GE
Grid Solutions

MiCOM P40 Agile

P345

Addendum
Generator Protection IED

Hardware Version: M
Software Version: 91
Publication Reference: P345-AD-EN-1

Contents

Chapter 11 Maintenance and Troubleshooting 253

Chapter 12 Technical Specifications 269

CHAPTER 1

INTRODUCTION

1 CHAPTER OVERVIEW

This chapter provides some general information about the technical manual and an introduction to the device(s) described in this technical manual.

This chapter contains the following sections:

2 FOREWORD

This technical manual provides a functional and technical description of GE's P345, as well as a comprehensive set of instructions for using the device. The level at which this manual is written assumes that you are already familiar with protection engineering and have experience in this discipline. The description of principles and theory is limited to that which is necessary to understand the product. For further details on general protection engineering theory, we refer you to GE's publication NPAG, which is available online or from our contact centre.

We have attempted to make this manual as accurate, comprehensive and user-friendly as possible. However we cannot guarantee that it is free from errors. Nor can we state that it cannot be improved. We would therefore be very pleased to hear from you if you discover any errors, or have any suggestions for improvement. Our policy is to provide the information necessary to help you safely specify, engineer, install, commission, maintain, and eventually dispose of this product. We consider that this manual provides the necessary information, but if you consider that more details are needed, please contact us.

All feedback should be sent to our contact centre via:

contact.centre@ge.com

2.1 TARGET AUDIENCE

This manual is aimed towards all professionals charged with installing, commissioning, maintaining, troubleshooting, or operating any of the products within the specified product range. This includes installation and commissioning personnel as well as engineers who will be responsible for operating the product.

The level at which this manual is written assumes that installation and commissioning engineers have knowledge of handling electronic equipment. Also, system and protection engineers have a thorough knowledge of protection systems and associated equipment.

2.2 TYPOGRAPHICAL CONVENTIONS

The following typographical conventions are used throughout this manual.

- The names for special keys appear in capital letters.
  For example: ENTER
- When describing software applications, menu items, buttons, labels etc as they appear on the screen are written in bold type.
  For example: Select **Save** from the file menu.
- Filenames and paths use the courier font
  For example: `Example\File.text`
- Special terminology is written with leading capitals
  For example: Sensitive Earth Fault
- If reference is made to the IED's internal settings and signals database, the menu group heading (column) text is written in upper case italics
  For example: The *SYSTEM DATA* column
- If reference is made to the IED's internal settings and signals database, the setting cells and DDB signals are written in bold italics
  For example: The ***Language*** cell in the *SYSTEM DATA* column
- If reference is made to the IED's internal settings and signals database, the value of a cell's content is written in the Courier font
  For example: The ***Language*** cell in the *SYSTEM DATA* column contains the value *`English`*

2.3 NOMENCLATURE

Due to the technical nature of this manual, many special terms, abbreviations and acronyms are used throughout the manual. Some of these terms are well-known industry-specific terms while others may be special product-specific terms used by GE. The first instance of any acronym or term used in a particular chapter is explained. In addition, a separate glossary is available on the GE website, or from the GE contact centre.

We would like to highlight the following changes of nomenclature however:

- The word 'relay' is no longer used to describe the device itself. Instead, the device is referred to as the 'IED' (Intelligent Electronic Device), the 'device', or the 'product'. The word 'relay' is used purely to describe the electromechanical components within the device, i.e. the output relays.
- British English is used throughout this manual.
- The British term 'Earth' is used in favour of the American term 'Ground'.

3 SCOPE OF THIS ADDENDUM

This document covers software version 91 and describes the functional enhancements, which have occurred since the release of the last full technical manual. The P345 includes the following updates:

- Front panel design
- USB port and supercapacitor functions
- Redundant Ethernet port protocols
- IEC 61850 Edition 2
- Cyber Security Role-Based Access Control (RBAC)
- Technical Specification standards

This document should be read alongside the last full technical manual covering this product:

- P34x/EN M/Ia8 - software version 38 & 72

4 PRODUCT SCOPE

The generator protection relays have been designed for the protection of a wide range of generators.

The P345 is suitable for protection of large generators (>50 MVA) providing 100% stator earth fault protection via a low frequency injection technique. in addition, it includes a second neutral voltage input for earth fault/interturn protection.

The P345 model variants are summarised below:

Feature	P345
Case	80TE
Number of CT Inputs	9
Number of VT inputs	6
Optically coupled digital inputs	16 - 32 (order option)
Standard relay output contacts	16 - 32 (order option)
Function keys	10
Programmable LEDs (tri-colour)	18

4.1 ORDERING OPTIONS

All current models and variants for this product are defined in an interactive spreadsheet called the CORTEC. This is available on the company website.

Alternatively, you can obtain it via the Contact Centre at:

contact.centre@ge.com

A copy of the CORTEC is also supplied as a static table in the Appendices of this document. However, it should only be used for guidance as it provides a snapshot of the interactive data taken at the time of publication.

5 FEATURES AND FUNCTIONS

5.1 PROTECTION FUNCTIONS

The device provides the following protection functions:

ANSI	Protection Function	Model
87	Phase segregated generator differential protection is provided for high speed discriminative protection for all fault types. The differential protection can be selected as biased or high impedance or interturn.	P345
87	Phase-segregated generator-transformer biased differential protection is provided for high-speed discriminative protection for all fault types. The differential protection includes ratio and vector compensation and 2nd/5th harmonic blocking for magnetizing inrush conditions.	P345
64	Restricted earth fault is configurable as a high impedance or a biased low impedance element. This can be used to provide high speed earth fault protection and is mainly applicable to small machines where differential protection is not possible or for transformer applications. The CT input is selectable as IA-1/IB-1/IC-1 or IA-2/IB-2/IC-2 via a setting.	P345
32P/Q	Four definite time stages of power/VAr protection are provided and each stage can be independently configured to operate as under/over and forward/reverse. The power protection can be used to provide simple back-up overload protection (Overpower), protection against motoring (Reverse Power), CB interlocking to prevent overspeeding during machine shutdown (Low Forward Power) and motor loss of load protection (Low Reverse Power). The reverse VAr protection can be used to provide simple under excitation protection. The P342-6 relays provide a standard 3 phase power/VAr protection element and also a single phase sensitive power/VAr protection element. The P345 sensitive power protection can be a single or wattmetric power/VAr element. The sensitive power/VAr protection can be used with dedicated metering class CTs using the sensitive current inputs (1 for single phase or 2 for wattmetric).	P345
40	A two stage offset mho definite time impedance element with a supervising directional line is provided to detect failure of the machine excitation. A power factor alarm element is also available to offer more sensitive protection.	P345
46T	Negative phase sequence thermal overload protection is provided to protect against unbalanced loading which can cause overheating in the rotor. Both alarm and trip stages are provided.	P345
51V, 21	A voltage dependent overcurrent (controlled or restrained) or underimpedance protection is provided for back-up protection of phase faults. The voltage dependent overcurrent protection may be set as controlled or restrained with an Inverse Definite Minimum Time (IDMT) or Definite Time (DT). There are 2 stages of underimpedance protection which may be set as definite time only.	P345
50/51/67	Four overcurrent protection stages are provided which can be selected to be either non-directional, directional forward or directional reverse. Stages 1 and 2 may be set Inverse Definite Minimum Time (IDMT) or Definite Time (DT); stages 3 and 4 may be set DT only. The CT input is selectable as IA-1/IB-1/IC-1 or IA-2/IB-2/IC-2 via a setting.	P345
46OC	Four definite time stages of negative phase sequence overcurrent protection are provided for remote back-up protection for both phase to earth and phase to phase faults. Each stage can be selected to be either non-directional, directional forward or directional reverse. The CT input is selectable as IA-1/IB-1/IC-1 or IA-2/IB-2/IC-2 via a setting.	P345
49G	Generator thermal overload protection based on I1 and I2 is provided to protect the stator/rotor against overloading due to balanced and unbalanced currents. Both alarm and trip stages are provided.	P345
49T	Transformer thermal overload protection is provided based on IEEE Std C57.91-1995. The thermal trip can be based on either hot spot or top oil temperature, each with three time-delayed stages available.	P345

ANSI	Protection Function	Model
50N/51N	Two stages of non-directional earth fault protection are provided for stator earth fault protection. Stage 1 may be set Inverse Definite Minimum Time (IDMT) or Definite Time (DT); stage 2 may be set DT only.	P345
64R	Rotor earth fault protection can be provided by a low frequency injection method. There are 2 stages of definite time under resistance protection. An external injection, coupling and measurement unit (P391) is required with this function. The measurement of the rotor resistance is passed to the P34x via a current loop output (0-20 mA) on the P391 connected to one of the 4 current loop inputs on the P34x. The rotor ground fault protection is only available if the relay includes the CLIO hardware option. The injection frequency is selectable 0.25/0.5/1 Hz via a jumper link in the P391	P345
67N/67W	One sensitive earth fault element is provided for discriminative earth fault protection of parallel generators. The protection can be selected to be either non-directional, directional forward or directional reverse. Either Zero sequence or negative sequence polarizing is available. The Sensitive Earth Fault element can be configured as an Icosf, Isinf or VIcosf (Wattmetric) element for application to isolated and compensated networks.	P345
59N	Residual overvoltage protection is available for stator earth fault protection where there is an isolated or high impedance earth. The residual voltage can be measured from a broken delta VT, from the secondary winding of a distribution transformer earth at the generator neutral, or can be calculated from the three phase to neutral voltage measurements. Two independent stages of protection are provided for each measured neutral voltage input and also for the calculated value, each stage can be selected as either IDMT or DT. The P342/3/4/5 have 2 measured and 2 calculated stages of residual overvoltage protection. The P344/5 has an additional neutral voltage input and so has an additional 2 stages of measured residual overvoltage protection.	P345
27TN/59TN	A 3rd harmonic voltage element is provided to detect earth fault close to the generator star point. This element combined with the standard stator earth fault protection (59N/50N/51N) provides 100% stator earth fault protection. A definite time 3rd harmonic undervoltage element is provided if neutral voltage measurement is available at the neutral of the machine. This element is supervised by a 3 phase undervoltage element and optionally by 3 phase W/VA/VAr elements. A 3rd harmonic overvoltage element is provided if neutral voltage measurement is available from the terminals of the machine.	P345
64S	100% stator earth fault protection can also be provided by a low frequency injection method. There are 2 stages of definite time under resistance protection and 1 stage of definite time overcurrent protection. An external 20 Hz generator and bandpass filter is required with this function.	P345
24	A five stage overfluxing (V/Hz) element is provided to protect the generator, or connected transformer, against overexcitation. The first stage is a definite time alarm, the second stage can be used to provide an inverse or definite time trip characteristic and stages 3/4/5 are definite time.	P345
81R	A 4-stage rate of change of frequency element (df/dt) is provided for Loss of Mains/Grid and load shedding applications.	P345
50/27	A voltage supervised overcurrent scheme is provided for dead machine/generator unintentional energization at standstill (GUESS) protection to detect if the machine circuit breaker is closed accidentally, when the machine is not running. The CT input is selectable as IA-1/IB-1/IC-1 or IA-2/IB-2/IC-2 via a setting.	P345
27	A 3 stage undervoltage protection element, configurable as either phase to phase or phase to neutral measuring is provided to back up the automatic voltage regulator. Stage 1 may be selected as either IDMT or DT and stage 2 and 3 are DT only.	P345
59	A 2 stage overvoltage protection element, configurable as either phase to phase or phase to neutral measuring is provided to back up the automatic voltage regulator. Stage 1 may be selected as either IDMT or DT and stage 2 is DT only.	P345
47	A definite time negative phase sequence overvoltage protection element is provided for either a tripping or interlocking function upon detection of unbalanced supply voltages.	P345

ANSI	Protection Function	Model
81U/O	A 4 stage definite time underfrequency and 2 stage definite time overfrequency protection is provided for load shedding and back-up protection of the speed control governor.	P345
81AB	Turbine abnormal frequency protection is provided to protect the turbine blade from potential damage due to prolonged under/overfrequency operation of the generator. Up to six frequency bands can be programmed, each having an integrating timer to record the time spent within the band.	P345
RTD	10 RTDs (PT100) are provided to monitor the temperature accurately in the windings and bearings of the machine. Each RTD has an instantaneous alarm and definite time trip stage.	P345(option)
50BF	A 2 stage circuit breaker failure function is provided with a 3 pole initiation input from external protection.	P345
37P/37N	Phase, neutral and sensitive earth fault undercurrent elements are available for use with for example the circuit breaker fail function.	P345
78	A lens shaped impedance characteristic is used to detect loss of synchronization (pole slipping) between the generation and the power system. Two zones are created by a reactance line which is used to distinguish whether the impedance centre of the pole slip is located in the power system or in the generator. Separate counters are used to count pole slips in the 2 zones. A setting is also provided to determine whether the protection operates in a generating mode, motoring mode or both.	P345
BOL	Blocked overcurrent logic is available on each stage of the overcurrent, earth fault and sensitive earth fault protection. This consists of start outputs and block inputs that can be used to implement busbar blocking schemes for example.	P345
LOL	Through faults are a major cause of transformer damage and failure. An I2t calculation based on the recorded time duration and maximum through fault current is performed for each phase. A single stage alarm is available for through-fault condition monitoring.	P345
Thru	Through faults are a major cause of transformer damage and failure. An I2t calculation based on the recorded time duration and maximum through fault current is performed for each phase. A single stage alarm is available for through-fault condition monitoring.	P345

5.2 CONTROL FUNCTIONS

The device provides the following protection functions:

Feature	IEC 61850	ANSI	Model
Watchdog contacts			P345
Read-only mode			P345
NERC compliant cyber-security			P345
Function keys (up to 10)	FnkGGIO		P345
Programmable tricolor LEDs (up to 18)	LedGGIO		P345
Programmable hotkeys (2)			P345
Programmable allocation of digital inputs and outputs			P345
Fully customizable menu texts			P345
Circuit breaker control, status & condition monitoring	XCBR	52	P345
Current Loop Input/Output (CLIO)		CLIO	P345 (option)
CT supervision		CTS	P345
VT supervision		VTS	P345
Trip circuit and coil supervision			P345
Check Synchronization		25	P345
Phase Rotation			P345
Control inputs	PloGGIO1		P345

Feature	IEC 61850	ANSI	Model
Power-up diagnostics and continuous self-monitoring			P345
Dual rated 1A and 5A CT inputs			P345
Alternative setting groups (4)			P345
Graphical programmable scheme logic (PSL)			P345
Fault locator	RFLO		

5.3 MEASUREMENT FUNCTIONS

Measurement Function	IEC 61850	ANSI
Measurement of all instantaneous & integrated values (Exact range of measurements depend on the device model)		MET
Disturbance recorder for waveform capture – specified in samples per cycle	RDRE	DFR
Fault Records		
Maintenance Records		
Event Records / Event logging		Event records
Time Stamping of Opto-inputs	Yes	Yes

