for GOOSE
  It is possible to process the quality attributes of any Data Object in an incoming GOOSE message. Devices that do not support IEC61850 quality flags send quality attributes as all zeros. The supported quality attributes for outgoing GOOSE messages are described in the Protocol Implementation eXtra Information for Testing (PIXIT) document.
- Address List
  An Address List document (to be titled ADL) is produced for each IED which shows the mapping between the IEC61850 data model and the internal data model of the IED. It includes a mapping in the reverse direction, which may be more useful. This document is separate from the PICS/MICS document.
- Originator of Control
  Originator of control mechanism is implemented for operate response message and in the data model on the ST of the related control object, consistent with the PACiS mechanism.
- Scaled Measurements
  The Unit definition, as per IEC specifies an SI unit and an optional multiplier for each measurement. This allows a magnitude of measurement to be specified e.g. mA, A, kA, MA.

The multiplier will always be included in the Unit definition and will be configurable in SCL, but not settable at runtime. It will apply to the magnitude, rangeC.min & rangeC.max attributes. rangeC.min & rangeC.max will not be settable at runtime to be more consistent with Px30 and to reduce configuration problems regarding deadbands.

Setting changes, such as changes to protection settings, are done using MiCOM S1 Studio. These changes can also be done using the relay’s front port serial connection or the relay’s Ethernet link, and is known as “tunneling”.

8.3.2 IEC 61850 Configuration

One of the main objectives of IEC 61850 is to allow IEDs to be directly configured from a configuration file generated at system configuration time. At the system configuration level, the capabilities of the IED are determined from an IED capability description file (ICD), which is provided with the product. Using a collection of these ICD files from different products, the entire protection of a substation can be designed, configured and tested (using simulation tools) before the product is even installed into the substation.

To help this process, the MiCOM S1 Studio Support Software provides an IEC61850 IED Configurator tool. Select **Tools > IEC61850 IED Configurator**. This tool allows the preconfigured IEC 61850 configuration file (SCD or CID) to be imported and transferred to the IED. The configuration files for MiCOM relays can also be created manually, based on their original IED Capability Description (ICD) file.

Other features include the extraction of configuration data for viewing and editing, and a sophisticated error-checking sequence. The error checking ensures the configuration data is valid for sending to the IED and ensures the IED functions correctly in the substation.

To help the user, some configuration data is available in the **IED CONFIGURATOR** column of the relay user interface, allowing read-only access to basic configuration data.

8.3.2.1 Configuration Banks

To promote version management and minimize down-time during system upgrades and maintenance, the MiCOM relays have incorporated a mechanism consisting of multiple configuration banks. These configuration banks are categorized as:

- Active Configuration Bank
- Inactive Configuration Bank

Any new configuration sent to the relay is automatically stored in the inactive configuration bank, therefore not immediately affecting the current configuration. Both active and inactive configuration banks can be extracted at any time.

When the upgrade or maintenance stage is complete, the IED Configurator tool can be used to transmit a command to a single IED. This command authorizes the activation of the new configuration contained in the inactive configuration bank, by switching the active and inactive configuration banks. This technique ensures that the system down-time is minimized to the start-up time of the new configuration. The capability to switch the configuration banks is also available using the **IED CONFIGURATOR** column.

For version management, data is available in the **IED CONFIGURATOR** column in the relay user interface, displaying the SCL Name and Revision attributes of both configuration banks.

8.3.2.2 Network Connectivity

Note	*This section presumes a prior knowledge of IP addressing and related topics. Further details on this topic may be found on the Internet (search for IP Configuration) and in numerous relevant books.*

Configuration of the relay IP parameters (IP Address, Subnet Mask, Gateway) and SNTP time synchronization parameters (SNTP Server 1, SNTP Server 2) is performed by the IED Configurator tool. If these parameters are not available using an SCL file, they must be configured manually.

If the assigned IP address is duplicated elsewhere on the same network, the remote communications do not operate in a fixed way. However, the relay checks for a conflict at power up and every time the IP configuration is changed. An alarm is raised if an IP conflict is detected.

Use the **Gateway** setting to configure the relay to accept data from networks other than the local network.

8.4 Data Model of MiCOM Relays

The data model naming adopted in the Px30 and Px40 relays has been standardized for consistency. The Logical Nodes are allocated to one of the five Logical Devices, as appropriate, and the wrapper names used to instantiate Logical Nodes are consistent between Px30 and Px40 relays.

The data model is described in the Model Implementation Conformance Statement (MICS) document, which is available separately. The MICS document provides lists of Logical Device definitions, Logical Node definitions, Common Data Class and Attribute definitions, Enumeration definitions, and MMS data type conversions. It generally follows the format used in Parts 7-3 and 7-4 of the IEC 61850 standard.

8.5 Communication Services of MiCOM Relays

The IEC 61850 communication services which are implemented in the Px30 and Px40 relays are described in the Protocol Implementation Conformance Statement (PICS) document, which is available separately. The PICS document provides the Abstract Communication Service Interface (ACSI) conformance statements as defined in Annex A of Part 7-2 of the IEC 61850 standard.

8.6 Peer-to-Peer (GSE) Communications

The implementation of IEC 61850 Generic Object Oriented Substation Event (GOOSE) sets the way for cheaper and faster inter-relay communications. The generic substation event model provides fast and reliable system-wide distribution of input and output data values. The generic substation event model is based on autonomous decentralization This provides an efficient method of allowing simultaneous delivery of the same generic substation event information to more than one physical device, by using multicast services.

The use of multicast messaging means that IEC 61850 GOOSE uses a publisher-subscriber system to transfer information around the network*. When a device detects a change in one of its monitored status points, it publishes (sends) a new message. Any device that is interested in the information subscribes (listens) to the data message.

*Note**	*Multicast messages cannot be routed across networks without specialized equipment.*

Each new message is retransmitted at user-configurable intervals until the maximum interval is reached, to overcome possible corruption due to interference and collisions. In practice, the parameters which control the message transmission cannot be calculated. Time must be allocated to the testing of GOOSE schemes before or during commissioning; in just the same way a hardwired scheme must be tested.

8.6.1 Scope

Virtual outputs and virtual inputs are available within the PSL. These can be mapped directly to a published dataset in a GOOSE message (only 1 fixed dataset is supported). All published GOOSE signals are BOOLEAN values. The maximum number of virtual outputs and inputs depends on the software version and the product. The virtual output and input numbers (and their DDB Numbers) are shown in the *Logic Nodes* table in the *Programmable Logic* chapter.

Note	*Analogue Goose subscribing: A new GGIO3 is provided for analogue value subscribing, the received analogue values will not be sent to the main card. The values will be stored only on the IEC 61850 data mode.*

Each GOOSE signal contained in a subscribed GOOSE message can be mapped to any of the virtual outputs and virtual inputs within the PSL. The virtual inputs allow the mapping to internal logic functions for protection control, directly to output contacts or LEDs for monitoring.

The MiCOM relay can subscribe to all GOOSE messages but only these data types can be decoded and mapped to a virtual input:

- BOOLEAN
- BSTR2
- INT16
- INT32
- INT8
- UINT16
- UINT32
- UINT8

The MiCOM relay on Ed2 mode can also subscribe analogue GOOSE messages with Float32 data type. The received analogue values can not apply to any application function, these values will be stored only on the IEC 61850 data model.

The MiCOM relay also can subscribe to analogue GOOSE messages with Float32 data type. The received analogue values can not apply to any application function, these values will be stored only on the IEC 61850 data mode.

8.6.2 Simulation GOOSE Configuration

From MiCOM S1 Studio select Tools > IEC 61850 IED Configurator (Ed.2). Make sure the configuration is correct as this ensures efficient GOOSE scheme operation.

The relay can be set to publish/subscribe simulation/test GOOSE; it is important that this setting is returned to publish/receive normal GOOSE messages after testing to permit normal operation of the application and GOOSE messaging.

The relay provides a single setting to receive Simulated GOOSE, however it manages each subscribed GOOSE signal independently when the setting is set to simulated GOOSE. Each subscription (virtual input) will continue to respond to GOOSE messages without the simulation flag set; however once the relay receives a GOOSE for a subscription with the simulation flag set, it will respond to this and ignore messages without the simulation flag set. Other subscriptions (virtual inputs) which have not received a GOOSE message with the simulation flag will continue to operate as before. When the setting is reset back to normal GOOSE messaging the relay will ignore all GOOSE messages with the simulation flag set and act on GOOSE messages without the simulation flag.

WARNING	**If you set the GOOSE in Simulation Mode, you MUST set it back to normal GOOSE after testing.** **IT IS POTENTIALLY EXTREMELY UNSAFE TO ATTEMPT TO USE ANY RELAY WHICH IS STILL IN GOOSE SIMULATION MODE.**

8.6.3 High Performance GOOSE

In addition, the Px40 device is designed to provide maximum performance through an optimized publishing mechanism. This optimized mechanism is enabled so that the published GOOSE message is mapped using only the data attributes rather than mapping a complete data object. If data objects are mapped, the GOOSE messaging will operate correctly; but without the benefit of the optimized mechanism.

A pre-configured dataset named as "HighPerformGOOSE" is available in Ed.2 ICD template, which include all data attributes of all virtual outputs. We recommend using this dataset to get the benefit of better GOOSE performance. The optimized mechanism also applies to Ed.1 but without such a pre-configured dataset.

8.7 Ethernet Functionality

Settings relating to a failed Ethernet link are available in the 'COMMUNICATIONS' column of the relay user interface.

Note	*Setting relating to the failed link is removed for the new Ethernet and the behaviour is fixed as Event.*

8.7.1 Ethernet Disconnection

IEC 61850 'Associations' are unique and made to the relay between the client (master) and server (IEC 61850 device). If the Ethernet is disconnected, such associations are lost and must be re-established by the client. The TCP_KEEPALIVE function is implemented in the relay to monitor each association and terminate any which are no longer active.

8.7.2 Redundant Ethernet Communication Ports (optional)

For information regarding the Redundant Ethernet communication ports, refer to the stand alone document *Px4x/EN REB/B11*.

8.7.3 Loss of Power

If the relay's power is removed, the relay allows the client to re-establish associations without a negative impact on the relay's operation. As the relay acts as a server in this process, the client must request the association. Uncommitted settings are cancelled when power is lost. Reports requested by connected clients are reset and must be re-enabled by the client when the client next creates the new association to the relay.

8.7.4 Courier Tunneling via Secure Ethernet Communications

8.7.4.1 Introduction

When the IED and Easergy Studio are connected via the Ethernet port they will communicate securely using TLS.

The benefits of secure communication are:

- Help in the prevention of unwanted eavesdropping between Easergy Studio (MiCOM S1 Studio) and the IED
- Help in the prevention of modification of data between Easergy Studio (MiCOM S1 Studio) and the IED
- Ensure integrity of data
- Prevent replay of data at a later data

Note	*The communication will be done using port 4422, ensure this port is left unblocked on your network.*

8.7.4.2 Setting up a Connection

As a quick guide, you need to do the following:

1. In Easergy Studio, click the Quick Connect… button
2. Select the relevant Device Type in the Quick Connect dialog box.
3. Select Ethernet port
4. Enter the relevant data i.e. IP address of IED
5. Click Finish
6. Easergy Studio will attempt to communicate with the device

Note	*When attempting to connect to the IED via Ethernet, Easergy Studio will first try to communicate with the IED via secure communication. If this is not possible, it will use open communication with no encryption.* *For secure communication, please ensure port 4422 is left unblocked on the firewalls on which Easergy Studio is running.*

p

Notes:

INSTALLATION

CHAPTER 16

Date (month/year):	07/2016			
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.			
Hardware suffix:	P141/P142/P143	J/L	P44y (P443/P446)	K/M
	P145	J/M	P547	K
	P241	J	P54x (P543/P544/P545/P546)	K/M
	P242/P243	K	P642	J/L
	P342	J	P643	K/M
	P343/P344/P345	K	P645	K/M
	P391	A	P74x (P741/P742/P743)	J/K
	P445	J/L	P746	K/M
	P44x (P441/P442/P444)	J/K	P841	K/M
	P44x (P442/P444)	M	P849	K
Software version:	P14x (P141/P142/P143/P145)	43/44/46/ B0/B1/B2	P44y (P443/P446) P547	55/H4 57
	P24x (P241/P242/P243):	57	P54x (P543/P544/P545/P546)	45/55/H4
	P342/P343/P344/P345/P391	36	P64x (P642/P643/P645)	04/A0/B1
	P445	35/36/J4	P74x (P741/P742/P743)	51/A0/B1
	P44x (P441/P442/P444)	C7.x/D4.x/ D5.x/D6.x/	P746 P841	A0/B1/B2/C1/C2 45/55/G4/H4
	P44x (P442/P444)	E0	P849	A0
Connection diagrams:	P14x (P141, P142, P143 & P145): 10P141xx (xx = 01 to 02) 10P142xx (xx = 01 to 05) 10P143xx (xx = 01 to 11) 10P145xx (xx = 01 to 11) P24x (P241, P242 & P243): 10P241xx (xx = 01 to 02) 10P242xx (xx = 01) 10P243xx (xx = 01) P34x (P342, P343, P344, P345 & P391): 10P342xx (xx = 01 to 17) 10P343xx (xx = 01 to 19) 10P344xx (xx = 01 to 12) 10P345xx (xx = 01 to 07) 10P391xx (xx = 01 to 02) P445: 10P445xx (xx = 01 to 04) P44x (P441, P442 & P444): 10P44101 (SH 1 & 2) 10P44201 (SH 1 & 2) 10P44202 (SH 1) 10P44203 (SH 1 & 2) 10P44401 (SH 1) 10P44402 (SH 1) 10P44403 (SH 1 & 2) 10P44404 (SH 1) 10P44405 (SH 1) 10P44407 (SH 1 & 2) P44y (P443 & P446): 10P44303 (SH 01 and 03) 10P44304 (SH 01 and 03) 10P44305 (SH 01 and 03) 10P44306 (SH 01 and 03) 10P44600 10P44601 (SH 1 to 2) 10P44602 (SH 1 to 2) 10P44603 (SH 1 to 2)		P54x (P543, P544, P545 & P546): 10P54302 (SH 1 to 2) 10P54303 (SH 1 to 2) 10P54400 10P54404 (SH 1 to 2) 10P54405 (SH 1 to 2) 10P54502 (SH 1 to 2) 10P54503 (SH 1 to 2) 10P54600 10P54604 (SH 1 to 2) 10P54605 (SH 1 to 2) 10P54606 (SH 1 to 2) P547: 10P54702xx (xx = 01 to 02) 10P54703xx (xx = 01 to 02) 10P54704xx (xx = 01 to 02) 10P54705xx (xx = 01 to 02) P64x (P642, P643 & P645): 10P642xx (xx = 1 to 10) 10P643xx (xx = 1 to 6) 10P645xx (xx = 1 to 9) P74x (P741, P742 & P743): 10P740xx (xx = 01 to 07) P746: 10P746xx (xx = 00 to 21) P841: 10P84100 10P84101 (SH 1 to 2) 10P84102 (SH 1 to 2) 10P84103 (SH 1 to 2) 10P84104 (SH 1 to 2) 10P84105 (SH 1 to 2) P849: 10P849xx (xx = 01 to 06)	

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TABLES

FIGURES

1 INTRODUCTION TO MICOM RANGE

About MiCOM Range

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

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

The components within MiCOM are:

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

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

For up-to-date information, please see:

www.schneider-electric.com

MiCOM Px4x Products

The MiCOM Px4x series of protection devices provide a wide range of protection and control functions and meet the requirements of a wide market segment.

Different parts of the Px4x range provide different functions. These include:

- **P14x** **Feeder Management** relay suitable for MV and HV systems
- **P24x** **Motors** and rotating machine management relay for use on a wide range of synchronous and induction machines
- **P34x** **Generator Protection** for small to sophisticated generator systems and interconnection protection
- **P445** Full scheme **Distance Protection** relays for MV, HV and EHV systems
- **P44x** Full scheme **Distance Protection** relays for MV, HV and EHV systems
- **P44y** Full scheme **Distance Protection** relays for MV, HV and EHV systems
- **P54x** **Line Differential** protection relays for HV/EHV systems with multiple communication options and phase comparison protection for use with PLC
- **P547** **Line Differential** protection relays for HV/EHV systems with multiple communication options and phase comparison protection for use with PLC
- **P64x** **Transformer Protection Relays**
- **P74x** **Numerical Busbar Protection** for use on MV, HV and EHV busbars
- **P746** **Numerical Busbar Protection** for use on MV, HV and EHV busbars
- **P84x** **Breaker Failure** protection relays

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

2 RECEIPT, HANDLING, STORAGE AND UNPACKING RELAYS

2.1 Receipt of Relays

Protective relays, although generally of robust construction, require careful treatment prior to installation on site.

Upon receipt, relays should be examined immediately to ensure no external damage has been sustained in transit. If damage has been sustained, a claim should be made to the transport contractor and Schneider Electric should be promptly notified.

Relays that are supplied unmounted and not intended for immediate installation should be returned to their protective polythene bags and delivery carton. See the *Storage* section for more information about the storage of relays.

2.2 Handling of Electronic Equipment

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

A person's normal movements can easily generate electrostatic potentials of several thousand volts. Discharge of these voltages into semiconductor devices when handling electronic circuits can cause serious damage which, although not always immediately apparent, will reduce the reliability of the circuit. This is particularly important to consider where the circuits use Complementary Metal Oxide Semiconductors (CMOS), as is the case with these relays.

The electronic circuits inside the relay are protected from electrostatic discharge when housed in the case. Do not expose them to risk by removing the front panel or Printed Circuit Boards (PCBs) unnecessarily.

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

- Before removing a PCB, ensure that you are at the same electrostatic potential as the equipment by touching the case.
- Handle analogue input modules by the front panel, frame or edges of the circuit boards. PCBs should only be handled by their edges. Avoid touching the electronic components, printed circuit tracks or connectors.
- Do not pass the module to another person without first ensuring you are both at the same electrostatic potential. Shaking hands achieves equipotential.
- Place the module on an anti-static surface, or on a conducting surface which is at the same potential as yourself.
- If it is necessary to store or transport printed circuit boards removed from the case, place them individually in electrically conducting anti-static bags.

In the unlikely event that you are making measurements on the internal electronic circuitry of a relay in service, it is preferable that you are earthed to the case with a conductive wrist strap. Wrist straps should have a resistance to ground between 500kΩ to 10MΩ. If a wrist strap is not available you should maintain regular contact with the case to prevent a build-up of electrostatic potential. Instrumentation which may be used for making measurements should also be earthed to the case whenever possible.

More information on safe working procedures for all electronic equipment can be found in IEC 61340-5-1. It is strongly recommended that detailed investigations on electronic circuitry or modification work should be carried out in a special handling area such as described in the aforementioned Standard document.

2.3 Storage

If relays are not to be installed immediately upon receipt, they should be stored in a place free from dust and moisture in their original cartons. Where de-humidifier bags have been included in the packing they should be retained. The action of the de-humidifier crystals will be impaired if the bag is exposed to ambient conditions and may be restored by gently heating the bag for about an hour prior to replacing it in the carton.

To prevent battery drain during transportation and storage a battery isolation strip is fitted during manufacture. With the lower access cover open, presence of the battery isolation strip can be checked by a red tab protruding from the positive side.

Care should be taken on subsequent unpacking that any dust which has collected on the carton does not fall inside. In locations of high humidity the carton and packing may become impregnated with moisture and the de-humidifier crystals will lose their efficiency.

Prior to installation, relays should be stored at a temperature of between -40°C to +70°C (-13°F to +158°F).

2.4 Unpacking

Care must be taken when unpacking and installing the relays so that none of the parts are damaged and additional components are not accidentally left in the packing or lost. Make sure that any user's CDROM or technical documentation is NOT discarded, and accompanies the relay to its destination substation.

Note	*With the lower access cover open, the red tab of the battery isolation strip will be seen protruding from the positive side of the battery compartment. Do not remove this strip because it prevents battery drain during transportation and storage and will be removed as part of the commissioning tests.*

Relays must only be handled by skilled persons.

The site should be well lit to facilitate inspection, clean, dry and reasonably free from dust and excessive vibration. This particularly applies to installations which are being carried out at the same time as construction work.

3 RELAY MOUNTING

MiCOM relays are dispatched either individually or as part of a panel/rack assembly. Individual relays are normally supplied with an outline diagram showing the dimensions for panel cut-outs and hole centres. This information can also be found in the product publication.

Secondary front covers can also be supplied as an option item to prevent unauthorised changing of settings and alarm status. They are available in sizes 40TE and 60TE. The 60TE cover also fits the 80TE case size of the relay.

Product	Size	Part No
P14x	40TE 60TE / 80TE	GN0037 001 GN0038 001
P24xxxxxxxxxxxA P24xxxxxxxxxxxC	40TE 60TE / 80TE	GN0037 001 GN0038 001
P24xxxxxxxxxxxJ P24xxxxxxxxxxxK	40TE 60TE / 80TE	GN0242 001 GN0243 001
P34xxxxxxxxxxxA P34xxxxxxxxxxxC	40TE 60TE / 80TE	GN0037 001 GN0038 001
P34xxxxxxxxxxxJ P34xxxxxxxxxxxK	40TE 60TE / 80TE	GN0242 001 GN0243 001
P44x	40TE 60TE / 80TE	GN0037 001 GN0038 001
P44y	60TE / 80TE	GN0038 001
P445	40TE 60TE / 80TE	GN0037001 GN0038 001
P54x	60TE / 80TE	GN0038 001
P547	60TE / 80TE	GN0038 001
P64xxxxxxxxxxxA/B/C	40TE 60TE / 80TE	GN0037 001 GN0038 001
P64xxxxxxxxxxxJ/K	40TE 60TE / 80TE	GN0242 001 GN0243 001
P74x P74x	40TE 60TE	GN0037 001 GN0038 001
P746	80TE	GN0038 001
P841	60TE / 80TE	GN0038 001
P849	80TE	GN0038 001

Note *The Part Numbers suitable for rack-mounting have an "N" as the 10th digit. The Part Numbers suitable for panel-mounting have an "M" as the 10th digit.*

Table 1 - Products, sizes and part numbers

The design of the relay is such that the fixing holes in the mounting flanges are only accessible when the access covers are open and hidden from sight when the covers are closed.

If a MiCOM P991 or Easergy test block is to be included with the relays, we recommend you position the test block on the right-hand side of the associated relays (when viewed from the front). This minimises the wiring between the relay and test block, and allows the correct test block to be easily identified during commissioning and maintenance tests.

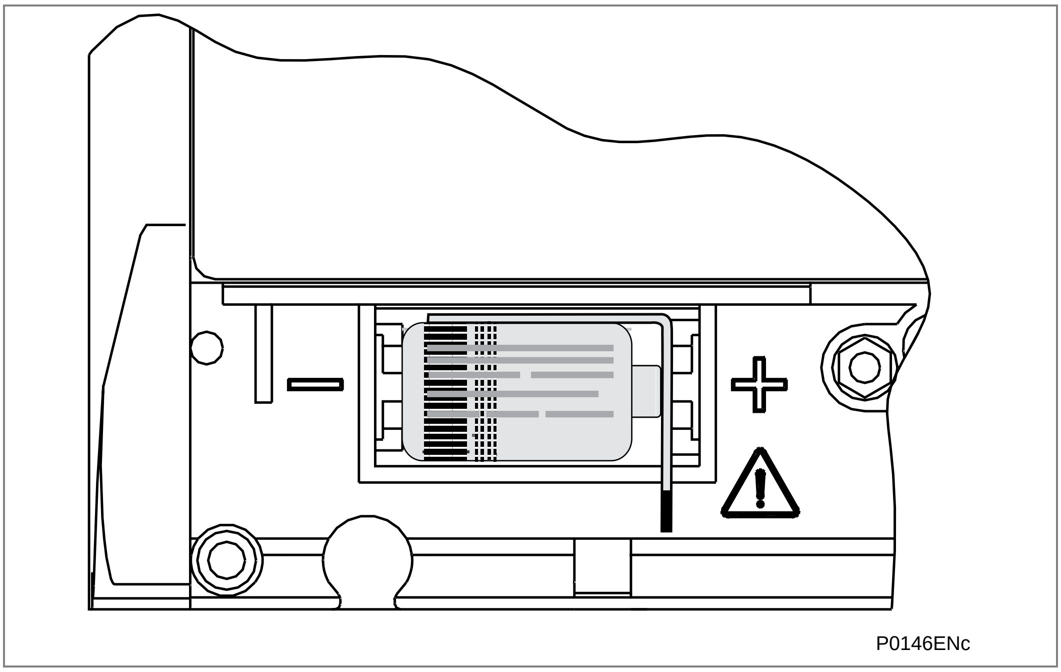

Figure 1 - Location of battery isolation strip

If you need to test correct relay operation during the installation, the battery isolation strip can be removed but should be replaced if commissioning of the scheme is not imminent. This will prevent unnecessary battery drain during transportation to site and installation. The red tab of the isolation strip can be seen protruding from the positive side of the battery compartment when the lower access cover is open. To remove the isolation strip, pull the red tab whilst lightly pressing the battery to prevent it falling out of the compartment. When replacing the battery isolation strip, ensure that the strip is refitted as shown in the *Location of battery isolation strip* diagram, i.e. with the strip behind the battery with the red tab protruding.

3.1 Rack Mounting

Virtually all MiCOM relays can be rack mounted using single tier rack frames (part number FX0021 101), see the ***Rack mounting of relays*** diagram below. These frames have dimensions in accordance with IEC 60297 and are supplied pre-assembled ready to use. On a standard 483 mm rack this enables combinations of case widths up to a total equivalent of size 80TE to be mounted side-by-side.

The two horizontal rails of the rack frame have holes drilled at approximately 26 mm intervals and the relays are attached via their mounting flanges using M4 Taptite self-tapping screws with captive 3 mm thick washers (also known as a SEMS unit). These fastenings are available in packs of 5 (part number ZA0005 104).

Warning **Risk of damage to the front cover moulding. Do not use conventional self-tapping screws, including those supplied for mounting other relays because they have slightly larger heads.**

Once the tier is complete, the frames are fastened into the racks using mounting angles at each end of the tier.

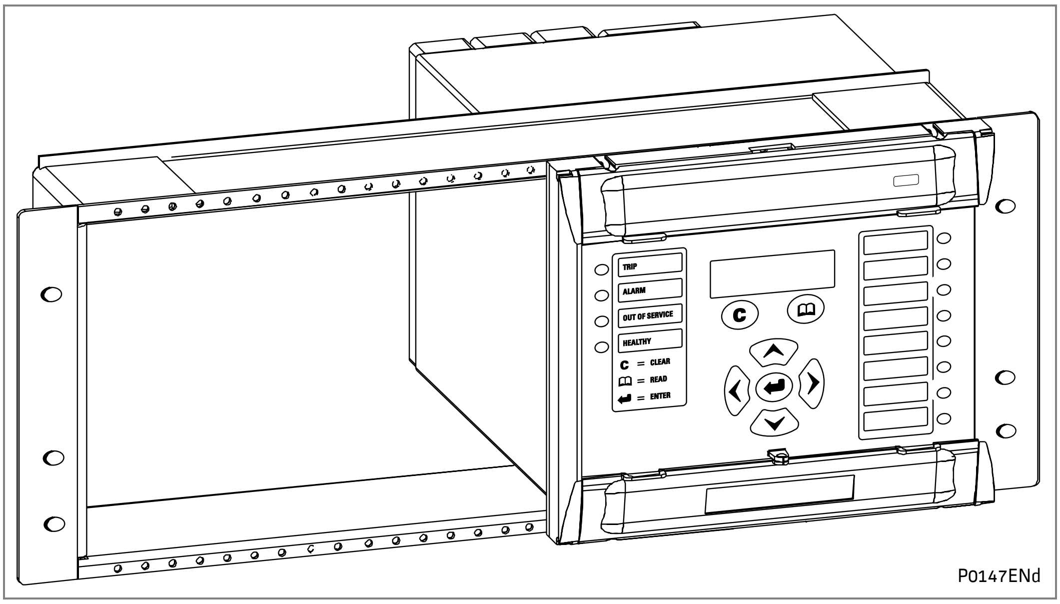

Figure 2 - Rack mounting of relays

Relays can be mechanically grouped into single tier (4U) or multi-tier arrangements by the rack frame. This enables schemes using MiCOM products to be pre-wired together prior to mounting.

Use blanking plates if there are empty spaces. The spaces may be for future installation of relays or because the total size is less than 80TE on any tier. Blanking plates can also be used to mount ancillary components. The following ***Blanking plates*** table shows the sizes that can be ordered.

Note	*Blanking plates are only available in grey.*

Case size summation	Blanking plate part number
5TE	GJ2028 101
10TE	GJ2028 102
15TE	GJ2028 103
20TE	GJ2028 104
25TE	GJ2028 105
30TE	GJ2028 106
35TE	GJ2028 107
40TE	GJ2028 108

Table 2 - Blanking plates

3.2 Panel Mounting

The relays can be flush mounted into panels using M4 SEMS Taptite self-tapping screws with captive 3 mm thick washers (also known as a SEMS unit). These fastenings are available in packs of 5 (part number ZA0005 104).

Warning **Risk of damage to the front cover moulding. Do not use conventional self-tapping screws, including those supplied for mounting other relays because they have slightly larger heads.**

Alternatively tapped holes can be used if the panel has a minimum thickness of 2.5 mm. If several relays are mounted in a single cut-out in the panel, mechanically group them together horizontally or vertically to form rigid assemblies prior to mounting in the panel.

Note *Fastening MiCOM relays with pop rivets is not advised because this does not allow easy removal if repair is necessary.*

Rack-mounting panel-mounted versions: it is possible to rack-mount some relay versions which have been designed to be panel-mounted. The relay is mounted on a single-tier rack frame, which occupies the full width of the rack. To make sure a panel-mounted relay assembly complies with BS EN60529 IP52, fit a metallic sealing strip between adjoining relays (Part No GN2044 001) and a sealing ring from the following ***IP52 sealing rings*** table around the complete assembly.

Width	Single tier	Double tier
40TE	GJ9018 008	GJ9018 024
45TE	GJ9018 009	GJ9018 025
50TE	GJ9018 010	GJ9018 026
55TE	GJ9018 011	GJ9018 027
60TE	GJ9018 012	GJ9018 028
65TE	GJ9018 013	GJ9018 029
70TE	GJ9018 014	GJ9018 030
75TE	GJ9018 015	GJ9018 031
80TE	GJ9018 016	GJ9018 032

Table 3 - IP52 sealing rings

4 RELAY WIRING

This section serves as a guide to selecting the appropriate cable and connector type for each terminal on the MiCOM relay.

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

4.1 Medium and Heavy Duty Terminal Block Connections

Key:

Heavy duty terminal block: CT and VT circuits, terminals with “C”,“D” or “F” prefix (depending on the relay)

Medium duty: All other terminal blocks (grey color)

Loose relays are supplied with sufficient M4 screws for making connections to the rear mounted terminal blocks using ring terminals, with a recommended maximum of two ring terminals per relay terminal.

If required, Schneider Electric can supply M4 90° crimp ring terminals in three different sizes depending on wire size (see the *M4 90° crimp ring terminals* table). Each type is available in bags of 100.

Part number	Wire size	Insulation colour
ZB9124 901	0.25 – 1.65mm^2 (22 – 16AWG)	Red
ZB9124 900	1.04 – 2.63mm^2 (16 – 14AWG)	Blue
ZB9124 904	2.53 – 6.64mm^2 (12 – 10AWG)	Uninsulated*

Note ** To maintain the terminal block insulation requirements for safety, fit an insulating sleeve over the ring terminal after crimping.*

Table 4 - M4 90° crimp ring terminals

The following minimum wire sizes are recommended:

- Current Transformers 2.5mm^2
- Auxiliary Supply Vx 1.5mm^2
- RS485 Port See separate section
- Rotor winding to P391 1.0mm^2
- Other circuits 1.0mm^2

Due to the limitations of the ring terminal, the maximum wire size that can be used for any of the medium or heavy duty terminals is 6.0mm^2 using ring terminals that are not pre-insulated. Where it required to only use pre-insulated ring terminals, the maximum wire size that can be used is reduced to 2.63mm^2 per ring terminal. If a larger wire size is required, two wires should be used in parallel, each terminated in a separate ring terminal at the relay.

The wire used for all connections to the medium and heavy duty terminal blocks, except the RS485 port, should have a minimum voltage rating of 300Vrms.

It is recommended that the auxiliary supply wiring should be protected by a 16A maximum High Rupture Capacity (HRC) fuse of type NIT or TIA. For safety reasons, current transformer circuits must never be fused. Other circuits should be appropriately fused to protect the wire used.

Note *The high-break contacts optional fitted to P44y (P443/P446) and P54x relays are polarity sensitive. External wiring must respect the polarity requirements which are shown on the external connection diagram to ensure correct operation.*

Each opto input has selectable filtering. This allows use of a pre-set filter of ½ cycle which renders the input immune to induced noise on the wiring: although this method is secure it can be slow, particularly for intertripping. This can be improved by switching off the ½ cycle filter in which case one of the following methods to reduce ac noise should be considered. The first method is to use double pole switching on the input, the second is to use screened twisted cable on the input circuit. The recognition time of the opto inputs without the filtering is <2 ms and with the filtering is <12 ms.

4.2 EIA(RS)485 Port

Connections to the first rear EIA(RS)485 port use ring terminals. 2-core screened cable is recommended with a maximum total length of 1000m or 200nF total cable capacitance. A typical cable specification would be:

Each core:	16/0.2mm copper conductors. PVC insulated
Nominal conductor area:	0.5mm^2 per core
Screen:	Overall braid, PVC sheathed

See the SCADA Communications chapter for details of setting up an EIA(RS)485 bus.

4.3 Current Loop Input Output (CLIO) Connections (if applicable)

Where current loop inputs and outputs are available on a MiCOM relay, the connections are made using screw clamp connectors, as per the RTD inputs, on the rear of the relay which can accept wire sizes between 0.1 mm^2 and 1.5 mm^2. It is recommended that connections between the relay and the current loop inputs and outputs are made using a screened cable. The wire should have a minimum voltage rating of 300 Vrms.

4.4 IRIG-B Connections (if applicable)

The IRIG-B input and BNC connector have a characteristic impedance of 50Ω. It is recommended that connections between the IRIG-B equipment and the relay are made using coaxial cable of type RG59LSF with a halogen free, fire retardant sheath.

4.5 EIA(RS)232 Port

Short term connections to the RS232 port, located behind the bottom access cover, can be made using a screened multi-core communication cable up to 15m long, or a total capacitance of 2500pF. The cable should be terminated at the relay end with a 9-way, metal shelled, D-type male plug. The Getting Started chapter of this manual details the pin allocations.

4.6 Optical Fiber Connectors (when applicable)

Warning **LASER LIGHT RAYS: Where fibre optic communication devices are fitted, never look into the end of a fiber optic due to the risk of causing serious damage to the eye. Optical power meters should be used to determine the operation or signal level of the device. Non-observance of this rule could possibly result in personal injury.**

If electrical to optical converters are used, they must have management of character idle state capability (for when the fibre optic cable interface is "Light off").
Specific care should be taken with the bend radius of the fibres, and the use of optical shunts is not recommended as these can degrade the transmission path over time.
The relay uses 1310nm multi mode 100BaseFx and BFOC 2.5 - (ST/LC according to the MiCOM model) connectors (one Tx – optical emitter, one Rx – optical receiver).