5.4 COMMUNICATION FUNCTIONS

The device offers the following communication functions:

Feature	ANSI
NERC compliant cyber-security	
USB port for configuration	16S
Rear serial RS485 communication port for SCADA control	16S
2nd Additional rear serial communication ports for SCADA control and teleprotection (fibre and copper) (optional)	16S
Ethernet communication (optional)	16E
Redundant Ethernet communication (optional)	16E
Courier protocol	16S
IEC 61850 protocol (optional)	16E
IEC 60870-5-103 protocol (optional)	16S
Modbus protocol (optional)	16S
DNP3.0 protocol over serial link (optional)	16S
IRIG-B time synchronisation (optional)	CLK

6 FUNCTIONAL OVERVIEW

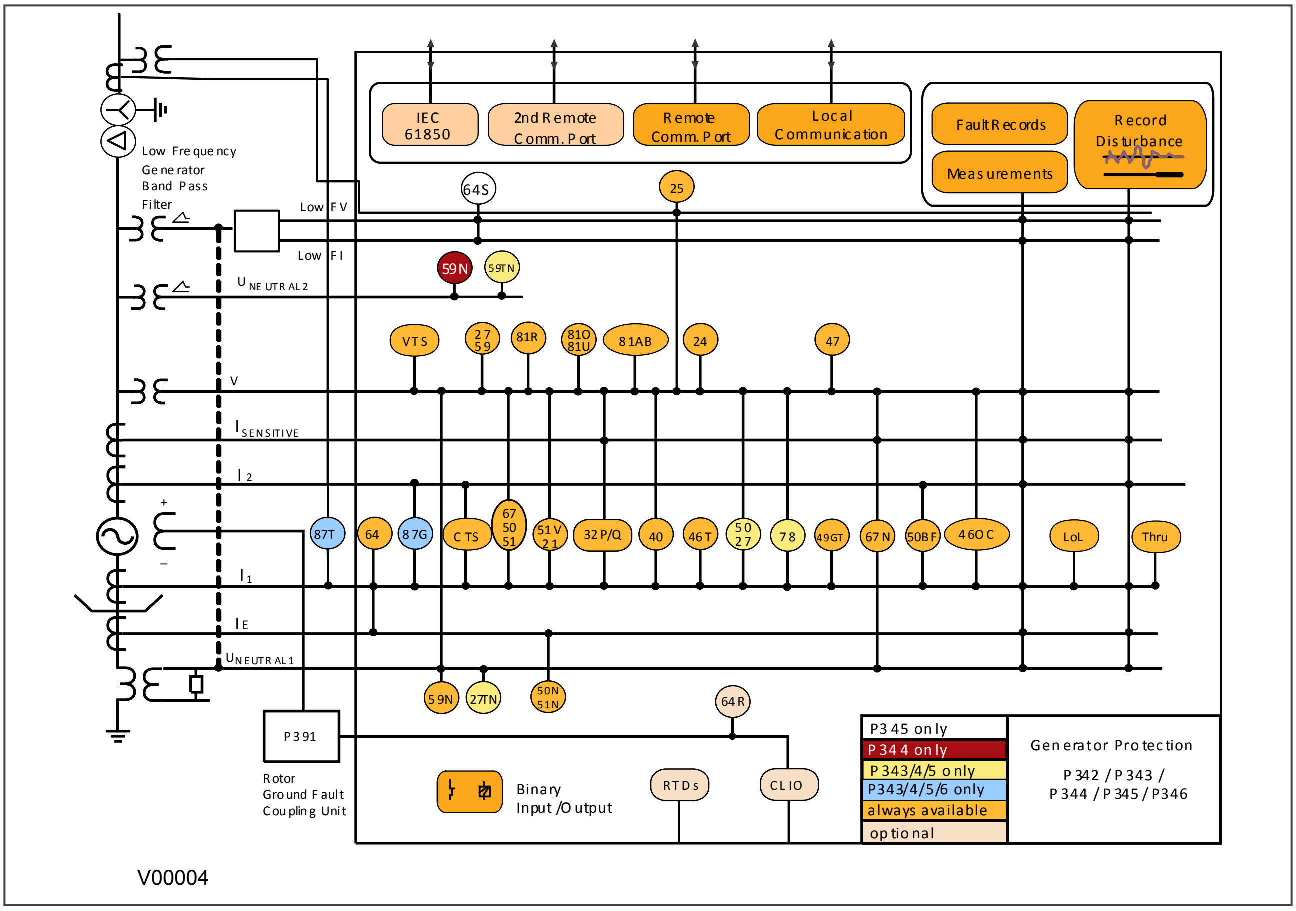


Figure 1: Functional Overview

CHAPTER 2

SAFETY INFORMATION

1 CHAPTER OVERVIEW

This chapter provides information about the safe handling of the equipment. The equipment must be properly installed and handled in order to maintain it in a safe condition and to keep personnel safe at all times. You must be familiar with information contained in this chapter before unpacking, installing, commissioning, or servicing the equipment.

This chapter contains the following sections:

2 HEALTH AND SAFETY

Personnel associated with the equipment must be familiar with the contents of this Safety Information.

When electrical equipment is in operation, dangerous voltages are present in certain parts of the equipment. Improper use of the equipment and failure to observe warning notices will endanger personnel.

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 the system to which it is being connected.
- familiar with accepted safety engineering practises and are authorised to energise and de-energise equipment in the correct manner.
- trained in the care and use of safety apparatus in accordance with safety engineering practises
- trained in emergency procedures (first aid).

The documentation provides instructions for installing, commissioning and operating the equipment. It cannot, however cover all conceivable circumstances. In the event of questions or problems, do not take any action without proper authorisation. Please contact your local sales office and request the necessary information.

3 SYMBOLS

Throughout this manual you will come across the following symbols. You will also see these symbols on parts of the equipment.

Caution:
Refer to equipment documentation. Failure to do so could result in damage to the equipment

Warning:
Risk of electric shock

Warning:
Risk of damage to eyesight

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.*

Protective conductor (earth) terminal

Instructions on disposal requirements

Note:
The term 'Earth' used in this manual is the direct equivalent of the North American term 'Ground'.

4 INSTALLATION, COMMISSIONING AND SERVICING

4.1 LIFTING HAZARDS

Many injuries are caused by:

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

Plan carefully, identify any possible hazards and determine how best to move the product. Look at other ways of moving the load to avoid manual handling. Use the correct lifting techniques and Personal Protective Equipment (PPE) to reduce the risk of injury.

4.2 ELECTRICAL HAZARDS

Caution:
All personnel involved in installing, commissioning, or servicing this equipment must be familiar with the correct working procedures.

Caution:
Consult the equipment documentation before installing, commissioning, or servicing the equipment.

Caution:
Always use the equipment as specified. Failure to do so will jeopardise the protection provided by the equipment.

Warning:
Removal of equipment panels or covers may expose hazardous live parts. Do not touch until the electrical power is removed. Take care when there is unlocked access to the rear of the equipment.

Warning:
Isolate the equipment before working on the terminal strips.

Warning:
Use a suitable protective barrier for areas with restricted space, where there is a risk of electric shock due to exposed terminals.

Caution:
Disconnect power before disassembling. Disassembly of the equipment may expose sensitive electronic circuitry. Take suitable precautions against electrostatic voltage discharge (ESD) to avoid damage to the equipment.

Warning:
NEVER look into optical fibres or optical output connections. Always use optical power meters to determine operation or signal level.

Warning:
Testing may leave capacitors charged to dangerous voltage levels. Discharge capacitors by reducing test voltages to zero before disconnecting test leads.

Caution:
Operate the equipment within the specified electrical and environmental limits.

Caution:
Before cleaning the equipment, ensure that no connections are energised. Use a lint free cloth dampened with clean water.

Note:
Contact fingers of test plugs are normally protected by petroleum jelly, which should not be removed.

4.3 UL/CSA/CUL REQUIREMENTS

The information in this section is applicable only to equipment carrying UL/CSA/CUL markings.

Caution:
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).

Caution:
To maintain compliance with UL and CSA/CUL, install the equipment using UL/CSA-recognised parts for: cables, protective fuses, fuse holders and circuit breakers, insulation crimp terminals, and replacement internal batteries.

4.4 FUSING REQUIREMENTS

Caution:
Where UL/CSA listing of the equipment is required for external fuse protection, a UL or CSA Listed fuse must be used for the auxiliary supply. The listed protective fuse type is: Class J time delay fuse, with a maximum current rating of 15 A and a minimum DC rating of 250 V dc (for example type AJT15).

Caution:
Where UL/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 dc rating of 250 V dc may be used for the auxiliary supply (for example Red Spot type NIT or TIA).
For P50 models, use a 1A maximum T-type fuse.
For P60 models, use a 4A maximum T-type fuse.

Caution:
Digital input circuits should be protected by a high rupture capacity NIT or TIA fuse with maximum rating of 16 A. for safety reasons, current transformer circuits must never be fused. Other circuits should be appropriately fused to protect the wire used.

Caution:
CTs must NOT be fused since open circuiting them may produce lethal hazardous voltages

4.5 EQUIPMENT CONNECTIONS

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

Caution:
Tighten M4 clamping screws of heavy duty terminal block connectors to a nominal torque of 1.3 Nm.
Tighten captive screws of terminal blocks to 0.5 Nm minimum and 0.6 Nm maximum.

Caution:
Always use insulated crimp terminations for voltage and current connections.

Caution:
Always use the correct crimp terminal and tool according to the wire size.

Caution:
Watchdog (self-monitoring) contacts are provided to indicate the health of the device on some products. We strongly recommend that you hard wire these contacts into the substation's automation system, for alarm purposes.

4.6 PROTECTION CLASS 1 EQUIPMENT REQUIREMENTS

Caution:
Earth the equipment with the supplied PCT (Protective Conductor Terminal).

Caution:
Do not remove the PCT.

Caution:
The PCT is sometimes used to terminate cable screens. Always check the PCT's integrity after adding or removing such earth connections.

Caution:
Use a locknut or similar mechanism to ensure the integrity of stud-connected PCTs.

Caution:
The recommended minimum PCT wire size is 2.5 mm² for countries whose mains supply is 230 V (e.g. Europe) and 3.3 mm² for countries whose mains supply is 110 V (e.g. North America). This may be superseded by local or country wiring regulations.
For P60 products, the recommended minimum PCT wire size is 6 mm². See product documentation for details.

Caution:
The PCT connection must have low-inductance and be as short as possible.

Caution:
All connections to the equipment must have a defined potential. Connections that are pre-wired, but not used, should be earthed, or connected to a common grouped potential.

4.7 PRE-ENERGISATION CHECKLIST

Caution:
Check voltage rating/polarity (rating label/equipment documentation).

Caution:
Check CT circuit rating (rating label) and integrity of connections.

Caution:
Check protective fuse or miniature circuit breaker (MCB) rating.

Caution:
Check integrity of the PCT connection.

Caution:
Check voltage and current rating of external wiring, ensuring it is appropriate for the application.

4.8 PERIPHERAL CIRCUITRY

Warning:
Do not open the secondary circuit of a live CT since the high voltage produced may be lethal to personnel and could damage insulation. Short the secondary of the line CT before opening any connections to it.

Note:
For most GE equipment with ring-terminal connections, the threaded terminal block for current transformer termination is automatically shorted if the module is removed. Therefore external shorting of the CTs may not be required. Check the equipment documentation and wiring diagrams first to see if this applies.

Caution:
Where external components such as resistors or voltage dependent resistors (VDRs) are used, these may present a risk of electric shock or burns if touched.

Warning:
Take extreme care when using external test blocks and test plugs such as the MMLG, MMLB and P990, as hazardous voltages may be exposed. Ensure that CT shorting links are in place before removing test plugs, to avoid potentially lethal voltages.

Warning:
Data communication cables with accessible screens and/or screen conductors, (including optical fibre cables with metallic elements), may create an electric shock hazard in a sub-station environment if both ends of the cable screen are not connected to the same equipotential bonded earthing system.

To reduce the risk of electric shock due to transferred potential hazards:

i. The installation shall include all necessary protection measures to ensure that no fault currents can flow in the connected cable screen conductor.

ii. The connected cable shall have its screen conductor connected to the protective conductor terminal (PCT) of the connected equipment at both ends. This connection may be inherent in the connectors provided on the equipment but, if there is any doubt, this must be confirmed by a continuity test.

iii. The protective conductor terminal (PCT) of each piece of connected equipment shall be connected directly to the same equipotential bonded earthing system.

iv. If, for any reason, both ends of the cable screen are not connected to the same equipotential bonded earth system, precautions must be taken to ensure that such screen connections are made safe before work is done to, or in proximity to, any such cables.

v. No equipment shall be connected to any download or maintenance circuits or connectors of this product except temporarily and for maintenance purposes only.

vi. Equipment temporarily connected to this product for maintenance purposes shall be protectively earthed (if the temporary equipment is required to be protectively earthed), directly to the same equipotential bonded earthing system as the product.

Warning:
Small Form-factor Pluggable (SFP) modules which provide copper Ethernet connections typically do not provide any additional safety isolation. Copper Ethernet SFP modules must only be used in connector positions intended for this type of connection.

4.9 UPGRADING/SERVICING

Warning:
Do not insert or withdraw modules, PCBs or expansion boards from the equipment while energised, as this may result in damage to the equipment. Hazardous live voltages would also be exposed, endangering personnel.

Caution:
Internal modules and assemblies can be heavy and may have sharp edges. Take care when inserting or removing modules into or out of the IED.

5 DECOMMISSIONING AND DISPOSAL

Caution:
Before decommissioning, completely isolate the equipment power supplies (both poles of any dc supply). The auxiliary supply input may have capacitors in parallel, which may still be charged. To avoid electric shock, discharge the capacitors using the external terminals before decommissioning.

Caution:
Avoid incineration or disposal to water courses. Dispose of the equipment in a safe, responsible and environmentally friendly manner, and if applicable, in accordance with country-specific regulations.

6 REGULATORY COMPLIANCE

Compliance with the European Commission Directive on EMC and LVD is demonstrated using a technical file.

6.1 EMC COMPLIANCE: 2014/30/EU

The product specific Declaration of Conformity (DoC) lists the relevant harmonised standard(s) or conformity assessment used to demonstrate compliance with the EMC directive.

6.2 LVD COMPLIANCE: 2014/35/EU

The product specific Declaration of Conformity (DoC) lists the relevant harmonized standard(s) or conformity assessment used to demonstrate compliance with the LVD directive.

Safety related information, such as the installation I overvoltage category, pollution degree and operating temperature ranges are specified in the Technical Data section of the relevant product documentation and/or on the product labelling.

Unless otherwise stated in the Technical Data section of the relevant product documentation, the equipment is intended for indoor use only. Where the equipment is required for use in an outdoor location, it must be mounted in a specific cabinet or housing to provide the equipment with the appropriate level of protection from the expected outdoor environment.

6.3 R&TTE COMPLIANCE: 2014/53/EU

Radio and Telecommunications Terminal Equipment (R&TTE) directive 2014/53/EU.

Conformity is demonstrated by compliance to both the EMC directive and the Low Voltage directive, to zero volts.

6.4 UL/CUL COMPLIANCE

If marked with this logo, the product is compliant with the requirements of the Canadian and USA Underwriters Laboratories.

The relevant UL file number and ID is shown on the equipment.

CHAPTER 3

HARDWARE DESIGN

1 CHAPTER OVERVIEW

This chapter provides information about the product's hardware design.

This chapter contains the following sections:

2 HARDWARE ARCHITECTURE

The main components comprising devices based on the Px4x platform are as follows:

- The housing, consisting of a front panel and connections at the rear
- The Main processor module consisting of the main CPU (Central Processing Unit), memory and an interface to the front panel HMI (Human Machine Interface)
- A selection of plug-in boards and modules with presentation at the rear for the power supply, communication functions, digital I/O, analogue inputs, and time synchronisation connectivity

All boards and modules are connected by a parallel data and address bus, which allows the processor module to send and receive information to and from the other modules as required. There is also a separate serial data bus for conveying sampled data from the input module to the CPU. These parallel and serial databuses are shown as a single interconnection module in the following figure, which shows typical modules and the flow of data between them.

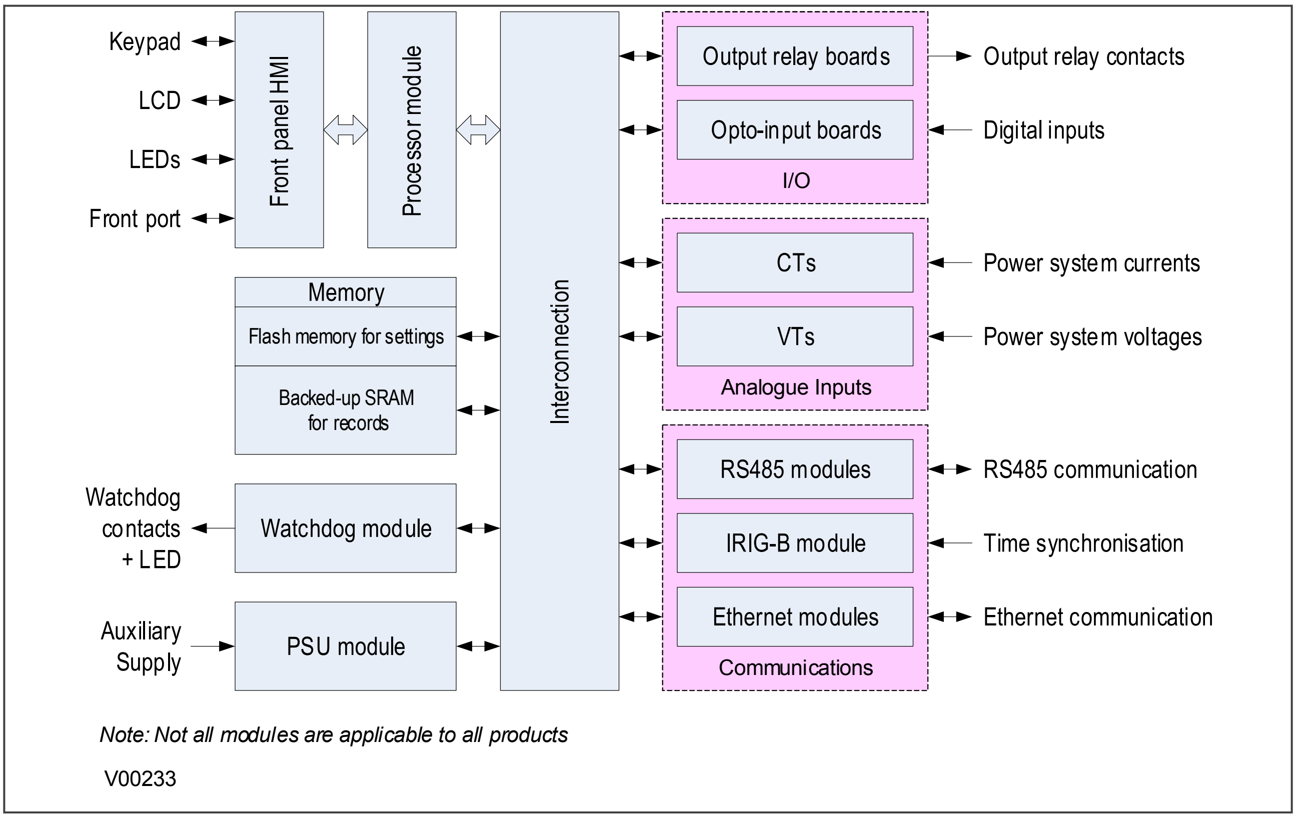


Figure 2: Hardware architecture

3 MECHANICAL IMPLEMENTATION

All products based on the Px4x platform have common hardware architecture. The hardware is modular and consists of the following main parts:

- Case and terminal blocks
- Boards and modules
- Front panel

The case comprises the housing metalwork and terminal blocks at the rear. The boards fasten into the terminal blocks and are connected together by a ribbon cable. This ribbon cable connects to the processor in the front panel.

The following diagram shows an exploded view of a typical product. The diagram shown does not necessarily represent exactly the product model described in this manual.

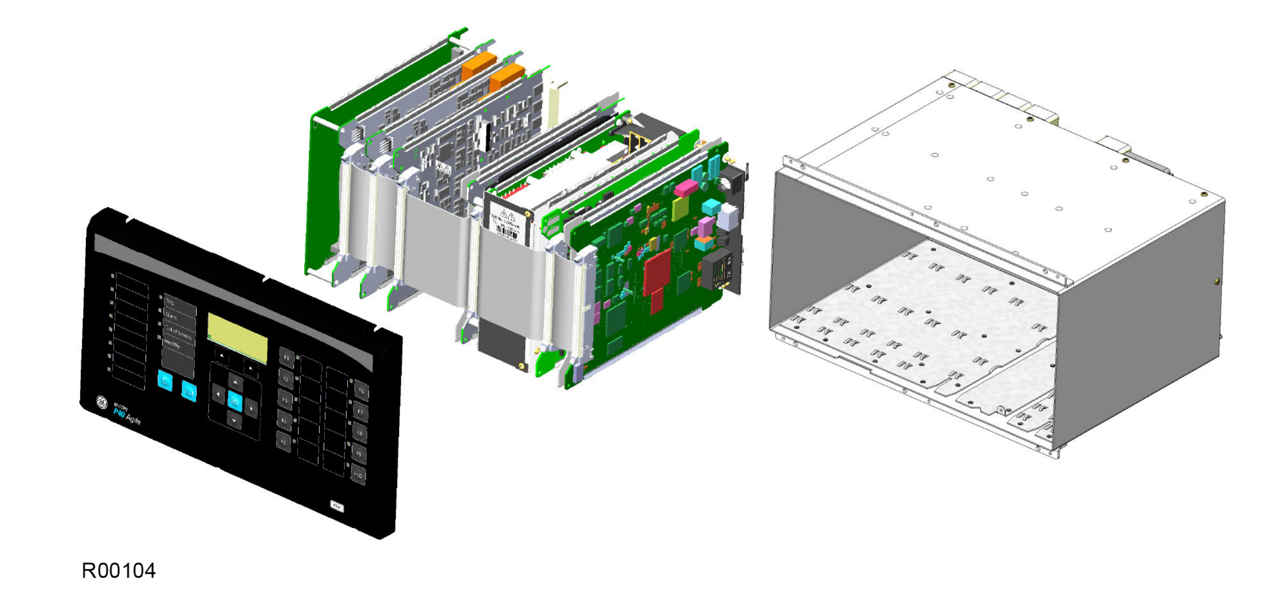


Figure 3: Exploded view of IED

3.1 HOUSING VARIANTS

The Px4x range of products are implemented in a range of case sizes. Case dimensions for industrial products usually follow modular measurement units based on rack sizes. These are: U for height and TE for width, where:

- 1U = 1.75 inches = 44.45 mm
- 1TE = 0.2 inches = 5.08 mm

The products are available in panel-mount or standalone versions. All products are nominally 4U high. This equates to 177.8 mm or 7 inches.

The cases are pre-finished steel with a conductive covering of aluminium and zinc. This provides good grounding at all joints, providing a low resistance path to earth that is essential for performance in the presence of external noise.

The case width depends on the product type and its hardware options. There are three different case widths for the described range of products: 40TE, 60TE and 80TE. The case dimensions and compatibility criteria are as follows:

Case width (TE)	Case width (mm)	Case width (inches)
40TE	203.2	8

Case width (TE)	Case width (mm)	Case width (inches)
60TE	304.8	12
80TE	406.4	16

Note:
Not all case sizes are available for all models.

3.2 LIST OF BOARDS

The product's hardware consists of several modules drawn from a standard range. The exact specification and number of hardware modules depends on the model number and variant. Depending on the exact model, the product in question will use a selection of the following boards.

Board	Use
Main Processor board – 60TE or larger	Main Processor board – with support for function keys
Power supply board 24/54 V DC	Power supply input. Accepts DC voltage between 24 V and 54 V
Power supply board - 48/125 V DC	Power supply input. Accepts DC voltage between 48 V and 125 V
Power supply board 110/250 V DC	Power supply input. Accepts DC voltage between 110 V and 250 V
Instrument Transformer board	Contains the voltage and current transformers
Input board	Contains the A/D conversion circuitry
Input board with opto-inputs	Contains the A/D conversion circuitry + 8 digital opto-inputs
Opto-input board	Contains 8 digital opto-inputs
Output relay board	Contains 8 digital output relays
Combined Opto-input / Output relay board	Contains 4 digital opto-inputs and 4 digital output relays
IRIG-B board - modulated	Interface board for modulated IRIG-B timing signal
IRIG-B - demodulated input	Interface board for demodulated IRIG-B timing signal
Fibre optic board	Interface board for fibre-based RS485 connection
Fibre optic board + IRIG-B	Interface board for fibre-based RS485 connection + demodulated IRIG-B
2nd rear communications board	Interface board for RS232 / RS485 connections
2nd rear communications board with IRIG-B input	Interface board for RS232 / RS485 + IRIG-B connections
Redundant Ethernet RSTP + PRP + HSR + Failover universal IRIG-B	Redundant Ethernet running RSTP + PRP + HSR + Failover (two fibre pairs), with on-board universal IRIG-B
Redundant Ethernet RSTP + PRP + HSR + Failover universal IRIG-B	Redundant Ethernet running RSTP + PRP + HSR + Failover (two copper pairs), with on-board universal IRIG-B
Redundant Ethernet RSTP + PRP + HSR + Failover universal IRIG-B	Redundant Ethernet running RSTP + PRP + HSR + Failover (one copper, one multi-mode fibre), with on-board universal IRIG-B
Output relay output board (8 outputs)	Standard output relay board with 8 outputs
RTD board	Contains 10 Resistive Temperature Device inputs
CLIO board	Contains 4 current loop inputs and 4 current loop outputs
High Break Output Relay Board	Output relay board with high breaking capacity relays

4 FRONT PANEL

4.1 FRONT PANEL

Depending on the exact model and chosen options, the product will be housed in either a 40TE, 60TE or 80TE case. The front panels of the products based on 40TE and 80TE cases have a lot of commonality and differ only in that the 40TE front panel does not include 10 function keys with their associated user-programmable LEDs.

R00299

Figure 4: Front panel (80TE)

The front panel consists of:

- Top and bottom compartments with hinged cover
- LCD display
- Keypad
- USB Type B port inside the bottom compartment
- Fixed function LEDs
- Function keys and LEDs (60TE and 80TE models)
- Programmable LEDs

4.1.1 FRONT PANEL COMPARTMENTS

The top compartment contains labels for the:

- Serial number
- Current and voltage ratings.

The bottom compartment contains:

- USB type B port

4.1.2 HMI PANEL

The keypad provides full access to the device functionality using a range of menu options. The information is displayed on the LCD. The LCD is a high resolution monochrome display with 16 characters by 3 lines and controllable back light.

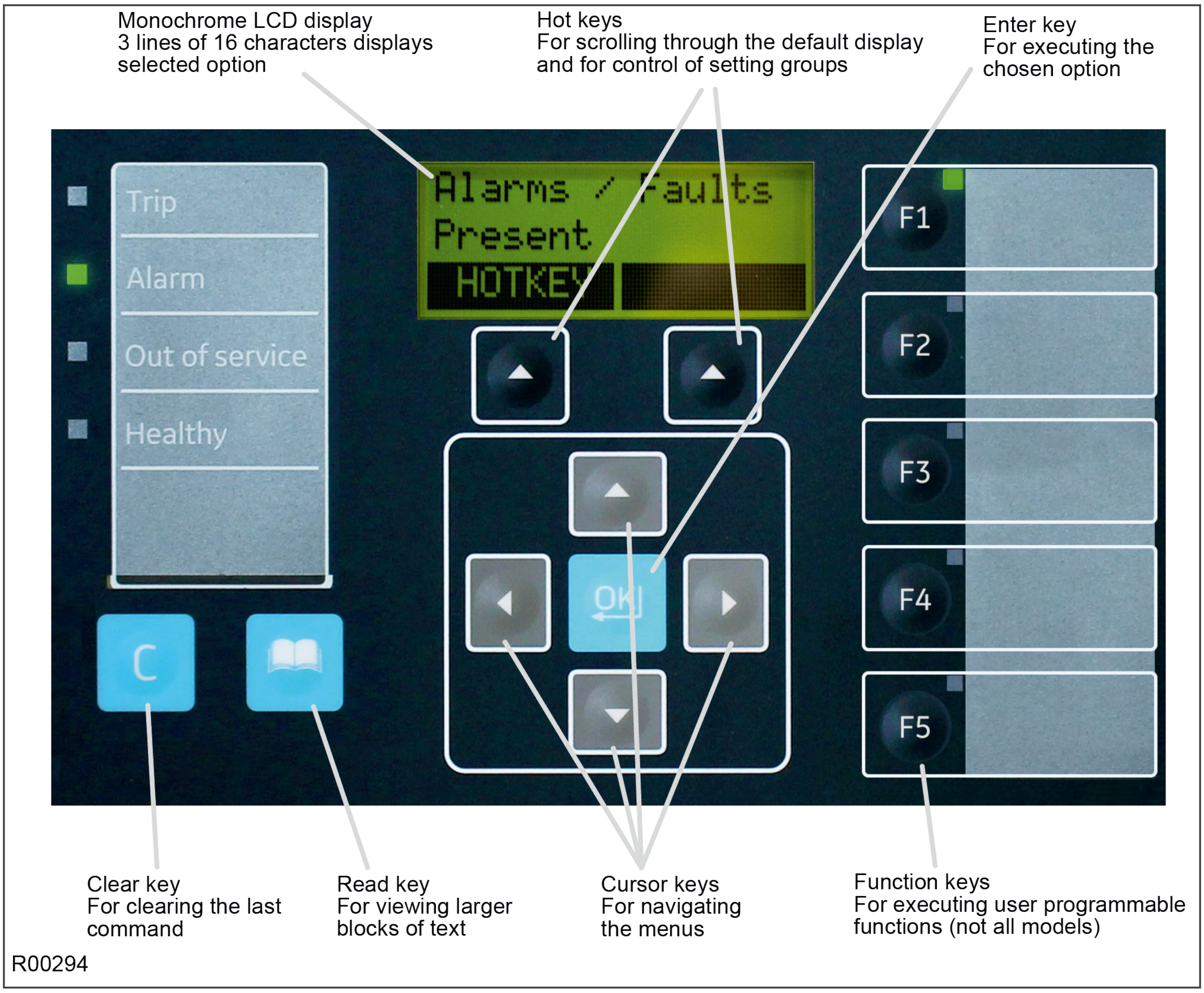
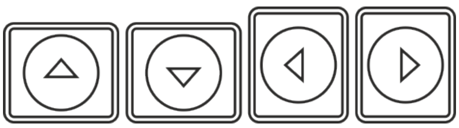


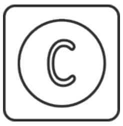
Figure 5: HMI panel

> *Note:*
> *As the LCD display has a resolution of 16 characters by 3 lines, some of the information is in a condensed mnemonic form.*

4.1.3 KEYPAD

The keypad consists of the following keys:

4 arrow keys to navigate the menus (organised around the Enter key)	

An enter key for executing the chosen option	
A clear key for clearing the last command	
A read key for viewing larger blocks of text (arrow keys now used for scrolling)	
2 hot keys for scrolling through the default display and for control of setting groups. These are situated directly below the LCD display.	