4.7 Ethernet Port for IEC 61850 and/or DNP3.0 (where applicable)

4.7.1 Fiber Optic (FO) Port

The relays can have 100 Mbps Ethernet port. Fibre Optic (FO) connection is recommended for use in permanent connections in a substation environment. The 100 Mbit port uses a type LC connector (according to the MiCOM model), compatible with fiber multimode 50/125 µm or 62.5/125 µm to 1310 nm.

Note	*The new LC fiber optical connector can be used with the Px40 Enhanced Ethernet Board.*

4.7.2 RJ-45 Metallic Port

The user can connect to either a 10Base-T or a 100Base-TX Ethernet hub; the port will automatically sense which type of hub is connected. Due to possibility of noise and interference on this part, it is recommended that this connection type be used for short-term connections and over short distance. Ideally, where the relays and hubs are located in the same cubicle.
The connector for the Ethernet port is a shielded RJ-45. The following ***Signals on the Ethernet connector*** table shows the signals and pins on the connector.

Pin	Signal name	Signal definition
1	TXP	Transmit (positive)
2	TXN	Transmit (negative)
3	RXP	Receive (positive)
4	-	Not used
5	-	Not used
6	RXN	Receive (negative)
7	-	Not used
8	-	Not used

Table 5 - Signals on the Ethernet connector

4.8 RTD Connections (if applicable)

Where RTD inputs are available on a MiCOM relay, the connections are made using screw clamp connectors on the rear of the relay that can accept wire sizes between 0.1 mm^2 and 1.5 mm^2. The connections between the relay and the RTDs must be made using a screened 3-core cable with a total resistance less than 10 Ω. The cable should have a minimum voltage rating of 300 Vrms.
A 3-core cable should be used even for 2-wire RTD applications, as it allows for the cable’s resistance to be removed from the overall resistance measurement. In such cases the third wire is connected to the second wire at the point the cable is joined to the RTD.
The screen of each cable must only be earthed at one end, preferably at the relay end and must be continuous. Multiple earthing of the screen can cause circulating current to flow along the screen, which induces noise and is unsafe.
It is recommended to minimize noise pick-up in the RTD cables by keeping them close to earthed metal casings and avoiding areas of high electromagnetic and radio interference. The RTD cables should not be run adjacent to or in the same conduit as other high voltage or current cables.
A typical cable specification would be:

Each core: 7/0.2 mm copper conductors heat resistant PVC insulated

Nominal conductor area: 0.22 mm^2 per core

Screen: Nickel-plated copper wire braid heat resistant PVC sheathed

The extract below may be useful in defining cable recommendations for the RTDs:
Noise pick-up by cables can be categorized in to three types:

- Resistive
- Capacitive
- Inductive

Resistive coupling	requires there to be an electrical connection to the noise source. So assuming that the wire and cable insulation is sound and that the junctions are clean then this can be dismissed.
Capacitive coupling	requires there to be sufficient capacitance for the impedance path to the noise source to be small enough to allow for significant coupling. This is a function of the dielectric strength between the signal cable on the noise source and the potential (i.e. power) of the noise source.
Inductive coupling	occurs when the signal cable is adjacent to a cable/wire carrying the noise or it is exposed to a radiated EMF.

Standard screened cable is normally used to protect against capacitively coupled noise, but in order for it to be effective the screen must only be bonded to the system ground at one point, otherwise a current could flow and the noise would be coupled in to the signal wires of the cable. There are different types of screening available, but basically there are two types: aluminum foil wrap and tin-copper braid.

Foil screens are good for low to medium frequencies and braid is good for high frequencies. High-fidelity screen cables provide both types.

Protection against magnetic inductive coupling requires very careful cable routing and magnetic shielding. The latter can be achieved with steel-armored cable and the use of steel cable trays. It is important that the armor of the cable is grounded at both ends so that the EMF of the induced current cancels the field of the noise source and hence shields the cables conductors from it. (However, the design of the system ground must be considered and care taken to not bridge two isolated ground systems since this could be hazardous and defeat the objectives of the original ground design). The cable should be laid in the cable trays as close as possible to the metal of the tray and under no circumstance should any power cable be in or near to the tray. (Power cables should only cross the signal cables at 90 degrees and never be adjacent to them).

Both the capacitive and inductive screens must be contiguous from the RTD probes to the relay terminals.

The best types of cable are those provided by the RTD manufactures. These tend to be three conductors (a so-called "triad") which are screened with foil. Such triad cables are available in armored forms as well as multi-triad armored forms.

4.9 Download/Monitor Port

Short term connections to the download/monitor port, located behind the bottom access cover, can be made using a screened 25-core communication cable up to 4m long. The cable should be terminated at the relay end with a 25-way, metal shelled, D-type male plug.

The Getting Started and Commissioning chapters this manual details the pin allocations.

4.10 Second EIA(RS)232/485 Port

Relays with Courier, MODBUS, IEC 60870-5-103 or DNP3 protocol on the first rear communications port have the option of a second rear port, running Courier protocol.
The second rear communications port can be used over one of three physical links:

- twisted pair K-Bus (non-polarity sensitive),
- twisted pair EIA(RS)485 (connection polarity sensitive) or
- EIA(RS)232. This EIA(RS)232 port is actually compliant to EIA(RS)574; the 9-pin version of EIA(RS)232, see www.tiaonline.org.

4.10.1 Connection to the Second Rear Port

The second rear Courier port connects via a 9-way female D-type connector (SK4) in the middle of the card end plate (in between IRIG-B connector and lower D-type). The connection is compliant to EIA(RS)574.

4.10.1.1 For IEC 60870-5-2 over EIA(RS)232/574

Pin	Connection
1	No Connection
2	RxD
3	TxD
4	DTR#
5	Ground
6	No Connection
7	RTS #
8	CTS #
9	No Connection
# - These pins are control lines for use with a modem.	

Table 6 - Pin connections for IEC 60870-5-2 over EIA(RS)232/574

Connections to the second rear port configured for EIA(RS)232 operation can be made using a screened multi-core communication cable up to 15 m long, or a total capacitance of 2500 pF. The cable should be terminated at the relay end with a 9-way, metal shelled, D-type male plug. The table above details the pin allocations.

4.10.1.2 For K-bus or IEC 60870-5-2 over EIA(RS)485

Pin*	Connection
4	EIA(RS)485 - 1 (+ ve)
7	EIA(RS)485 - 2 (- ve)
* - All other pins unconnected.	

Note *Connector pins 4 and 7 are used by both the EIA(RS)232/574 and EIA(RS)485 physical layers, but for different purposes. Therefore, the cables should be removed during configuration switches.*
For the EIA(RS)485 protocol an EIA(RS)485 to EIA(RS)232/574 converter will be required to connect a modem or PC running MiCOM S1 Studio, to the relay. A Schneider Electric CK222 is recommended.
EIA(RS)485 is polarity sensitive, with pin 4 positive (+) and pin 7 negative (-).
The K-Bus protocol can be connected to a PC via a KITZ101 or 102.
It is recommended that a 2-core screened cable be used. To avoid exceeding the second communications port flash clearances it is recommended that the length of cable between the port and the communications equipment should be less than 300 m. This length can be increased to 1000 m or 200nF total cable capacitance if the communications cable is not laid in close proximity to high current carrying conductors. The cable screen should be earthed at one end only.

Table 7 - Pin connections for K-bus or IEC 60870-5-2 over EIA(RS)485

A typical cable specification would be:

Each core:	16/0.2mm copper conductors. PVC insulated
Nominal conductor area:	0.5mm^2 per core
Screen:	Overall braid, PVC sheathed

4.11 Earth Connection (Protective Conductor)

Every relay must be connected to the local earth bar using the M4 earth studs in the bottom left hand corner of the relay case. The minimum recommended wire size is 2.5mm^2 and should have a ring terminal at the relay end.

Due to the limitations of the ring terminal, the maximum wire size that can be used for any of the medium or heavy duty terminals is 6.0mm^2 per wire. If a greater cross-sectional area is required, two parallel connected wires, each terminated in a separate ring terminal at the relay, or a metal earth bar could be used.

Note	*To prevent any possibility of electrolytic action between brass or copper earth conductors and the rear panel of the relay, precautions should be taken to isolate them from one another. This could be achieved in a number of ways, including placing a nickel-plated or insulating washer between the conductor and the relay case, or using tinned ring terminals.*

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

4.12 P391 Rotor Earth Fault Unit (REFU) Mounting

Under rotor earth fault conditions, DC currents of up to 29mA can appear in the earth circuit. Accordingly, the P391 must be permanently connected to the local earth via the protective conductor terminal provided.

This section serves as a guide to selecting the appropriate cable and connector type for each terminal on the P391 unit.

Caution	**You must be familiar with all safety statements listed in the Commissioning chapter and the Safety Information section SFTY/4LM/G11 (or later issue) before undertaking any work on the P391.**

Caution	**Under no circumstances should the high voltage DC rotor winding supply be connected via Easergy or P99x test blocks. Both Easergy and P990 test blocks are not rated for continuous working voltages greater than 300 Vrms. These test blocks are not designed to withstand the inductive EMF voltages which will be experienced on disconnection or de-energization of the DC rotor winding supply.**

4.12.1 Medium Duty Terminal Block Connections

Information about the medium duty terminal block connections is described in the ***Medium and Heavy Duty Terminal Block Connections*** section.

Caution **Wiring between the DC rotor winding and the P391 must be suitably rated to withstand at least twice the rotor winding supply voltage to earth. This is to ensure that the wiring insulation can withstand the inductive Electro Motive Force (EMF) voltage which will be experienced on disconnection or de-energization of the DC rotor winding supply.**

Due to the limitations of the ring terminal, the maximum wire size that can be used for any of the medium terminals is 6.0 mm^2 using ring terminals that are not pre-insulated (protective conductor terminal (PCT) only). All P391 terminals, except PCT shall be pre-insulated ring terminals, the maximum wire size that can be used is reduced to 2.63 mm^2 per ring terminal.

Wiring between the DC rotor winding and the P391 shall be suitably rated to withstand at least twice the rotor winding supply voltage to earth. The wire used for other P391 connections to the medium duty terminal blocks should have a minimum voltage rating of 300 Vrms.

The dielectric withstand of P391 injection resistor connections (A16, B16, A8, B8) to earth is 5.8 kV rms, 1 minute.

It is recommended that the auxiliary supply wiring should be protected by a High Rupture Capacity (HRC) fuse of type NIT or TIA, rated between 2 A and 16 A. Other circuits should be appropriately fused to protect the wire used.

5 CASE DIMENSIONS

The MiCOM range of products are available in a series of different case sizes.
The case sizes available for each product are shown here:

Range	Case Size		
	40TE	60TE	80TE
P14x	P141, P142	P143, P145	P143
P24x	P241	P242	P243
P34x	P341, P342	P341, P342, P343	P343, P344, P345
P441	P441		
P44x		P442	P444
P44y			P443, P446
P445	P445	P445	
P541	P541		
P542		P542	
P54x		P543, P544	P545, P546
P547			P547
P64x	P642	P643, P645	P645
P74x	P742	P743	P741
P746			P746
P841		P841	P841
P849			P849

Table 8 - Products and case sizes

5.1 40TE Case Dimensions

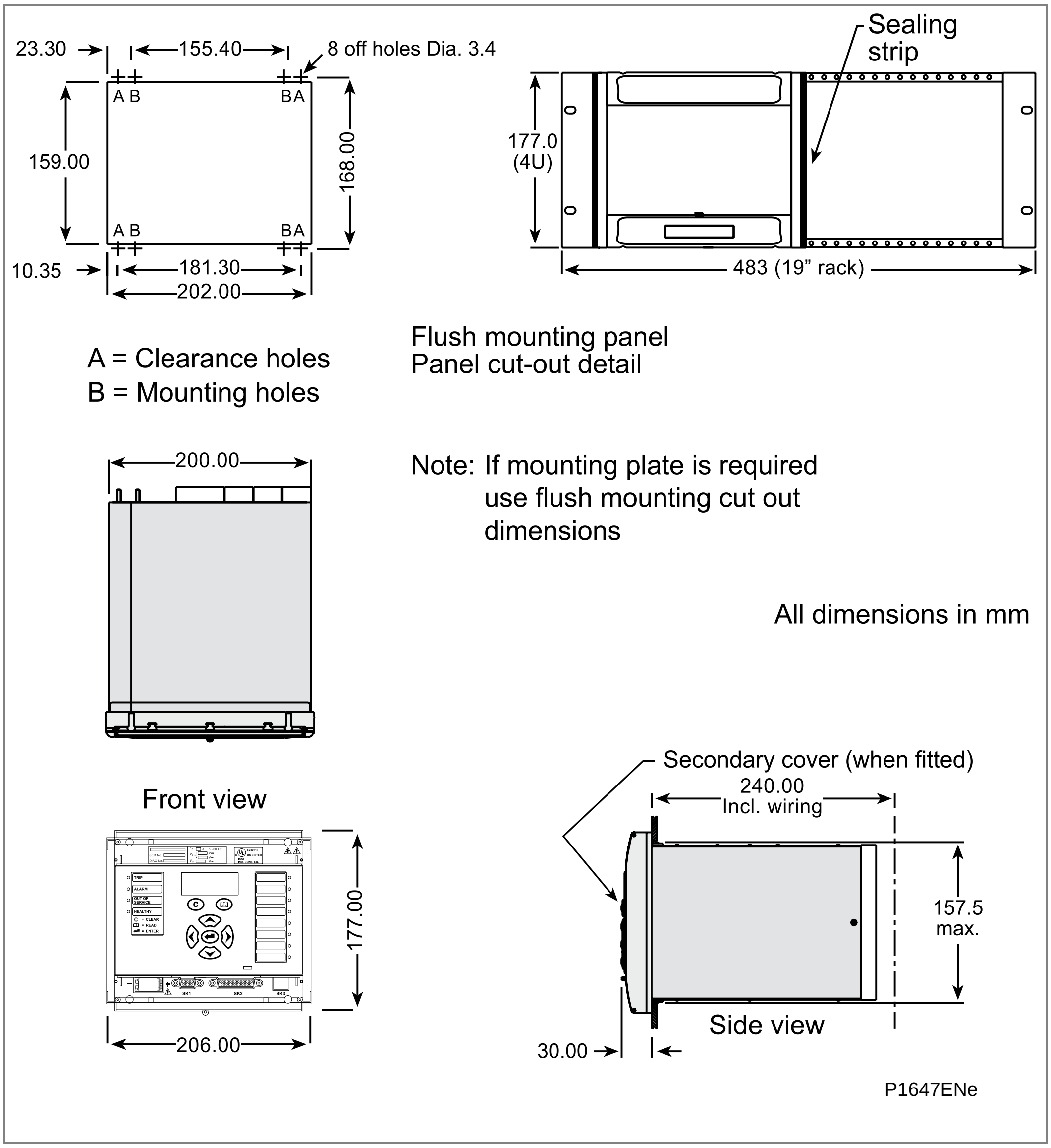

Figure 3 - 40TE Case Dimensions

5.2 60TE Case Dimensions

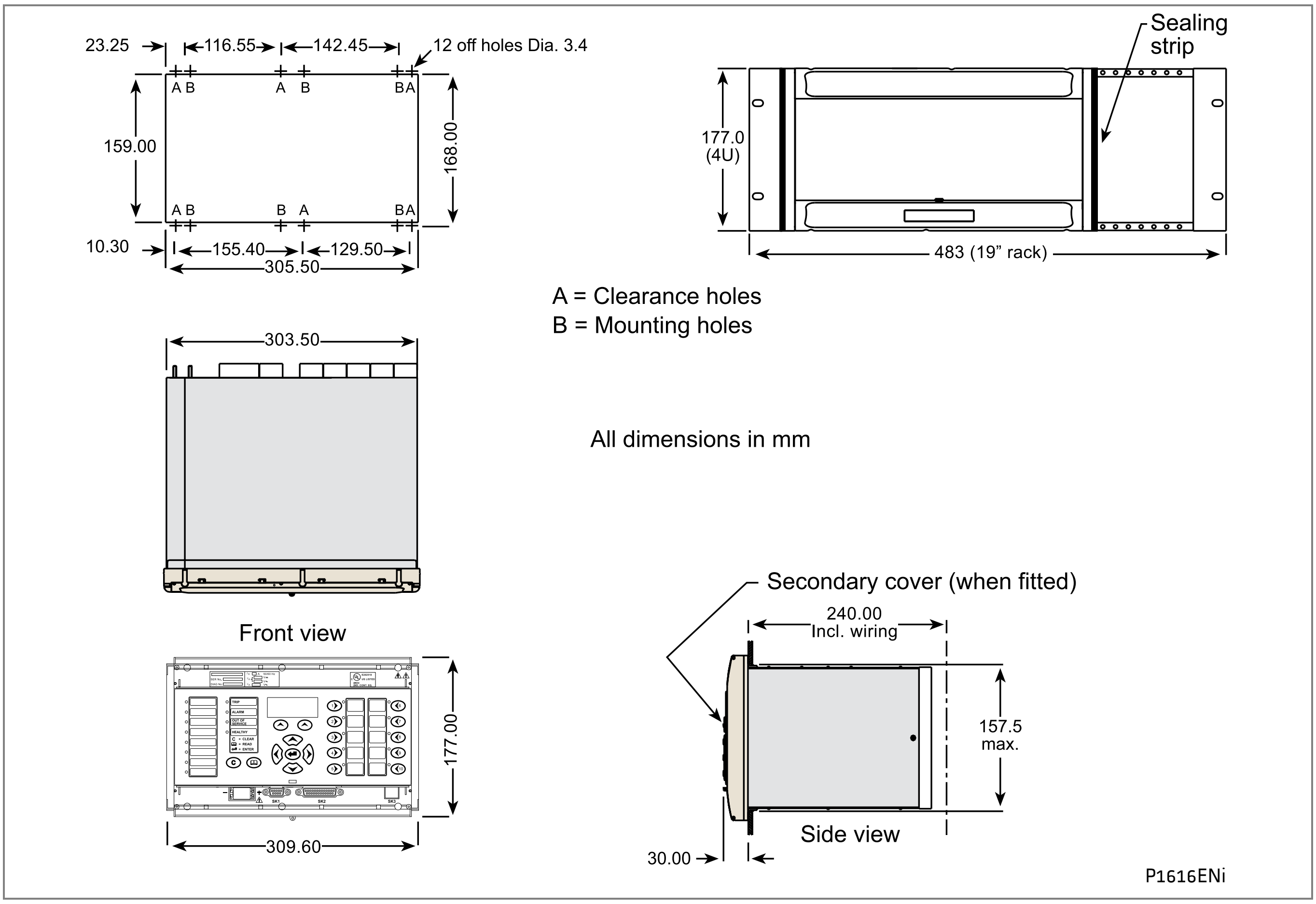

Figure 4 - 60TE Case Dimensions

5.3 80TE Case Dimensions

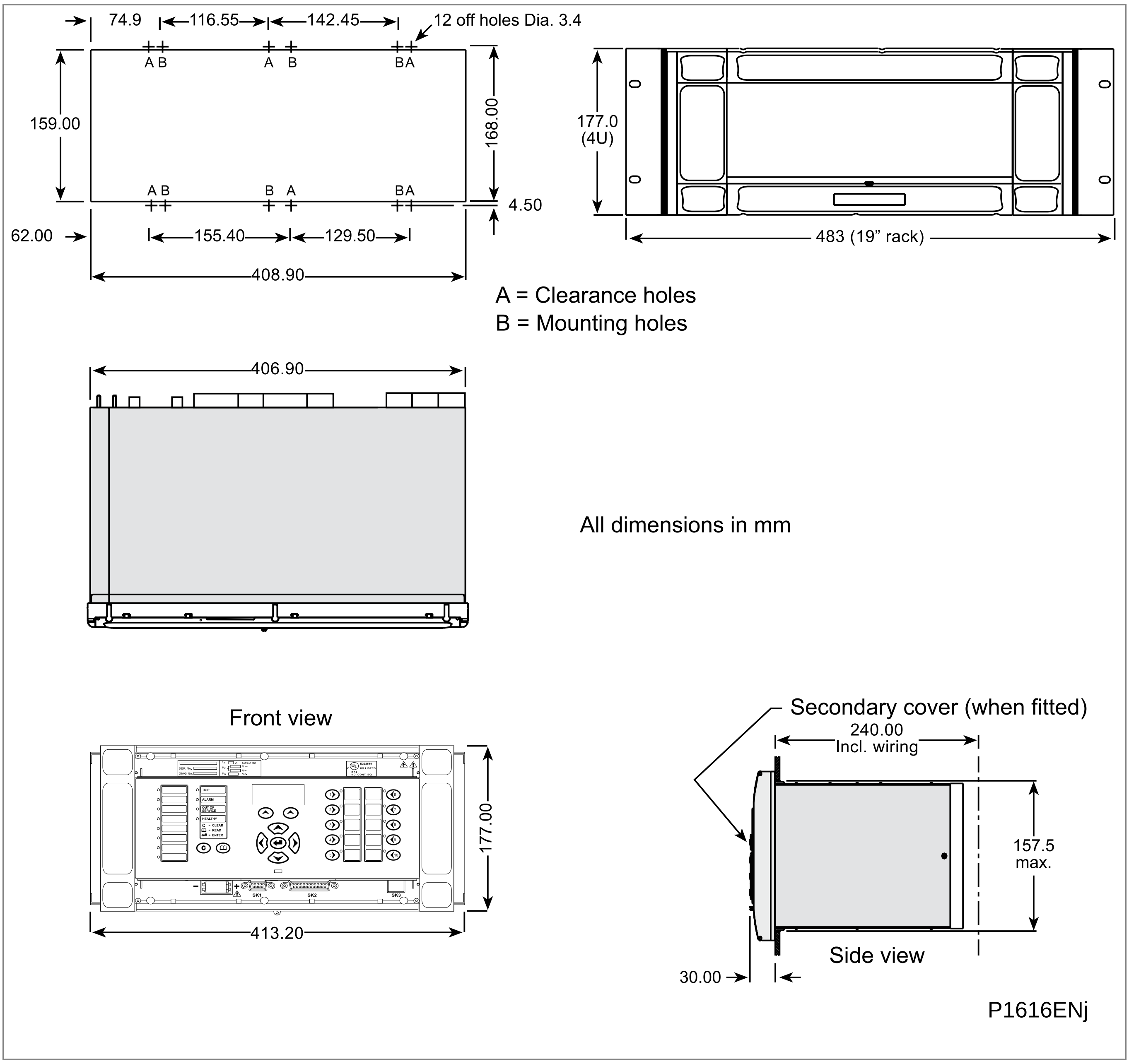

Figure 5 - 80TE Case Dimensions

CONNECTION DIAGRAMS

CHAPTER 17

Date:	12/2017
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.
Hardware Suffix:	M
Software Version:	B2
Connection Diagrams:	10P849xx (xx = 01 to 06)

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Notes:

1 COMMUNICATION OPTIONS

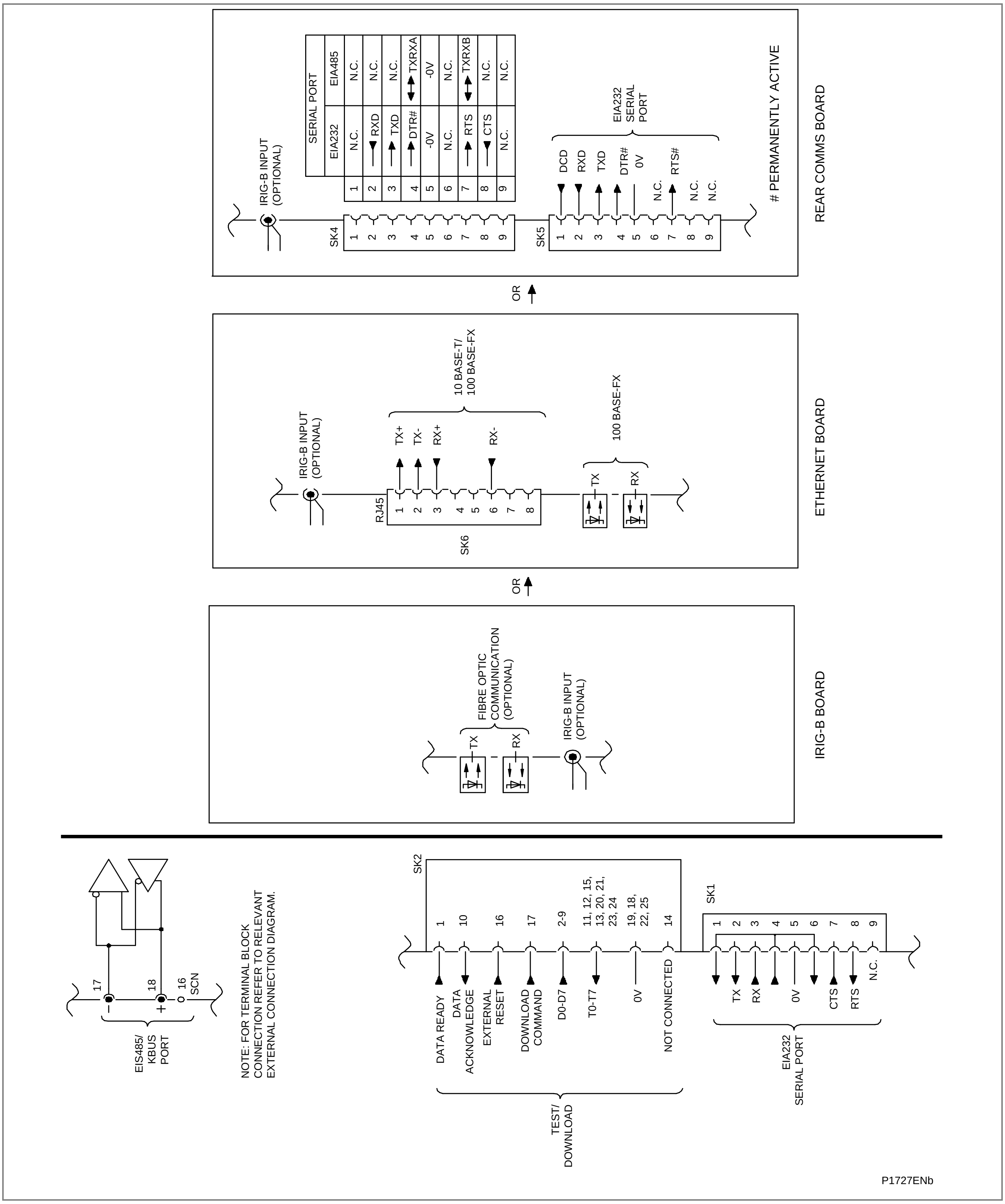


Figure 1 - Comms. Options MiCOM Px40 platform

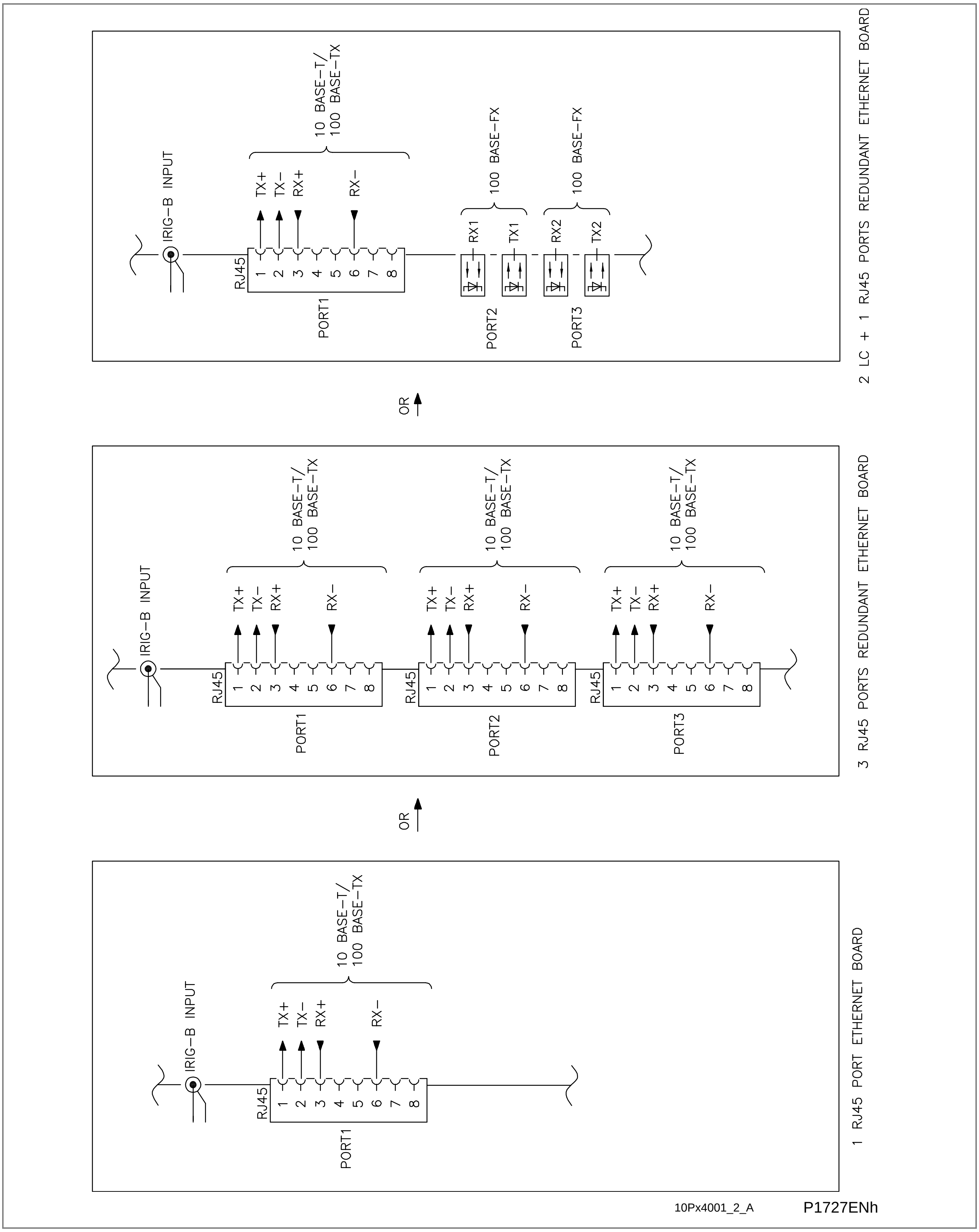


Figure 2 - External Communications Options MiCOM Px40 platform

2 P849 HARDWARE

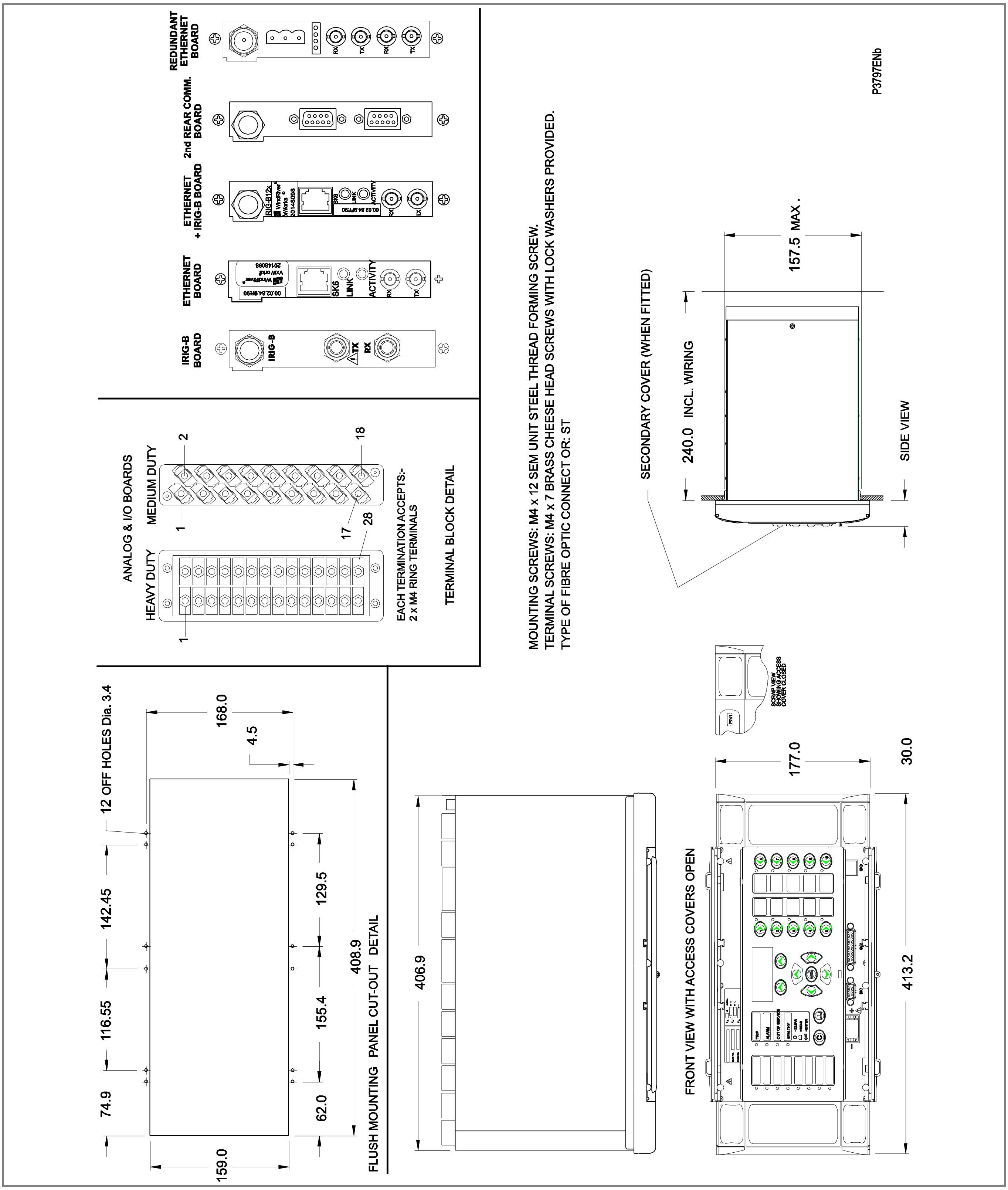
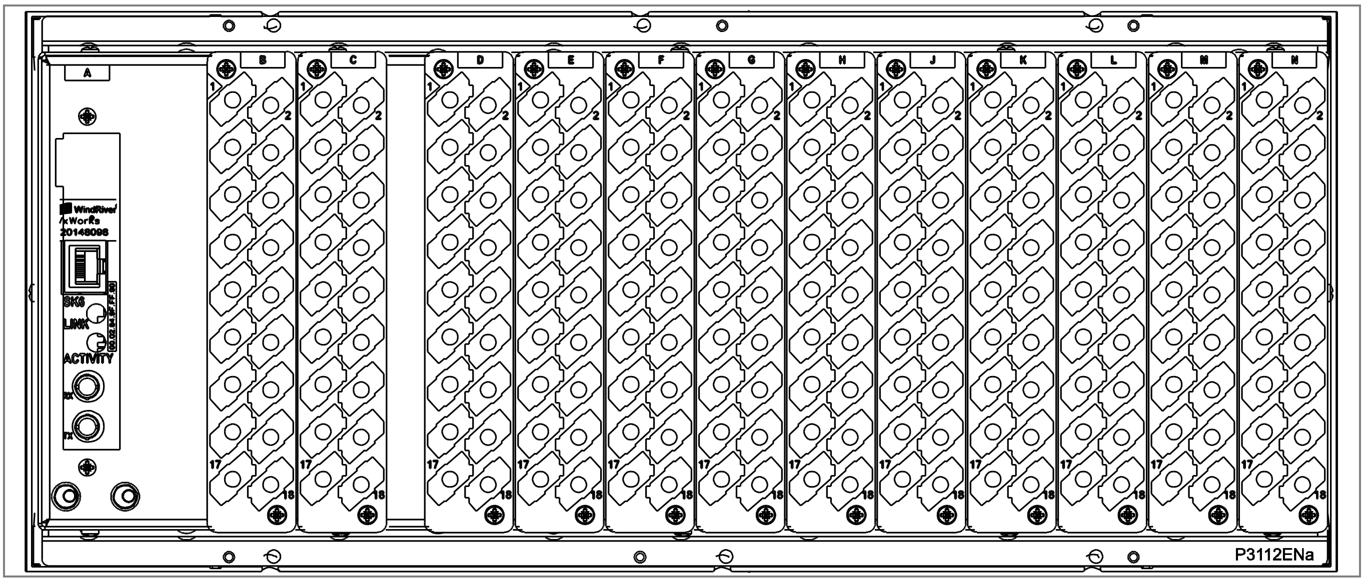


Figure 3 - P849 (80TE) – Hardware description



A – IRIG B / Ethernet / COMMS (1)
B – Opto input board (2)
C – Opto input board (2)
D – Opto input board (2)
E – Relay \ Opto (2)
F – Relay \ Opto (2)
G – Relay \ Opto \ High Break (2)
H – Relay \ Opto \ high break (2)
J – Relay \ Opto \ high break (2)
K – Relay \ Opto \ high break (2)
L – Relay board (2)
M – Relay board (2)
N – Power supply board

Figure 4 - P849 (80TE) – Rear View

(1) Hardware options:

– Standard version	P849xx1
– IRIG-B Only (Modulated)	P849xx2
– Single Ethernet 100Mbit/s fibre optic port	P849xx6
– Second Rear Comms (Courier EIA232 / EIA485 / KBUS)	P849xx7
– Second Rear Comms (Courier EIA232 / EIA485 / KBUS) + IRIG-B modulated	P849xx8
– Single Ethernet (100Mbit/s) plus IRIG-B (Modulated)	P849xxA
– Single Ethernet (100Mbit/s) plus IRIG-B (De-modulated)	P849xxB
– IRIG-B (De-modulated)	P849xxC
– InterMiCOM + Courier Rear Port	P849xxE
– InterMiCOM + Courier Rear Port + IRIG-B modulated	P849xxF
– Redundant Ethernet Self-Healing Ring, 2 multi-mode fibre ports + Modulated IRIG-B	P849xxG
– Redundant Ethernet Self-Healing Ring, 2 multi-mode fibre ports + Un-modulated IRIG-B	P849xxH
– Redundant Ethernet RSTP, 2 multi-mode fibre ports + Modulated IRIG-B	P849xxJ
– Redundant Ethernet RSTP, 2 multi-mode fibre ports + Un-modulated IRIG-B	P849xxK
– Redundant Ethernet Dual-Homing Star, 2 multi-mode fibre ports + Modulated IRIG-B	P849xxL
– Redundant Ethernet Dual-Homing Star, 2 multi-mode fibre ports + Un-modulated IRIG-B	P849xxM
– Redundant Ethernet (100Mbit/s) PRP or HSR and Dual IP, 2 LC ports + 1 RJ45 port + Modulated/Un-modulated IRIG-B	P849xxQ
– Redundant Ethernet (100Mbit/s) PRP or HSR and Dual IP, 3 RJ45 ports + Modulated/Unmodulated IRIG-B	P849xxR
– Ethernet (100Mbit/s), 1 RJ45 port + Modulated/Un-modulated IRIG-B	P849xxS

(2) Models:

– P849×××A – (32 Opto-inputs, 16 output relays)
  - B: empty
  - C: Opto input board (2071960A22)
  - D: Opto input board (2071960A22)
  - E: Opto input board (2071960A22)
  - F: Opto input board (2071960A22)
  - G: empty
  - H: empty
  - J: empty
  - K: empty
  - L: Relay board (8 relays – 2071962A01)
  - M: Relay board (8 relays – 2071962A01)

- P849×××B – (32 Opto-inputs, 16 output relays)
  B: empty
  C: Opto input board (2071960A22)
  D: Opto input board (2071960A22)
  E: Opto input board (2071960A22)
  F: Opto input board (2071960A22)
  G: Opto input board (2071960A22)
  H: Opto input board (2071960A22)
  J: empty
  K: Relay board (8 relays – 2071962A01)
  L: Relay board (8 relays – 2071962A01)
  M: Relay board (8 relays – 2071962A01)

P849×××C – (32 Opto-inputs, 30 output relays (16 high break relays))
  B: Opto input board (2071960A22)
  C: Opto input board (2071960A22)
  D: Opto input board (2071960A22)
  E: Opto input board (2071960A22)
  F: empty
  G: High break relay board (ZN0042-001)
  H: High break relay board (ZN0042-001)
  J: High break relay board (ZN0042-001)
  K: High break relay board (ZN0042-001)
  L: Relay board (7 relays – ZN0031-001)
  M: Relay board (7 relays – ZN0031-001)

- P849×××D – (16 Opto-inputs, 60 output relays)
  B: empty
  C: Opto input board (2071960A22)
  D: Opto input board (2071960A22)
  E: Relay board (7 relays – ZN0031-001)
  F: Relay board (7 relays – ZN0031-001)
  G: Relay board (7 relays – ZN0031-001)
  H: Relay board (7 relays – ZN0031-001)
  J: Relay board (8 relays – 2071962A01)
  K: Relay board (8 relays – 2071962A01)
  L: Relay board (8 relays – 2071962A01)
  M: Relay board (8 relays – 2071962A01)

- P849×××E – (32 Opto-inputs, 16 output relays)
  B: empty
  C: Opto input board (2071960A22)
  D: Opto input board (2071960A22)
  E: Opto input board (2071960A22)
  F: Opto input board (2071960A22)
  G: Opto input board (2071960A22)
  H: Opto input board (2071960A22)
  J: Opto input board (2071960A22)
  K: Opto input board (2071960A22)
  L: Relay board (8 relays – 2071962A01)
  M: Relay board (8 relays – 2071962A01)

- P849×××F – (32 Opto-inputs, 16 output relays)

  B: empty
  C: Opto input board (2071960A22)
  D: Opto input board (2071960A22)
  E: Opto input board (2071960A22)
  F: Opto input board (2071960A22)
  G: Relay board (8 relays – 2071962A01)
  H: Relay board (8 relays – 2071962A01)
  J: Relay board (8 relays – 2071962A01)
  K: Relay board (8 relays – 2071962A01)
  L: Relay board (7 relays – ZN0031-001)
  M: Relay board (7 relays – ZN0031-001)

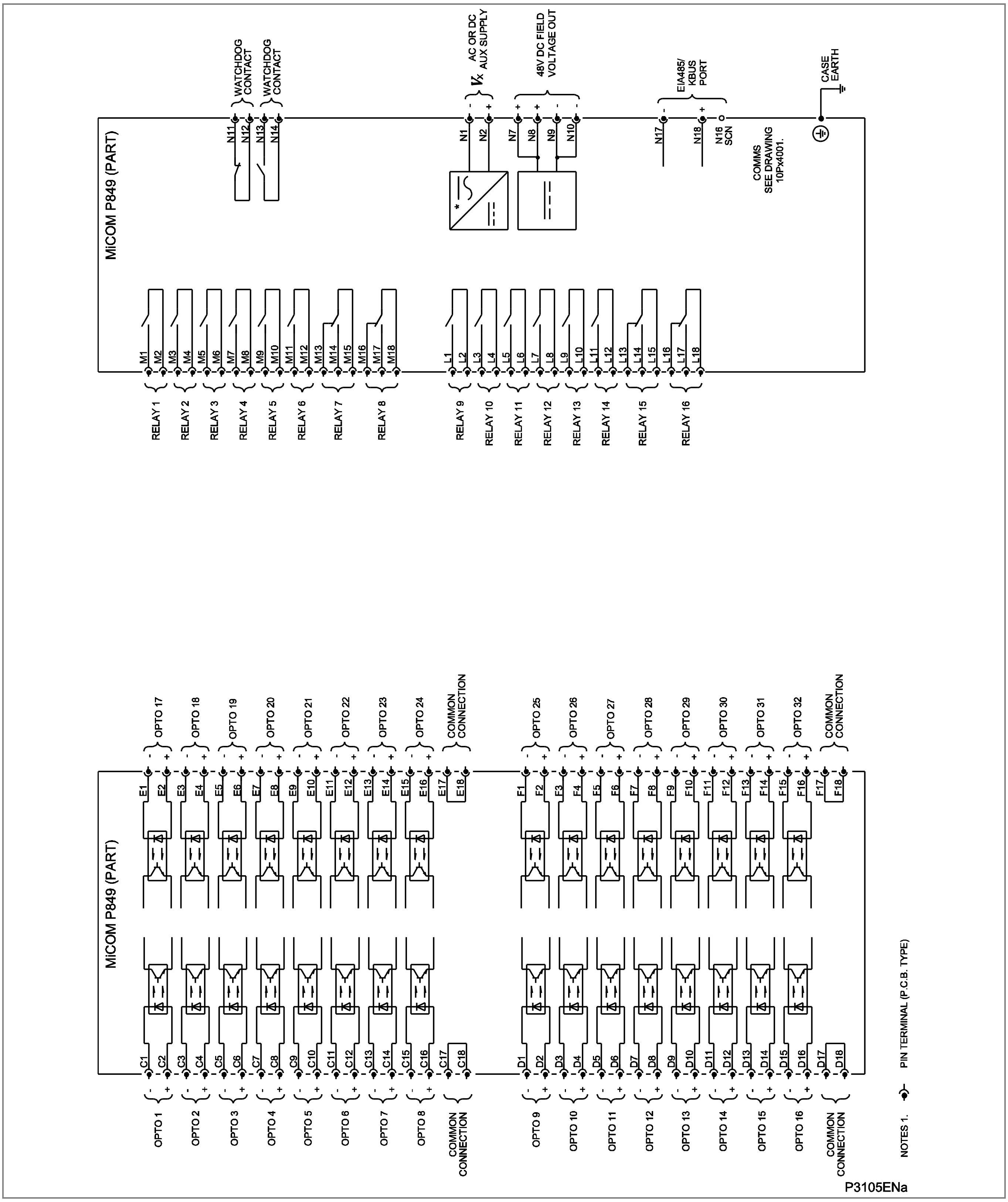


Figure 5 - P849 –P849xxxA (Connection Diagram No P84901)

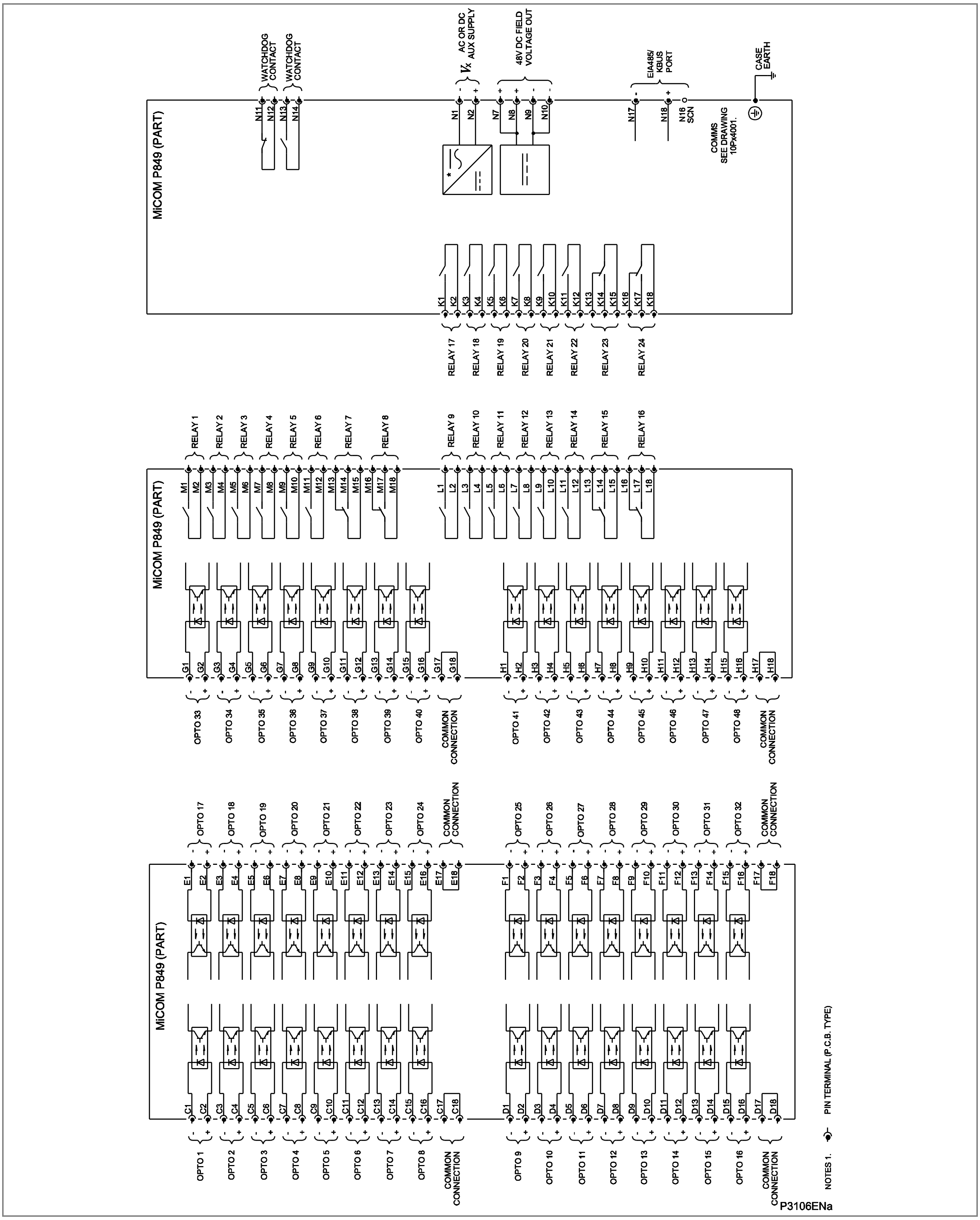


Figure 6 - P849 –P849xxxB (Connection Diagram No P84902)

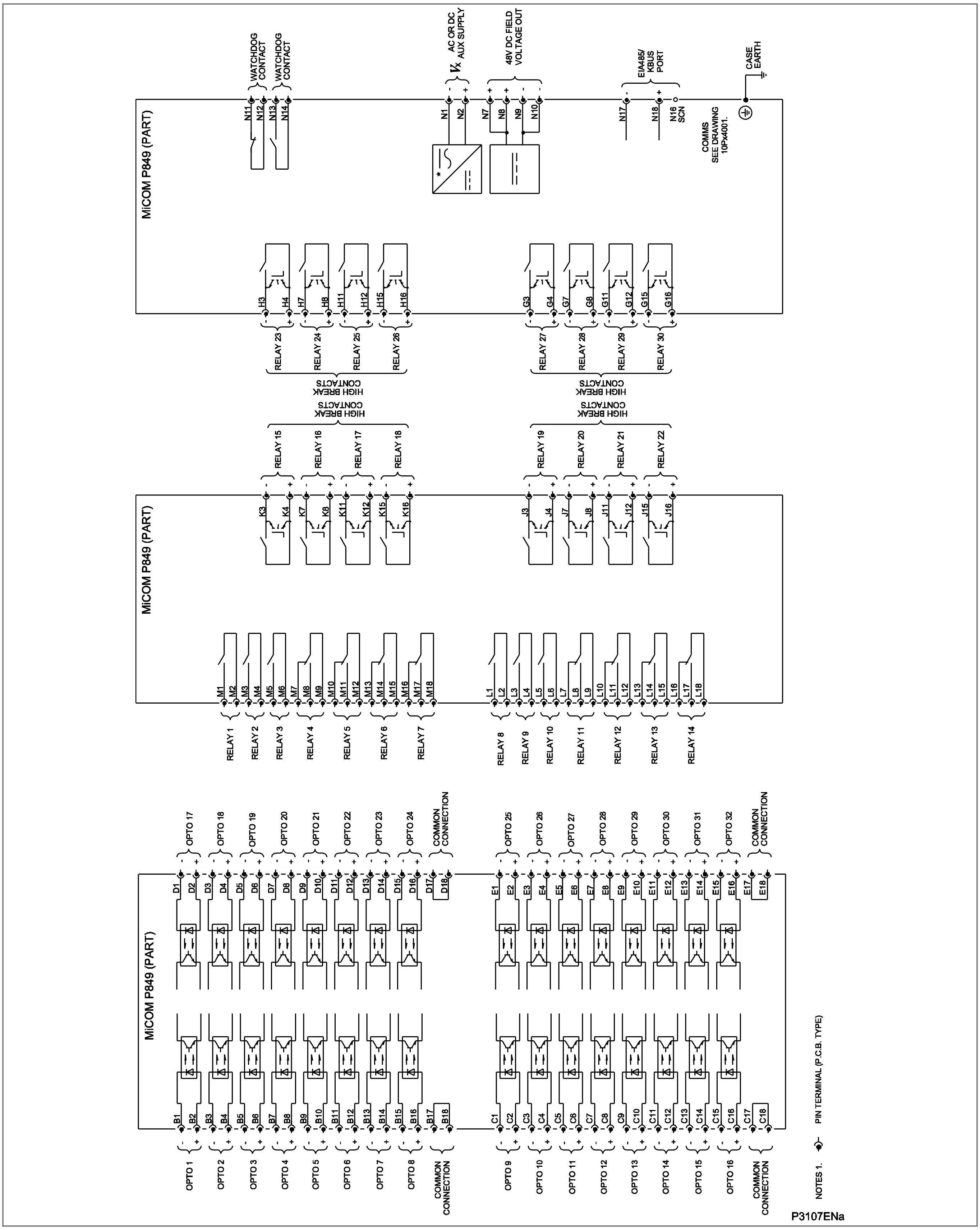


Figure 7 - P849 –P849xxxC (Connection Diagram No P84903)

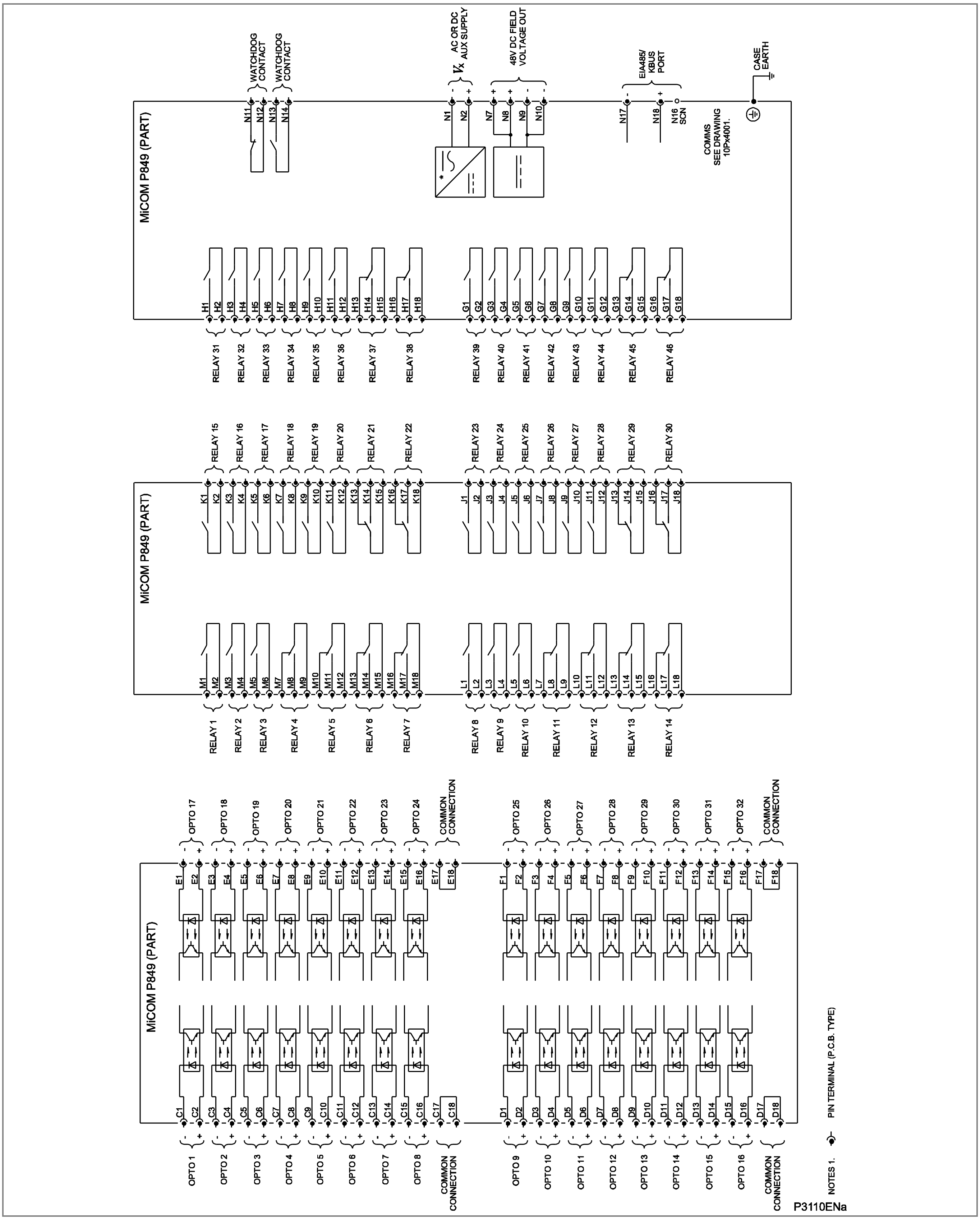


Figure 8 - P849 –P849xxxD (Connection Diagram No P84904)

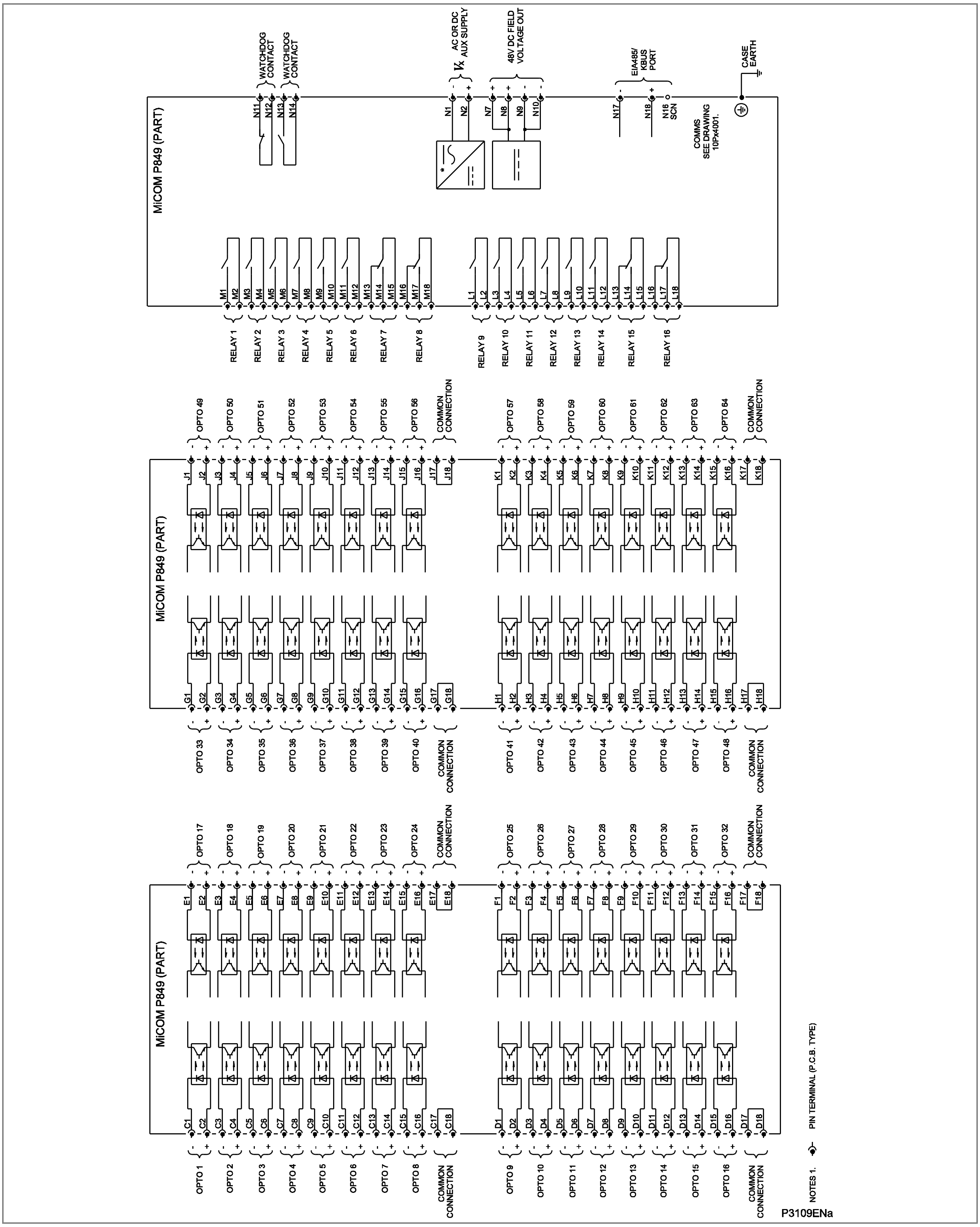


Figure 9 - P849 –P849xxxE (Connection Diagram No P84905)

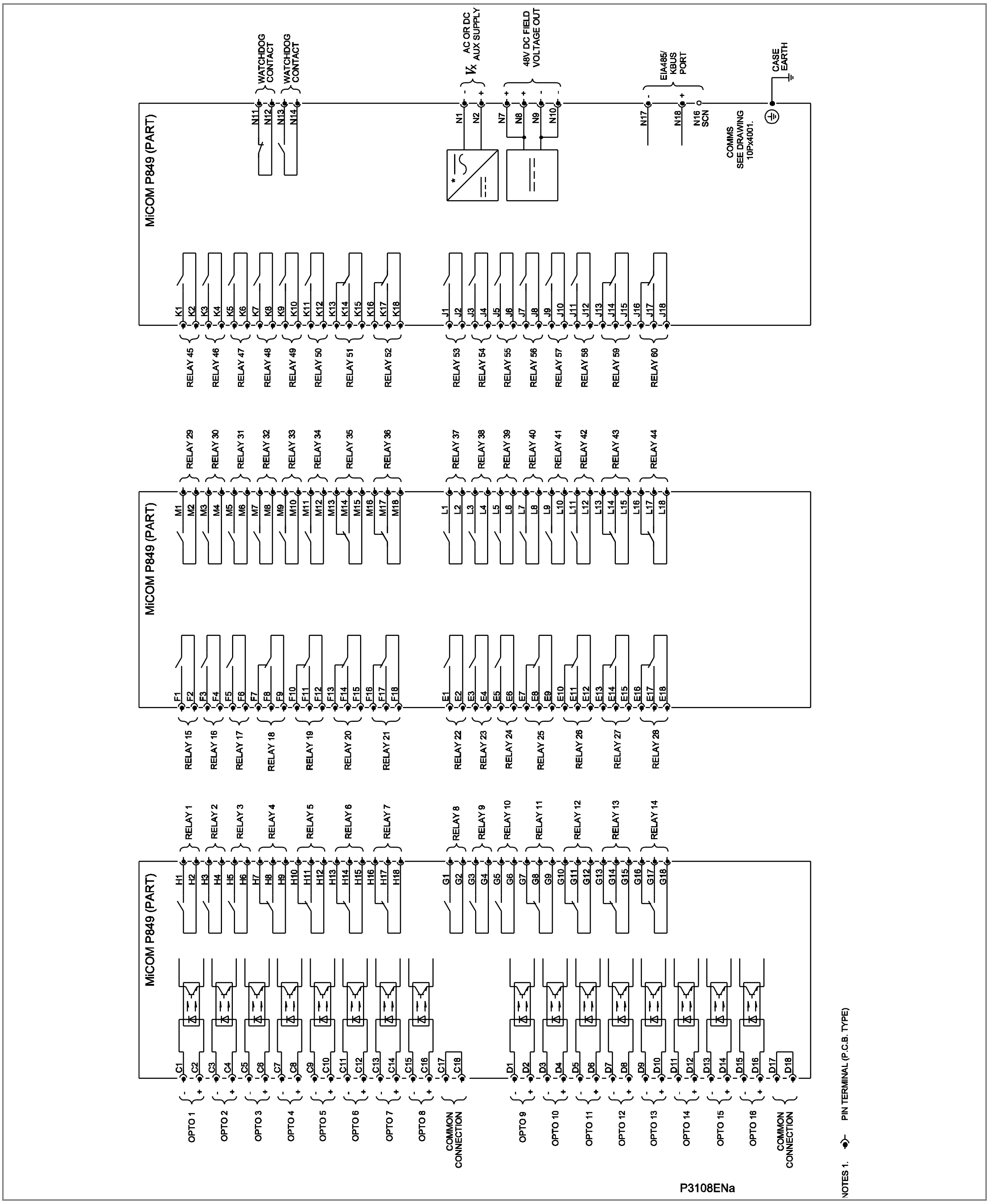


Figure 10 - P849 –P849xxxF (Connection Diagram No P84906)

Notes:

CYBER SECURITY

CHAPTER 18

Date (month/year):	11/2016	
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.	
Hardware Suffix:	P141/P142/P143 L P145 M P445 L P44x (P442/P444) M P44y (P443/P446) M	P54x (P543/P544/P545/P546) M P642 L P643/P645 M P746 M P841A (one circuit breaker) M P841B (two circuit breakers) M P849 M
Software Version:	P14x (P141/P142/P143/P145) B2 P445 J4 P44x (P442/P444) E1 P44y (P443/P446) H4	P54x (P543/P544/P545/P546) H4 P64x (P642/P643/P645) B2 P746 B3/C3 P841A (one circuit breaker) G4 P841B (two circuit breakers) H4 P849 B1
Connection Diagrams:	P14x (P141, P142, P143 & P145): 10P141xx (xx = 01 to 02) 10P142xx (xx = 01 to 05) 10P143xx (xx = 01 to 11) 10P145xx (xx = 01 to 11) P445: 10P445xx (xx = 01 to 04) P44x (P442 & P444): 10P44101 (SH 1 & 2) 10P44201 (SH 1 & 2) 10P44202 (SH 1) 10P44203 (SH 1 & 2) 10P44401 (SH 1) 10P44402 (SH 1) 10P44403 (SH 1 & 2) 10P44404 (SH 1) 10P44405 (SH 1) 10P44407 (SH 1 & 2) P44y (P443 & P446): 10P44303 (SH 01 and 03) 10P44304 (SH 01 and 03) 10P44305 (SH 01 and 03) 10P44306 (SH 01 and 03) 10P44600 10P44601 (SH 1 to 2) 10P44602 (SH 1 to 2) 10P44603 (SH 1 to 2)	P54x (P543, P544, P545 & P546): 10P54302 (SH 1 to 2) 10P54303 (SH 1 to 2) 10P54400 10P54404 (SH 1 to 2) 10P54405 (SH 1 to 2) 10P54502 (SH 1 to 2) 10P54503 (SH 1 to 2) 10P54600 10P54604 (SH 1 to 2) 10P54605 (SH 1 to 2) 10P54606 (SH 1 to 2) P64x (P642, P643 & P645): 10P642xx (xx = 1 to 10) 10P643xx (xx = 1 to 6) 10P645xx (xx = 1 to 9) P746: 10P746xx (xx = 00 to 21) P841: 10P84100 10P84101 (SH 1 to 2) 10P84102 (SH 1 to 2) 10P84103 (SH 1 to 2) 10P84104 (SH 1 to 2) 10P84105 (SH 1 to 2) P849: 10P849xx (xx = 01 to 06)
	Note *This chapter covers the combinations of Products, Software Versions and Hardware Suffixes identified here. If you are using earlier software or hardware, please refer to the Schneider Electric Customer Care Centre (www.schneider-electric.com/ccc) for details of which version of this chapter to refer to.*	

CONTENTS

TABLES

FIGURES

1 OVERVIEW

1.1 Definition

Cyber security is a domain that addresses attacks on or by computer systems and through computer networks that can result in accidental or intentional disruptions. Cyber security addresses not only deliberate attacks, such as from disgruntled employees, industrial espionage, and terrorists, but also inadvertent compromises of the information infrastructure due to user errors, equipment failures, and natural disasters.

1.2 Introduction to Cyber Security

The objective of cyber security is to provide increased levels of protection for information and physical assets from theft, corruption, misuse, or accidents while maintaining access for their intended users.

To achieve this objective the owner of the grid must take into account Cyber Security at every level of his organization by the management of an ongoing process that encompasses procedures, policies, technical (software, and hardware asset) and regulatory constraints.

The following diagram outlines some of the associated topics.