4.1.3.1 LIQUID CRYSTAL DISPLAY

The LCD is a high resolution monochrome display with 16 characters by 3 lines and controllable back light.

4.1.4 USB PORT

The USB port is situated inside the bottom compartment, and is used to communicate with a locally connected PC. It has two main purposes:

- To transfer settings information to/from the PC from/to the device.
- For downloading firmware updates and menu text editing.

The port is intended for temporary connection during testing, installation and commissioning. It is not intended to be used for permanent SCADA communications. This port supports the Courier communication protocol only. Courier is a proprietary communication protocol to allow communication with a range of protection equipment, and between the device and the Windows-based support software package.

You can connect the unit to a PC with a USB cable up to 5 m in length.

The inactivity timer for the front port is set to 15 minutes. This controls how long the unit maintains its level of password access on the front port. If no messages are received on the front port for 15 minutes, any password access level that has been enabled is cancelled.

> *Note:*
> *The front USB port does not support automatic extraction of event and disturbance records, although this data can be accessed manually.*

Caution:
When not in use, always close the cover of the USB port to prevent contamination.

4.1.5 FIXED FUNCTION LEDS

Four fixed-function LEDs on the left-hand side of the front panel indicate the following conditions.

- Trip (Red) switches ON when the IED issues a trip signal. It is reset when the associated fault record is cleared from the front display. Also the trip LED can be configured as self-resetting.
- Alarm (Yellow) flashes when the IED registers an alarm. This may be triggered by a fault, event or maintenance record. The LED flashes until the alarms have been accepted (read), then changes to constantly ON. When the alarms are cleared, the LED switches OFF.
- Out of service (Yellow) is ON when the IED's functions are unavailable.
- Healthy (Green) is ON when the IED is in correct working order, and should be ON at all times. It goes OFF if the unit's self-tests show there is an error in the hardware or software. The state of the healthy LED is reflected by the watchdog contacts at the back of the unit.

4.1.6 FUNCTION KEYS

The programmable function keys are available for custom use for some models.

Factory default settings associate specific functions to these keys, but by using programmable scheme logic, you can change the default functions of these keys to fit specific needs. Adjacent to these function keys are programmable LEDs, which are usually set to be associated with their respective function keys.

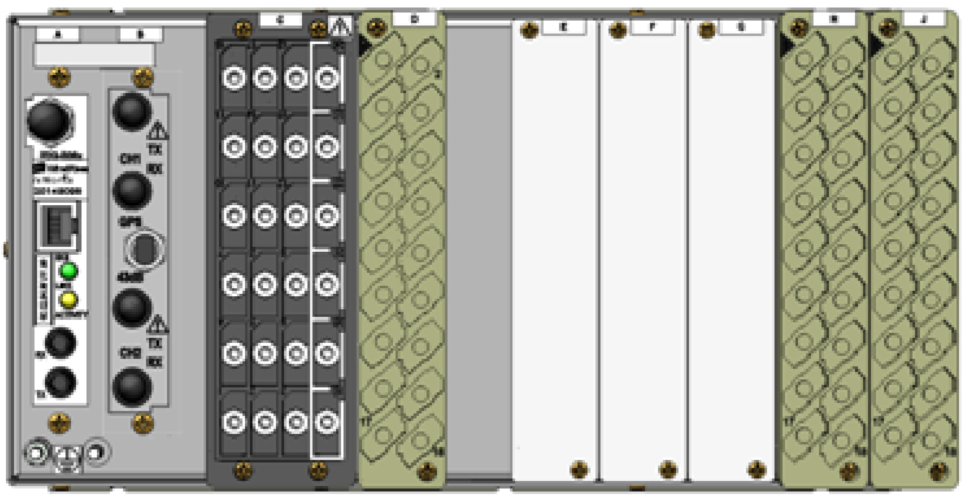
4.1.7 PROGRAMABLE LEDS

The device has a number of programmable LEDs, which can be associated with PSL-generated signals. The programmable LEDs for most models are tri-colour and can be set to RED, YELLOW or GREEN. However the programmable LEDs for some models are single-colour (red) only. The single-colour LEDs can be recognised by virtue of the fact they are large and slightly oval, whereas the tri-colour LEDs are small and round.

5 REAR PANEL

The MiCOM Px40 series uses a modular construction. Most of the internal workings are on boards and modules which fit into slots. Some of the boards plug into terminal blocks, which are bolted onto the rear of the unit. However, some boards such as the communications boards have their own connectors. The rear panel consists of these terminal blocks plus the rears of the communications boards.

The back panel cut-outs and slot allocations vary. This depends on the product, the type of boards and the terminal blocks needed to populate the case. The following diagram shows a typical rear view of a case populated with various boards.



R00257

Figure 6: Rear view of populated case

> *Note:*
> *This diagram is just an example and may not show the exact product described in this manual. It also does not show the full range of available boards, just a typical arrangement.*

Not all slots are the same size. The slot width depends on the type of board or terminal block. For example, HD (heavy duty) terminal blocks, as required for the analogue inputs, require a wider slot size than MD (medium duty) terminal blocks. The board positions are not generally interchangeable. Each slot is designed to house a particular type of board. Again this is model-dependent.

The device may use one or more of the terminal block types shown in the following diagram. The terminal blocks are fastened to the rear panel with screws.

- Heavy duty (HD) terminal blocks for CT and VT circuits
- Medium duty (MD) terminal blocks for the power supply, opto-inputs, relay outputs and rear communications port
- MiDOS terminal blocks for CT and VT circuits
- RTD/CLIO terminal block for connection to analogue transducers

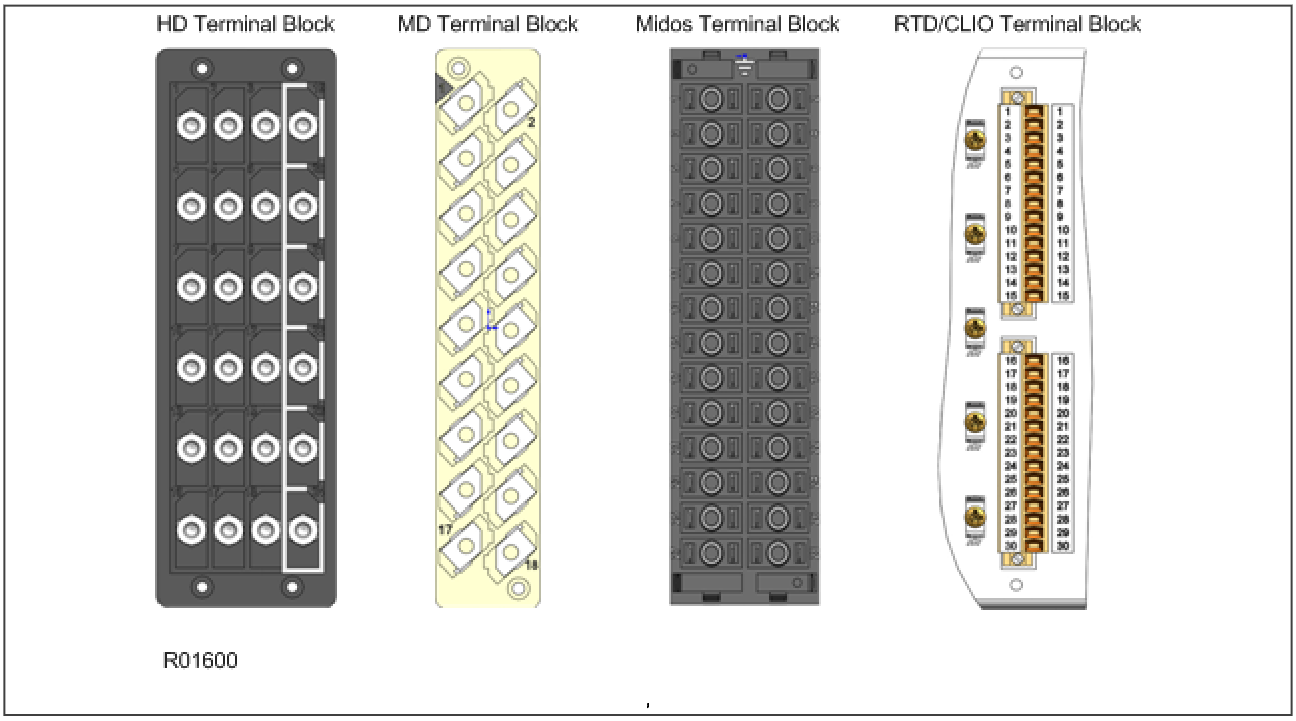


Figure 7: Terminal block types

Note:
Not all products use all types of terminal blocks. The product described in this manual may use one or more of the above types.

5.1 TERMINAL BLOCK INGRESS PROTECTION

IP2x shields and side cover panels are designed to provide IP20 ingress protection for MiCOM terminal blocks. The shields and covers may be attached during installation or retrofitted to upgrade existing installations—see figure below. For more information, contact your local sales office or our worldwide Contact Centre.

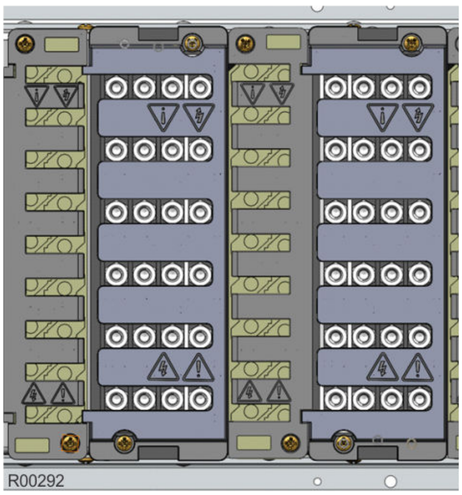


Figure 8: Example—fitted IP2x shields (cabling omitted for clarity)

6 BOARDS AND MODULES

Each product comprises a selection of PCBs (Printed Circuit Boards) and subassemblies, depending on the chosen configuration.

6.1 PCBS

A PCB typically consists of the components, a front connector for connecting into the main system parallel bus via a ribbon cable, and an interface to the rear. This rear interface may be:

- Directly presented to the outside world (as is the case for communication boards such as Ethernet Boards)
- Presented to a connector, which in turn connects into a terminal block bolted onto the rear of the case (as is the case for most of the other board types)

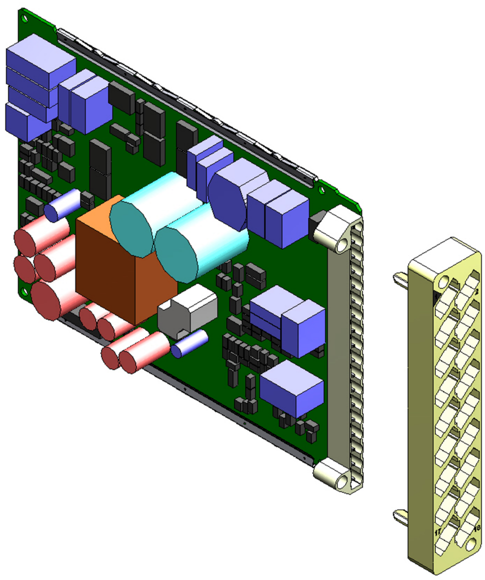


Figure 9: Rear connection to terminal block

6.2 SUBASSEMBLIES

A sub-assembly consists of two or more boards bolted together with spacers and connected with electrical connectors. It may also have other special requirements such as being encased in a metal housing for shielding against electromagnetic radiation.

Boards are designated by a part number beginning with ZN, whereas pre-assembled sub-assemblies are designated with a part number beginning with GN. Sub-assemblies, which are put together at the production stage, do not have a separate part number.

The products in the Px40 series typically contain two sub-assemblies:

- The power supply assembly comprising:
  - A power supply board
  - An output relay board
- The input module comprising:
  - One or more transformer boards, which contains the voltage and current transformers (partially or fully populated)
  - One or more input boards
  - Metal protective covers for EM (electromagnetic) shielding

The input module is pre-assembled and is therefore assigned a GN number, whereas the power supply module is assembled at production stage and does not therefore have an individual part number.