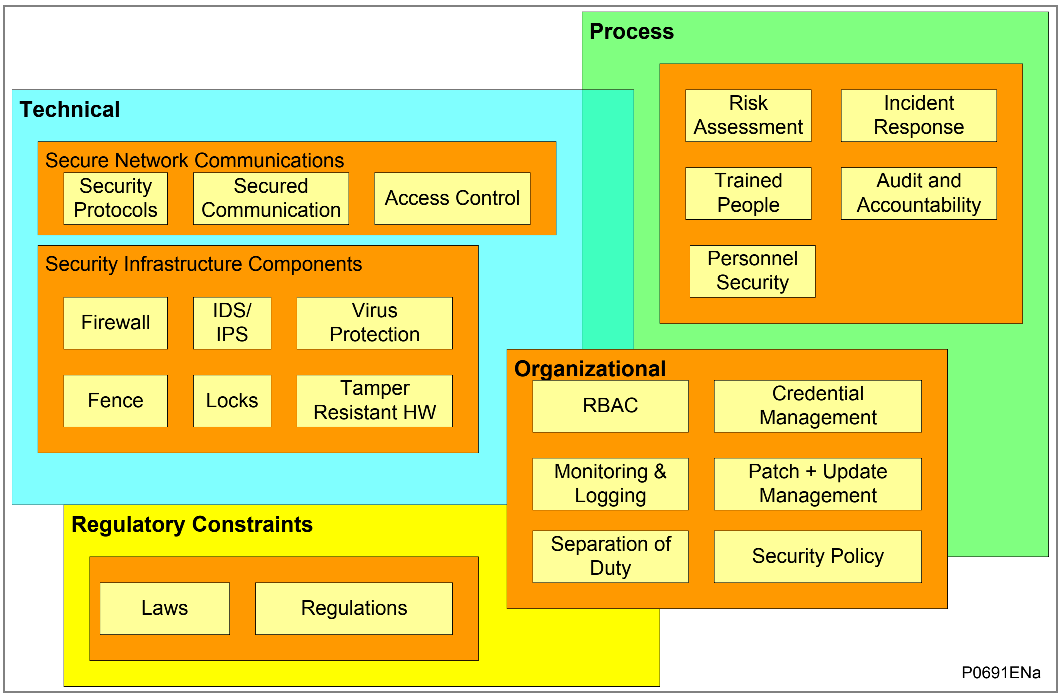


Figure 1 – Associated topics

The asset owner needs to run a continuous improvement process as outlined here:

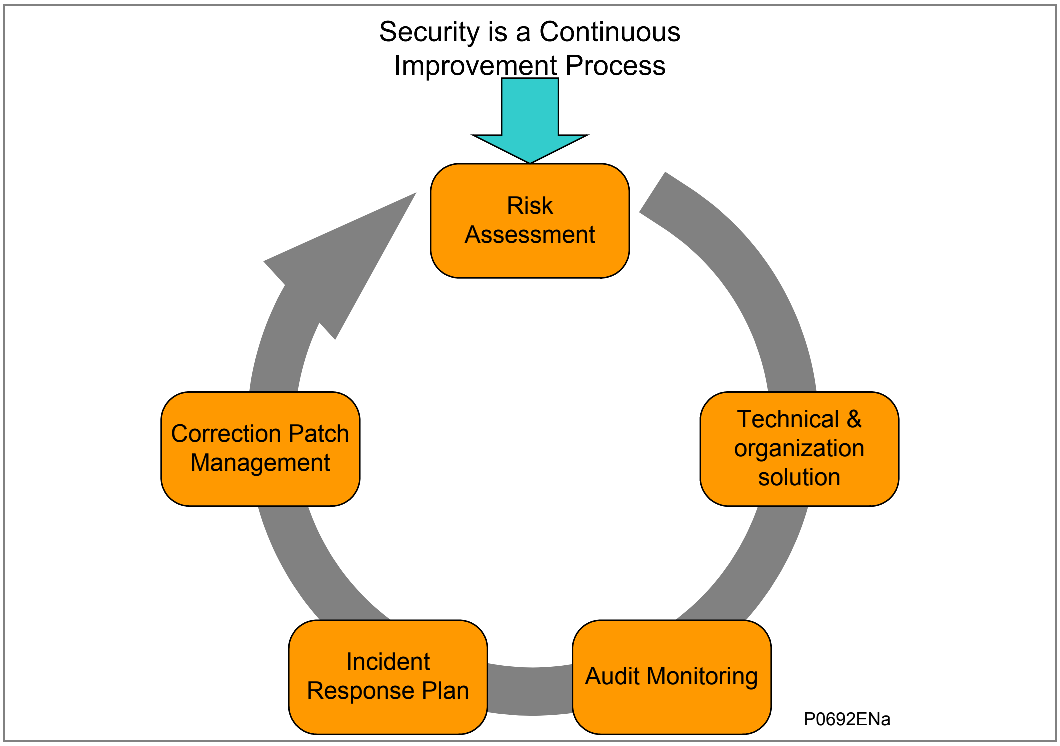


Figure 2 – Continuous improvement process

No single solution can provide adequate protection against all cyber attacks on the control network. Schneider Electric recommends employing a “defense in depth” approach using multiple security techniques to help mitigate risk.

A secured system is to offer:

- Detective controls: Monitor and record specific types of events: Security logs, Intrusion, detection systems, Video Surveillance etc.
- Preventive controls: Help blocking or controlling specific event : Antivirus, White listing, Firewall etc.
- Recovery controls: Help achieve Business continuity and Disaster recovery planning objectives in case of an incident: Backup and Restore solution.

As protective relay vendor, Schneider Electric helps the grid owner to achieve by providing technical features inside the IED, described in the next chapters.

Important	**This product contains a cyber-security function, which manages the encryption of the data exchanged through some of the communication channels. The aim is to protect the data (configuration and process data) from any corruption, malice, attack. Subsequently, this product might be subject to control from customs authorities. It might be necessary to request special authorization from these customs authorities before any export/import operation. For any technical question relating to the characteristics of this encryption please contact your Customer Care Centre - www.schneider-electric.com/ccc.**

1.3 Roles, Rights and relationship between IEC62351 and MiCOM Px4x

1.3.1 Role Based Access Control (RBAC)

The Role Based Access Control (RBAC) is a method to restrict resource access to authorized users. RBAC is an alternative to traditional Mandatory Access Control (MAC) and Discretionary Access Control (DAC).

A key feature of RBAC model is that all access is through roles. A role is essentially a collection of permissions, and all users receive permissions only through the roles to which they are assigned, or through roles they inherit through the role hierarchy.

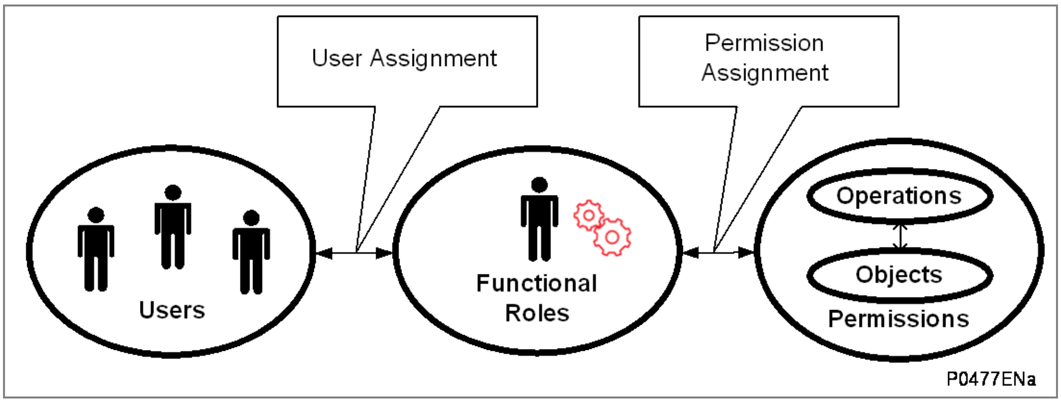


Figure 3 - RBAC Role structure

Roles are created for various job activities. The ***Permissions***, to perform certain operations, are assigned to specific roles. ***Users*** are assigned particular roles, and through those role assignments acquire the computer permissions to perform particular computer-system functions. Since ***users*** are not assigned permissions directly, but only acquire them through their role (or roles), management of individual user rights becomes a matter of simply assigning appropriate roles to the user's account; this simplifies common operations, such as adding a user, or changing user's account.

RBAC defines four different concepts:

RBAC Standard Definition	Description
Object	An ***object*** can represent information containers (e.g. files, directories in an operating system, tables and views in a database management system) or device resources, such as IEDs.
Subject	A ***subject*** is a user of the system. Note that a subject can be a person, or an automated agent / device.
Right	A ***right*** is the ability to access an object in order to perform certain operations (e.g. setting a data or reading a file)
Role	A ***role*** defines a certain authority level in the system. Rights are assigned to roles.

Table 1 – RBAC object, subject, rights and roles definitions

RBAC defines three primary rules:

RBAC Rule	Description
Role assignment	A subject can exercise a permission only if the subject has selected or been assigned a role.
Role authorization	A subject's active role must be authorized for the subject. With rule 1 above, this rule ensures that users can take on only roles for which they are authorized.
Permission authorization	A subject can exercise permission only if the permission is authorized for the subject's active role. With rules 1 and 2, this rule ensures that users can exercise only permissions for which they are authorized.

Table 2 – RBAC permission and authorization rules

1.3.2 User Roles

Different named roles are associated with different access rights. Roles and Rights are setup in a pre-defined arrangement, according to the IEC62351 standard, but customized to the MiCOM Px4x equipment.

When the user tries to access an IED, they need to login using their own username and their own password. The username/password combination is then checked against the records stored on the IED. If they are allowed to login, a message appears which shows them what Role they have been assigned to. It is the role that defines their access to the relevant parts of the system.

The default user roles for MiCOM Px4x are shown here:

Role	Description
VIEWER	Can View what objects are present within a Logical-Device by presenting the type ID of those objects.
OPERATOR	An Operator can view what objects and values are present within a Logical-Device by presenting the type ID of those objects as well as perform control actions.
ENGINEER	An Engineer can view what objects and values are present within a Logical-Device by presenting the type ID of those objects. Moreover, an engineer has full access to Datasets and Files and can configure the server locally or remotely.
SECADM	Security Administrator can change subject-to-role assignments (outside the device) and role-to-right assignment (inside the device) and security policy setting; change security setting such as certificates for subject authentication and access token verification.
SECAUD	Security Auditor can view audit logs

Table 3 – Default user roles summary for MiCOM Px4x

Each authorized user must be placed into at least ONE of these roles that most suits their job description. It is possible to assign a user into a different role; and/or to change the rights associated with a particular role. This means that the administrator can change the access rights for one role; and this will affect ALL the users who are assigned to that role.

It is possible for MiCOM Px4x to create the customized user roles.

1.3.3 Rights

In a similar way in which a set of pre-defined Roles have been created, a pre-defined set of Rights have been created.

These Rights give different permissions to look at what devices may be present, what those devices may contain, manage data within those devices (directly or by using files) and configure rights for other people.

A list of the pre-defined Rights for IEC 62351-8 is given here:

Right	Description
VIEW	Allows the subject/role to discover what objects are present within a Logical-Device by presenting the type ID of those objects. If this right is not granted to a subject/role, the Logical-Device for which the View right has not been granted shall not appear
READ	Allows the subject/role to obtain all or some of the values in addition to the type and ID of objects that are present within a Logical-Device;
DATASET	Allows the subject/role to have full management rights for both permanent and non-permanent Datasets;
REPORTING	Allows a subject/role to use buffered reporting as well as un-buffered reporting;
FILEREAD	Allows the subject/role to have read rights for file objects;
FILEWRITE	Allows the subject/role to have write rights for file objects. This right includes the FILEREAD right
CONTROL	Allows a subject to perform control operations;
CONFIG	Allows a subject to locally or remotely configure certain aspects of the server;
SETTINGGROUP	Allows a subject to remotely configure Settings Groups;
FILEMNGT	Allows the role to transfer files to the Logical-Device, as well as delete existing files on the Logical-Device;
SECURITY	Allows a subject/role to perform security functions at both a Server/Service Access Point and Logical-Device basis. To add Information about the concept of Rights.

Table 4 – Pre-defined rights for IEC 62351-8

The specific Rights for MiCOM Px4x are listed below. These are dependent on the IED data type. Please refer to each product MD file (Menu Database) for the IED data type.

Rights	Authorized Actions to IED	IED_DESC	IED_DATA	DISPLAY	IED_CONFIG	PROT_CONFIG	IEC_COMMAND	AUDIT	IED_FN_KEY	IED_CLEAR
Read Only (SAT default_access_right)	Read	x	x	x	x		x			
	Write	x								
IED Configuration (SAT configuration_right)	Read/write/upload/do wnload				x					
HMI Display Settings (SAT display_action_right)	Read/write/select			x						
Protection Configuration (SAT protection_configuration_right)	Read/write					x				
IED Commands (SAT control_right)	Read/write/clear/reset /select						x			
Reading of Records & Events (SAT audit_read_right)	Read/select/upload							x		
Extraction of Records and Events (SAT audit_write_right)	Send/accept							x		
IED Function Key (SAT fn_key_access_right)	Write								x	
IED Records Clear (SAT clear_right)	Read/write/clear									x

Table 5 – Specific rights for MiCOM Px4x

1.3.4 Roles and their Access Rights

A complete list of the Roles and their access Rights is shown in this table:

Rights \ Roles		VIEWER	OPERATOR	ENGINEER	SECADM	SECAUD
Pre-defined Rights for IEC 62351	VIEW	X	X	X	X	X
	READ		X	X	X	X
	DATASET			X		
	REPORTING	X	X	X		X
	FILEREAD					X
	FILEWRITE			X	X	
	FILEMNGT			X	X	
	CONTROL		X		X	
	CONFIG			X	X	
	SETTINGGROUP				X	
	LOGS				X	X
	SECURITY				X	
Specific Rights for MiCOM Px4x	Read Only	X	X	X		X
	IED Configuration			X		
	HMI Display Settings		X	X		
	Protection Configuration			X		
	IED Commands		X	X		
	Reading of Records and Events	X	X	X		X
	Extraction of Records and Events		X	X		X
	IED Function Key		X	X		
	IED Clear			X		

Table 6 – Pre-defined roles (and rights) for IEC 62351-8 and MiCOM Px4x

Important	**The reason why these are described as Default, is that it is possible to change the definitions of Roles and Rights, using the full version of the SAT software. Depending on the work done by the system administrator, it is possible that your own situation may vary from these initial recommendations.**

1.4 Security Administration Tool (SAT) Software

Important	**This can only be used with Px4x relays with cyber security CSL1 features.**

Important	**For Dual Ethernet cards the SAT functionality is available from communication interface 1. The connection to the SAT would be available from interface 2 only when interface 1 is disconnected from the network.**

The Security Administration Tool (SAT) is the security configuration tool of MiCOM Px4x equipment. It allows the security administrator to define the security policy to the IEDs.

The Security Administrator manages RBAC and security policies data. Security Administrator defines needs to protect devices in accordance with user privileges. Thus, the system security can be configured easily and precisely.

The SAT is used by the Security Administrator to manage the system's security database and deploys security configurations to IED(s).

The SAT allows to Manage User Accounts, Roles, Permission, Elements to Secure (ETS) and Security Server parameters without connection with devices. Information is store on the MS SQL database. This is the Offline mode. SAT allows devices management connected on network. This is the online mode.

The Role Based Access Control (RBAC) is a method to restrict resource access to authorized users. Please refer to this documentation on section "*System RBAC Management*" for more details.

The following table contains the main user main functions of the SAT:

Category	User Function	Note
Offline General Administration	User Accounts Management	User Account Functions: * Creation * Edition * Suppress * Viewing * Sorting * Filtering
	Server Configuration	
	Users Accounts & Roles association Management	Associate a role to the user account
Offline Advanced Administration	Roles Management	Roles Functions: * Creation * Edition * Suppress * Viewing * Sorting
	Element To Secure (ETS) Management	Define ETS which are in fact the PACiS assets present in the project (C264, PACiS Gateway, ECOSUI, IED and SAM). Add, Suppress and Sort permissions associated with the ETS.
	Global Security Management	The Global Security allows scope(s) and associate or disassociate role(s) management for each user account. The security administrator manages the current scope by the Roles: * View Roles List, User Account List and associations User-Roles or Role-Users * Associate / dissociate role(s) for each User Account * Add / Suppress User account(s) for each Role
	Permission access	Define parameters: * Password validity * Inactivity period * Automatic logout period * Maximum attempts of login and lockout period
Communication	Refresh IED list	
	Display IED Logs	
	Display SAM Logs	
	Push RBAC and Security Policies	Send Security Configuration to all Devices integrating Security features.

Table 7 – Main SAT user functions

The details of how to use the SAT are provided in the SAT documentation:

SAT (Security Administration Tool) Documentation - User Guide

This is available from the Schneider Electric website: www.schneider-electric.com.

2 MICOM PX4X CYBER SECURITY IMPLEMENTATION

Schneider Electric MiCOM Px4x IEDs have always been and will continue to be equipped with state-of-the-art security measures. Due to the ever-evolving communication technology and new threats to security, this requirement is not static. Hardware and software security measures are continuously being developed and implemented to mitigate the associated threats and risks.

Considered some users may not want to use the cyber security, Schneider Electric offers MiCOM Px4x relays with CSL0 and CSL1 as below:

CSL0: Simple password management, No SAT required.

CSL1: Advanced cyber security, SAT required.

This depends on the model number, as CSL1 is depend on the Ethernet communication. Hence if the IED if supports only legacy protocol this will be CLS0 default as. The digit position number 9 (protocol options) in the Cortec / model number is used to distinguish it.

Protocol Option Number	Protocol options	Cyber Security options
1	K-Bus/Courier	CSL0
2	Modbus	CSL0
3	IEC 60870 -5 - 103	CSL0
4	DNP3.0	CSL0
6	IEC 61850 Edition 1 / 2 and Courier via rear K-Bus/RS485	CSL0
7	IEC 61850 Edition 1 / 2 and CS103 via rear port RS485	CSL0
B	IEC 61850 Edition 1 / 2 and DNP3oE and DNP Serial	CSL0
G	IEC 61850 Edition 1 / 2 and Courier via rear K-Bus/RS485	CSL1
H	IEC 61850 Edition 1 / 2 and CS103 via rear port RS485	CSL1
L	IEC 61850 Edition 1 / 2 and DNP3oE and DNP3 serial	CSL1

Table 8 – MiCOM Px4x protocol options for cyber security options

2.1 MiCOM Px4x with CSL1 - Advance Cyber Security

For MiCOM Px4x IEDs which support CSL1, this means the IED supports advanced user account right management. Moreover, the IED supports security logs/events and secure administration capability.

If you want to use cyber security, you need to order the IED that supports CSL1. In this case, the Security Administration Tool (SAT) is required for RBAC configuration.

At the IED level, these cyber security features have been implemented:

- Passwords management (via the SAT)
- RBAC Management (via the SAT)
- User Locking
- Inactivity Timer
- RBAC recovery
- Port Disablement (via S1 Studio or the front panel)
- Simple Network Management Protocol (SNMP)
- Security Logs

2.1.1 Password Management

For the IED if CSL1 supported, there are two types of password possible for the IED access: alphanumeric password or Arrow Key password.

The alphanumeric password is only settable via the SAT:

- Passwords may be any length between 1 and 32 characters long
- Passwords may contain any ASCII character in the range ASCII code 33 (21 Hex) to ASCII code 122 (7A Hex) inclusive
- Passwords may or may not be NERC/IEEE 1686 compliant
- The alphanumeric password will used for courier client access

For more details about NERC/IEEE 1686 password compliant, please check the standard.

The Arrow Key password is only settable via the SAT:

- The Arrow Key password is a combination of the four arrow keys on the front panel
- The Arrow Key password may be any length between 1 and 8 of arrow keys long
- The Arrow Key password can only used in the front panel
- The user also can disable the Arrow Key password by not setting it

Important	**If the Arrow Key password is not configured, the alphanumeric password will be used for the front panel access. In this case, alphanumeric passwords longer than 16 characters are not allowed.** **MiCOM S1 Studio and the front panel are not allowed to change the password.**

2.1.2 RBAC Management (via the SAT)

By default, the IED includes a factory RBAC which has three users, and for each user, the Rights depend on the user Role. Please refer to the *Roles and their Access Rights* section for more details.

Username	Role	Default password
SecurityAdmin	SECADM	AAAAAAAA
EngineerLevel	ENGINEER	AAAA
OperatorLevel	OPERATOR	AAAA

Table 9 – Factory RBAC

A Local Default Access function also available for the default RBAC, with the VIEWER role, which allows everyone login the IED in the front panel with VIEWER role. For more details about the Local Default Access function, please refer to the *Local Default Access* section.

For more information about how the SAT management the RBAC and cyber security policies, please see the *Security Administration Tool (SAT)* section.

2.1.3 User Locking

The user is locked out temporarily, after a defined number of failed password entry attempts.

Important	**If a user is locked out, the block is applied to that named user and to the all IED interfaces. The blocking of one user, does not apply blocks to others.** **If the user entry is blocked, recover the RBAC or push a new RBAC will not reset the blocked user entry, but IED reboot will reset the blocking time and attempts count, so the user entry will be unblocked.**

The first invalid password entry sets the attempts count (actual text here) to 1 and initiates an 'attempts timer'. Further invalid passwords during the timed period increments the attempts count. When the maximum number of attempts has been reached, access is blocked. If the attempts timer expires, or the correct password is entered *before* the 'attempt count' reaches the maximum number, then the 'attempts count' is reset to 0.

Once the user entry is blocked, a 'blocking timer' is initiated. Attempts to access the interface whilst the 'blocking timer' is running results in an error message, irrespective of whether the correct password is entered or not. Only after the 'blocking timer' has expired will access to the interface be unblocked, whereupon the attempts counter is reset to zero.

Attempts to write to the password entry whilst it is blocked results in the following message, which is displayed for 2 seconds.

```
LOGIN FAILED
INCORRECT PASSWORD
```

Appropriate responses achieve the same result if the password is written through a communications port.

The attempts count, attempts timer and blocking timer are configurable at the SAT (not by the IED). Attempts remain and blocking time remain information also are visible in IED. Refer to the *Configurable cyber security settings* table for more details about the settings.

2.1.4 Inactivity Timer

The MiCOM device runs an inactivity timer, which means that it records the last time an action was taken by a user who was logged in.

If the user does not perform an action within a pre-defined interval, the user will be logged off. This is to reduce the risk that a device can accidentally be left open to access by unauthorized people.

The inactivity timer is separate for each interface.

The inactivity timer is configurable by using the SAT.

Important	**In case of a connection through an Ethernet interface, the actual inactive time depends on the setting value of both "Minimum inactivity period" & "[0E A7] ETH Tunl Timeout", the smaller value of both timers will be applied.**

Refer to the Table 12 for more details about the settings.

2.1.5 RBAC Recovery

RBAC recovery is the means by which the device can be reset to the factory RBAC settings if required. To obtain the recovery password, the customer must go to www.schneider-electric.com/ccc to raise a recovery password request and supply the IED *Security Code*.

Caution	**The "recovery" password gives you access to the Factory RBAC Configuration. This action deletes all existing users (and their passwords), and restores to Factory RBAC Configuration. Recover the RBAC does not affect relay proper settings and does not provoke reboot of the relay - the protection functions of the relay are always maintained.**

2.1.5.1 Generate Security Code

The security code is a 16-character ASCII string. It is a read-only parameter. The IED generates its own random security code. This is when a new code is generated:

- On power up
- On expiry of validity timer (see below)
- When the recovery password is entered

As soon as the security code is ***first*** displayed on the LCD display, a validity timer is started. This validity timer is set to 120 hours and is not configurable. The validity timer is not reset if you request a subsequent code within the 120 hour period.

To prevent accidental reading of the IED security code the cell will initially display a warning message on the front panel of the IED:

```
PRESS ENTER TO
READ SEC. CODE
```

The security code will be displayed on confirmation, whereupon the validity timer will be started. Note that the security code can only be read from the front panel.

Important	**The recover password will be invalid once the new Security Code is generated, so please make sure the IED is always powered on before you get the reover password, and make sure you input the recover password within 120 hours.**

2.1.5.2 Entry of the Recovery Password

The "recovery" password is intended for recovery only. It is not a replacement password that can be used continually. It can only be used once – for password recovery.

Entry of the recovery password is done at the local front panel and it causes the IED to reset the RBAC back to default.

On this action, the following message is displayed on the front panel of the IED:

```
RBAC reset done
Press any key
```

2.1.6 Port Disabling (Equipment Hardening)

The availability of unused ports could provide a security risk. Hence, unused ports can be disabled (also known as equipment hardening) – either via the front panel or by MiCOM S1 Studio. An Engineer role is needed to perform this action.

These physical ports and logical ports can be enabled/disabled:

Port types	Menu text	Col	Row	Default Setting	Available Value
Physical Ports	Front port	25	05	Enable	Enable/Disable
	Rear Port 1	25	06	Enable	Enable/Disable
	Rear Port 2	25	07	Enable	Enable/Disable
	Ethernet Port 1	25	08	Enable	Enable/Disable
	Ethernet Port 1/2	25	09	Enable	Enable/Disable
	Ethernet Port 2/3	25	0A	Enable	Enable/Disable
	Ethernet Port 3	25	0B	Enable	Enable/Disable
Logical Ports	Courier Tunnel	25	0C	Enable	Enable/Disable
	IEC61850	25	0D	Enable	Enable/Disable
	DNP3oE	25	0E	Enable	Enable/Disable

Table 10 - Port hardening settings

Note	*The port disabling setting cells are not provided in the settings file. In addition, it is not possible to disable simultaneously more than one physical port or Logical port.* *New redundant Ethernet boards have three physical ports but total two interfaces. The actual disabled physical port is depended on the redundant communication mode (PRP, HSR or Dual IP). Refer to the Dual Redundant Ethernet Board (Upgrade) (DREB) chapter (Px4x/EN EB) for more details.*

When the Ethernet board related physical ports or logical ports are disabled or enabled, the Ethernet card will reboot. The status of the ports will be available after reboot of the Ethernet board.

For more details about how to disable/enable the unused ports, please see sections:

- How to Disable a Physical Port
- How to Disable a Logical Port

2.1.7 Simple Network Management Protocol (SNMP)

Simple Network Management Protocol (SNMP) allows security monitoring of events and alarms. Standard third-party SNMP client software can be used to access the log of these events and alarms. Access to the SNMP MIB is given on a read-only basis. For further details of gaining access to the MIB, please contact Schneider Electric.

2.1.8 Security Logs

The Security Logs needs to store logs from each item of equipment. These logs are generated by the system, and cannot be edited by the user. A variety of different items are recorded, including: bad/faulty access attempts, login attempts, authentication errors, changes to roles, users and access control lists, network backup and configuration changes, communication failures and so on.

Security logs emissions depend on the security standards that are configurable by the SAT.

The security logs will push to a Syslog server if the Syslog server IP address and Syslog server IP port are configured and connected.

SAT also can be used to explore the security logs but MiCOM S1 studio is not supported.

The settings for the security log standards and Syslog server IP address and ports are listed in the *Configurable cyber security settings* table. For more detail about the security log configuration, please refer to the SAT documentation.

Note	*The Security logs time stamp may be time shifted by several milliseconds compared with local event log.* *The security logs will not be generated if the Ethernet card is starting up.* *If the Syslog server is unavailable, the new logs will be stored and overwriting the oldest logs.*

This table lists the security logs categories available for each standard.

Log ID	Additional field	Explanation	Level	Standards					
				BDEW	E3	NERC CIP	IEEE 1686	IEC 62351	CS Phase 1
CONNECTION_SUCCESS	The additional field will contain the issuer of the connection: LOCAL or NETWORK	Successful connection	INFO	x	x	x	x		x
CONNECTION_FAILURE		Failed connection (wrong credentials)	WARNING	x	x	x	x		x
CONNECTION_FAILURE_ AND_BLOCK		Failed connection (wrong credentials) triggering the blocking of the account on the IED	DANGER	x	x	x	x		x
CONNECTION_FAILURE_ ALREADY_BLOCKED		Failed connection because of a blocked userID on this IED	DANGER	x	x	x	x		x
DISCONNECTION		Disconnection triggered by the peer /user	INFO	x	x	x	x		x
DISCONNECTION_TIMEOUT		Disconnection triggered by a timeout	INFO	x	x	x	x		x
CONTROL_OPERATION	Type & Data associated to the control	Trace and control / override of real data from a peer	INFO				x		
CONFIGURATION_ DOWNLOAD	Version	Download of the configuration file from the device - Files include PSL, Courier setting, DNP setting, MCL/CID and user curves (crv)	INFO				x		
CONFIGURATION_UPLOAD	Version	Upload of a new configuration file into the device - Files include PSL, Courier setting, DNP setting, MCL and user curves (crv)	INFO				x		
RBAC_UPDATE	Version	Update of the RBAC cache in the IED	INFO				x		x
SEC_LOGS_RETRIEVAL	Version	Retrieval of the security logs of the IED	INFO				x		
TIME_CHANGE	New & Old time	Modification of the time of the IED	INFO				x		
REBOOT_ORDER	None	Reboot order sent to the IED / IED start up	DANGER				x		x
PORT_MANAGEMENT	Port, action (enable / disable)	Any comms port enabled / disabled	INFO						x
AUTHORIZATION_REQ	Action, object	Any authorization request sent to the CS brick	INFO			x		x	x

Table 11 – Security logs recorded

2.1.9 Common Cyber Security Settings

The System Administrator can customize the cyber security settings at the SAT. The following table shows the common cyber security settings. Parts of settings also are visible on the IED with specific Courier cells but not editable in IED or MiCOM S1 Studio. These are shown in the right hand columns of this table:

Setting in SAT	Default Setting	Available Value	Menu in IED	Col	Row
Minimum inactivity period	15	1 to 99 Minutes	-	-	-
If the user does not perform any action within this interval, the user will be logged off.					
Allow user locking	Yes	Yes/No	-	-	-
Option allows user account locking					
Maximum login attempts	5	1 to 99	Attempts Limit	25	02
The maximum failed password entry attempts, the user will lock once the attempts reached.					
Password attempts timer	3	1 to 30 Minutes	Attempts timer	25	03
The time for reset the attempts count to 0. The user got to maximum login attempts.					
Automatic user account unlocking	Yes	Yes/No	-	-	-
Enable/disable the attempts times aromatic reset function.					
Locking period duration	240	1 to 86400 Seconds	Blocking timer	25	04
The Locking period duration (seconds)					
Password Complexity	None	None / IEEE1686/ NERC	-	-	-
Set the password compliant standard.					
Log and monitoring standard	BDEW	BDEW / E3 /NERC-CIP / IEE1686 / IEC62351/ CS_PH1	-	-	-
Setup security log emission standard					
Syslog server IP address	0.0.0.0		-	-	-
Syslog server IP address					
Syslog server IP port	601	1 to 65535	-	-	-
Syslog server IP port					
SNMP client IP address	0.0.0.0		-	-	-
SNMP client IP address					

Table 12 – Configurable cyber security settings

These settings show some common information about cyber security, which are not configurable whether by SAT, or MiCOM S1 Studio or the front panel.

Menu in IED	Col	Row	Description
User Banner	25	01	Show user banner information: ACCESS ONLY FOR AUTHORITY USERS
Attempts remain	25	11	Show the remains attempt times for user login.
Blk time remain	25	12	Show the remains time for blocked user to unlock
User Name	25	21~2F	Configured user name (in SAT)
Security Code	25	FE	The security code used to recovery the password.
RBAC Password	25	FF	Enter 16 characters recover password to recovery password

Table 13 – Un-configurable cyber security settings

2.1.10 Local Default Access

Local Default Access function can be disabled/enabled in the SAT.

The intention for Local Default Access function is to allow the user easy to access the IED from the front panel and without any authorization required. This means if the Local Default Access function is enabled, everyone will be authorized to access the front panel with associated Rights.

By default, the Local Default Access has the VIEWER role, it is also possible to associate the other Roles to the Local Default Access, which is configurable in the SAT.

Local Default Access function is only available in the front panel.

The Local Default Access login/logout process is invisible for the user.

2.2 MiCOM Px4x with CSL0- Simple Password Management

For MiCOM Px4x IED with CSL0, as the Security Administration Tool (SAT) is not supported, all the cyber security features which need SAT support will not be available.

This section describes the different implementations by comparing with CLS1.

The cyber security features that are not mentioned in this section will default to be the same as CSL1.

2.2.1 Password Management

For MiCOM Px4x IED with CSL0, SAT is not supported for the configuration, so only the alphanumeric password can be used.

- The alphanumeric password is settable via MiCOM S1 Studio and the Front panel
- Passwords may be any length between 1 and 16 characters long
- Passwords may contain any ASCII character in the range ASCII code 33 (21 Hex) to ASCII code 122 (7A Hex) inclusive
- No password compliance is required
- The alphanumeric password will used for Courier access and the front panel access

Arrow key password is not available for IED with CLS0.

2.2.2 Fixed Factory RBAC

For MiCOM Px4x IED with CSL0, the user list and its role/right will be fixed as factory RBAC and not configurable. Refer to the *Factory RBAC* table for more details.

2.2.3 Security Logs/SNMP Services

The security logs/SNMP services are not available for MiCOM Px4x IED with CSL0.

2.2.4 Cyber Security Settings

For MiCOM Px4x IED with CSL0, all cyber security settings are fixed as default setting and un-configurable. Refer to the *Configurable cyber security settings* table for the default settings.

2.2.5 Disable/Blank Password

For MiCOM Px4x IED with CSL0, it is possible to remove the user password. In MiCOM S1 Studio, this is achieved by click the BOX “Disable the password”. In the IED, this is achieved by setting the password as blank.

Once the password is disabled/blank, the user can login to the IED directly and there is no need to enter the password.

3 HOW TO USE CYBER SECURITY FEATURES

These sections shows the most common tasks associated with Cyber Security features.

For many of these tasks, the steps you take are the same as you have performed previously; with the main changes being in the steps you use to login and/or logout.

3.1 How to Login

3.1.1 Local Default Access

If the Local Default Access is enabled, the user may login to the front panel with associated roles.

See Table 14 for the applied cases.

3.1.2 Auto Login

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

CS Version	Interface	RBAC/PW Cases	Login Process
CSL1	Front panel	Factory RBAC	Auto login with **EngineerLevel**
		Customized RBAC	Local Default Access Enabled: Login with **Local Default Access** Local Default Access Disabled: Login with **Prompt User List**
	Courier Interface	All cases	Login with **Prompt User List**
CSL0	Front panel	Factory RBAC	Auto login with **EngineerLevel**
		Password changed	**EngineerLevel** password is “AAAA” or is disabled/blank: Auto login with **EngineerLevel** **OperatorLevel** password is “AAAA” or is disabled/blank: Auto login with **OperatorLevel** **EngineerLevel** and **OperatorLevel** password changed: Auto login with **ViewerLevel Access**
	Courier Interface	Factory RBAC	Auto login with **EngineerLevel**
		Password changed	**EngineerLevel** password is “AAAA” or is disabled/blank: Auto login with **EngineerLevel** **OperatorLevel** password is “AAAA” or is disabled/blank: Auto login with **OperatorLevel** **EngineerLevel** and **OperatorLevel** password changed: Login with **Prompt User List**

Table 14 – Auto Login process

For more details about the Factory RBAC, please refer to Table 9.

3.1.3 Login with Prompt User List

This login process will happen if:

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

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

3.2 How to Logout

3.2.1 How to Logout at the IED

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

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

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

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

```
LOGGED OUT
User Name
```

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

```
LOGOUT CANCELLED
User Name
```

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

3.2.2 How to Logout at MiCOM S1 Studio

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

3.3 How to Disable a Physical Port

Using MiCOM S1 Studio or the front panel it is possible to disable unused physical ports. This can not be done by the SAT. By default, an Engineer-role is needed to perform this action.

To prevent accidental disabling of a port, a warning message is displayed according to whichever port is required to be disabled. For example if rear port 1 is to be disabled, the following message appears:

```
REAR PORT 1 TO BE
DISABLED.CONFIRM
```

There are between two and four ports eligible for disablement:

- Front port
- Rear port 1
- Rear port 2 (available in the specific models)
- Ethernet port (available in the specific models)

Important	**It is not possible to disable a port from which the disabling port command originates.**

3.4 How to Disable a Logical Port

Using MiCOM S1 Studio or the front panel it is possible to disable unused logical ports. This can't be done by the SAT. An Engineer-role is needed to perform this action.

Caution	**Disabling the Ethernet port will disable all Ethernet based communications.**

If it is not desirable to disable the Ethernet port, it is possible to disable selected protocols on the Ethernet card and leave others functioning.

These protocols can be disabled:

- IEC61850 (available in the specific models)
- Courier Tunnelling (available in the specific models)
- IEC61850 + DNPoE (available in the specific models)

3.5 How to Secure a Function key

In cyber security implementation, this function has been linked to the front panel authorization.

- When the function key pressed, if there is no user login in the front panel or the logged- in user is not authorized, a prompt message will be raised in the front panel to ask the user to login. Once the user is logged-in, they need to press the function key again to execute the command.
- If the user is already logged in and the authorization is OK, the command will be executed immediately.
- By default, the OPERATOR or ENGINEER Roles are able to operate the function keys.
- The function key will be executed immediately if the auto login process is applied and the user is authorized.
- If unauthorized users press the Function Key during the setting change, they need to commit the changes first then login with authorized user to operate the function key.

4 GLOSSARY FOR CYBER SECURITY

Term	Meaning
CIP Standards	Critical Infrastructure Protection standards. NERC CIP standards have been given the force of law by the Federal Energy Regulatory Commission (FERC)
DCS	Distributed Control System
HMI	Human Machine Interface
IED	Intelligent Electronic Device. It is a power industry term to describe microprocessor-based controllers of power system equipments (e.g. Circuit breaker, transformer, etc)
LOGS	All the operations related to the security (connection, configuration…) are automatically caught in events that are logged in order to provide a good visibility of the previous actions to the security administrators.
MIB	Management Information Base
NERC	North American Electric Reliability Corporation
RBAC	Role Based Access Control. Authentication and authorization mechanism based on roles granted to a user. Roles are made of rights, themselves being actions that can be applied on objects. Each user's action is authorized or not based on his roles
Roles	A role is a logical representation of a person activity. This activity authorizes or forbids operations within the tool suite thanks to permissions that are associated to the role. A role needs to be attached to a user account to have a real purpose.
SAM	Security Administration Module. Device in charge of security management on an IP-over-Ethernet network.
SAT	Security Administration Tool TSF based application used to define and create security configuration
Secured IED	Devices embedding security mechanisms defined in the security architecture document
Security Administrator	A user of the system granted to manage its security
SNMP	Simple Network Management Protocol (SNMP) is an "Internet-standard protocol for managing devices on IP networks
TAT	Transfer Administration Tool
Unsecured IED	Relay/IEDs with no security mechanisms.

Table 15 – Glossary for cyber security

Notes:

DUAL REDUNDANT ETHERNET BOARD (UPGRADE) (DREB)

CHAPTER 19

Date (month/year):	07/2016			
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.			
Hardware Suffix:	P141/P142/P143 P145 P241 P242/P243 P342 P343/P344/P345 P391 P445 P44x (P441/P442/P444) P44x (P442/P444) P44y (P443/P446)	L M L M L M A K/L K M M	P54x (P543/P544/P545/P546) P642 P643/P645 P741/P743 P742 P746 P74x (P741, P743) P841A (one circuit breaker) P841B (two circuit breakers) P849	M L M M L M K M M M
Software Version:	P14x (P141/P142/P143/P145) P24x (P241/P242/P243) P34x (P342/P343/P344/P345/P391) P445 P44x (P442/P444) P44y (P443/P446)	B0/B2 D0 B0 J4 E0 H4	P54x (P543/P544/P545/P546) P64x (P642/P643/P645) P746 P74x (P741/P742/P743) P841A P841B P849	H4 B1 B1/B2/ C1/C2 B0 G4 H4 B0
Connection Diagrams:	P14x (P141, P142, P143 & P145): 10P141xx (xx = 01 to 02) 10P142xx (xx = 01 to 05) 10P143xx (xx = 01 to 11) 10P145xx (xx = 01 to 11) P24x (P241, P242 & P243): 10P241xx (xx = 01 to 02) 10P242xx (xx = 01) 10P243xx (xx = 01) P34x (P342, P343, P344, P345 & P391): 10P342xx (xx = 01 to 17) 10P343xx (xx = 01 to 19) 10P344xx (xx = 01 to 12) 10P345xx (xx = 01 to 07) 10P391xx (xx = 01 to 02) P44x (P442 & P444): 10P44101 (SH 1 & 2) 10P44201 (SH 1 & 2) 10P44202 (SH 1) 10P44203 (SH 1 & 2) 10P44401 (SH 1) 10P44402 (SH 1) 10P44403 (SH 1 & 2) 10P44404 (SH 1) 10P44405 (SH 1) 10P44407 (SH 1 & 2) P44y (P443 & P446): 10P44303 (SH 01 and 03) 10P44304 (SH 01 and 03) 10P44305 (SH 01 and 03) 10P44306 (SH 01 and 03) 10P44600 10P44601 (SH 1 to 2) 10P44602 (SH 1 to 2) 10P44603 (SH 1 to 2) P445: 10P445xx (xx = 01 to 04)		P54x (P543, P544, P545 & P546): 10P54302 (SH 1 to 2) 10P54303 (SH 1 to 2) 10P54400 10P54404 (SH 1 to 2) 10P54405 (SH 1 to 2) 10P54502 (SH 1 to 2) 10P54503 (SH 1 to 2) 10P54600 10P54604 (SH 1 to 2) 10P54605 (SH 1 to 2) 10P54606 (SH 1 to 2) P547: 10P54702xx (xx = 01 to 02) 10P54703xx (xx = 01 to 02) 10P54704xx (xx = 01 to 02) 10P54705xx (xx = 01 to 02) P64x (P642, P643 & P645): 10P642xx (xx = 1 to 10) 10P643xx (xx = 1 to 6) 10P645xx (xx = 1 to 9) P74x (P741, P742 & P743): 10P740xx (xx = 01 to 07) P746: 10P746xx (xx = 00 to 21) P841: 10P84100 10P84101 (SH 1 to 2) 10P84102 (SH 1 to 2) 10P84103 (SH 1 to 2) 10P84104 (SH 1 to 2) 10P84105 (SH 1 to 2) P849: 10P849xx (xx = 01 to 06)	

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FIGURES

TABLES

Notes:

1 INTRODUCTION

The redundant Ethernet board assures redundancy at IED level. It is fitted into the following MiCOM IEDs from Schneider Electric.

- P141, P142, P143, P145
- P241, P242, P243
- P341, P342, P343, P344, P345
- P442, P443, P444, P445, P446
- P543, P544, P545, P546, P547
- P642, P643, P645
- P741, P743, P746
- P841, P849

1.1 Standard Safety Statements

For safety information please see the Safety Information chapter of the relevant Px4x Technical Manual.

2 HARDWARE DESCRIPTION

IEC 61850 work over Ethernet. Three boards are available:

- 1RJ45 Port Ethernet Board
- 3RJ45 Ports Redundant Ethernet Board
- 2LC+1RJ45 Ports Redundant Ethernet Board.

All are required for communications but 3RJ45 Ports and 2LC+1RJ45 Ports Redundant Ethernet Board allow an alternative path to be always available, providing bumpless redundancy.

Industrial network failure can be disastrous. Redundancy provides increased security and reliability, but also devices can be added to or removed from the network without network downtime.

The following list shows Schneider Electric's implementation of Ethernet redundancy, which has two variants with embedded IEC 61850 over Ethernet, plus PRP and HSR redundancy protocols.

- Parallel Redundancy Protocol (PRP)/High-availability Seamless Redundancy (HSR) with 1310 nm multi mode 100BaseFx fiber optic Ethernet ports (LC connector) and modulated/un- modulated IRIG-B input. Part number 2072069A01.

Note	*The board offers compatibility with any PRP/HSR device.*

- Parallel Redundancy Protocol (PRP)/High-availability Seamless Redundancy (HSR) with 100BaseTx Ethernet ports (RJ45) and modulated/un- modulated IRIG-B input. Part number 2072071A01.

Note	*The board offers compatibility with any PRP/HSR device.*

The redundant Ethernet board is fitted into Slot A of the IED, which is the optional communications slot. Each Ethernet board has three MAC addresses for two groups, one group (PORT 1) including one host MAC address, the other group (PORT 2 & 3) used for redundant application, including one host MAC address and one redundant agency device MAC address. Two host MAC addresses of the IED are printed on the rear panel of the IED.

In additional above for HSR/PRP redundant protocols, the redundant Ethernet board also can be operate on Dual IP mode. In this case, each Ethernet board has two host MAC addresses.

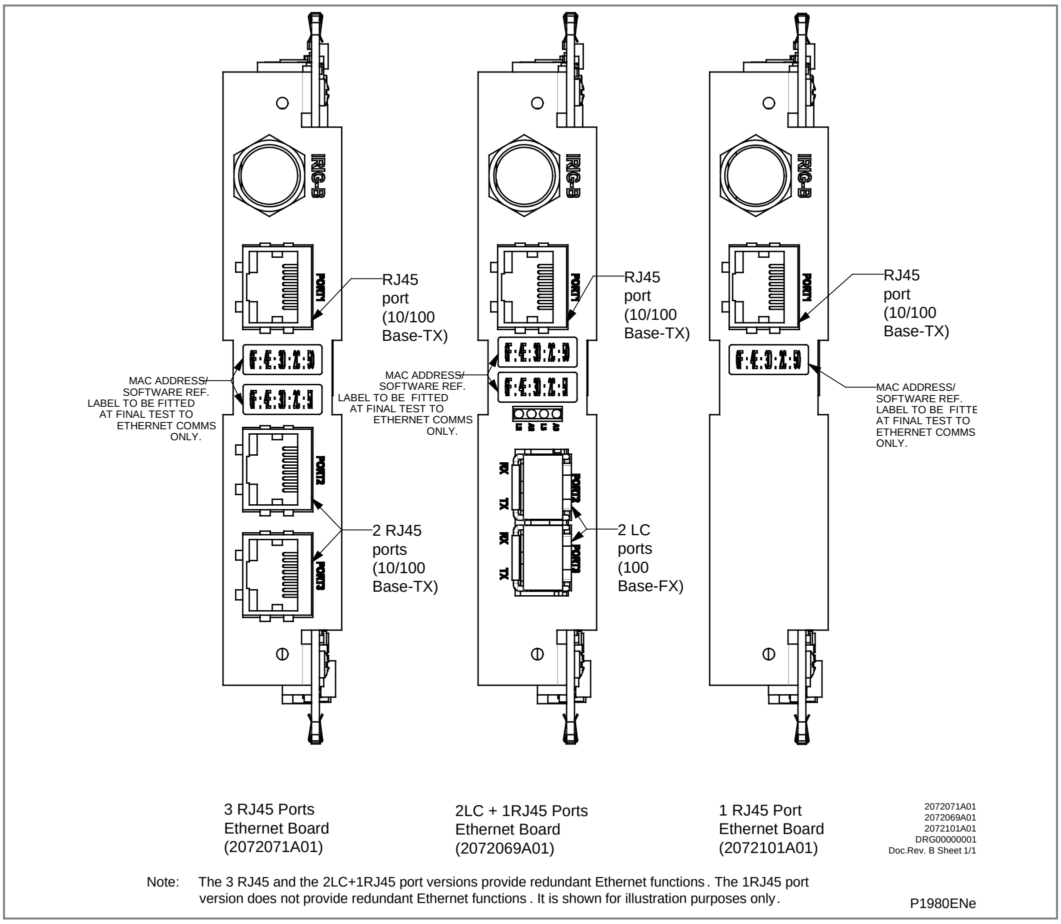


Figure 1 - Ethernet board connectors (3 RJ45 or 2 LC + RJ45 or 1 RJ45)

2.1 IRIG-B Connector

This is available as a modulated/un-modulated input.
See section 6.1.

2.2 LEDs

LED	Function	On	Off	Flashing
Green	Link	Link ok	Link broken	
Yellow	Activity			Traffic activity

Table 1 - LED functionality

2.3 Optical Fiber Connectors

Use 1310 nm multi mode 100BaseFx and LC connectors.

See Figure 1 and section 6.1.

Connector	PRP	HSR
2	R_X	R_X
2	T_X	T_X
3	R_X	R_X
3	T_X	T_X

Table 2 - Optical fiber connector functionality

3 REDUNDANCY PROTOCOLS

There are two redundancy protocols available:

- PRP (Parallel Redundancy Protocol)
- HSR (High-availability Seamless Redundancy)

3.1 Parallel Redundancy Protocol (PRP)

When the upper protocol layers send a data packet, the PRP interface creates a “twin packet” from this. The PRP interface then transmits redundant data packet of the twin pair to each participating LAN simultaneously. As they are transmitted via different LANs, the data packets may have different run times.

The receiving PRP interface forwards the first packet of a pair towards the upper protocol layers and discards the second packet. When viewed from the application, a PRP interface functions like a standard Ethernet interface.

The PRP interface or a Redundancy Box (RedBox) injects a Redundancy Control Trailer (RCT) into each packet. The RCT is a 48-bit identification field and is responsible for the identification of duplicates. This field contains, LAN identification (LAN A or B), information about the length of the payload, and a 16-bit sequence number. The PRP interface increments the sequence number for each packet sent. Using the unique attributes included in each packet, such as Physical MAC source address and sequence number, the receiving RedBox or Double Attached Node (DAN) interface identifies and discards duplicates.

Depending on the packet size, with PRP it attains a throughput of 93 to 99% of the available bandwidth.

3.1.1 PRP Network Structure

PRP uses two independent LANs. The topology of each of these LANs is arbitrary, and ring, star, bus and meshed topologies are possible.

The main advantage of PRP is loss-free data transmission with an active (transit) LAN. When the terminal device receives no packets from one of the LANs, the second (transit) LAN maintains the connection. As long as 1 (transit) LAN is available, repairs and maintenance on the other (transit) LAN have no impact on the data packet transmission.

The elementary devices of a PRP network are known as RedBox (Redundancy Box) and DANP (Double Attached Node implementing PRP).

Both devices have one connection each to the (transit) LANs.

The devices in the (transit) LAN are conventional switches that do not require any PRP support. The devices transmit PRP data packets transparently, without evaluating the RCT information.

Terminal devices that are connected directly to a device in the (transit) LAN are known as SAN (Single Attached Node). If there is an interruption, these terminal devices cannot be reached via the redundant line. To use the uninterruptible redundancy of the PRP network, you integrate your device into the PRP network via a RedBox.

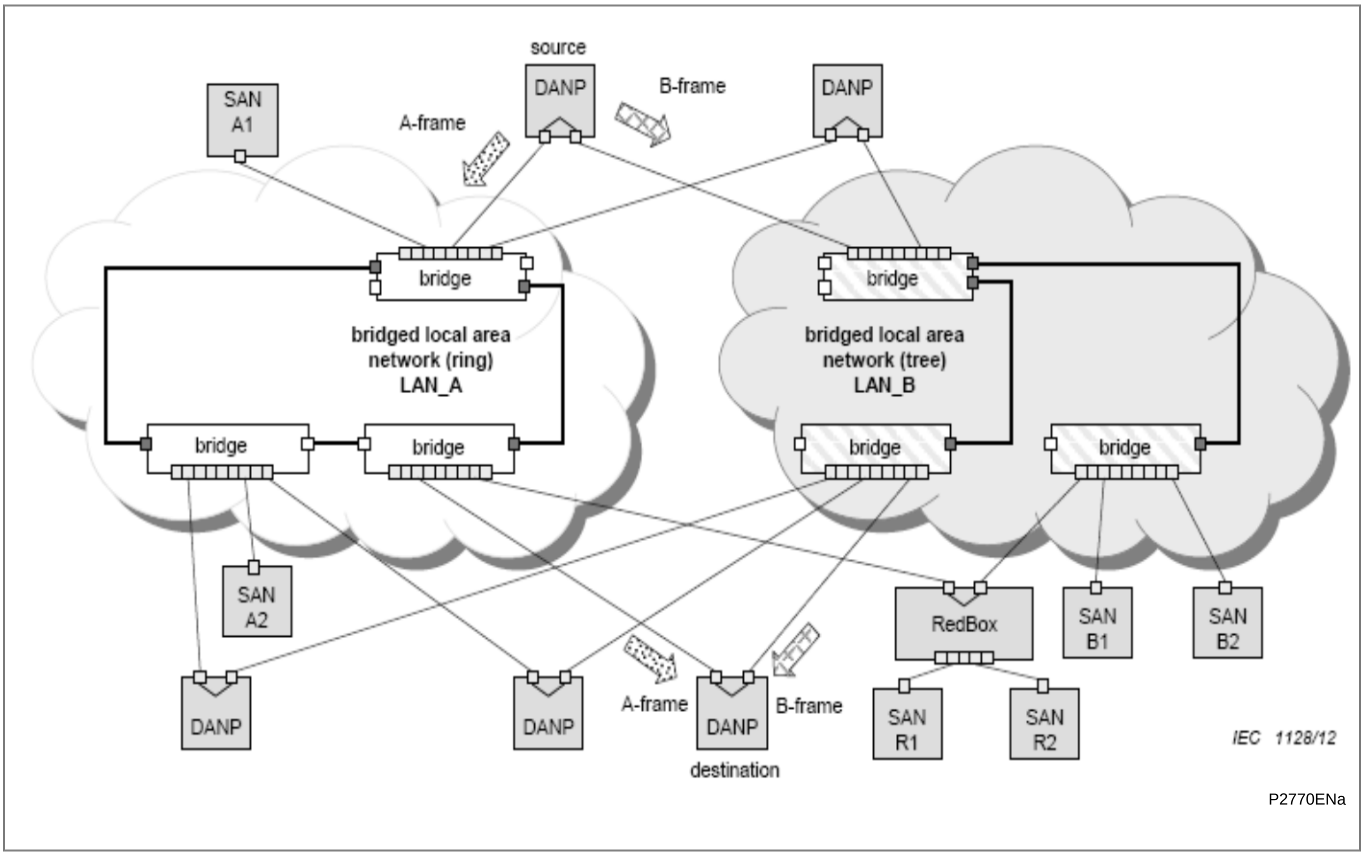


Figure 2 - PRP example of general redundant network

3.1.2 Example Configuration

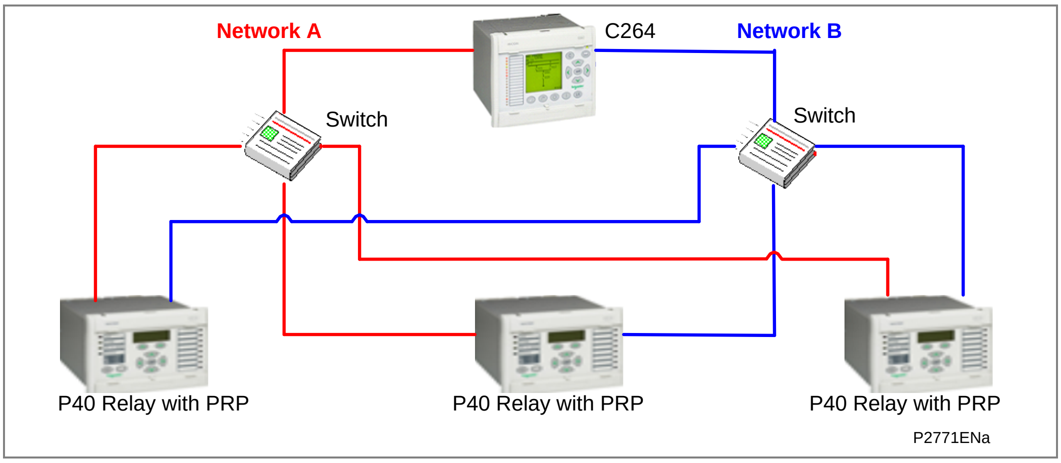


Figure 3 - PRP Relay Configuration

3.2 High-availability Seamless Redundancy (HSR)

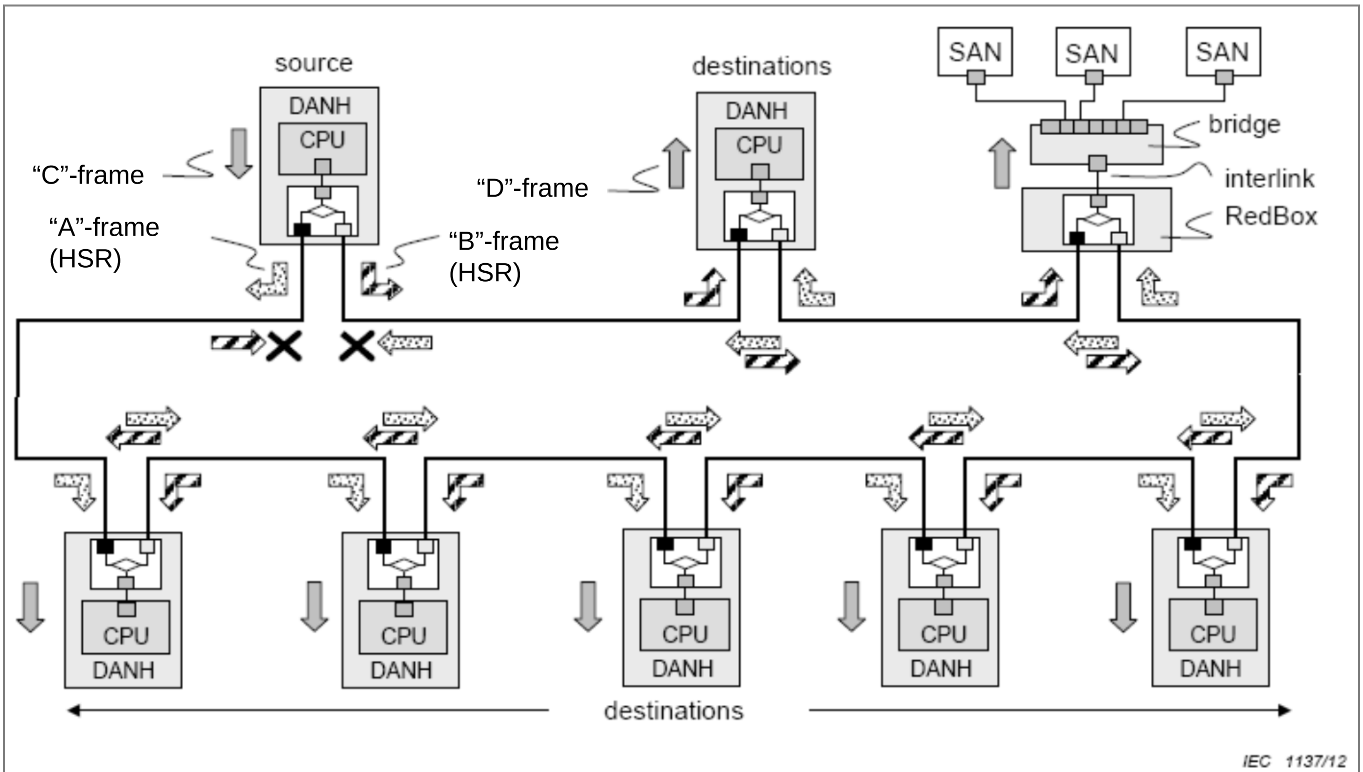
High-availability Seamless Redundancy (HSR) can only be used in a ring topology, This section describes the application of the PRP principles (IEC 62439-3- Clause 4) to implement a High-availability Seamless Redundancy (HSR), retaining the PRP property of zero recovery time, applicable to rings. With respect to PRP, HSR allows you to greatly reduce the network infrastructure. With respect to rings based on IEEE 802.1D (RSTP), IEC 62439-2 (MRP), IEC 62439-6 (DRP) or IEC 62439-7 (RRP), the available network bandwidth for network traffic is somewhat reduced depending on the type of traffic. Nodes within the ring are restricted to be HSR-capable bridging nodes, thus avoiding the use of dedicated bridges. Singly Attached Nodes (SANs) such as laptops or printers cannot be attached directly to the ring, but need attachment through a RedBox (redundancy box).

3.2.1 HSR Network Structure

As in PRP, a node has two ports operated in parallel; it is a DANH (Doubly Attached Node with HSR protocol).

A simple HSR network consists of doubly-attached bridging nodes, each having two ring ports, interconnected by full-duplex links, as shown in these examples for a ring topology:

- Figure 4 (multicast)
- Figure 5 (unicast)



Key	
dotted arrows	"A" frames
cross-hatched arrows	"B" frames
grey arrows	non-HSR frames exchanged between ring and host
cross	frame is removed from the ring by the next node

P2772ENa

Figure 4 - HSR example of ring configuration for multicast traffic

A source DANH sends a frame passed from its upper layers (“C” frame), prefixes it by an HSR tag to identify frame duplicates and sends the frame over each port (“A”-frame and “B”-frame). A destination DANH receives, in the fault-free state, two identical frames from each port within a certain interval, removes the HSR tag of the first frame before passing it to its upper layers (“D”-frame) and discards any duplicate.

The nodes support the IEEE 802.1D bridge functionality and forward frames from one port to the other, except if they already sent the same frame in that same direction.

In particular, the node will not forward a frame that it injected into the ring.

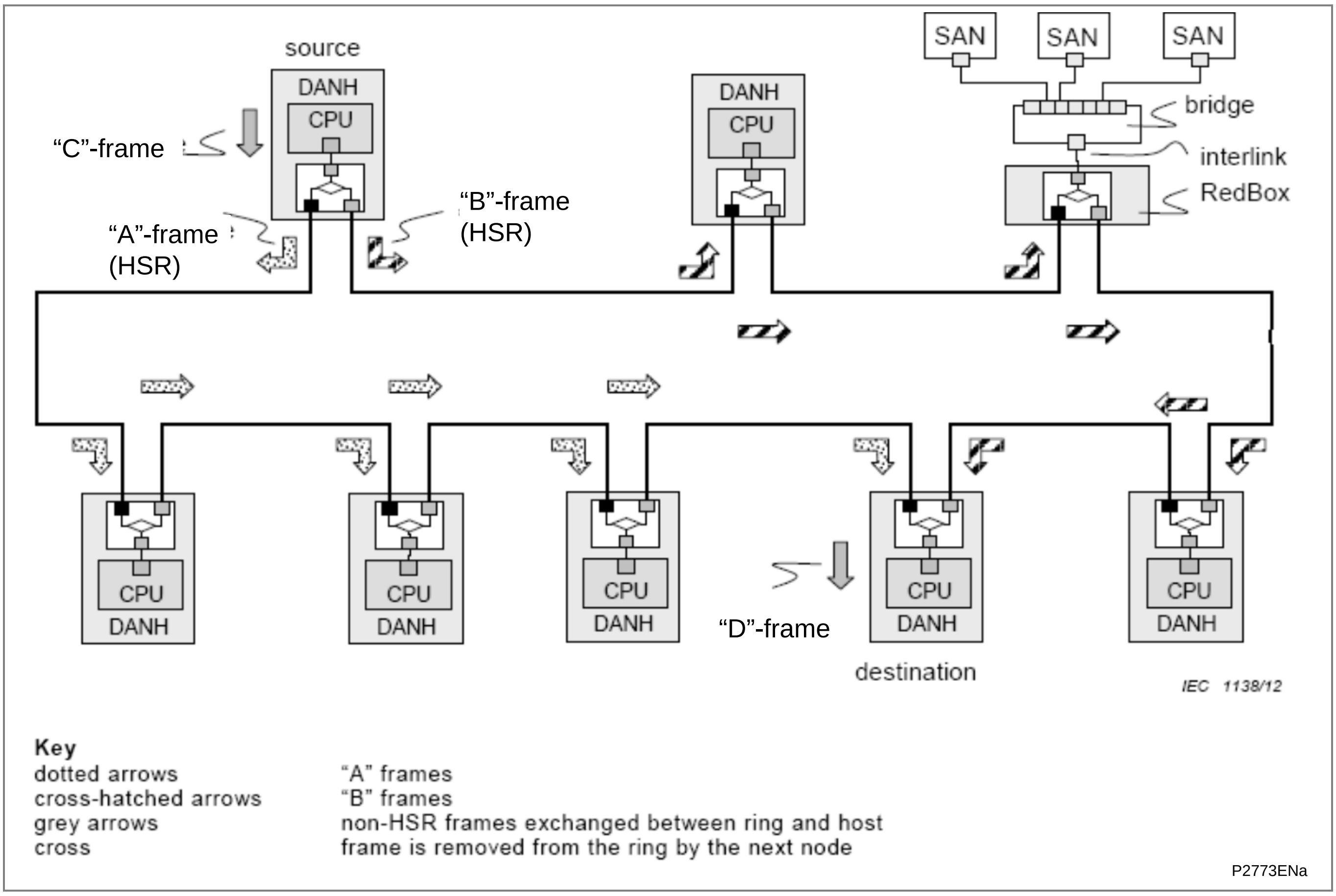


Figure 5 - HSR example of ring configuration for unicast traffic

A destination node of a unicast frame does not forward a frame for which it is the only destination, except for testing.

Frames circulating in the ring carry the HSR tag inserted by the source, which contains a sequence number. The doublet {source MAC address, sequence number} uniquely identifies copies of the same frame.

Singly Attached Nodes (SANs), for instance maintenance laptops or printers cannot be inserted directly into the ring since they have only one port and cannot interpret the HSR tag in the frames. SANs communicate with ring devices through a RedBox (redundancy box) that acts as a proxy for the SANs attached to it, as shown in the diagram. Connecting non-HSR nodes to ring ports, breaking the ring, is allowed to enable configuration. Non-HSR traffic within the closed ring is supported in an optional mode.

3.2.2 Example Configuration

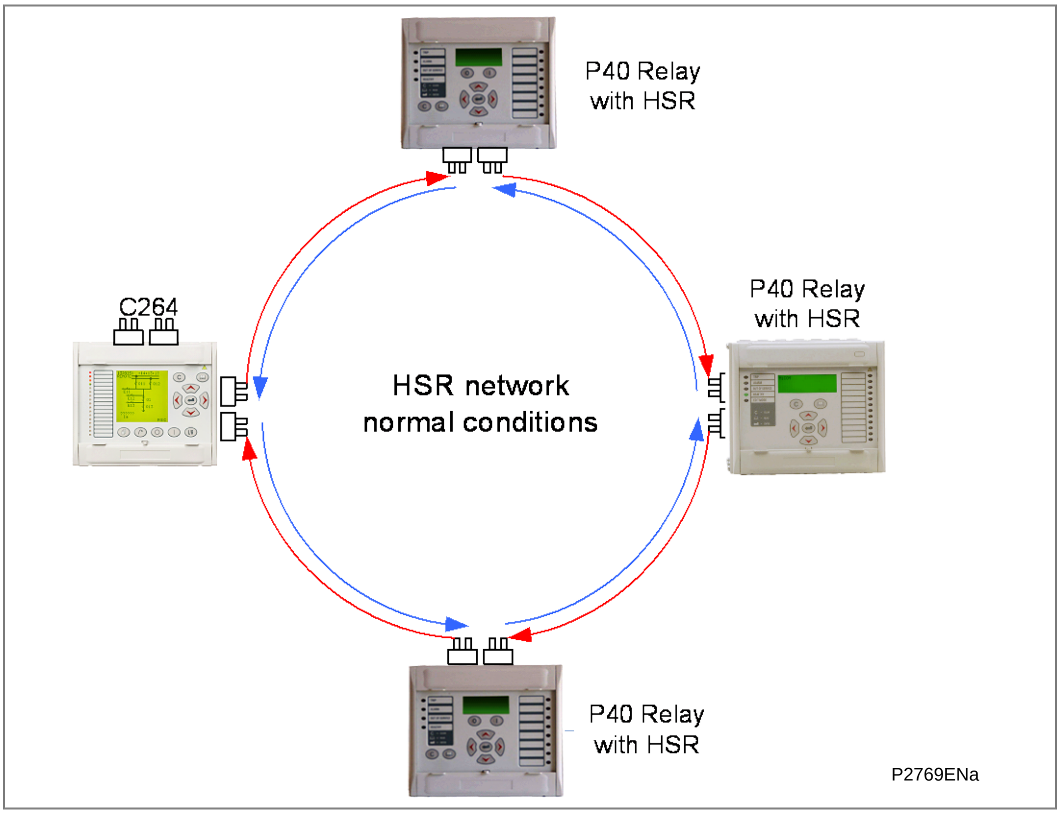


Figure 6 - HSR Relay Configuration

3.3 Generic Functions for all Redundant Ethernet Boards

The following apply to the redundant Ethernet protocols (PRP and HSR).

3.3.1 Priority Tagging

802.1p priority is enabled on all ports.

3.3.2 Simple Network Management Protocol (SNMP)

Simple Network Management Protocol (SNMP) is the network protocol developed to manage devices in an IP network. SNMP relies on a Management Information Base (MIB) that contains information about parameters to supervise. The MIB format is a tree structure, with each node in the tree identified by a numerical Object IDentifier (OID). Each OID identifies a variable that can be read or set using SNMP with the appropriate software. The information in the MIBs is standardized.