6.3 MAIN PROCESSOR BOARD

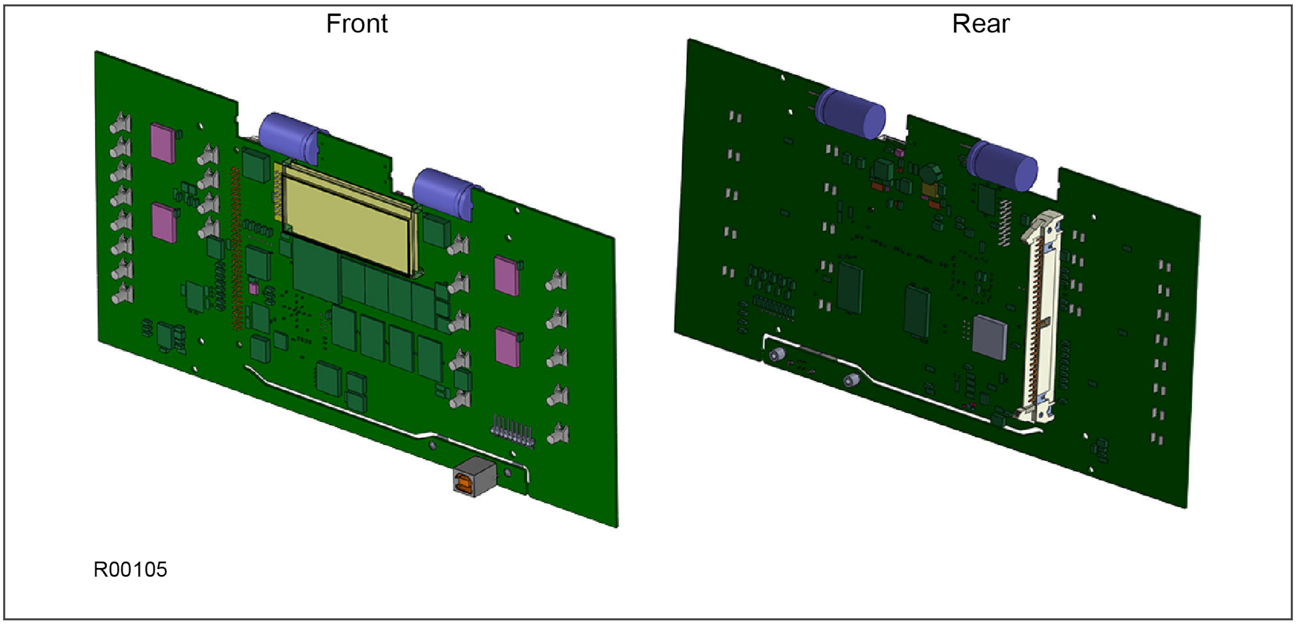


Figure 10: Main processor board

The main processor board performs all calculations and controls the operation of all other modules in the IED, including the data communication and user interfaces. This is the only board that does not fit into one of the slots. It resides in the front panel and connects to the rest of the system using an internal ribbon cable.

The LCD and LEDs are mounted on the processor board along with the front panel communication ports.

The memory on the main processor board is split into two categories: volatile and non-volatile. The volatile memory is fast access SRAM, used by the processor to run the software and store data during calculations. The non-volatile memory is sub-divided into two groups:

- Flash memory to store software code, text and configuration data including the present setting values.
- Supercapacitor-backed SRAM to store disturbance, event, fault and maintenance record data.

There are two board types available depending on the size of the case:

- For models in 40TE cases
- For models in 60TE cases and larger

6.4 POWER SUPPLY BOARD

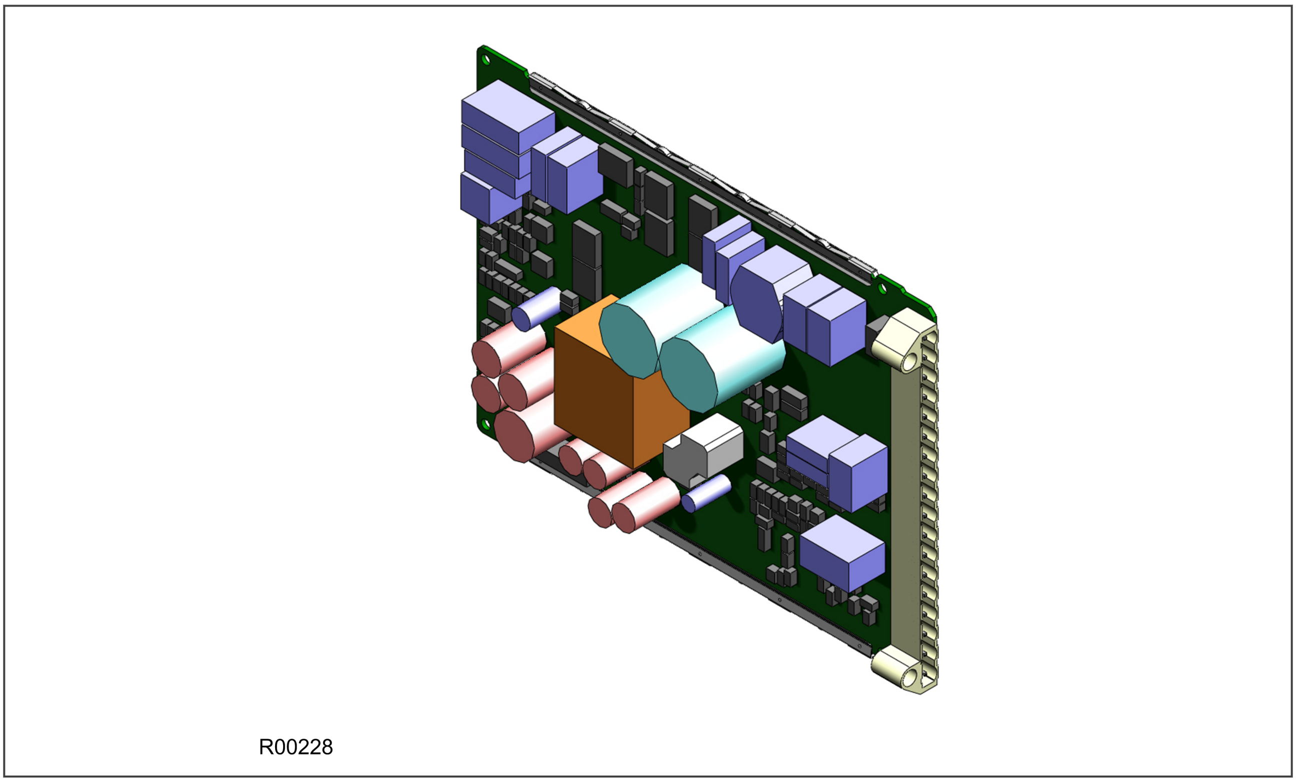


Figure 11: Power supply board

The power supply board provides power to the unit. One of three different configurations of the power supply board can be fitted to the unit. This is specified at the time of order and depends on the magnitude of the supply voltage that will be connected to it.

There are three board types, which support the following voltage ranges:

- 24/54 V DC
- 48/125 V DC or 40-100V AC
- 110/250 V DC or 100-240V AC

The power supply board connector plugs into a medium duty terminal block. This terminal block is always positioned on the right hand side of the unit looking from the rear.

The power supply board is usually assembled together with a relay output board to form a complete subassembly, as shown in the following diagram.

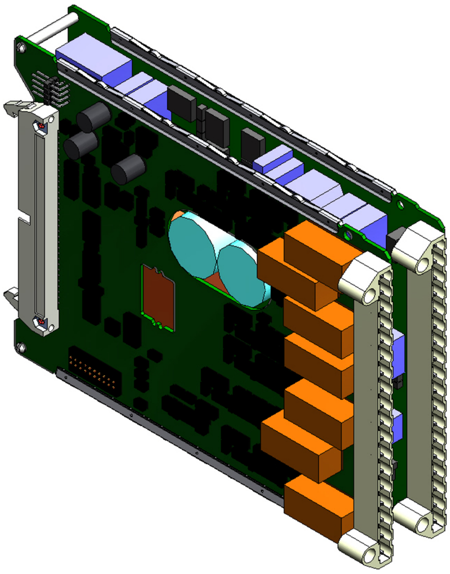


Figure 12: Power supply assembly

The power supply outputs are used to provide isolated power supply rails to the various modules within the unit. Three voltage levels are used by the unit's modules:

- 5.1 V for all of the digital circuits
- +/- 16 V for the analogue electronics such as on the input board
- 22 V for driving the output relay coils.

All power supply voltages, including the 0 V earth line, are distributed around the unit by the 64-way ribbon cable.

The power supply board incorporates inrush current limiting. This limits the peak inrush current to approximately 10 A.

Power is applied to pins 1 and 2 of the terminal block, where pin 1 is negative and pin 2 is positive. The pin numbers are clearly marked on the terminal block as shown in the following diagram.

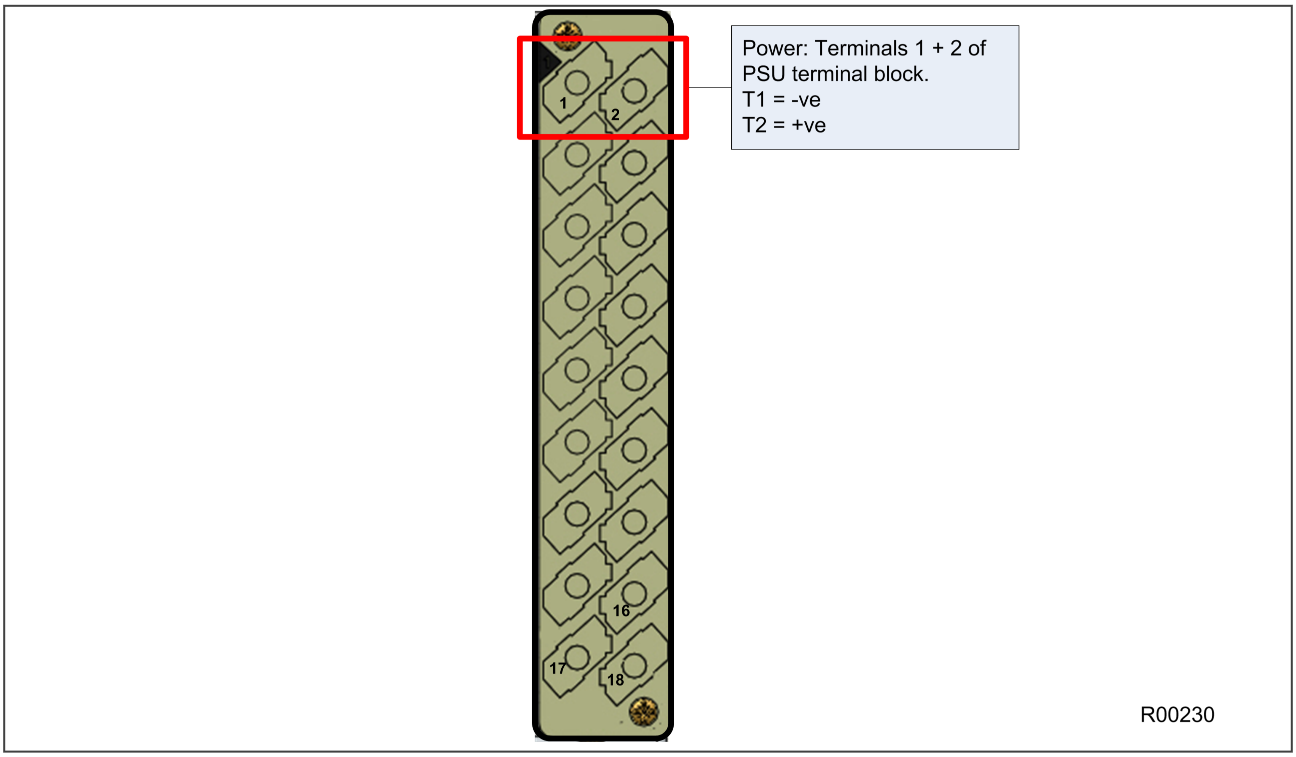


Figure 13: Power supply terminals

6.4.1 WATCHDOG

The Watchdog contacts are also hosted on the power supply board. The Watchdog facility provides two output relay contacts, one normally open and one normally closed. These are used to indicate the health of the device and are driven by the main processor board, which continually monitors the hardware and software when the device is in service.

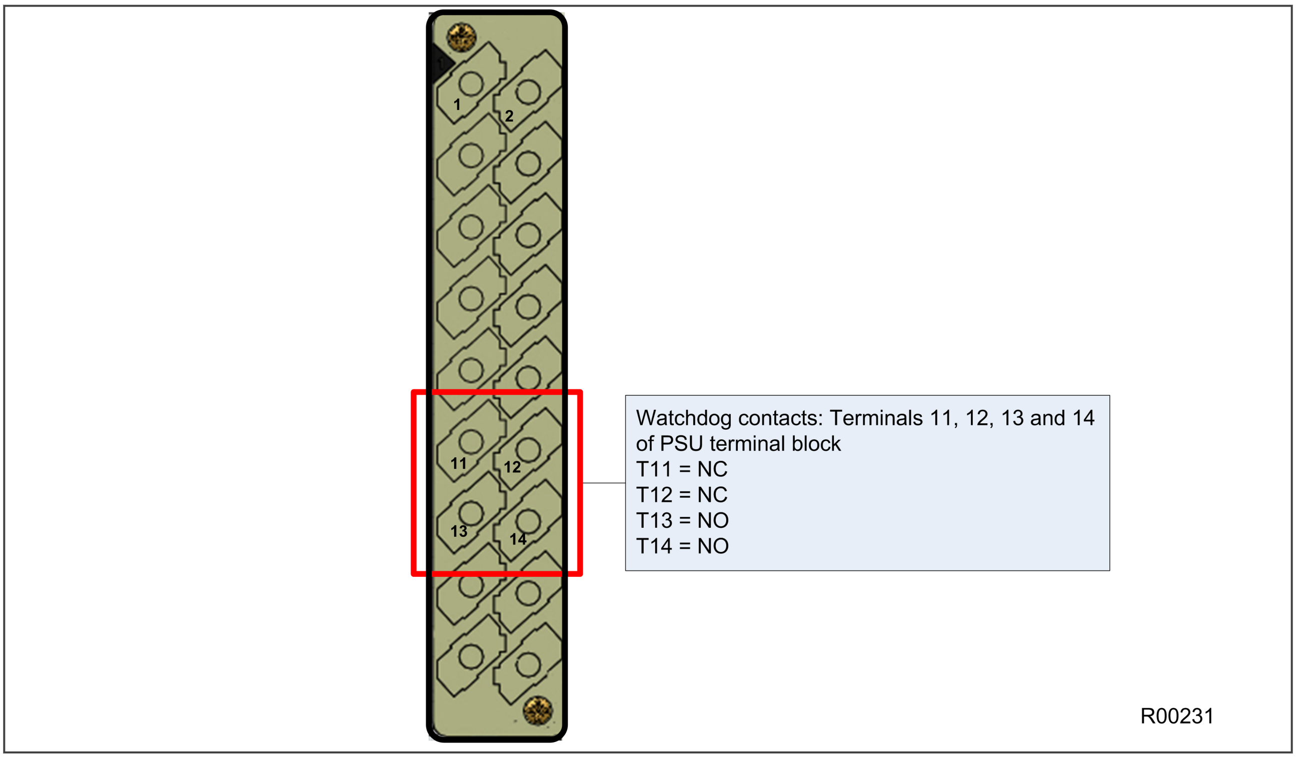


Figure 14: Watchdog contact terminals

6.4.2 REAR SERIAL PORT

The rear serial port (RP1) is housed on the power supply board. This is a three-terminal EIA(RS)485 serial communications port and is intended for use with a permanently wired connection to a remote control centre for SCADA communication. The interface supports half-duplex communication and provides optical isolation for the serial data being transmitted and received.

The physical connectivity is achieved using three screw terminals; two for the signal connection, and the third for the earth shield of the cable. These are located on pins 16, 17 and 18 of the power supply terminal block, which is on the far right looking from the rear. The interface can be selected between RS485 and K-bus. When the K-Bus option is selected, the two signal connections are not polarity conscious.

The polarity independent K-bus can only be used for the Courier data protocol. The polarity conscious MODBUS, IEC 60870-5-103 and DNP3.0 protocols need RS485.

The following diagram shows the rear serial port. The pin assignments are as follows:

- Pin 16: Earth shield
- Pin 17: Negative signal
- Pin 18: Positive signal

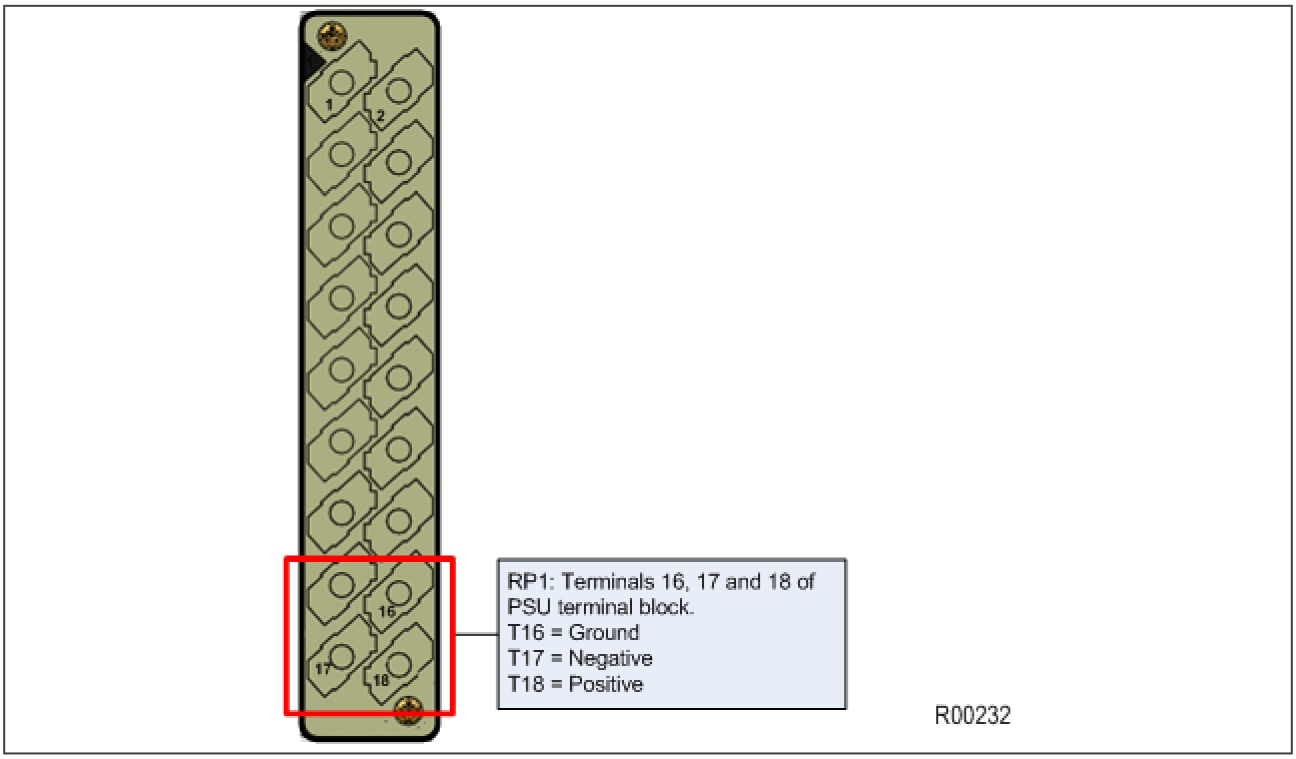


Figure 15: Rear serial port terminals

An additional serial port with D-type presentation is available as an optional board, if required.

6.5 INPUT MODULE - 1 TRANSFORMER BOARD

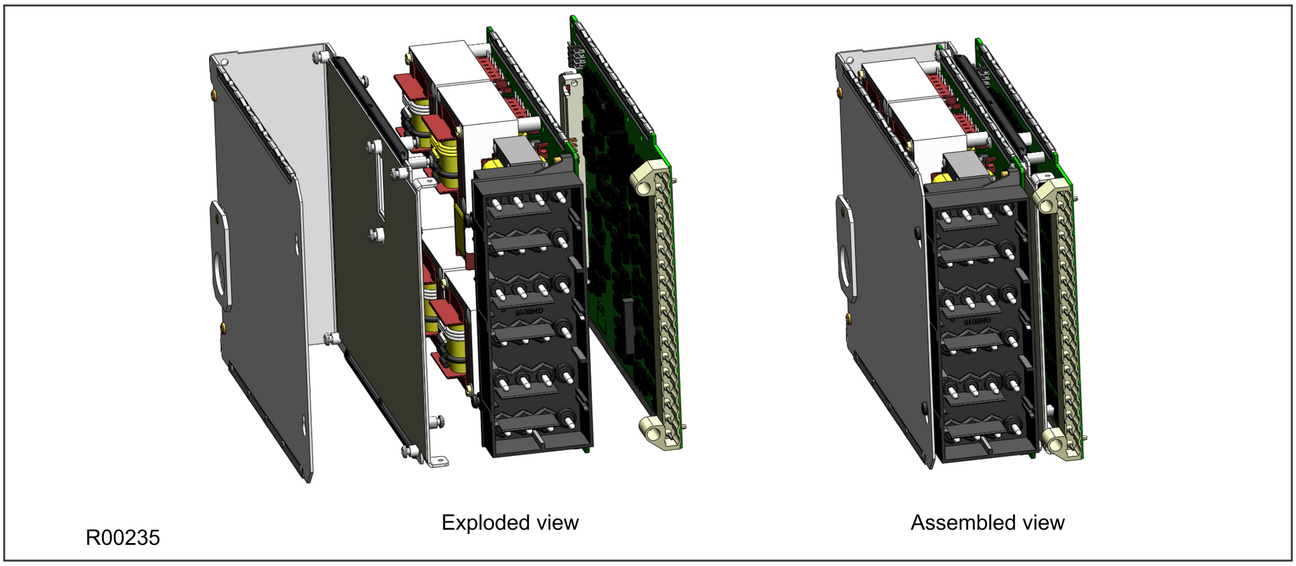


Figure 16: Input module - 1 transformer board

The input module consists of the main input board coupled together with an instrument transformer board. The instrument transformer board contains the voltage and current transformers, which isolate and scale the analogue input signals delivered by the system transformers. The input board contains the A/D conversion and digital processing circuitry, as well as eight digital isolated inputs (opto-inputs).

The boards are connected together physically and electrically. The module is encased in a metal housing for shielding against electromagnetic interference.

6.5.1 INPUT MODULE CIRCUIT DESCRIPTION

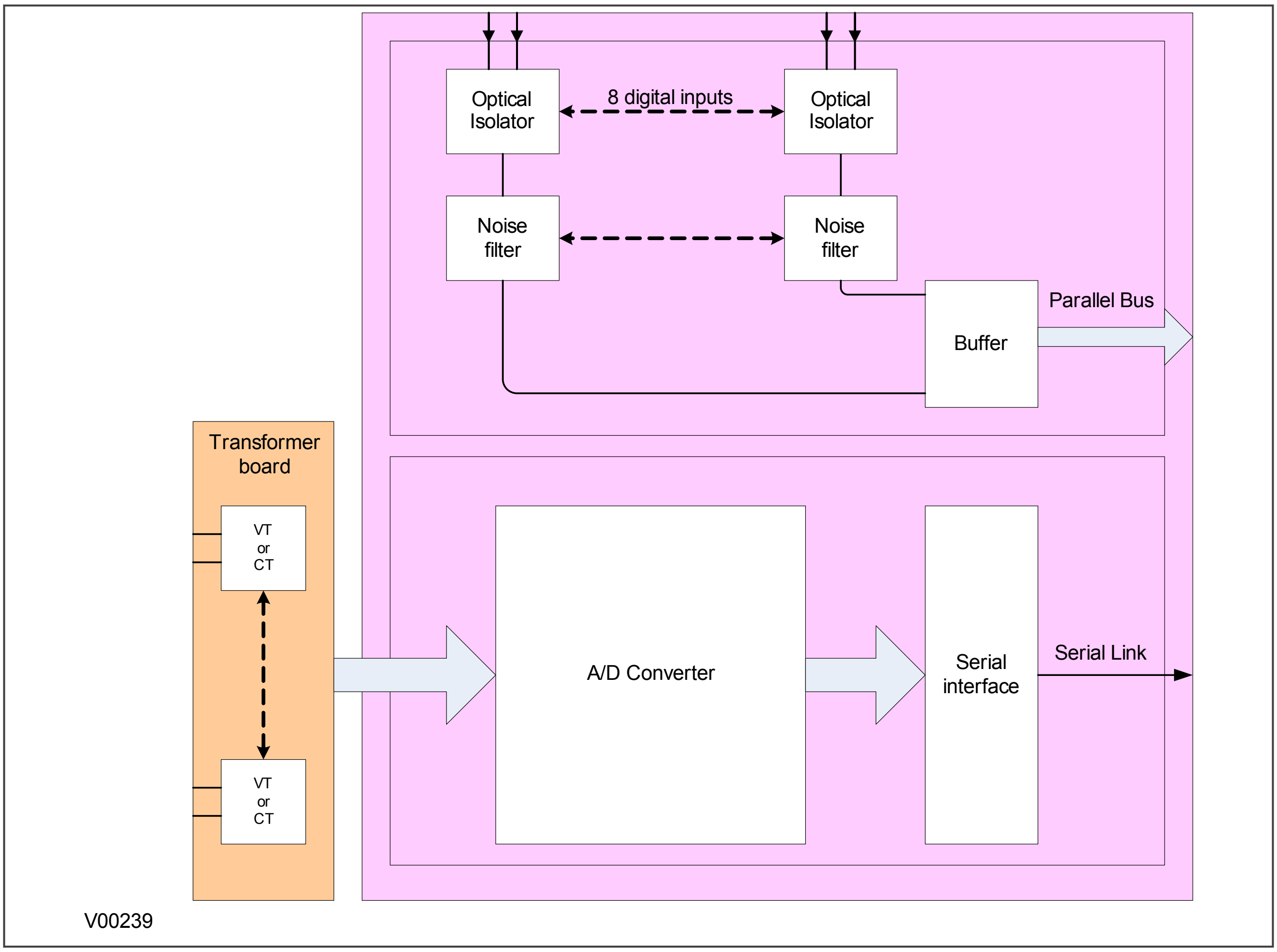


Figure 17: Input module schematic

A/D Conversion

The differential analogue inputs from the CT and VT transformers are presented to the main input board as shown. Each differential input is first converted to a single input quantity referenced to the input board's earth potential. The analogue inputs are sampled and converted to digital, then filtered to remove unwanted properties. The samples are then passed through a serial interface module which outputs data on the serial sample data bus.

The calibration coefficients are stored in non-volatile memory. These are used by the processor board to correct for any amplitude or phase errors introduced by the transformers and analogue circuitry.

Opto-isolated inputs

The other function of the input board is to read in the state of the digital inputs. As with the analogue inputs, the digital inputs must be electrically isolated from the power system. This is achieved by means of the 8 on-board optical isolators for connection of up to 8 digital signals. The digital signals are passed through an optional noise filter before being buffered and presented to the unit's processing boards in the form of a parallel data bus.

This selectable filtering allows the use of a pre-set filter of ½ cycle which renders the input immune to induced power-system noise on the wiring. Although this method is secure it can be slow, particularly for inter-tripping. 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.

- Use double pole switching on the input
- Use screened twisted cable on the input circuit

The opto-isolated logic inputs can be configured for the nominal battery voltage of the circuit for which they are a part, allowing different voltages for different circuits such as signalling and tripping.

> *Note:*
> *The opto-input circuitry can be provided without the A/D circuitry as a separate board, which can provide supplementary opto-inputs.*

6.5.2 FREQUENCY RESPONSE

With the exception of the RMS measurements, all other measurements and protection functions are based on the Fourier-derived fundamental component. The fundamental component is extracted by using a 24 sample Discrete Fourier Transform (DFT). This gives good harmonic rejection for frequencies up to the 23rd harmonic. The 23rd is the first predominant harmonic that is not attenuated by the Fourier filter and this is known as an 'Alias'. However, the Alias is attenuated by approximately 85% by an additional, analogue, 'anti-aliasing' filter (low pass filter). The combined affect of the anti-aliasing and Fourier filters is shown below.

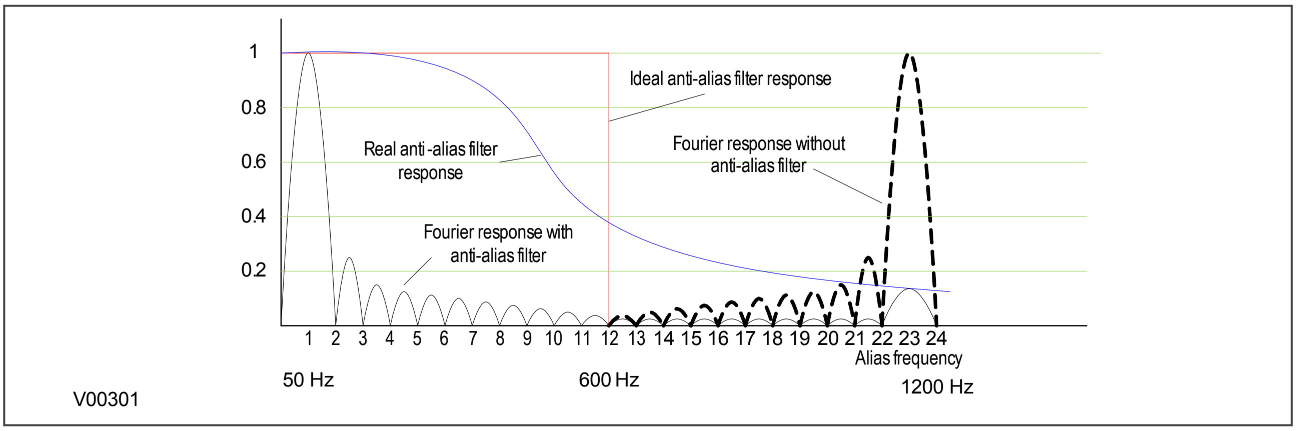


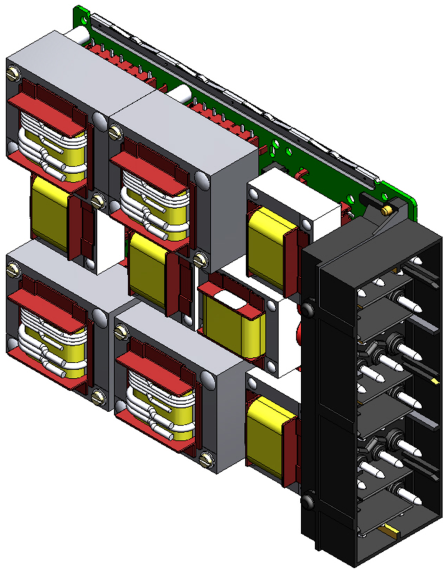
Figure 18: Frequency response

For power frequencies that are not equal to the selected rated frequency, the harmonics are attenuated to zero amplitude. For small deviations of +/-1 Hz, this is not a problem but to allow for larger deviations, frequency tracking is used.