3.3.2.1 Redundant Ethernet Board MIB Structure

The IEC 62439-3 MIB provides the following objects available at the OID = .1.0.62439:

SNMP OID	Parameter name	Description
1	iso	
1	std	
1.0.62439	iec62439	
1.0.62439.2	prp	
1.0.62439.2.0	linkRedundancyEntityNotifications	
1.0.62439.2.1	linkRedundancyEntityObjects	
1.0.62439.2.1.0	lreConfiguration	
1.0.62439.2.1.0.0	lreConfigurationGeneralGroup	
1.0.62439.2.1.0.0.1	lreManufacturerName	Specifies the name of the LRE device manufacturer
1.0.62439.2.1.0.0.2	lreInterfaceCount	Total number of LREs present in this system
1.0.62439.2.1.0.1	lreConfigurationInterfaceGroup	
1.0.62439.2.1.0.1.0	lreConfigurationInterfaces	
1.0.62439.2.1.0.1.0.1	lreInterfaceConfigTable	List of PRP/HSR LREs. Each entry corresponds to one PRP/HSR Link Redundancy Entity (LRE), each representing a pair of LAN ports A and B. Basic devices supporting PRP/HSR may have only one LRE and thus one entry in the table, while more complex devices may have several entries for multiple LREs
1.0.62439.2.1.0.1.0.1.1	lreInterfaceConfigEntry	Each entry contains management information
1.0.62439.2.1.0.1.0.1.1.1	lreInterfaceConfigIndex	A unique value for each LRE
1.0.62439.2.1.0.1.0.1.1.2	lreRowStatus	Indicates the status of the LRE table entry
1.0.62439.2.1.0.1.0.1.1.3	lreNodeType	Specifies the operation mode of the LRE: PRP mode 1 (1) HSR mode (2). Note: PRP mode 0 is considered deprecated and is not supported by this revision of the MIB
1.0.62439.2.1.0.1.0.1.1.4	lreNodeName	Specifies this LRE's node name
1.0.62439.2.1.0.1.0.1.1.5	lreVersionName	Specifies the version of this LRE's software
1.0.62439.2.1.0.1.0.1.1.6	lreMacAddress	Specifies the MAC address to be used by this LRE. MAC addresses are identical for all ports of a single LRE
1.0.62439.2.1.0.1.0.1.1.7	lrePortAdminStateA	Specifies whether the port A shall be active or not Active through administrative action (Default: active)
1.0.62439.2.1.0.1.0.1.1.8	lrePortAdminStateB	Specifies whether the port B shall be active or not Active through administrative action (Default: active)

SNMP OID	Parameter name	Description
1.0.62439.2.1.0.1.0.1.1.9	lreLinkStatusA	Shows the actual link status of the LRE's port A
1.0.62439.2.1.0.1.0.1.1.10	lreLinkStatusB	Shows the actual link status of the LRE's port B
1.0.62439.2.1.0.1.0.1.1.11	lreDuplicateDiscard	Specifies whether a duplicate discard algorithm is used at reception (Default: discard)
1.0.62439.2.1.0.1.0.1.1.12	lreTransparentReception	If removeRCT is configured, the RCT is removed when forwarding to the upper layers, only applicable for PRP LRE (Default: removeRCT)
1.0.62439.2.1.0.1.0.1.1.13	lreHsrLREMode	This enumeration is only applicable if the LRE is an HSR bridging node or RedBox. It shows the mode of the HSR LRE: (1) Default mode: The HSR LRE is in mode h and bridges tagged HSR traffic (2) Optional mode: The HSR LRE is in mode n and bridging between its HSR ports is disabled. Traffic is HSR tagged (3) Optional mode: The HSR LRE is in mode t and bridges non-tagged HSR traffic between its HSR ports (4) Optional mode: The HSR LRE is in mode u and behaves like in mode h, except it does not remove unicast messages (5) Optional mode: The HSR LRE is configured in mixed mode. HSR frames are handled according to mode h. Non-HSR frames are handled according to 802.1D bridging rules
1.0.62439.2.1.0.1.0.1.1.14	lreSwitchingEndNode	This enumeration shows which feature is enabled in this particular LRE: (1): an unspecified non-bridging node, e.g. SRP. (2): an unspecified bridging node, e.g. RSTP. (3): a PRP node/RedBox. (4): an HSR RedBox with regular Ethernet traffic on its interlink. (5): an HSR switching node. (6): an HSR RedBox with HSR tagged traffic on its interlink. (7): an HSR RedBox with PRP traffic for LAN A on its interlink. (8): an HSR RedBox with PRP traffic for LAN B on its interlink.
1.0.62439.2.1.0.1.0.1.1.15	lreRedBoxIdentity	Applicable to RedBox HSR-PRP A and RedBox HSR-PRP B. One ID is used by one pair of RedBoxes (one configured to A and one configured to B) coupling an HSR ring to a PRP network. The integer value states the value of the path field a RedBox inserts into each frame it receives from its interlink and injects into the HSR ring. When interpreted as binary values, the LSB denotes the configuration of the RedBox (A or B), and the following 3 bits denote the identifier of a RedBox pair.
1.0.62439.2.1.0.1.0.1.1.16	lreEvaluateSupervision	True if the LRE evaluates received supervision frames. False if it drops the supervision frames without evaluating. Note: LREs are required to send supervision frames, but reception is optional. Default value is dependent on implementation.
1.0.62439.2.1.0.1.0.1.1.17	lreNodesTableClear	Specifies that the Node Table is to be cleared
1.0.62439.2.1.0.1.0.1.1.18	lreProxyNodeTableClear	Specifies that the Proxy Node Table is to be cleared
1.0.62439.2.1.1	lreStatistics	
1.0.62439.2.1.1.1	lreStatisticsInterfaceGroup	
1.0.62439.2.1.1.1.0	lreStatisticsInterfaces	
1.0.62439.2.1.1.1.0.1	lreInterfaceStatsTable	List of PRP/HSR LREs. Each entry corresponds to one PRP/HSR Link Redundancy Entity (LRE), each representing a pair of LAN ports A and B and a port C towards the application/interlink. Basic devices supporting PRP/HSR may have only one LRE and thus one entry in the table, while more complex devices may have several entries for multiple LREs.
1.0.62439.2.1.1.1.0.1.1	lreInterfaceStatsEntry	An entry containing management information applicable to a particular LRE
1.0.62439.2.1.1.1.0.1.1.1	lreInterfaceStatsIndex	A unique value for each LRE
1.0.62439.2.1.1.1.0.1.1.2	lreCntTxA	Number of frames sent over port A that are HSR tagged or fitted with a PRP Redundancy Control Trailer. Only frames that are HSR tagged or do have a PRP RCT are counted. Initial value = 0.
1.0.62439.2.1.1.1.0.1.1.3	lreCntTxB	Number of frames sent over port B that are HSR tagged or fitted with a PRP Redundancy Control Trailer. Only frames that are HSR tagged or do have a PRP RCT are counted. Initial value = 0.

SNMP OID	Parameter name	Description
1.0.62439.2.1.1.1.0.1.1.4	lreCntTxC	Number of frames sent towards the application interface of the DANP or DANH or over the interlink of the RedBox. All frames (with our without PRP RCT or HSR tag) are counted. Initial value = 0
1.0.62439.2.1.1.1.0.1.1.5	lreCntErrWrongLanA	Number of frames with the wrong LAN identifier received on LRE port A. Initial value = 0. Only applicable to PRP ports.
1.0.62439.2.1.1.1.0.1.1.6	lreCntErrWrongLanB	Number of frames with the wrong LAN identifier received on LRE port B. Initial value = 0. Only applicable to PRP ports
1.0.62439.2.1.1.1.0.1.1.7	lreCntErrWrongLanC	Number of frames with the wrong LAN identifier received on the interlink of a RedBox. Only applicable to HSR RedBoxes in HSR-PRP configuration (hsrredboxprpa and hsrredboxprpb).
1.0.62439.2.1.1.1.0.1.1.8	lreCntRxA	Number of frames received on a LRE port A. Only frames that are HSR tagged or fitted with a PRP Redundancy Control Trailer are counted. Initial value = 0.
1.0.62439.2.1.1.1.0.1.1.9	lreCntRxB	Number of frames received on a LRE port B. Only frames that are HSR tagged or fitted with a PRP Redundancy Control Trailer are counted. Initial value = 0
1.0.62439.2.1.1.1.0.1.1.10	lreCntRxC	Number of frames received from the application interface of a DANP or DANH or the number of number of frames received on the interlink of a RedBox. All frames (with our without PRP RCT or HSR tag) are counted. Initial value = 0.
1.0.62439.2.1.1.1.0.1.1.11	lreCntErrorsA	Number of frames with errors received on this LRE port A. Initial value = 0
1.0.62439.2.1.1.1.0.1.1.12	lreCntErrorsB	Number of frames with errors received on this LRE port B. Initial value = 0
1.0.62439.2.1.1.1.0.1.1.13	lreCntErrorsC	Number of frames with errors received on the application interface of a DANP or DANH or on the interlink of a RedBox. Initial value = 0.
1.0.62439.2.1.1.1.0.1.1.14	lreCntNodes	Number of nodes in the Nodes Table
1.0.62439.2.1.1.1.0.1.1.15	lreCntProxyNodes	Number of nodes in the Proxy Node Table. Only applicable to RedBox. Initial value = 0.
1.0.62439.2.1.1.1.0.1.1.16	lreCntUniqueRxA	Number of entries in the duplicate detection mechanism on port A for which no duplicate was received. Initial value = 0
1.0.62439.2.1.1.1.0.1.1.17	lreCntUniqueRxB	Number of entries in the duplicate detection mechanism on port B for which no duplicate was received. Initial value = 0
1.0.62439.2.1.1.1.0.1.1.18	lreCntUniqueRxC	Number of entries in the duplicate detection mechanism on the application interface of the DAN or the interlink of the RedBox for which no duplicate was received. Initial value = 0
1.0.62439.2.1.1.1.0.1.1.19	lreCntDuplicateRxA	Number of entries in the duplicate detection mechanism on port A for which one single duplicate was received. Initial value = 0.
1.0.62439.2.1.1.1.0.1.1.20	lreCntDuplicateRxB	Number of entries in the duplicate detection mechanism on port B for which one single duplicate was received. Initial value = 0.
1.0.62439.2.1.1.1.0.1.1.21	lreCntDuplicateRxC	Number of entries in the duplicate detection mechanism on the application interface of the DAN or the interlink of the RedBox for which one single duplicate was received. Initial value = 0.
1.0.62439.2.1.1.1.0.1.1.22	lreCntMultiRxA	Number of entries in the duplicate detection mechanism on port A for which more than one duplicate was received. Initial value = 0.
1.0.62439.2.1.1.1.0.1.1.23	lreCntMultiRxB	Number of entries in the duplicate detection mechanism on port B for which more than one duplicate was received. Initial value = 0
1.0.62439.2.1.1.1.0.1.1.24	lreCntMultiRxC	Number of entries in the duplicate detection mechanism on the application interface of the DAN or the interlink of the RedBox for which more than one duplicate was received. Initial value = 0
1.0.62439.2.1.1.1.0.1.1.25	lreCntOwnRxA	Number of HSR tagged frames received on Port A that originated from this device. Frames originate from this device if the source MAC matches the MAC of the LRE, or if the source MAC appears in the proxy node table (if implemented). Applicable only to HSR. Initial value = 0.
1.0.62439.2.1.1.1.0.1.1.26	lreCntOwnRxB	Number of HSR tagged frames received on Port B that originated from this device. Frames originate from this device if the source MAC matches the MAC of the LRE, or if the source MAC appears in the proxy node table (if implemented). Applicable only to HSR. Initial value = 0.

SNMP OID	Parameter name	Description
1.0.62439.2.1.1.1.0.2	lreNodesTable	The node table (if it exists on that node) contains information about all remote LRE, which advertised themselves through supervision frames
1.0.62439.2.1.1.1.0.2.1	lreNodesEntry	Each entry in the node table (if it exists) contains information about a particular remote LRE registered in the node table, which advertised itself through supervision frames.
1.0.62439.2.1.1.1.0.2.1.1	lreNodesIndex	Unique value for each node in the LRE's node table
1.0.62439.2.1.1.1.0.2.1.2	lreNodesMacAddress	Each MAC address corresponds to a single Dual Attached Node
1.0.62439.2.1.1.1.0.2.1.3	lreTimeLastSeenA	Time in TimeTicks (1/100s) since the last frame from this remote LRE was received over LAN A. Initialized with a value of 0 upon node registration in the node table
1.0.62439.2.1.1.1.0.2.1.4	lreTimeLastSeenB	Time in TimeTicks (1/100s) since the last frame from this remote LRE was received over LAN B. Initialized with a value of 0 upon node registration in the node table.
1.0.62439.2.1.1.1.0.2.1.5	lreRemNodeType	DAN type, as indicated in the received supervision frame
1.0.62439.2.1.1.1.0.3	lreProxyNodeTable	The proxy node table (if implemented) contains information about all nodes, for which the LRE acts as a connection to the HSR/PRP network.
1.0.62439.2.1.1.1.0.3.1	lreProxyNodeEntry	Each entry in the proxy node table contains information about a particular node for which the LRE acts as a connection to the HSR/PRP network.
1.0.62439.2.1.1.1.0.3.1.1	lreProxyNodeIndex	A unique value for each node in the LRE's proxy node table.
1.0.62439.2.1.1.1.0.3.1.2	lreProxyNodeMacAddress	Each entry contains information about a particular node for which the LRE acts as a proxy for the HSR/PRP network.
1.0.62439.2.2	linkRedundancyEntityConformance	

Table 3 - Redundant Ethernet board MIB Structure

*Port number: 1 to 6 for the RJ45, port 7 management, port 8 ring

Various SNMP client software tools can be used with the MiCOM Px4x, C264 and Hx8x range. Schneider Electric recommends using an SNMP MIB browser which can perform the basic SNMP operations such as GET, GETNEXT, and RESPONSE.

Redundant agency device configuration will be required to access SNMP, refer to section 4.4 for more details.

3.3.3 Simple Network Time Protocol (SNTP)

Simple Network Time Protocol (SNTP) is supported by both the IED and the redundant Ethernet switch. SNTP is used to synchronize the clocks of computer systems over packet-switched, variable-latency data networks. A jitter buffer is used to reduce the effects of variable latency introduced by queuing in packet switched networks, ensuring a continuous data stream over the network.

The IED receives the synchronization from the SNTP server. This is done using the IP address of the SNTP server entered into the IED from the IED Configurator software.

3.3.4 Dual Ethernet Communication (Dual IPs)

3.3.4.1 Dual IP Introduction

Dual IP means the IED provides two independent IEC 61850 interfaces, and both these interfaces support MMS and Goose message.

The IED which supports Dual IP can provide the customer with more flexible network connections: two fully segregated Station BUS networks, or one Station Bus and one Process Bus (for Goose message transmission).

Dual IP is not mutually exclusive with PRP/HSR - Dual IP is automatically supported even if the IED is operate under HSR/PRP mode.

3.3.4.2 Dual IP in MiCOM

Dual IP is only supported for devices with the new Ethernet board assembly. This is shown by the model number, where the 7th digit is either hardware option Q or R. These boards have three Ethernet ports, as shown in Figure 1.

A setting is provided in the HMI to switch the operation mode between PRP/HSR/Dual IP.

Operation mode	Port 1	Port 2	Port3
PRP	Interface 1	Interface 2 (PRP)	Interface 2 (PRP)
HSR	Interface 1	Interface 2 (HSR)	Interface 2 (HSR)
Dual IP	* Interface 1 on Port 1 or Port 2		Interface 2

** Note In Dual IP mode, interface 1 can be available on port 1 or port 2. If both of port 1 and port 2 are connected, only port 1 will work.*

Table 4 - Ethernet ports operation mode

For each interface, the fully IEC 61850 functions (GOOSE and MMS services) are supported independently.

For outgoing GOOSE messages, you need to configure whether a message is to be transmitted across one or both Ethernet connections. You also need to configure the destination parameters such as multicast MAC address, AppID, VLAN, etc.

Two communication parameters also need to be configured for each interface (IP address, MAC address, subnet mask). For the CID which is exported from SCD file, the second interface communication parameters are not configured. This needs to be done by manually editing in the IED configurator (this being invisible by the SCD file). This process needs to be completed before the exported CID file is downloaded to the IED. (this being invisible by the SCD file).

3.3.4.3 Typical User Cases

Below for Interface 1 and Interface 2, from a functional point of view it is same. The customer has flexibility to define the functionality according their requirements.

- Both for Station Bus to have duplicated network for DCS.
- One for Station Bus and one for process bus (Goose message)

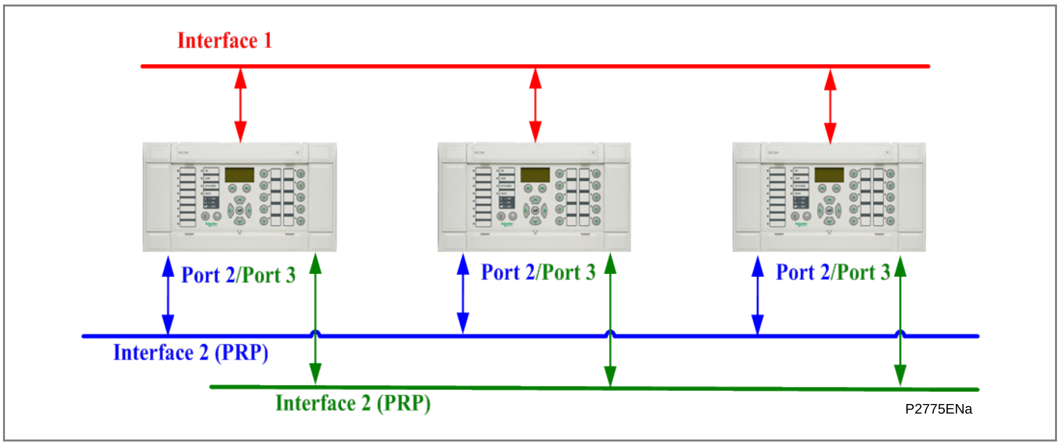


Figure 7 – PRP + Dual IP (Ethernet Mode PRP)

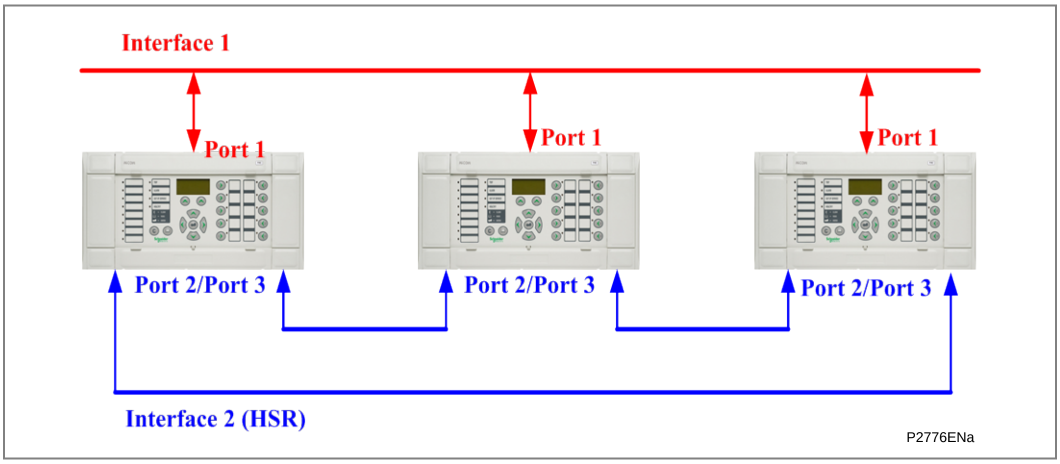


Figure 8 – HSR + Dual IP (Ethernet Mode HSR)

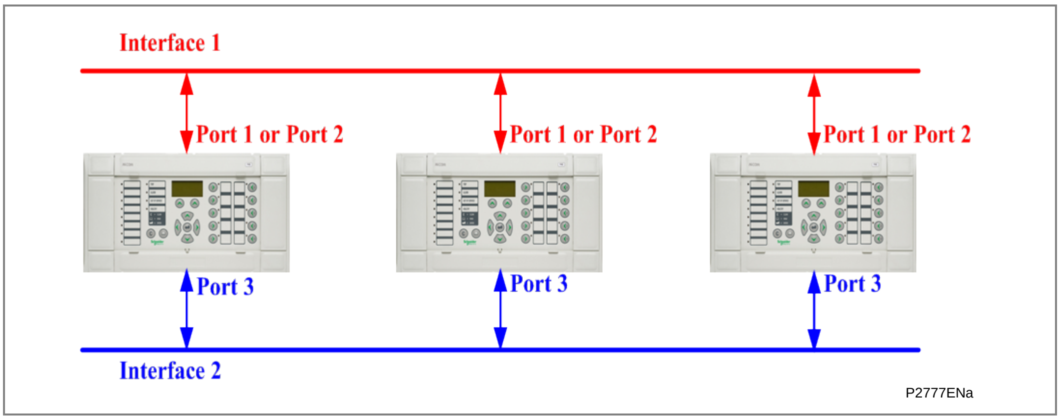


Figure 9 – Dual IP (Ethernet Mode Dual IP)

4 CONFIGURATION

The new redundant Ethernet board supports three communication operation modes. These can be achieved by change the setting in HMI. It is not necessary to flash the firmware.

Also for the two interfaces, the communication parameters need to be configured. These include the IP address, MAC address, and subnet mask, etc.

For redundant protocols, the communication parameters for redundant agency device also need to be configured.

4.1 Configuring Ethernet Communication Mode

Menu Text	Cell Add.	Default Setting	Available Setting
ETH COMM Mode	0016	Dual IP	Dual IP, PRP, HSR
This setting can only be change using the HMI, and the setting change will cause the Ethernet board reboot. Restore default setting does not apply to this setting.			

Table 5 - Ethernet communication mode setting

4.2 Configuring the IED Communication Parameters

The communication parameter for each interface is configured using the IED Configurator software in MiCOM S1 Studio. **Customers can configure these parameters according to their needs, but the IP address for these two interfaces should not be in the same subnet.**

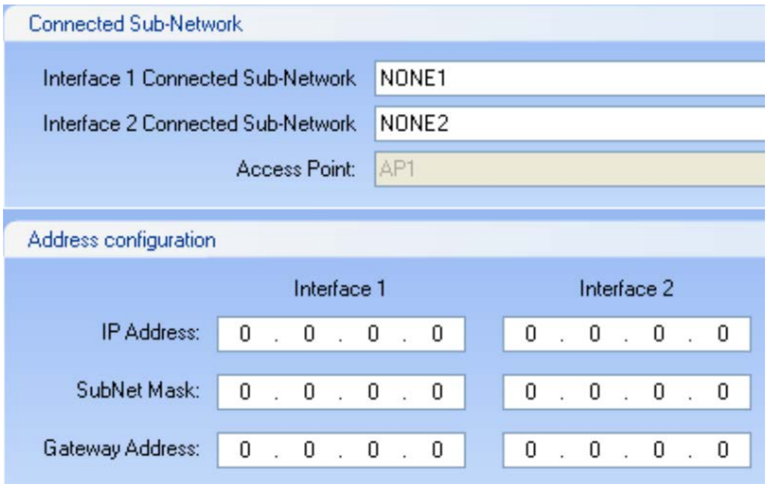


Figure 10 - Communication Parameters for two Interfaces

To use the device configuration with Courier Tunneling, for each interface, a default IP address has been applied. The default IP address for the first three bytes is fixed for each interface as below,

Interface	First three Bytes for IP address
Interface 1	169.254.0.xxx
Interface 2	169.254.1.yyy

Note *xxx = Mod(The last byte MAC1 address, 128) + 1*
yyy = Mod(The last byte MAC2 address, 128) + 1

Table 6 - First three bytes for default IP address

The default IP address can be found in the ***IED CONFIGURATOR*** column. Also, you can also calculate it according the MAC address label which is mounted on the rear panel of the Ethernet card.

4.3 Configuring GOOSE Publish Parameters

For outgoing GOOSE messages, you need to configure whether a message is to be transmitted over one or both Ethernet connections. You also need to configure the destination parameters including multicast MAC address, AppID, VLAN, etc.

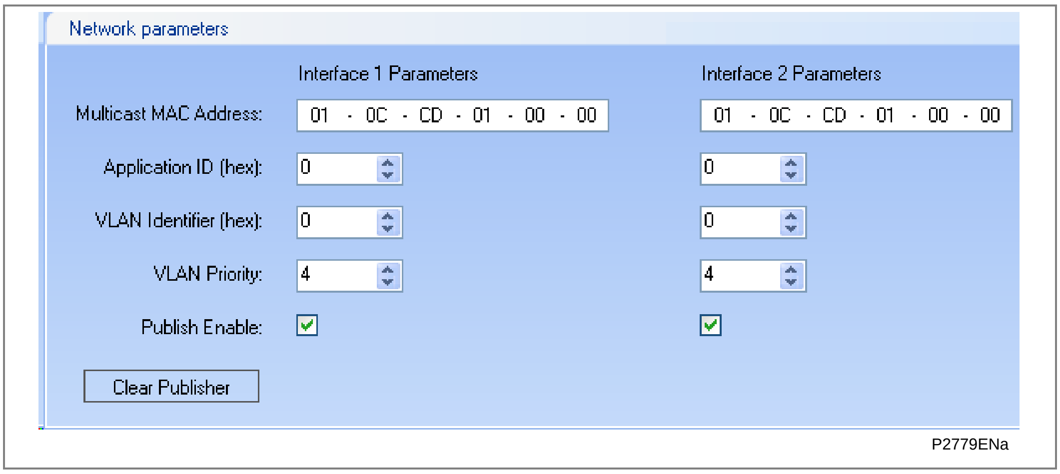


Figure 11 - Goose Publish Parameters for two Interfaces

4.4 Redundant Agency Device Configuration

The redundant agency device configuration is used by the SNMP server and only available for the device which works on PRP/HSR mode. The SNMP server can only be connected with Interface 2 (HSR/PRP port).

The following settings need to be configured in setting files:

- IP address
- Subnet Mask
- Gateway.

The MAC address is set when the device is manufactured. Also, the default IP is applied and linked to the MAC address. This default IP address can be seen in the HMI, in the Communication settings section.

The default IP address is 169.254.2.zzz.

zzz = Mod (The last byte MAC3 address, 128) + 1

5 COMMISSIONING

5.1 PRP Star Connection

The following diagram shows the Px4x IEDs with the PRP variant of Redundant Ethernet boards connected in a STAR topology. The STAR topology can have one or more high-end PRP-enabled Ethernet switches to interface with another network. The Ethernet switch is an HSR-enabled switch with a higher number of ports, which should be configured as the root bridge.

The number of IEDs that can be connected in the STAR can be up to 128.

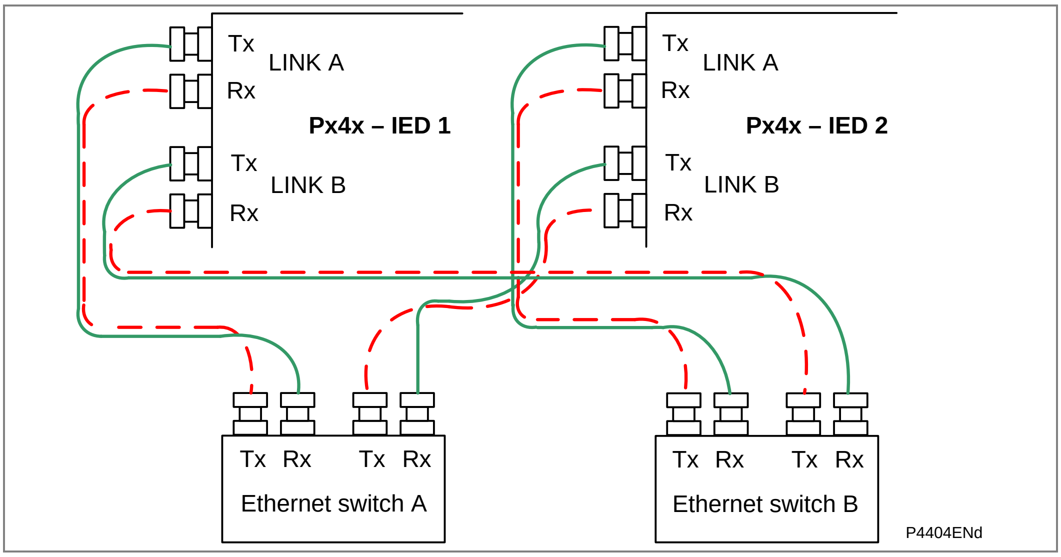


Figure 12 - PRP star connection

5.2 HSR Ring Connection

The following diagram shows the Px4x IEDs (Px4x – IED 1 to IED N) with the HSR variant of redundant Ethernet boards connected in a ring topology. The ring topology can have one or more high-end HSR-enabled Ethernet switches to interface with another network or a control center. The Ethernet switch is an HSR enabled switch with a higher number of ports.

The Ethernet switch, which is connected to the controlling PC, should be configured as the root bridge.

The number of IEDs that can be connected in the ring can be up to 128.

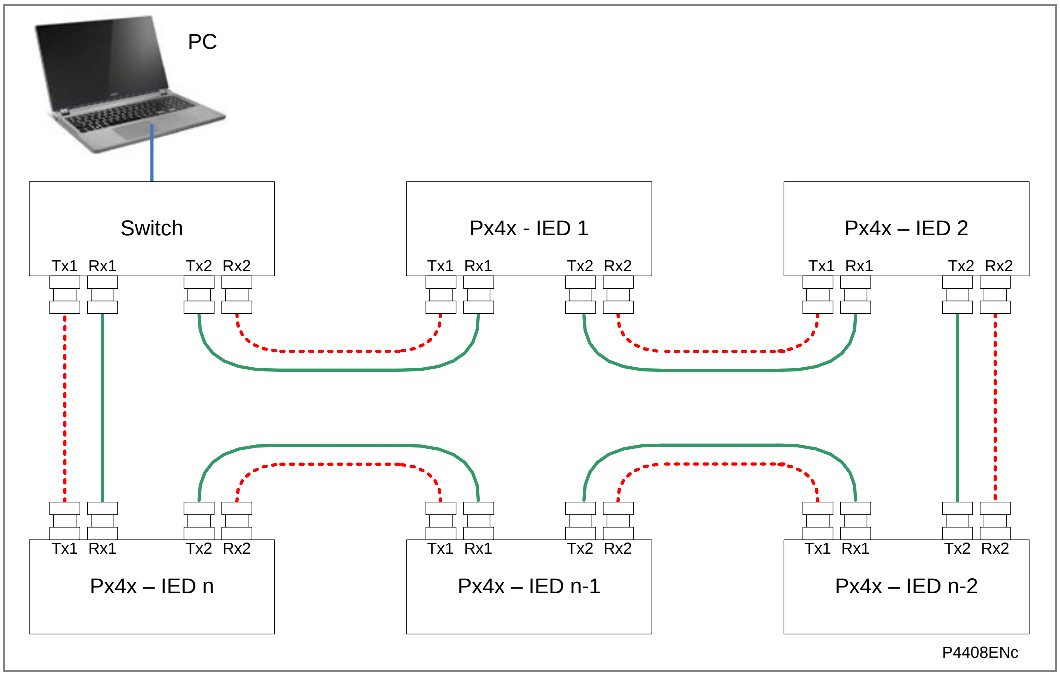


Figure 13 - HSR ring topology

The number of IEDs that can be connected in the ring can be up to 128.

6 TECHNICAL DATA

The technical data applies to a Redundant Ethernet board fitted into these MiCOM products.

- P141, P142, P143, P145
- P241, P242, P243
- P341, P342, P343, P344, P345
- P442, P443, P444, P445, P446
- P543, P544, P545, P546, P547
- P642, P643, P645
- P741, P743, P746
- P841, P849

6.1 Board Hardware

6.1.1 100 Base TX Communications Interface (in accordance with IEEE802.3 and IEC 61850)

Cable type	Screened Twisted Pair (STP)
Connector type	RJ45
Maximum distance	100m
Full Duplex	100 Mbps

Table 7 - 100 Base TX interface

6.1.2 100 Base FX Communications Interface (in accordance with IEEE802.3 and IEC 61850)

Optical fiber cable	Multi-mode 50/125 µm or 62.5/125 µm
Center wavelength	1310 nm
Connector type	LC
Maximum distance	2 km
Full Duplex	100 Mbps

Table 8 - 100 Base FX interface

6.1.3 Transmitter Optical Characteristics

(TA = -40° C to 85° C, Single +3.3 V power supply)

Parameter	Sym	Min.	Typ.	Max.	Unit
Output Optical Power 62.5/125 µm, NA = 0.275 Fiber	PO	-20	-17.0	-14	dBm avg.
Output Optical Power 50/125 µm, NA = 0.20 Fiber	PO	-23.5	-20.0	-14	dBm avg.
Optical Extinction Ratio				10	dB
Output Optical Power at Logic “0” State	PO (“0”)			-45	dBm avg.

Table 9 - Tx optical characteristics

6.1.4 Receiver Optical Characteristics

(TA = -40° C to 85° C, Single +3.3 V power supply)

Parameter	Sym	Min.	Typ.	Max.	Unit
Input Optical Power	PIN	-31		-14	dBm avg.

Table 10 - Rx optical characteristics

6.1.5 IRIG-B and Real-Time Clock

6.1.5.1 Performance

Year 2000: Compliant
Real time accuracy: < ±2 seconds / day
External clock synchronization: Conforms to IRIG standard 200-98, format B

6.1.5.2 Features

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

6.1.5.3 Self-adapted Rear IRIG-B interface (Modulated or Unmodulated)

BNC plug
Isolation to SELV level
50 ohm coaxial cable

6.2 Type Tests

6.2.1 Insulation

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

6.2.2 Creepage Distances and Clearances

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

6.2.3 High Voltage (Dielectric) Withstand

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

(i) As for EN / IEC 60255-27:

2 kV rms AC, 1 minute:
Between all independent circuits.
Between independent circuits and case earth (ground).
1 kV rms AC for 1 minute, across open watchdog contacts.
1 kV rms AC for 1 minute, across open contacts of changeover output relays.
1 kV rms AC for 1 minute for all D-type EIA(RS)-232 or EIA(RS)-485 ports between the communications port terminals and protective (earth) conductor terminal.
1 kV rms AC for 1 minute between RJ45 ports and the case earth (ground).

(ii) As for ANSI/IEEE C37.90:

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

6.2.4 Impulse Voltage Withstand Test

As for EN / IEC 60255-27:

(i) Front time: 1.2 µs, Time to half-value: 50 µs,
Peak value: 5 kV, 0.5 J
Between all independent circuits.
Between independent circuits and case earth ground.

(ii) Front time: 1.2 µs, Time to half-value: 50 µs,
Peak value: 1.5kV, 0.5 J
Between RJ45 ports and the case earth (ground).
EIA(RS)-232 & EIA(RS)-485 ports and normally open contacts of output relays excepted.

6.3 ElectroMagnetic Compatibility (EMC)

6.3.1 1 MHz Burst High Frequency Disturbance Test

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

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

(EIA(RS)-232 ports excepted).

6.3.2 100 kHz and 1MHz Damped Oscillatory Test

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

6.3.3 Immunity to Electrostatic Discharge

As for EN / IEC 60255-22-2, EN / IEC 61000-4-2:

15kV discharge in air to user interface, display, communication ports and exposed metalwork.
6kV contact discharge to the screws on the front of the front communication ports.
8kV point contact discharge to any part of the front of the product.

6.3.4 Electrical Fast Transient or Burst Requirements

As for EN / IEC 60255-22-4, Class B:
- ±4.0 kV, 5kHz and 100kHz applied to all inputs / outputs excluding communication ports
- ±2.0 kV, 5kHz and 100kHz applied to all communication ports

As for EN / IEC 61000-4-4, severity level 4:
- ±2.0 kV, 5kHz and 100kHz applied to all inputs / outputs and communication ports excluding power supply and earth.
- ±4.0 kV, 5kHz and 100kHz applied to all power supply and earth port

Rise time of one pulse:	5 ns
Impulse duration (50% value):	50 ns
Burst duration:	15 ms or 0.75ms
Burst cycle:	300 ms
Source impedance:	50 Ω

6.3.5 Surge Withstand Capability

As for IEEE/ANSI C37.90.1:
4 kV fast transient and 2.5 kV oscillatory
applied directly across each output contact, optically isolated input, and power supply circuit.

6.3.6 Surge Immunity Test

As for EN / IEC 61000-4-5, EN / IEC 60255-26:

Time to half-value:	1.2 to 50 μs,
Amplitude:	4 kV between all groups and case earth (ground),
Amplitude:	2 kV between terminals of each group.
Amplitude:	1kV for LAN ports

6.3.7 Conducted/Radiated Immunity

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

6.3.8 Immunity to Radiated Electromagnetic Energy

Per EN / IEC 61000-4-3 and EN / IEC 60255-22-3, Class 3
- Test field strength, frequency band 80 to 1000 MHz and
- 1.4 GHz to 2.7GHz: 10 V/m,
- Test using AM: 1 kHz / 80%, Spot tests at 80, 160, 450, 900, 1850, 2150 MHz

Per IEEE/ANSI C37.90.2:
- 80MHz to 1000MHz, zero and 100% square wave modulated.
- Field strength of 35V/m.

6.3.9 Radiated Immunity from Digital Communications

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

6.3.10 Radiated Immunity from Digital Radio Telephones

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

6.3.11 Immunity to Conducted Disturbances Induced by Radio Frequency Fields

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

6.3.12 Power Frequency Magnetic Field Immunity

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

6.3.13 Conducted Emissions

As for CISPR 22 Class A:
Power supply:
0.15 - 0.5 MHz, 79 dBμV (quasi peak) 66 dBμV (average)
0.5 - 30 MHz, 73 dBμV (quasi peak) 60 dBμV (average)
Permanently connected communications ports:
0.15 - 0.5MHz, 97dBμV (quasi peak) 84dBμV (average)
0.5 - 30MHz, 87dBμV (quasi peak) 74dBμV (average)

6.3.14 Radiated Emissions

As for CISPR 22 Class A:
30 to 230 MHz, 40 dBμV/m at 10m measurement distance
230 to 1 GHz, 47 dBμV/m at 10 m measurement distance.
1 – 3GHz, 76dBμV/m (peak), 56dBμV/m (average) at 3m measurement distance.
3 – 5GHz, 80dBμV/m (peak), 60dBμV/m (average) at 3m measurement distance.

6.4 Environmental Conditions

6.4.1 Ambient Temperature Range

Per EN 60068-2-1 & EN / IEC 60068-2-2

Operating temperature range:	-25°C to +55°C (or -13°F to +131°F)
Storage and transit:	-25°C to +70°C (or -13°F to +158°F)

6.4.2 Ambient Humidity Range

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

6.4.3 Corrosive Environments

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

6.5 EU Directives

6.5.1 EMC Compliance

As for 2004/108/EC:

Compliance to the European Commission Directive on EMC is demonstrated using a Technical File. Product Specific Standards were used to establish conformity:
EN 60255-26

6.5.2 Product Safety

Per 2006/95/EC:

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

EN 60255-27

6.5.3 R&TTE Compliance

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

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

Applicable to rear communications ports.

Compliance demonstrated by Notified Body certificates of compliance.

6.5.4 Other Approvals

For ATEX Potentially Explosive Atmospheres directive 94/9/EC compliance, consult Schneider Electric.
For other approvals such as UL / CUL / CSA, consult Schneider Electric.

6.6 Mechanical Robustness

6.6.1 Vibration Test

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

6.6.2 Shock and Bump

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

6.6.3 Seismic Test

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

7 CORTEC

This is a generic Cortec to cover all IEDs using the **Redundant Ethernet** boards.
It does not necessarily include all the possible options for all products in the MiCOM Px4x range.

Variants	Order Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
MiCOM Protection		P														
Application/Platform:																
Feeder Management:			1	4	*											
Motor Protection:			2	4	*											
Generator Protection Relay:			3	4	*											
Distance Protection Relay:			4	4	*											
Current Differential:			5	4	*											
Transformer:			6	4	*											
Busbar:			7	4	*											
Breaker Fail:			8	4	*											
Vx Aux Rating:																
24 - 32 Vdc						9										
48 - 110 Vdc						2										
110 - 250 Vdc (100 - 240 Vac)						3										
In/Vn Rating:																
HV-LV (In = 1A/5A), (Vn = 100/120V) (8CT/1VT)							1									
HV-LV (In = 1A/5A), (Vn = 100/120V) (8CT/2VT)							2									
Hardware Options:																
Standard - no options								1								
IRIG-B only (modulated)								2								
Fibre optic converter only								3								
IRIG-B (modulated) & fibre optic converter								4								
Ethernet with 100Mits/s fibre-optic port								6								
Second Rear Comms Port (Courier EIA232/EIA485/k-bus)								7								
Second Rear Comms Port + IRIG-B (modulated) (Courier EIA232/EIA485/k-bus)								8								
InterMiCOM + Courier Rear Port								E								
InterMiCOM + Courier Rear Port + IRIG-B modulated								F								
Redundant Ethernet (100Mbit/s) PRP or HSR and Dual IP, 2 LC ports + 1 RJ45 port + Modulated/Unmodulated IRIG-B								Q								
Redundant Ethernet (100Mbit/s) PRP or HSR and Dual IP, 3 RJ45 ports + Modulated/Unmodulated IRIG-B								R								
Ethernet (100Mbit/s), 1 RJ45 port + Modulated/Unmodulated IRIG-B								S								
Product Specific Options :																
Size 8 (40TE) Case, 8 Optos + 8 Relays									A							
Size 8 (40TE) Case, 8 Optos + 8 Relays + RTD									B							
Size 8 (40TE) Case, 8 Optos + 8 Relays + CLIO (mA I/O)									C							
Size 8 (40TE) Case, 12 Optos + 12 Relays									D							
Size 8 (40TE) Case, 8 Optos + 12 Relays (including 4 High Break)									E							
Protocol Options:																
K-Bus/Courier										1						
Modbus										2						
IEC60870-5-103 (VDEW)										3						
DNP3.0										4						
IEC 61850 over Ethernet and Courier via rear K-Bus/RS485 OR IEC 61850 Edition 1 and Edition 2 and Courier via rear K-Bus/RS485										6						
IEC 61850 over ethernet with CS103 rear port RS485 protocol OR IEC 61850 Edition 1 and Edition 2 and CS103 via rear port RS485										7						
IEC 61850 Edition 1 / 2 and DNPoE and DNP3 Serial with simple password management - (CSL0)										B						
IEC 61850 Edition 1 / 2 and Courier via rear K-Bus/RS485 with advanced Cyber Security - CSL1 - Security Administration Tool (SAT) required										G						

IEC 61850 Edition 1 / 2 and CS103 via rear port RS485 with advanced Cyber Security - CSL1 - Security Administration Tool (SAT) required	H
IEC 61850 Edition 1 / 2 and DNPoE and DNP3 Serial with advanced Cyber Security - CSL1 - Security Administration Tool (SAT) required	L
Mounting Options:	
Flush Panel Mounting	M
Rack Mounting (80TE only)	N
Language Options:	
English, French, German, Spanish	0
English, French, German, Russian	5
Chinese, English or French via HMI, with English or French only via Communications port	C
Software Version:	
	* *
Customisation:	
Default	8
Customer Settings	9
Design Suffix:	
	*

Notes:

PRP NOTES

CHAPTER 20

<table>
<tr><td>Date (month/year):</td><td colspan="4">07/2016</td></tr>
<tr><td>Products covered by this chapter:</td><td colspan="4">This chapter covers the specific versions of the MiCOM products listed below. This includes only the following combinations of Software Version and Hardware Suffix.</td></tr>
<tr><td rowspan="11">Hardware Suffix:</td><td>P141/P142/P143</td><td>L</td><td>P54x (P543/P544/P545/P546)</td><td>M</td></tr>
<tr><td>P145</td><td>M</td><td>P642</td><td>L</td></tr>
<tr><td>P241</td><td>L</td><td>P643/P645</td><td>M</td></tr>
<tr><td>P242/P243</td><td>M</td><td>P741/P743</td><td>M</td></tr>
<tr><td>P342</td><td>L</td><td>P742</td><td>L</td></tr>
<tr><td>P343/P344/P345</td><td>M</td><td>P746</td><td>M</td></tr>
<tr><td>P391</td><td>A</td><td>P74x (P741, P743)</td><td>K</td></tr>
<tr><td>P445</td><td>K/L</td><td>P841A (one circuit breaker)</td><td>M</td></tr>
<tr><td>P44x (P441/P442/P444)</td><td>K</td><td>P841B (two circuit breakers)</td><td>M</td></tr>
<tr><td>P44x (P442/P444)</td><td>M</td><td>P849</td><td>M</td></tr>
<tr><td>P44y (P443/P446)</td><td>M</td><td></td><td></td></tr>
<tr><td rowspan="8">Software Version:</td><td>P14x (P141/P142/P143/P145)</td><td>B0/B2</td><td>P54x (P543/P544/P545/P546)</td><td>H4</td></tr>
<tr><td>P24x (P241/P242/P243)</td><td>D0</td><td>P64x (P642/P643/P645)</td><td>B1</td></tr>
<tr><td>P34x (P342/P343/P344/P345/P391)</td><td>B0</td><td>P746</td><td>B1/B2/
C1/C2</td></tr>
<tr><td>P445</td><td>J4</td><td>P74x (P741/P742/P743)</td><td>B0</td></tr>
<tr><td>P44x (P442/P444)</td><td>E0</td><td>P841A</td><td>G4</td></tr>
<tr><td>P44y (P443/P446)</td><td>H4</td><td>P841B</td><td>H4</td></tr>
<tr><td></td><td></td><td>P849</td><td>B0</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>Connection Diagrams:</td><td colspan="2">P14x (P141, P142, P143 & P145):
10P141xx (xx = 01 to 02)
10P142xx (xx = 01 to 05)
10P143xx (xx = 01 to 11)
10P145xx (xx = 01 to 11)
P24x (P241, P242 & P243):
10P241xx (xx = 01 to 02)
10P242xx (xx = 01)
10P243xx (xx = 01)
P34x (P342, P343, P344, P345 & P391):
10P342xx (xx = 01 to 17)
10P343xx (xx = 01 to 19)
10P344xx (xx = 01 to 12)
10P345xx (xx = 01 to 07)
10P391xx (xx = 01 to 02)
P445:
10P445xx (xx = 01 to 04)
P44x(P442 & P444):
10P44101 (SH 1 & 2)
10P44201 (SH 1 & 2)
10P44202 (SH 1)
10P44203 (SH 1 & 2)
10P44401 (SH 1)
10P44402 (SH 1)
10P44403 (SH 1 & 2)
10P44404 (SH 1)
10P44405 (SH 1)
10P44407 (SH 1 & 2)
P44y (P443 & P446):
10P44303 (SH 01 and 03)
10P44304 (SH 01 and 03)
10P44305 (SH 01 and 03)
10P44306 (SH 01 and 03)
10P44600
10P44601 (SH 1 to 2)
10P44602 (SH 1 to 2)
10P44603 (SH 1 to 2)</td><td colspan="2">P54x (P543, P544, P545 & P546):
10P54302 (SH 1 to 2)
10P54303 (SH 1 to 2)
10P54400
10P54404 (SH 1 to 2)
10P54405 (SH 1 to 2)
10P54502 (SH 1 to 2)
10P54503 (SH 1 to 2)
10P54600
10P54604 (SH 1 to 2)
10P54605 (SH 1 to 2)
10P54606 (SH 1 to 2)
P547:
10P54702xx (xx = 01 to 02)
10P54703xx (xx = 01 to 02)
10P54704xx (xx = 01 to 02)
10P54705xx (xx = 01 to 02)
P64x (P642, P643 & P645):
10P642xx (xx = 1 to 10)
10P643xx (xx = 1 to 6)
10P645xx (xx = 1 to 9)
P74x (P741, P742 & P743):
10P740xx (xx = 01 to 07)
P746:
10P746xx (xx = 00 to 21)
P841:
10P84100
10P84101 (SH 1 to 2)
10P84102 (SH 1 to 2)
10P84103 (SH 1 to 2)
10P84104 (SH 1 to 2)
10P84105 (SH 1 to 2)
P849:
10P849xx (xx = 01 to 06)</td></tr>
</table>

CONTENTS

TABLES

FIGURES

Notes:

1 PARALLEL REDUNDANCY PROTOCOL (PRP) NOTES

1.1 Introduction to PRP

This section gives an introduction to the Parallel Redundancy Protocol (PRP); and how it is implemented on MiCOM-based products manufactured by Schneider Electric.

1.2 Protocols

Industrial real-time Ethernets typically need much better levels of availability and uninterrupted operation than normal office-type Ethernet solutions. For power networks, even a short loss of connectivity may result in a significant loss of functionality or impaired safety. To recover from a network failure, various redundancy schemes have been considered, including: Rapid Spanning Tree Protocol (RSTP), Media Redundancy Protocol (MRP) and Parallel Redundancy Protocol (PRP). The key properties of these are as follows:

RSTP this uses mesh-based topologies or ring topology and computes a tree, based on path costs and priorities. In case of network failure, a typical reset time for RSTP-based system is normally a few seconds.

MRP This uses ring-based topologies. In case of network failure, the network is broken into two separate lines, which are reconnected by de-blocking the previously blocked part. The guaranteed reset time for MRP protocol-based systems is typically around 100ms.

PRP this does not change the active topology as it uses two independent networks. Each message is replicated and sent over both networks. The first network node to receive it acts on it, with all later copies of the message being discarded. Importantly, these details are controlled by the low-level PRP layer of the network architecture, with the two networks being hidden from the higher level layers. Consequently, PRP-based networks are continuously available.

Power networks need to be able to respond to problems very quickly (typically in less than 10ms), and PRP is an available protocol which is robust enough to achieve this. The PRP protocol used in the MiCOM relay/IEDs is defined in the IEC62439-3 (2012) standard and is configured using the existing redundant Ethernet card(s).

1.3 PRP Summary (IEC 62439-3 Clause 4)

A summary of the main PRP features is given below:

- Ethernet redundancy method independent of any Ethernet protocol or topology (tree, ring or mesh)
- Seamless switchover and recovery in case of failure, which supports real-time communication
- Supervises redundancy continuously for better management of network devices
- Suitable for hot swap - 24 hour/365 day operation in substations
- Allows the mixing of devices with single and double network attached nodes on the same Local Area Network (LAN)
- Allows laptops and workstations to be connected to the network with standard Ethernet adapters (on double or single attached nodes)
- Particularly suited for substation automation, high-speed drives and transportation

1.4 Example of a PRP Network

Essentially a PRP network is a pair of similar Local Area Networks (LANs) which can be any topology (tree, ring or mesh). An example of a PRP network is shown in Figure 1:

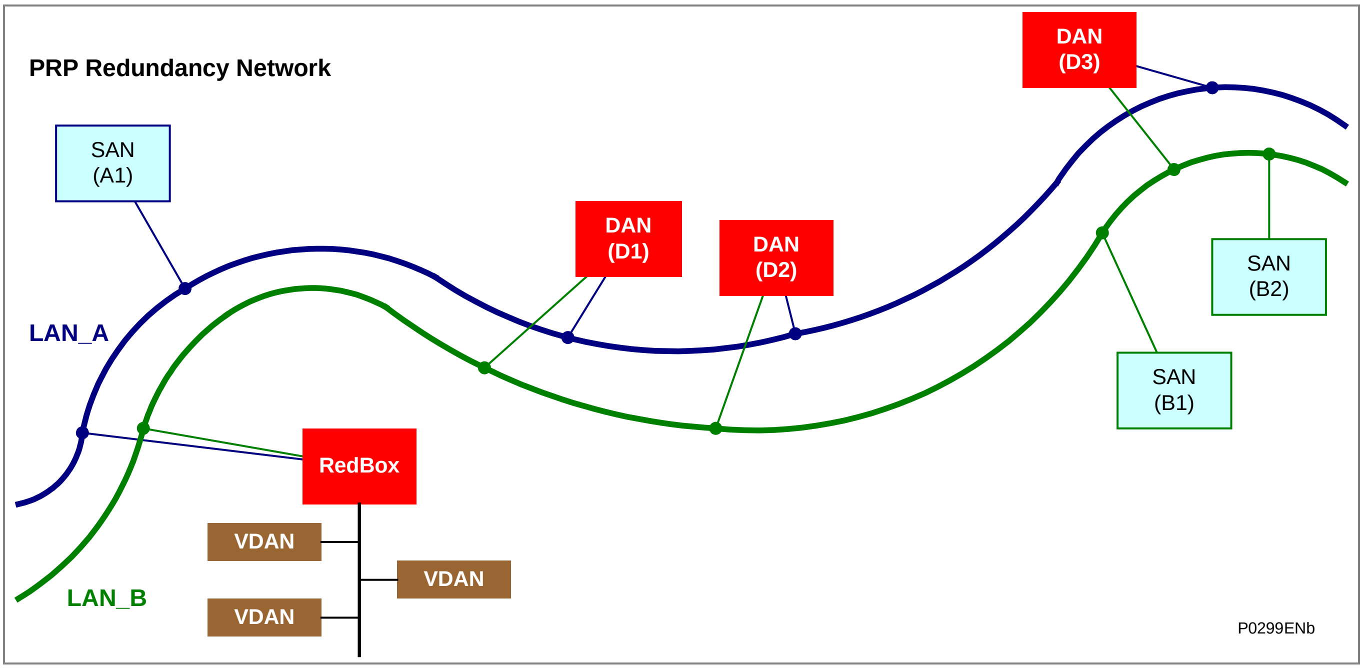


Figure 1 - PRP Redundancy Network

Figure 1 shows two similar Local Area Networks (LANs) which have various Nodes in common. The key features of these networks include:

- With the exception of a RedBox (see below), no direct cable connections can be made between the two LANs.
- Each of these LANs can have one or more Single Attached Nodes (SANs). These are normally non-critical devices that are attached only to a single network. SANs can talk to one another, but only if they are on the same LAN.
- Matched pairs of devices which are critical to the operation of the overall scheme are connected one to each network as Doubly Attached Nodes (DANs).
- To be sure that network messages (also known as frames) are transferred correctly to each DAN, each DAN must have the same Media Access Control (MAC) code and Internet Protocol (IP) address. This will also mean that TCP/IP traffic will automatically communicate with both of the paired devices, so it will be unaware of any two-layer redundancy or frame duplication issues.
- A Redundancy Box (RedBox) is used when a single interface node has to be connected to both networks. The RedBox can talk to all other nodes. So far as other nodes are concerned, the RedBox behaves like a DAN, so a SAN that is connected through a RedBox is also called a Virtual Doubly Attached Node (VDAN). The RedBox must have its own unique IP address.
- Transmission delays can be different between related Nodes of the two LANs.
- Each LAN (i.e. LAN_A and LAN_B) must be powered from a different power source and must be failure independent.

The two LANs can differ in terms of performance and topology. The redundant Ethernet interface can be made using an optical fiber connection with an LC or ST connector type or with RJ45 copper connector type. There is no need for an optical interface away from the relay.

1.5 PRP Network Structure

PRP uses two independent LANs. The topology of each of these LANs is arbitrary, and ring, star, bus and meshed topologies are possible.

The main advantage of PRP is loss-free data transmission with an active (transit) LAN. When the terminal device receives no packets from one of the LANs, the second (transit) LAN maintains the connection. As long as 1 (transit) LAN is available, repairs and maintenance on the other (transit) LAN have no impact on the data packet transmission.

The elementary devices of a PRP network are known as RedBox (Redundancy Box) and DANP (Double Attached Node implementing PRP).

Both devices have one connection each to the (transit) LANs.

The devices in the (transit) LAN are conventional switches that do not require any PRP support. The devices transmit PRP data packets transparently, without evaluating the RCT information.

Terminal devices that are connected directly to a device in the (transit) LAN are known as SAN (Single Attached Node). If there is an interruption, these terminal devices cannot be reached via the redundant line. To use the uninterruptible redundancy of the PRP network, you integrate your device into the PRP network via a RedBox.

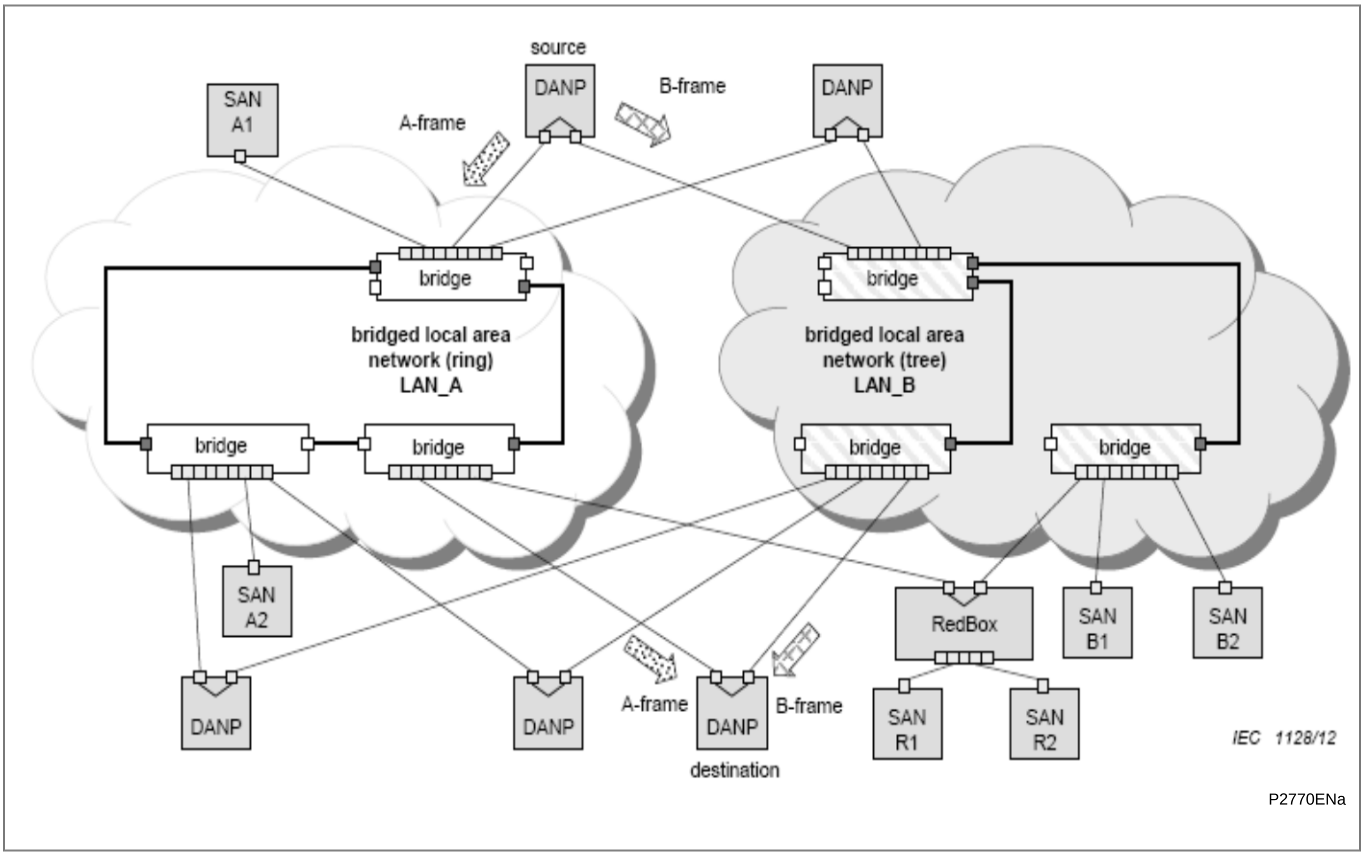


Figure 2 - PRP example of general redundant network

1.6 Structure of a DAN

A MiCOM P40 relay working in PRP Mode works as a DAN within the overall network topology. Each DAN has two ports that operate in parallel. They are attached to the upper layers of the communications stack through the Link Redundancy Entity (LRE) as in Figure 2:

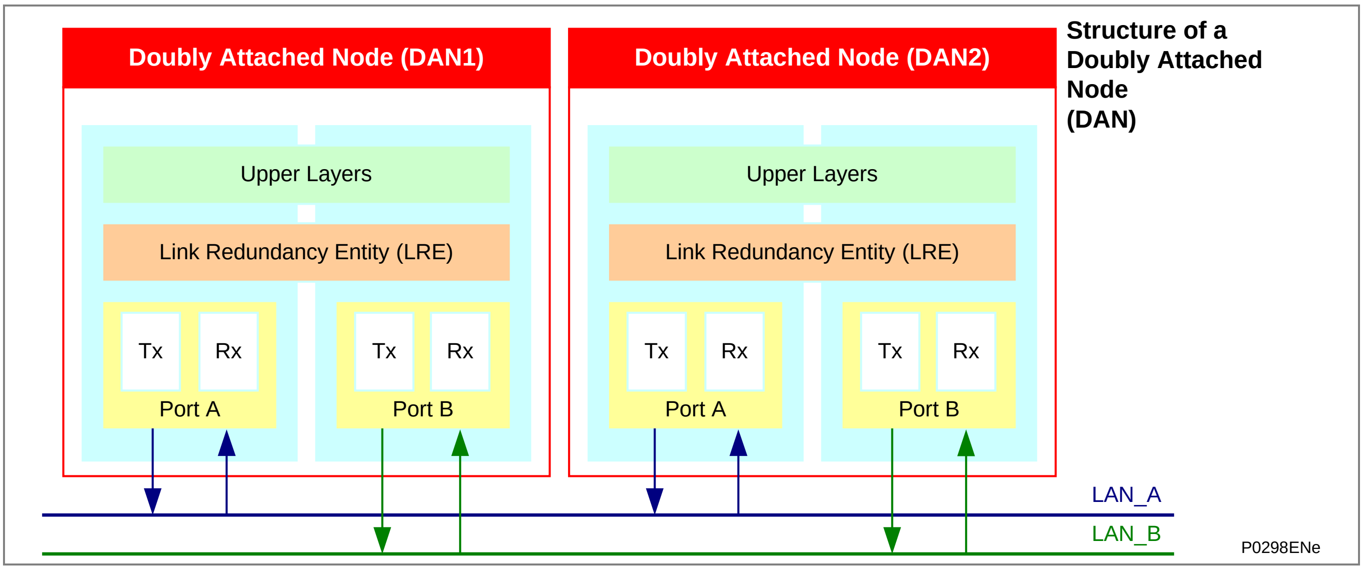


Figure 3 –Communication between two DANs (in PRP)

The LRE has two main tasks:

- handling message frames and
- management of redundancy

When an upper layer sends a frame to the LRE, the LRE replicates the frame and sends it through both its ports at nearly the same time. The two frames move through the two LANs with slightly different delays, ideally arriving at the destination node within a small time window.

When receiving frames, the LRE forwards the first frame it received to its upper layers and then discards the duplicate.

As both DAN nodes have the same MAC and IP addresses, this makes redundancy transparent to the upper layers. This allows the Address Resolution Protocol (ARP) to work in the same way as with a SAN. Accordingly, to the upper layers of a DAN, the LRE layer shows the same interface as the network adapter of a non-redundant adapter.

To manage redundancy, the LRE:

- Adds a 32-bit Redundancy Check Tag (RCT) to each frame it sends and
- Removes the RCT from each frame it receives

1.7 Communication between SANs and DANs

A SAN can be connected to any LAN and can communicate with any other SAN on the same LAN or any DAN. However, a SAN which connected to one LAN can not communicate directly to a SAN which is connected to the other LAN.

A DAN is connected to both LANs and can communicate with any RedBox or any other DANs or any SANs on either network. For communication purposes, a DAN “views” a SAN connected through a RedBox as a VDAN.

When a SAN generates a basic frame, it sends the frame only onto the LAN to which it is connected.

Originating at the SAN, a typical frame contains these parameters:

- dest_addr Destination Address
- src_addr Source Address
- type Type
- data
- fcs Frame Check Sequence (i.e. extra checksum characters added to allow error detection and correction)

The frame from the SAN is then received by the DAN; which sends the frame to its upper layers, which act accordingly.

When a DAN generates a frame, it needs to send the frame onto both of the LANs to which it is connected. When it does this, it extends the frame by adding the 32-bit Redundancy Control Trailer (RCT) into the frame.

The RCT consists of these parameters:

- 16-bit Sequence Number
- 4-bit LAN identifier, 1010 (0xA) for LAN_A and 1011 (0xB) for LAN_B
- 12-bit frame size
- PRP suffix

Note	*The Sequence number is a measure of the number of messages which have been sent since the last system reset. Each time the link layer sends a frame to a particular destination the sender increases the sequence number corresponding to that destination and sends the (nearly) identical frames over both LANs.*

Accordingly, originating at the DAN, a typical frame then contains these parameters:

- dest_addr Destination Address
- src_addr Source Address
- type Type
- lsdu Link Service Data Unit
- Padding if needed
- RCT data:
  - 16-bit sequence number:
    4-bit LAN identifier
    12-bit frame size
  - 16-bit PRP suffix (0X88 0XFB)
- fcs Frame Check Sequence

LSDU	*The Link Service Data Unit (LSDU) data allows PRP frames to be distinguished from none-PRP frames.*

Padding	*After the LSDU data, there may be some data padding. This is added to frames which would otherwise be too short for conventional network traffic (minimum frame size is 64 octets).*
Size	*The frame size will vary depending on the contents of the frame and how it has been tagged by the various SANs and DANs. In VLANs, frame tags may be added or removed during transit through a switch. To make the length field independent of tagging, only the LSDU and the RCT are considered in the size.*

Figure 3 shows the frame types with different types of data.

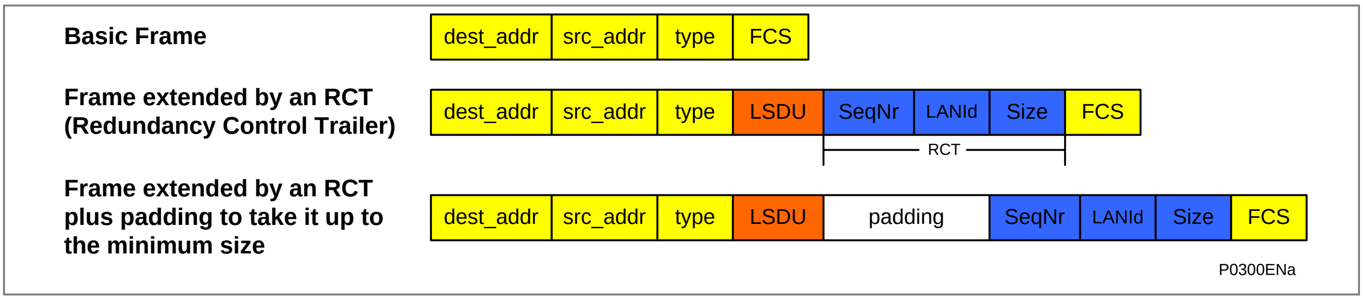


Figure 4 - Frames without and with RCT and padding

The key points about these differing frame structures is that:

- SANs do not implement any redundancy features, so they generate basic frames which SANs and DANs can understand.
- SANs can still understand the frames that come from DANs, as SANs ignore the RCT components in frames which come from DANs (a SAN cannot distinguish the RCT from the IEEE802.3 padding)
- If a DAN receives a frame which does not include the RCT component, it sends a single copy of the frame to its upper layers.
- If a DAN receives a frame which does include the RCT component, it does not send a duplicate copy of the frame to its upper layers.
- If a DANP cannot identify that the remote Node is a DAN, it inserts no RCT.

When using a Single Attached Nodes connected to the IED, a redbox is suggested to handle the case when the TPDU size for the client has been set above than 1024.

1.8 PRP Technical Data

- One VLAN tag supported.
- 128 publishers supported per receiver.
- Up to 100Mbit/s full duplex Ethernet.
- Dynamic frame memory allocation (page manager).
- Configurable duplicate detection.
- Wishbone interface for configuration and status registers.
- CPU port interface - Ethernet or Wishbone.
- Support for link-local protocols - CPU may send to specific ports only - CPU knows receive port.
- Configurable frame memory and queue length.
- Duplicate detection with configurable size and aging time.
- MAC address filtering (8 filter masks for interlink, 6 for CPU).
- Support for interfaces with or without Ethernet preamble.

Maximum Transmission Unit

According to the IEC 8802-3, the MTU (Ethernet maximum packet size) is:

- 1518 bytes without VLAN and without PRP
- 1522 bytes with VLAN and without PRP
- 1524 bytes without VLAN and with PRP
- 1528 bytes with VLAN and with PRP

Note: Check that the LAN switches setting for the MTU is at least 1528 bytes

2 PRP AND MICOM FUNCTIONS

2.1 MiCOM Products and PRP

The PRP functions being introduced as part of the overall MiCOM product range provide additional functionality, which is backwards compatible with existing Schneider Electric MiCOM equipment. This means that existing MiCOM relays/IEDS can be used on networks which use PRP functions, with no changes being made to those relays/IEDs.

The new MiCOM products that use the PRP, will interrogate other equipment to determine the equipment model number, and then use the model number to decide (at runtime), whether that particular item of equipment can support PRP or not.

MiCOM models which include the following Ethernet board assembly provide the possibility of PRP function support. This is denoted by Digit 7 where the Hardware option is N, P, Q or R, as shown in Table 1:

Hardware Option	Type	Model No format
"N" at Digit No 7	2 ST ports redundant Ethernet board (Modulated IRIG-B)	**Px4xxxNx6Mxxx8K**
"P" at Digit No 7	2 ST ports redundant Ethernet board (Un-modulated IRIG-B)	**Px4xxxPx6Mxxx8K**
"Q" at Digit No 7	2 LC + 1 RJ45 ports redundant Ethernet board (Modulated/ Un-modulated IRIG-B)	**Px4xxxQx6Mxxx8M**
"R" at Digit No 7	3 RJ45 ports redundant Ethernet board (Modulated/ Un-modulated IRIG-B)	**Px4xxxRx6Mxxx8M**

Table 1 - MiCOM model numbers for PRP options

The MiCOM relay/IED firmware has been modified to allow the PRP options to be accepted for the power-up tests in addition to the implementation of the supervision frame transmission.

2.2 MiCOM S1 Studio Software and the PRP Function

The addition of this function has no impact of the MiCOM S1 Studio support files so there is no need to upgrade any MiCOM S1 Studio software.

2.3 MiCOM Relay Configuration and the PRP Function

There is no need to change the configuration of any relay (as relays which include support for this function will be able to recognize other devices which support it).

2.4 Hardware Changes for PRP Protocol

This protocol is implemented using the existing redundant Ethernet and dual redundant Ethernet card as a starting point. The Frame management is achieved by re-programming the Field-Programmable Gate Array (FPGA).

The low-level management of the redundant frames is performed within the FPGA; this being defined as the Link Redundancy Entity (LRE). This will involve the addition of the Redundancy Check Tag (RCT) to a frame to be transmitted; this identifies the LAN and the sequence number of the message over the two networks. The FPGA is also responsible for the stripping of the RCT from received frames and discarding the duplicated messages such that only a single application frame is received by the Ethernet processor.

The LRE functionality of the supervision frame transmission is performed by the Ethernet processor card.

2.5 PRP Parameters

The Redundant Ethernet standard (IEC 62439-3:2012) defines several parameters for the PRP protocol; these being fixed at a default value within this release. The following values are set:

Parameter	Value	Description
Supervision Frame Multicast Address	01-15-4E-00-01-00	Target MAC Address for multicast supervision frame
Life Check Interval	2 seconds	Period between transmission of supervision frames
PRP Mode	Duplicate Discard	This is normal PRP mode, Duplicate address will not be supported.
Node Forget Time	60 s	This is the time after which a node entry is cleared.
Entry Forget Time	400 ms	Duration that the received message Sequence number will be held to discard a duplicate message.
Node Reboot Interval	500ms	Duration following reboot for which no PRP frames should be transmitted.

Table 2 - PRP parameter values (for PRP Protocol Version 1)

2.6 Product Implementation Features

Here is a list of the main Product Requirements for MiCOM products which support PRP:

- The MiCOM relay/IED provides two redundant Ethernet ports using PRP.
- The MiCOM relay/IED must be connected to the redundant Ethernet network as a Double Attached Node (DAN) using PRP (DAN using PRP is known as DANP)
- The redundant Ethernet interface can be made using an RJ45 or an optical fibre connection with an LC or ST connector type (Ethernet card dependent).
- The management of the PRP redundancy is transparent to the application data provided via the Ethernet interface.
- The PRP option is available with any of the existing protocol options via the Ethernet Interface (IEC61850 and/or DNPoE)
- Loss of one of the LAN connections to the device does not cause any loss or degradation to the Application data over the Ethernet interface.
- The MiCOM relay/IED supports the transmission of the PRP Supervision frame at a fixed time period (LifeCheckInterval) of 2s (+/- 100ms)
- Each supervision frame includes a sequence number as defined in the IEC 62439-3:2012 specification. This is incremented for each supervision message and the value starts from zero following a system restart.
- The MiCOM relay/IED does not process received supervision frames to provide supervision of the redundant network.
- The MiCOM relay/IED does not provide for the PRP management to be configured (via either the MiCOM relay/IED HMI or the Ethernet interface). Accordingly, the default values (as defined within this document) are used for all PRP parameters.
- The performance of the Ethernet Interface is not degraded by using the PRP interface.