Frequency tracking automatically adjusts the sampling rate of the analog to digital conversion to match the applied signal. In the absence of a suitable signal to amplitude track, the sample rate defaults to the selected rated frequency (Fn).

If the signal is in the tracking range of 5 to 70 Hz, the relay locks on to the signal and the measured frequency coincides with the power frequency, as shown in the figure above. The resulting outputs for harmonics up to the 23rd will be zero. The device frequency tracks off any voltage or current in the order VA/VB/VC/IA/IB/IC down to 10% Vn for voltage and 5%In for current.

6.5.3 TRANSFORMER BOARD



R00237

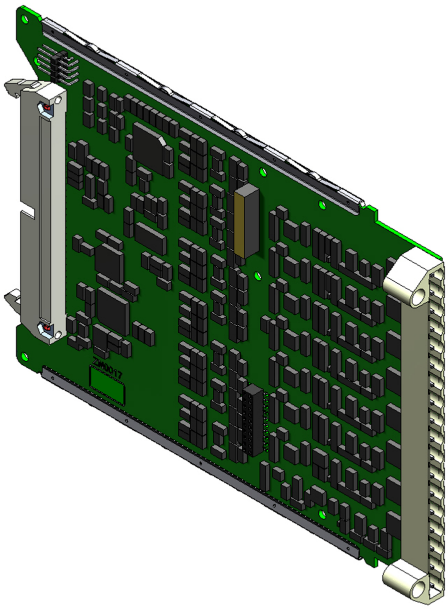
Figure 19: Transformer board

The transformer board hosts the current and voltage transformers. These are used to step down the currents and voltages originating from the power systems' current and voltage transformers to levels that can be used by the devices' electronic circuitry. In addition to this, the on-board CT and VT transformers provide electrical isolation between the unit and the power system.

The transformer board is connected physically and electrically to the input board to form a complete input module.

For terminal connections, please refer to the wiring diagrams.

6.5.4 INPUT BOARD



R00238

Figure 20: Input board

The input board is used to convert the analogue signals delivered by the current and voltage transformers into digital quantities used by the IED. This input board also has on-board opto-input circuitry, providing eight optically-isolated digital inputs and associated noise filtering and buffering. These opto-inputs are presented to the user by means of a MD terminal block, which sits adjacent to the analogue inputs HD terminal block.

The input board is connected physically and electrically to the transformer board to form a complete input module.

The terminal numbers of the opto-inputs are as follows:

Terminal Number	Opto-input
Terminal 1	Opto 1 -ve
Terminal 2	Opto 1 +ve
Terminal 3	Opto 2 -ve
Terminal 4	Opto 2 +ve
Terminal 5	Opto 3 -ve
Terminal 6	Opto 3 +ve
Terminal 7	Opto 4 -ve
Terminal 8	Opto 4 +ve
Terminal 9	Opto 5 -ve
Terminal 10	Opto 5 +ve
Terminal 11	Opto 6 -ve
Terminal 12	Opto 6 +ve
Terminal 13	Opto 7 –ve
Terminal 14	Opto 7 +ve
Terminal 15	Opto 8 –ve
Terminal 16	Opto 8 +ve

Terminal Number	Opto-input
Terminal 17	Common
Terminal 18	Common

6.6 STANDARD OUTPUT RELAY BOARD

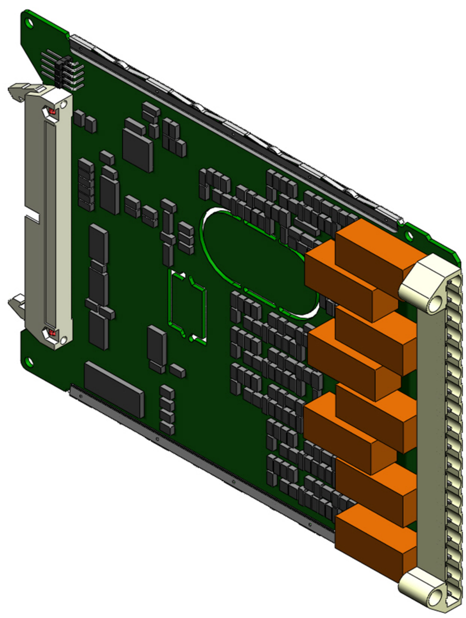


Figure 21: Standard output relay board - 8 contacts

This output relay board has 8 relays with 6 Normally Open contacts and 2 Changeover contacts.

The output relay board is provided together with the power supply board as a complete assembly, or independently for the purposes of relay output expansion.

There are two cut-out locations in the board. These can be removed to allow power supply components to protrude when coupling the output relay board to the power supply board. If the output relay board is to be used independently, these cut-out locations remain intact.

The terminal numbers are as follows:

Terminal Number	Output Relay
Terminal 1	Relay 1 NO
Terminal 2	Relay 1 NO
Terminal 3	Relay 2 NO
Terminal 4	Relay 2 NO
Terminal 5	Relay 3 NO
Terminal 6	Relay 3 NO
Terminal 7	Relay 4 NO
Terminal 8	Relay 4 NO
Terminal 9	Relay 5 NO
Terminal 10	Relay 5 NO

Terminal Number	Output Relay
Terminal 11	Relay 6 NO
Terminal 12	Relay 6 NO
Terminal 13	Relay 7 changeover
Terminal 14	Relay 7 changeover
Terminal 15	Relay 7 common
Terminal 16	Relay 8 changeover
Terminal 17	Relay 8 changeover
Terminal 18	Relay 8 common

6.7 IRIG-B BOARD

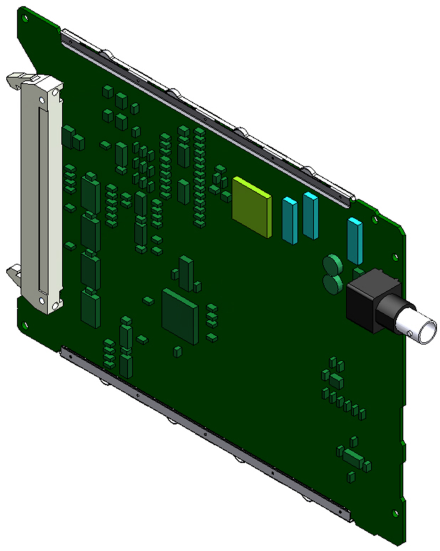


Figure 22: IRIG-B board

The IRIG-B board can be fitted to provide an accurate timing reference for the device. The IRIG-B signal is connected to the board via a BNC connector. The timing information is used to synchronise the IED's internal real-time clock to an accuracy of 1 ms. The internal clock is then used for time tagging events, fault, maintenance and disturbance records.

IRIG-B interface is available in modulated or demodulated formats.

The IRIG-B facility is provided in combination with other functionality on a number of additional boards, such as:

- Fibre board with IRIG-B
- Second rear communications board with IRIG-B
- Ethernet board with IRIG-B
- Redundant Ethernet board with IRIG-B

There are three types of each of these boards; one type which accepts a modulated IRIG-B input, one type which accepts a demodulated IRIG-B input and one type which accepts a universal IRIG-B input.

6.8 FIBRE OPTIC BOARD

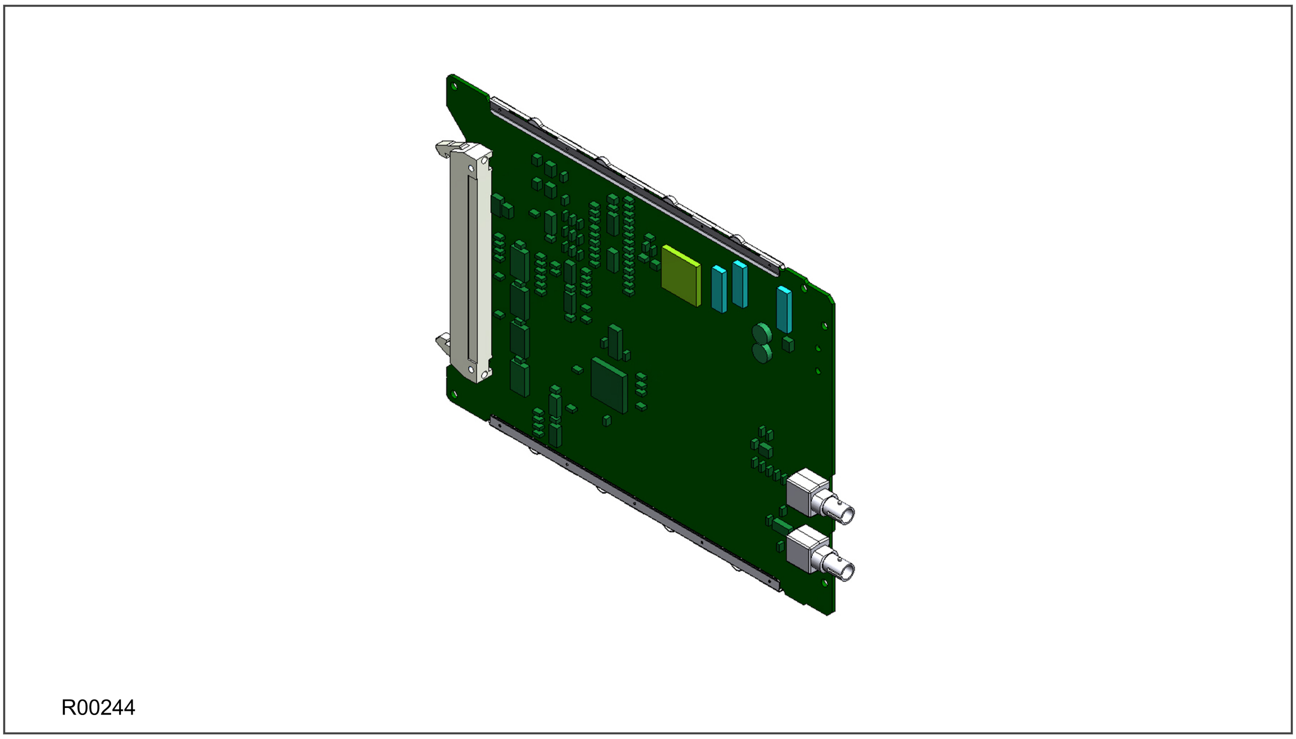


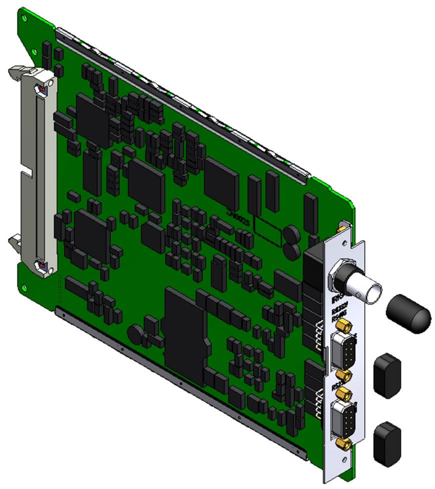
Figure 23: Fibre optic board

This board provides an interface for communicating with a master station. This communication link can use all compatible protocols (Courier, IEC 60870-5-103, MODBUS and DNP 3.0). It is a fibre-optic alternative to the metallic RS485 port presented on the power supply terminal block. The metallic and fibre optic ports are mutually exclusive.

The fibre optic port uses BFOC 2.5 ST connectors.

The board comes in two varieties; one with an IRIG-B input and one without:

6.9 REAR COMMUNICATION BOARD



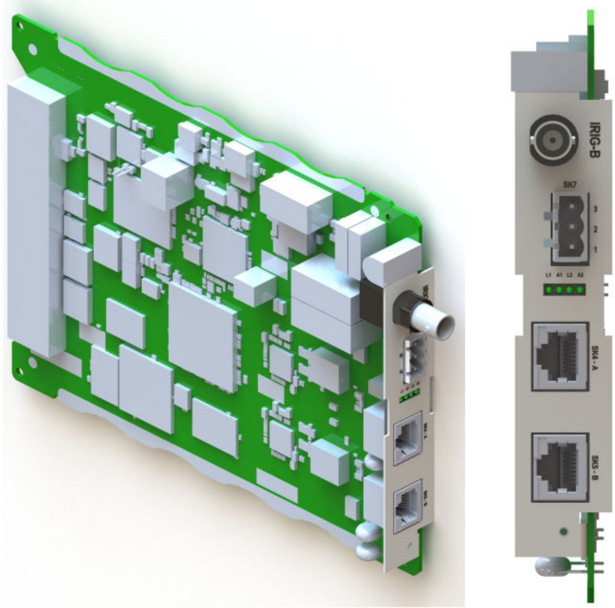
R00243

Figure 24: Rear communication board

The optional communications board containing the secondary communication ports provide two serial interfaces presented on 9 pin D-type connectors. These interfaces are known as SK4 and SK5. Both connectors are female connectors, but are configured as DTE ports. This means pin 2 is used to transmit information and pin 3 to receive.

SK4 can be used with RS232, RS485 and K-bus. SK5 can only be used with RS232 and is used for electrical teleprotection. The optional rear communications board and IRIG-B board are mutually exclusive since they use the same hardware slot. However, the board comes in two varieties; one with an IRIG-B input and one without.

6.10 REDUNDANT ETHERNET BOARD



R00293

Figure 25: Redundant Ethernet board

This board provides dual redundant Ethernet together with an IRIG-B interface for timing.