2.6.1 Abbreviations and Acronyms

Abbreviations / Acronyms	Meaning
CRC	Cyclic Redundancy Check
DAN	Doubly Attached Nodes
DANP	Doubly Attached Node implementing PRP
FPGA	Field-Programmable Gate Array
HMI	Human Machine Interface
IED	Intelligent Electronic Devices
IP	Internet Protocol
LAN	Local Area Network
LRE	Link Redundancy Entity
MAC	Media Access Control
MRP	Media Redundancy Protocol
PRP	Parallel Redundancy Protocol
RCT	Redundancy Check Tag
RedBox	Redundancy Box
RSTP	Rapid Spanning Tree Protocol
SAN	Singly Attached Node
TCP	Transmission Control Protocol
VDAN	Virtual Doubly Attached Node

Notes:

HSR NOTES

CHAPTER 21

Date (month/year):	07/2016			
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.			
Hardware Suffix:	P141/P142/P143	L	P54x (P543/P544/P545/P546)	M
	P145	M	P642	L
	P241	L	P643/P645	M
	P242/P243	M	P741/P743	M
	P342	L	P742	L
	P343/P344/P345	M	P746	M
	P391	A	P74x (P741, P743)	K
	P445	K/L	P841A (one circuit breaker)	M
	P44x (P441/P442/P444)	K	P841B (two circuit breakers)	M
	P44x (P442/P444)	M	P849	M
	P44y (P443/P446)	M		
Software Version:	P14x (P141/P142/P143/P145)	B0/B2	P54x (P543/P544/P545/P546)	H4
	P24x (P241/P242/P243)	D0	P64x (P642/P643/P645)	B1
	P34x (P342/P343/P344/P345/P391)	B0	P746	B1/B2/C1/C2
	P445	J4	P74x (P741/P742/P743)	B0
	P44x (P442/P444)	E0	P841A	G4
	P44y (P443/P446)	H4	P841B	H4
			P849	B0
Connection Diagrams:	P14x (P141, P142, P143 & P145): 10P141xx (xx = 01 to 02) 10P142xx (xx = 01 to 05) 10P143xx (xx = 01 to 11) 10P145xx (xx = 01 to 11) P24x (P241, P242 & P243): 10P241xx (xx = 01 to 02) 10P242xx (xx = 01) 10P243xx (xx = 01) P34x (P342, P343, P344, P345 & P391): 10P342xx (xx = 01 to 17) 10P343xx (xx = 01 to 19) 10P344xx (xx = 01 to 12) 10P345xx (xx = 01 to 07) 10P391xx (xx = 01 to 02) P445: 10P445xx (xx = 01 to 04) P44x(P442 & P444): 10P44101 (SH 1 & 2) 10P44201 (SH 1 & 2) 10P44202 (SH 1) 10P44203 (SH 1 & 2) 10P44401 (SH 1) 10P44402 (SH 1) 10P44403 (SH 1 & 2) 10P44404 (SH 1) 10P44405 (SH 1) 10P44407 (SH 1 & 2) P44y (P443 & P446): 10P44303 (SH 01 and 03) 10P44304 (SH 01 and 03) 10P44305 (SH 01 and 03) 10P44306 (SH 01 and 03) 10P44600 10P44601 (SH 1 to 2) 10P44602 (SH 1 to 2) 10P44603 (SH 1 to 2)		P54x (P543, P544, P545 & P546): 10P54302 (SH 1 to 2) 10P54303 (SH 1 to 2) 10P54400 10P54404 (SH 1 to 2) 10P54405 (SH 1 to 2) 10P54502 (SH 1 to 2) 10P54503 (SH 1 to 2) 10P54600 10P54604 (SH 1 to 2) 10P54605 (SH 1 to 2) 10P54606 (SH 1 to 2) P547: 10P54702xx (xx = 01 to 02) 10P54703xx (xx = 01 to 02) 10P54704xx (xx = 01 to 02) 10P54705xx (xx = 01 to 02) P64x (P642, P643 & P645): 10P642xx (xx = 1 to 10) 10P643xx (xx = 1 to 6) 10P645xx (xx = 1 to 9) P74x (P741, P742 & P743): 10P740xx (xx = 01 to 07) P746: 10P746xx (xx = 00 to 21) P841: 10P84100 10P84101 (SH 1 to 2) 10P84102 (SH 1 to 2) 10P84103 (SH 1 to 2) 10P84104 (SH 1 to 2) 10P84105 (SH 1 to 2) P849: 10P849xx (xx = 01 to 06)	

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FIGURES

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1 INTRODUCTION TO HSR

1.1 Introduction to High-availability Seamless Redundancy (HSR)

This section gives an introduction to the High-availability Seamless Redundancy (HSR); and how it is implemented on MiCOM-based products manufactured by Schneider Electric.

1.2 Protocols

Industrial real-time Ethernets typically need much better levels of availability and uninterrupted operation than normal office-type Ethernet solutions. For power networks, even a short loss of connectivity may result in a significant loss of functionality or impaired safety. To recover from a network failure, various redundancy schemes have been considered, including: Rapid Spanning Tree Protocol (RSTP), Media Redundancy Protocol (MRP), High-availability Seamless Redundancy (HSR). The key properties of these are as follows:

RSTP This uses mesh-based topologies or ring topology and computes a tree, based on path costs and priorities. In case of network failure, a typical reset time for RSTP-based system is normally a few seconds.

MRP This uses ring-based topologies. In case of network failure, the network is broken into two separate lines, which are reconnected by de-blocking the previously blocked part. The guaranteed reset time for MRP protocol-based systems is typically around 100ms.

HSR HSR basically uses ring topology, This Clause describes the application of the HSR principles (Clause 5) to implement a High-availability Seamless Redundancy (HSR), retaining the PRP property of zero recovery time, applicable to any topology, in particular rings and rings of rings. With respect to PRP, HSR allows to roughly halve the network infrastructure. With respect to rings based on IEEE 802.1D (RSTP), IEC 62439-2 (MRP), IEC 62439-6 (DRP) or IEC 62439-7 (RRP), the available network bandwidth for network traffic is somewhat reduced depending on the type of traffic. Nodes within the ring are restricted to be HSR-capable bridging nodes, thus avoiding the use of dedicated bridges. Singly Attached Nodes (SANs) such as laptops or printers cannot be attached directly to the ring, but need attachment through a RedBox (redundancy box).

Power networks need to be able to respond to problems very quickly (typically in less than 10ms), and HSR is an available protocol which is robust enough to achieve this. The HSR protocol used in the MiCOM relay/IED is defined in the IEC62439-3 (2012) standard and is configured using the existing redundant Ethernet card(s).

1.3 HSR Summary (IEC 62439-3 Clause 5)

A summary of the main HSR features is given below:

- HSR Ethernet redundancy method independent of any industrial Ethernet protocol and typically used in a ring topology
- Seamless switchover and recovery in case of failure, which supports real-time communication
- Supervises redundancy continuously for better management of network devices
- Suitable for hot swap, 24 hour/365 day operation in substations
- Allows laptops and workstations to be connected to the network with HSR Redbox
- Particularly suited for substation automation, high-speed drives and transportation

1.4 Example of an HSR Network

Essentially a HSR network is a ring topology. An example of a HSR network is shown in Figure 1:

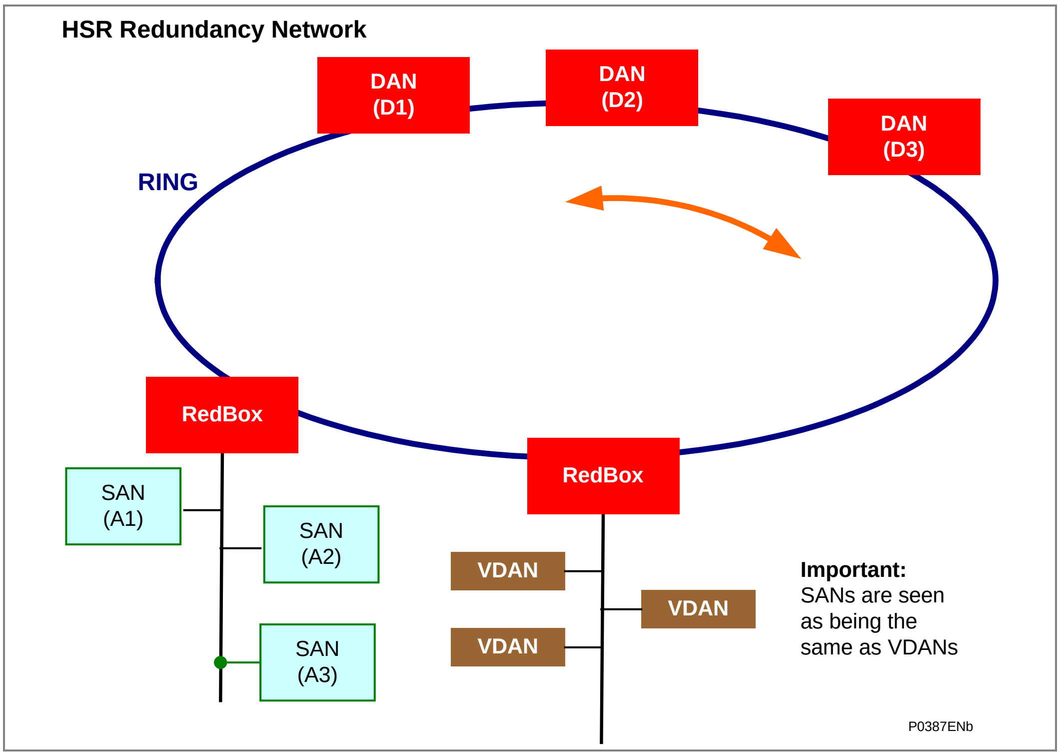

Figure 1 - HSR Redundancy Network

Figure 1 shows typical ring networks that have various Nodes in common.

The key features of the network include:

- Nodes within the ring are restricted to be HSR-capable bridging nodes, thus avoiding the use of dedicated bridges
- Singly Attached Nodes (SANs) such as laptops or printers cannot be attached directly to the ring, but need attachment through a RedBox (redundancy box)
- A simple HSR network consists of doubly attached bridging nodes, each having two ports, interconnected by full-duplex link
- A source DANH sends a frame passed from its upper layers, prefixes it by an HSR tag to identify frame duplicates and sends the frame over each port
- A destination DANH receives, in the fault-free state, two identical frames from each port within a certain interval, if it is a multicast frame, it instantaneously forwards it on the ring (see Note *), removes the HSR tag of the first frame before passing it to its upper layers and discards any duplicate.

*Note **	*In particular, the node will not forward a frame that it injected into the ring.*
*Note **	*A destination node of a unicast frame does not forward a frame for which it is the only destination, except for testing.*

1.5 Structure of a DAN

A MiCOM P40 relay working in HSR Mode works as a DAN within the overall network topology. Each DAN has two ports that operate in parallel. As in Figure 2, The two HSR ports A and B and the device port C are connected by the LRE, which includes a switching matrix allowing to forward frames from one port to the other. The switching matrix allows cut-through bridging. The Link Redundancy Entity (LRE) presents to the higher layers the same interface as a standard Ethernet transceiver would do.

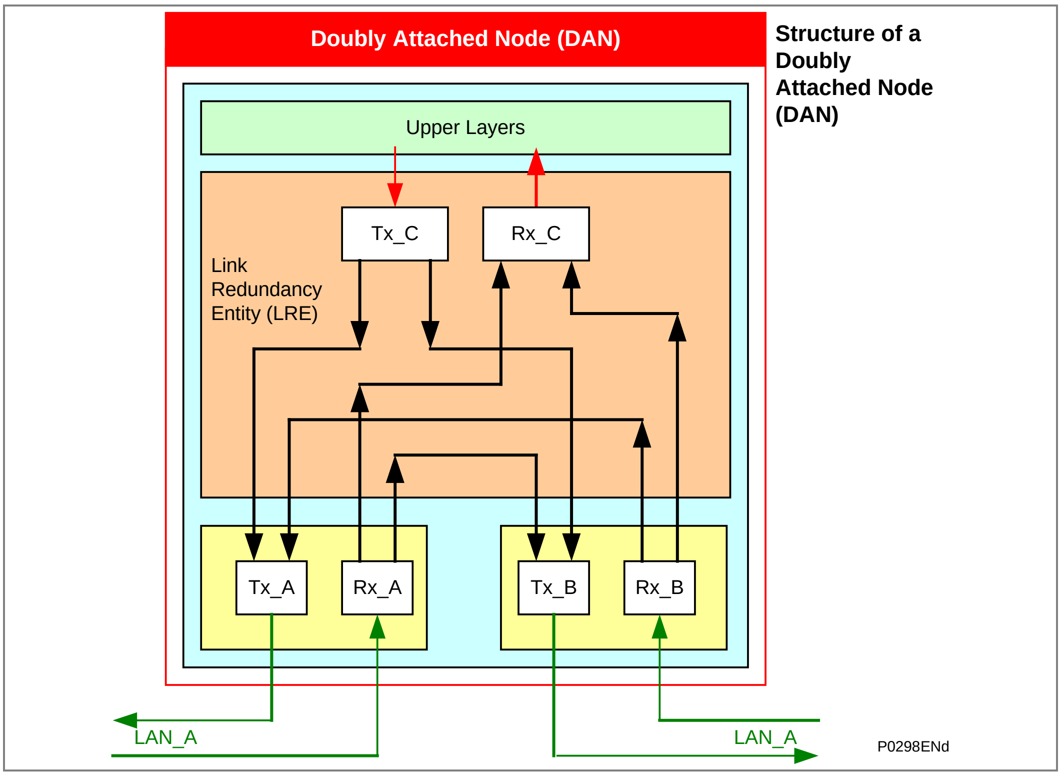

Figure 2 - DAN communication between two paths (in HSR)

DAN node is operable in HSR-tagged forwarding mode, the DAN inserts the HSR tag on behalf of its host and forwards the ring traffic, except for frames sent by the node itself. Duplicate frames and frames where the node is the unicast destination is not forwarded.

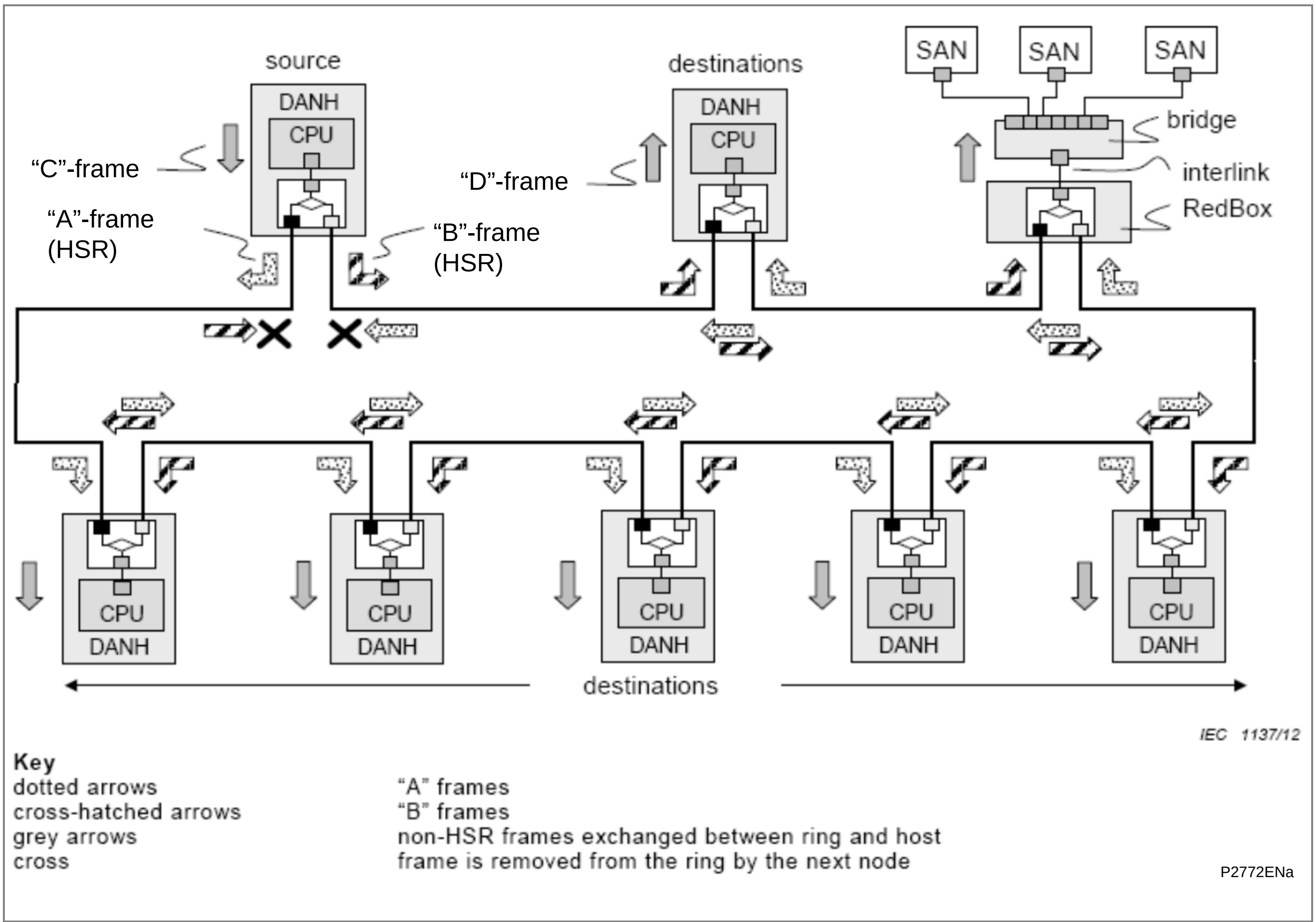

Figure 3 - HSR example of ring configuration for multicast traffic

1.6 Structure of a RedBox

The RedBox has a LRE that performs the duties of the HSR protocol, in particular:

- forwards the frames received from one HSR port to the other HSR port, unless the frame receives frames addressed to its own upper protocols
- prefixes the frames sent by its own upper layers with the corresponding HSR tag before sending two copies over its HSR ports

The switching logic is incorporated into the RedBox, so interlink becomes an internal connection.

A simple RedBox is present in every node, since the LRE makes a transition to a single non-HSR host. In addition, it is usual to have more than one host in a node, since a port for maintenance often exists.

A node does not send over a port a frame that is a duplicate of a frame previously sent over that port in that same direction.

For the purpose of Duplicate Discard, a frame is identified by:

- its source MAC address;
- its sequence number.

The Duplicate Discard method forgets an entry identified by <Source MAC Address><Sequence number> after a time EntryForgetTime.

1.7 Communication between SANs, DANs and RedBoxs

Singly Attached Nodes (SANs), for instance maintenance laptops or printers cannot be inserted directly into the ring since they have only one port and cannot interpret the HSR tag in the frames. SANs communicate with ring devices through a RedBox (Redundancy Box) that acts as a proxy for the SANs attached to it.

A source DANH sends a frame passed from its upper layers, and prefixes it by an HSR tag to identify frame duplicates and sends the frame over both ports.

A destination DANH receives, in the fault-free state, two identical frames from each port within a certain interval, if it is a multicast frame, it instantaneously forwards it on the ring, removes the HSR tag of the first frame before passing it to its upper layers (and discards any duplicate.

A typical frame contains these parameters:

- dest_addr Destination Address
- src_addr Source Address
- type Type
- data
- fcs Frame Check Sequence (i.e. extra checksum characters added to allow error detection and correction)

HSR frames are identified uniquely by their HSR tag.

The HSR tag consists of these parameters:

- 16-bit Ethertype (HSR_EtherType = 0x892F)
- 4-bit path identifier (PathId), 0000 for both HSR nodes A and B, and 0010-1111 for one of 7 PRP networks (A/B).
- 12-bit frame size (LSDUsize)
- 16-bit Sequence Number (SeqNr)

Note	*The 4-bit PathId field prevents reinjection of frames coming from one PRP network to another PRP network.*

Accordingly, a typical HSR frame then contains these parameters:

- dest_addr Destination Address
- src_addr Source Address
- HSR tag data:
  - 16-bit Ethertype (HSR_EtherType = 0x892F)
  - 4-bit path identifier
  - 12-bit frame size
  - 16-bit sequence number:
- type Type
- payload Payload
- Padding if needed
- fcs Frame Check Sequence

Padding	*After the payload data, there may be some data padding. This is added to frames which would otherwise be too short for conventional network traffic (minimum frame size is 70 octets).*
Size	*The frame size will vary depending on the contents of the frame and how it has been tagged by the various SANs and DANs. In VLANs, frame tags may be added or removed during transit through a switch. To make the length field independent of tagging, only the original LPDU and the HSR tag are considered in the size.*

Figure 3 and Figure 4 shows the frame types with different types of data.

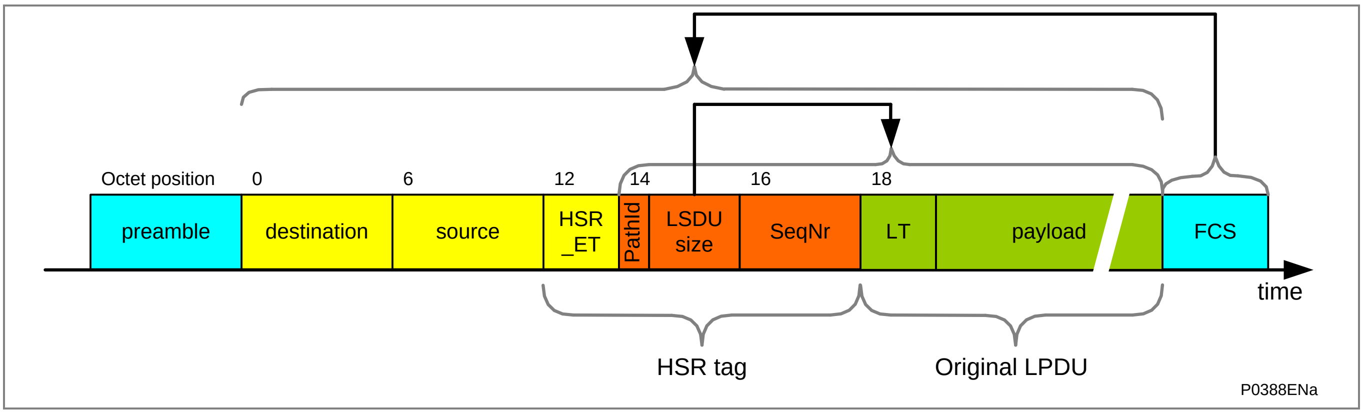

Figure 4 - HSR frame without a VLAN tag

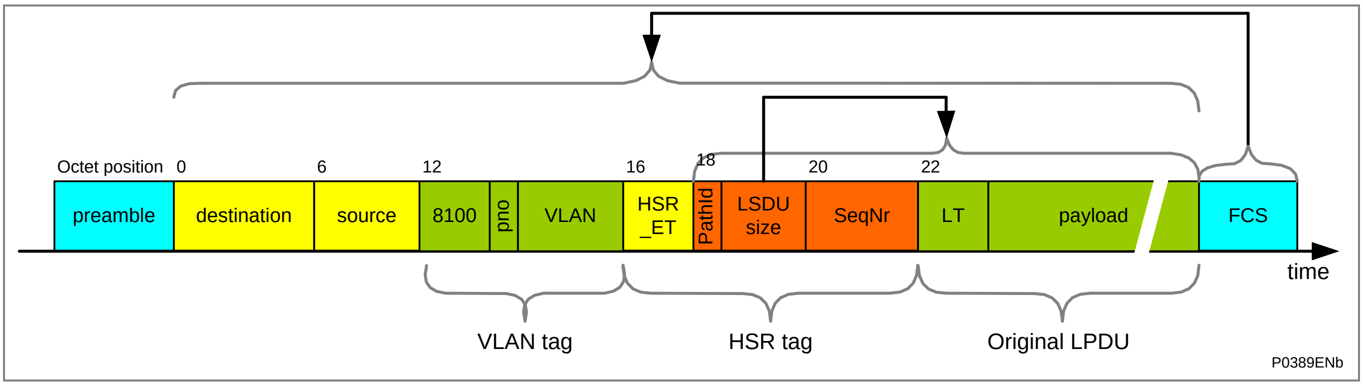

Figure 5 - HSR frame with VLAN tag

The key points about these differing frame structures are that:

- Unlike PRP, SANs cannot be attached directly to such a duplicated network unless they are able to interpret the HSR tag.
- In particular, the node will not forward a frame that it injected into the ring.
- A destination node of a unicast frame does not forward a frame for which it is the only destination, except for testing.
- DANH receiving from an HSR port, if this frame is not HSR-tagged and is a link local traffic, consume the frame and do not forward it.
- DANH receiving from an HSR port, if this frame is HSR-tagged and this node is not a destination, do not pass the frame to the link layer interface.
- A node accepts an HSR tagged frame also if the LanId does not correspond to the PortId and if the LSDUsize does not match the frame size.

1.8 HSR Technical Data

- One VLAN tag supported
- Up to 128 devices supported
- Up to 100Mbit/s full duplex Ethernet
- Dynamic frame memory allocation (page manager)
- Configurable duplicate detection
- Wishbone interface for configuration and status registers
- CPU port interface - Wishbone
- Support for link-local protocols - CPU may send to specific ports only - CPU knows receive port
- Configurable frame memory and queue length
- Duplicate detection with configurable size and aging time

- MAC address filtering (8 filter masks for interlink port, 6 for CPU port)
- Support for interfaces with or without Ethernet preamble

Limitations:

Number of IEDs on a same ring at 100Mbit/s:

Each hop (IED or RedBox) not only carries its own messages but also all the other IED messages thus the bandwidth used is proportional to the number of IEDs.

The maximum number of hops is around 20 when the GOOSE messages are highly used or 40 if the number and importance of GOOSE messages is not high.

When Precision Time Protocol («IEEE1588/IEC 61588») is used:

As the GPS receiver inaccuracy is 200ns and as each hop (IED or RedBox) can add a 50ns inaccuracy, the maximum number of hops is 16 if 1µs accuracy is required (PMU application or Process Bus)

2 HSR AND MICOM FUNCTIONS

2.1 MiCOM Products and HSR

The HSR functions being introduced as part of the overall MiCOM product range provide additional functionality, which is backwards compatible with existing Schneider Electric MiCOM equipment. This means that existing MiCOM relays/IEDS can be used on networks, which use HSR functions, with no changes being made to those relays/IEDs.

The new MiCOM products that use the HSR, will interrogate other equipment to determine the equipment model number, and then use the model number to decide (at runtime), whether that particular item of equipment can support HSR or not.

MiCOM models which include the following Ethernet board assembly provide the possibility of HSR function support. This is denoted by Digit 7 where the Hardware option is Q or R, as shown below:

Hardware Option	Type	Model No format
"Q" at Digit No 7	2 LC + 1 RJ45 ports redundant Ethernet board (Modulated/ Un-modulated IRIG-B)	**Px4xxxQx6Mxxx8M**
"R" at Digit No 7	3 RJ45 ports redundant Ethernet board (Modulated/ Un-modulated IRIG-B)	**Px4xxxRx6Mxxx8M**

Table 1 – Hardware option numbers with HSR functions

The MiCOM relay/IED firmware has been modified to allow the HSR options to be accepted for the power-up tests in addition to the implementation of the supervision frame transmission.

2.2 MiCOM S1 Studio Software and the HSR Function

The addition of this function has no impact of the MiCOM S1 Studio support files so there is no need to upgrade any MiCOM S1 Studio software.

2.3 MiCOM Relay Configuration and the HSR Function

There is no need to change the configuration of any relay (as relays which include support for this function will be able to recognize other devices which support it).

2.4 Hardware Changes for HSR Protocol

This protocol is implemented using the redundant Ethernet card as a starting point. The Frame management is achieved by programming the Field-Programmable Gate Array (FPGA).
The low-level management of the redundant frames is performed within the FPGA; this being defined as the Link Redundancy Entity (LRE). This will add the HSR tag to a frame to be transmitted. The FPGA is also responsible for the stripping of the HSR tag from received frames and discarding the duplicated messages so that only a single application frame is received by the Ethernet processor.
The LRE functionality of the supervision frame transmission is performed by the NIOS II.

The new version of the redundant Ethernet card is based on the 2072069A01 and 2072071A01 (both have modulated and un-modulated IRIG-B).

2.5 HSR Parameters

The Redundant Ethernet standard (IEC 62439-3:2012/FDIS) defines several parameters for the HSR protocol; these being fixed at a default value within this release. The following values are set:

Parameter	Value	Description
Supervision Frame Multicast Address	01-15-4E-00-01-00	Target MAC Address for multicast supervision frame
Life Check Interval	2 seconds	Period between transmission of supervision frames
HSR Mode	Duplicate Discard	This is normal HSR mode, Duplicate address will not be supported.
Node Forget Time	60 s	This is the time after which a node entry is cleared.
Entry Forget Time	400 ms	Duration that the received message Sequence number will be held to discard a duplicate message.
Node Reboot Interval	500ms	Duration following reboot for which no HSR frames should be transmitted.
MulticastFilterSize	16	Number of multicast addresses to be filtered

Table 2 - HSR parameter values

2.6 Product Implementation Features

Here is a list of the main Product Requirements for MiCOM products that support HSR:

- The MiCOM relay/IED provides two redundant Ethernet ports using HSR.
- The MiCOM relay/IED must be connected to the redundant Ethernet network as a Double Attached Node (DAN) using HSR (DAN using HSR is known as DANH)
- The redundant Ethernet interface can be made using an RJ45 or an optical fibre connection with an LC connector type.
- The management of the HSR redundancy is transparent to the application data provided via the Ethernet interface.
- The HSR option is available with any of the existing protocol options via the Ethernet Interface (IEC61850 and/or DNPoE)
- Loss of one of the Node connections to the device does not cause any loss or degradation to the Application data over the Ethernet interface.
- The MiCOM relay/IED supports the transmission of the HSR Supervision frame at a fixed time period (LifeCheckInterval) of 2s (+/- 100ms)
- Each supervision frame includes a sequence number as defined in the IEC 62439-3:2012/FDIS specification. This will be incremented for each supervision message and the value will start from zero following a system restart.
- The MiCOM relay/IED support SNMP.
- The MiCOM relay/IED does not provide for the HSR management to be configured (via either the MiCOM relay/IED HMI or the Ethernet interface). Accordingly, the default values (as defined within this document) are used for all HSR parameters.
- The performance of the Ethernet Interface is not degraded by using the HSR interface.

2.6.1 Abbreviations and Acronyms

Abbreviations / Acronyms	Meaning
CRC	Cyclic Redundancy Check
DAN	Doubly Attached Nodes
DANH	Doubly Attached Node implementing HSR
FPGA	Field-Programmable Gate Array
HMI	Human Machine Interface
HSR	High-availability Seamless Redundancy
IED	Intelligent Electronic Devices
IP	Internet Protocol
LAN	Local Area Network
LRE	Link Redundancy Entity
MAC	Media Access Control
MRP	Media Redundancy Protocol
PRP	Parallel Redundancy Protocol
HSR	High-availability Seamless Redundancy
RedBox	Redundancy Box
RSTP	Rapid Spanning Tree Protocol
SAN	Singly Attached Node
TCP	Transmission Control Protocol
VDAN	Virtual Doubly Attached Node (effectively seen as a DAN)

Notes:

VERSION HISTORY

CHAPTER 22

Date:	12/2017
Products covered by this chapter:	This chapter covers the specific versions of the MiCOM products listed below. This includes ***only*** the following combinations of Software Version and Hardware Suffix.
Hardware Suffix:	M
Software Version:	B2
Connection Diagrams:	10P849xx (xx = 01 to 06)

CONTENTS

Notes:

1 VERSION HISTORY

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

Software Version		Hard-ware Suffix	Original Date of Issue	Description of Changes	S1 Compat-ibility	Technical Document-ation
Major	**Minor**					
A0		K	Jan 2012	Original Issue. First release to production.	V3.4	P849/EN xx/A11
A0		K	Sept 2012	New Assembly power supplies: 2071964A01, 2071964A02 and 2071964A03. New opto input board: 2071960A22. New Output relay boards: (2071966A01, 2071966A01).	V3.4	P849/EN xx/B12
A0	B	K	May 2013	Parallel Redundancy Protocol (PRP) Notes added.	V3.4	P849/EN xx/C22
B0	A	M	Aug 2015	**Hardware:** Update hardware design suffix to M. The 24-48 Vdc power supply range has been changed to cover 24-32 Vdc only. Three new Ethernet boards released. **Software:** IEC 61850 Ed.2 and Ed.1 by configuration. GOOSE number and GOOSE performance enhancement. Disturbance Record LN RDRE Enhancement. Time Synchronization via LTIM/LTMS. Monitor DDB for port physical link status. High-availability Seamless Redundancy (HSR). Parallel Redundancy Protocol (PRP) Dual Ethernet communications (Dual IP). **Corrections of these issues:** Fixed and enhanced various small issues. **Note:** DNP Over Ethernet is not included in this release.	V5.0.1 or later	P849/EN M/D33
B1	A	M	Nov 2016	New protocol option IEC61850 Ed1/2 and DNPoE and DNP serial Cyber Security. This release integrated the Cyber Security RBAC and provided the option for the user if they want/don't want to use the Cyber Security which depends on the protocol options. CLS0 - Simple password management - No Security Administration Tool (SAT) required. CLS1 - Advanced user account right management, security logs/events and secure administration capability - Security Administration Tool (SAT) required. Courier Tunneling via Secured Communication. 35 User Alarms. Virtual I/O Naming. Restore Record Clear Functions. New DDB: Logic 0, IRIG-B Valid and Simul. GOOSE Bug Fixes.	Easergy Studio V7.0.0	P849/EN M/E43
B2	A	M	Dec 2017	DNPOE unsolicited messages feature. Bug Fixes.	Easergy Studio V8.0.0 or later	P849/EN M/E43

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

2 RELAY SOFTWARE AND SETTING FILE SOFTWARE VERSION

	Relay Software Version			
Setting File Software Version	**A0**	**B0**	**B1**	**B2**
A0	✓			
B0		✓		
B1			✓	
B2				✓

3 RELAY SOFTWARE AND PSL FILE SOFTWARE VERSION

	Relay Software Version			
PSL File Software Version	A0	B0	B1	B2
A0	✓			
B0		✓		
B1			✓	
B2				✓

4 RELAY SOFTWARE AND MENU TEXT FILE SOFTWARE VERSION

	Relay Software Version			
Menu Text File Software Version	**A0**	**B0**	**B1**	**B2**
A0	✓			
B0		✓		
B1			✓	
B2				✓

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Publisher: Schneider Electric

Publication: Easergy MiCOM P849/EN M/F53 Input and Output Extension Device Software Version: B2 Hardware Suffix: M
12/2017