Different board variants are available, depending on the redundancy protocol and the type of IRIG-B signal (unmodulated and modulated). The available redundancy protocols are:

- RSTP (Rapid Spanning Tree Protocol)
- PRP (Parallel Redundancy Protocol)
- HSR (High-availability Seamless Redundancy)
- Failover

There are several variants for this board as follows:

- 100 Mbps redundant Ethernet running RSTP + PRP + HSR + Failover (two fibre pairs), with on-board universal IRIG-B
- 100 Mbps redundant Ethernet running RSTP + PRP + HSR + Failover (two copper pairs), with on-board universal IRIG-B
- 100 Mbps redundant Ethernet running RSTP + PRP + HSR + Failover (one copper, one multi-mode fibre), with on-board universal IRIG-B

The Ethernet and other connection details are described below:

IRIG-B Connector

- Centre connection: Signal
- Outer connection: Earth

Link Fail Connector (Ethernet Board Watchdog Relay)

Pin	Closed	Open
1-2	Link fail Channel 1 (A)	Link ok Channel 1 (A)
2-3	Link fail Channel 2 (B)	Link ok Channel 2 (B)

LEDs

LED	Function	On	Off	Flashing
Green	Link	Link ok	Link broken	
Yellow	Activity	Running		PRP, RSTP traffic

Optical Fibre Connectors (ST)

Connector	RSTP	PRP	HSR
A	RX1	RXA	RXA
B	TX1	TXA	TXA
C	RX2	RXB	RXB
D	TX2	TXB	TXB

RJ45 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

6.11 RTD BOARD

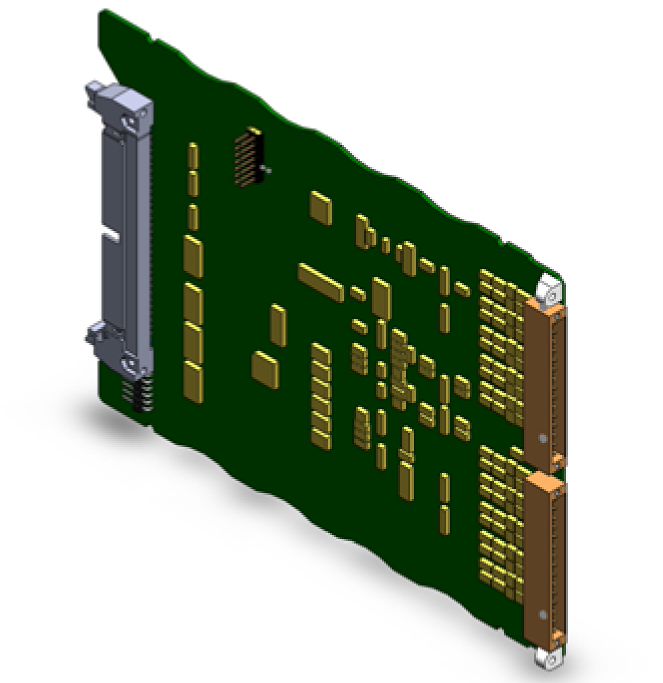


Figure 26: RTD board

The RTD board provides two banks of 15 terminals to support ten RTD inputs, of the type PT100, Ni100, or Ni120, depending on the product. There are three terminals for each RTD, therefore 30 terminals altogether. The RTD board fits into slot B or slot C, depending on the model variant.

The terminal numbers of the RTDs are as follows:

Terminal Number	RTD connection
Terminal 1	RTD1 wire 1
Terminal 2	RTD1 wire 2
Terminal 3	RTD1 wire 3
Terminal 4	RTD2 wire 1
Terminal 5	RTD2 wire 2
Terminal 6	RTD2 wire 3
Terminal 7	RTD3 wire 1
Terminal 8	RTD3 wire 2
Terminal 9	RTD3 wire 3
Terminal 10	RTD4 wire 1
Terminal 11	RTD4 wire 2
Terminal 12	RTD4 wire 3
Terminal 13	RTD5 wire 1
Terminal 14	RTD5 wire 2
Terminal 15	RTD5 wire 3
Terminal 16	RTD6 wire 1

Terminal Number	RTD connection
Terminal 17	RTD6 wire 2
Terminal 18	RTD6 wire 3
Terminal 19	RTD7 wire 1
Terminal 20	RTD7 wire 2
Terminal 21	RTD7 wire 3
Terminal 22	RTD8 wire 1
Terminal 23	RTD8 wire 2
Terminal 24	RTD8 wire 3
Terminal 25	RTD9 wire 1
Terminal 26	RTD9 wire 2
Terminal 27	RTD9 wire 3
Terminal 28	RTD10 wire 1
Terminal 29	RTD10 wire 2
Terminal 30	RTD10 wire 3

6.12 CLIO BOARD

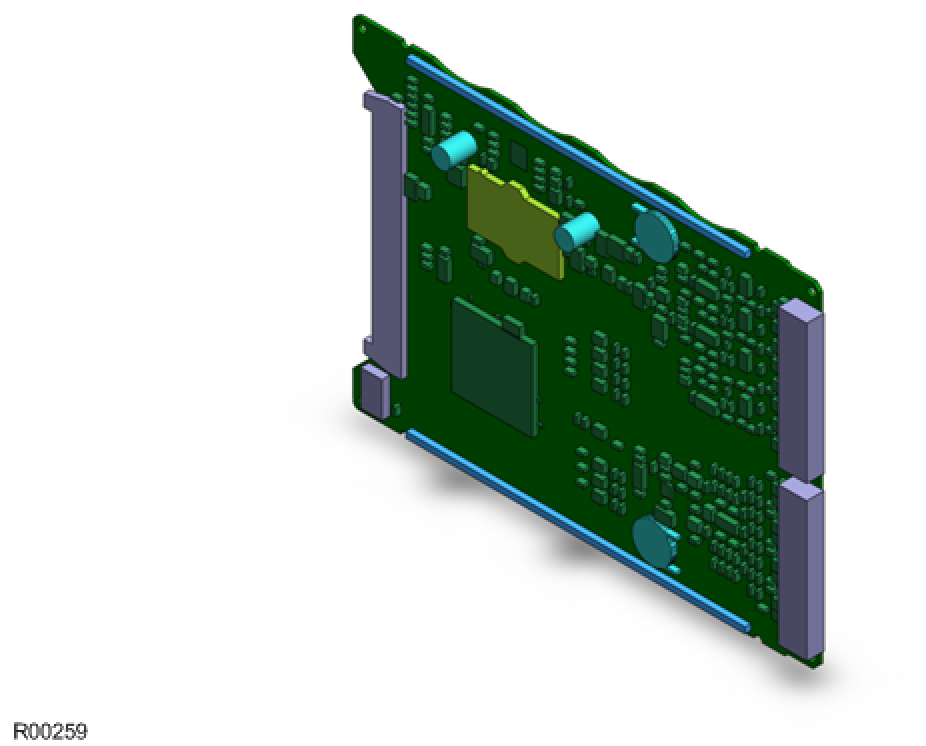


Figure 27: RTD board

The CLIO board provides two banks of 15 terminals to support four current loop inputs and four current loop outputs. There are three terminals for each input and three for each output, therefore 24 of the terminals are used altogether. The CLIO board fits into slot B or slot C, depending on the model variant.

The terminal numbers of the current loop inputs and outputs are as follows:

Terminal Number	Current Loop Connection
Terminal 1	CLO1 - 20 mA input
Terminal 2	CLO1 - 1 mA input
Terminal 3	CLO1 - common input
Terminal 4	Not used
Terminal 5	CLO2 - 20 mA input
Terminal 6	CLO2 - 1 mA input
Terminal 7	CLO2 - common input
Terminal 8	Not used
Terminal 9	CLO3 - 20 mA input
Terminal 10	CLO3 - 1 mA input
Terminal 11	CLO3 - common input
Terminal 12	Not used
Terminal 13	CLO4 - 20 mA input
Terminal 14	CLO4 - 1 mA input
Terminal 15	CLO4 - common input
Terminal 16	CLI1 - 20 mA input
Terminal 17	CLI1 - 1 mA input
Terminal 18	CLI1 - common input
Terminal 19	Not used
Terminal 20	CLI2 - 20 mA input
Terminal 21	CLI2 - 1 mA input
Terminal 22	CLI2 - common input
Terminal 23	Not used
Terminal 24	CLI3 - 20 mA input
Terminal 25	CLI3 - 1 mA input
Terminal 26	CLI3 - common input
Terminal 27	Not used
Terminal 28	CLI4 - 20 mA input
Terminal 29	CLI4 - 1 mA input
Terminal 30	CLI4 - common input

6.13 HIGH BREAK OUTPUT RELAY BOARD

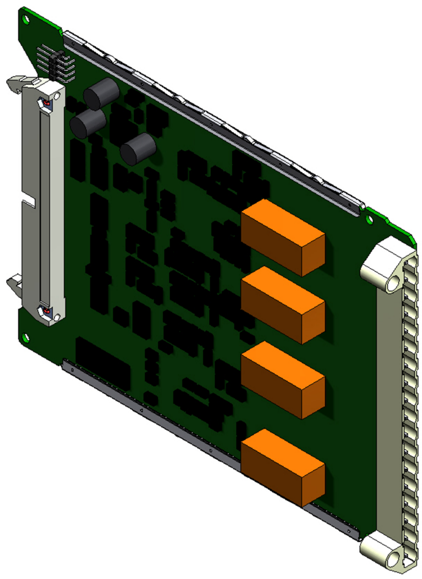


Figure 28: High Break relay output board

A High Break output relay board is available as an option. It comprises four normally open output contacts, which are suitable for high breaking loads.

A High Break contact consists of a high capacity relay with a MOSFET in parallel with it. The MOSFET has a varistor placed across it to provide protection, which is required when switching off inductive loads. This is because the stored energy in the inductor causes a high reverse voltage that could damage the MOSFET, if not protected.

When there is a control input command to operate an output contact the miniature relay is operated at the same time as the MOSFET. The miniature relay contact closes in nominally 3.5 ms and is used to carry the continuous load current. The MOSFET operates in less than 0.2 ms, but is switched off after 7.5 ms.

When the control input is reset, the MOSFET is again turned on for 7.5 mS. The miniature relay resets in nominally 3.5 ms before the MOSFET. This means the MOSFET is used to break the load. The MOSFET absorbs the energy when breaking inductive loads and so limits the resulting voltage surge. This contact arrangement is for switching DC circuits only.

The board number is:

- ZN0042 001

High Break Contact Operation

The following figure shows the timing diagram for High Break contact operation.

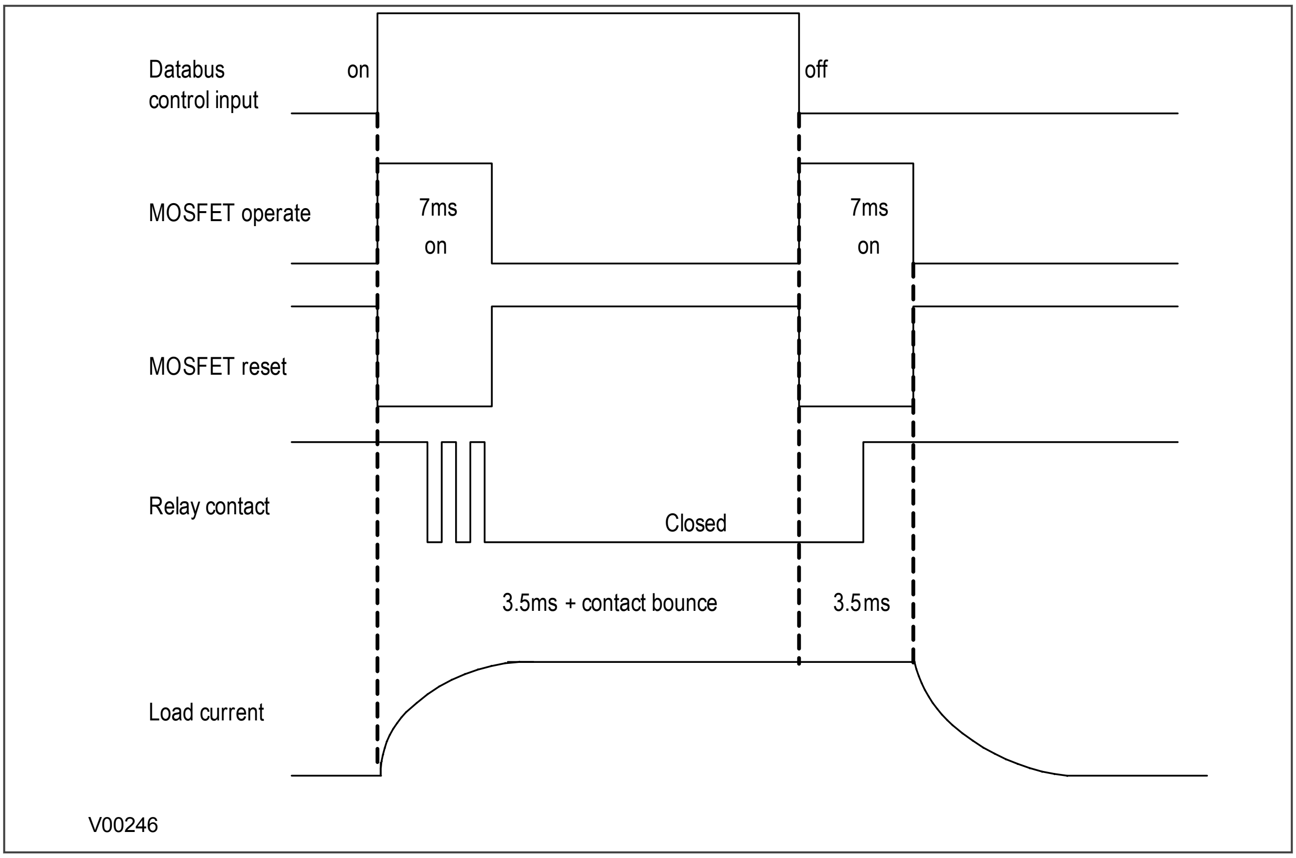


Figure 29: High Break contact operation

High Break Contact Applications

- Efficient scheme engineering

  In traditional hard wired scheme designs, High Break capability could only be achieved using external electromechanical trip relays. Instead, these internal High Break contacts can be used thus reducing space requirements.
- Accessibility of CB auxiliary contacts

  It is common practise to use circuit breaker 52a (CB Closed) auxiliary contacts to break the trip coil current on breaker opening, thereby easing the duty on the protection contacts. In some cases (such as operation of disconnectors, or retrofitting), it may be that 52a contacts are either unavailable or unreliable. In such cases, High Break contacts can be used to break the trip coil current in these applications.
- Breaker fail

  In the event of failure of the local circuit breaker (stuck breaker), or defective auxiliary contacts (stuck contacts), it is incorrect to use 52a contact action. The interrupting duty at the local breaker then falls on the relay output contacts, which may not be rated to perform this duty. High Break contacts should be used in this case to avoid the risk of burning out relay contacts.
- Initiation of teleprotection

  The High Break contacts also offer fast making, which results in faster tripping. In addition, fast keying of teleprotection is a benefit. Fast keying bypasses the usual contact operation time, such that permissive, blocking and intertrip commands can be routed faster.

Warning:
These relay contacts are POLARITY SENSITIVE. External wiring must comply with the polarity requirements described in the external connection diagram to ensure correct operation.

CHAPTER 4

SOFTWARE DESIGN

1 CHAPTER OVERVIEW

This chapter describes the software design of the IED.

This chapter contains the following sections:

2 SOFWARE DESIGN OVERVIEW

The device software can be conceptually categorized into several elements as follows:

- The system level software
- The platform software
- The protection and control software

These elements are not distinguishable to the user, and the distinction is made purely for the purposes of explanation. The following figure shows the software architecture.

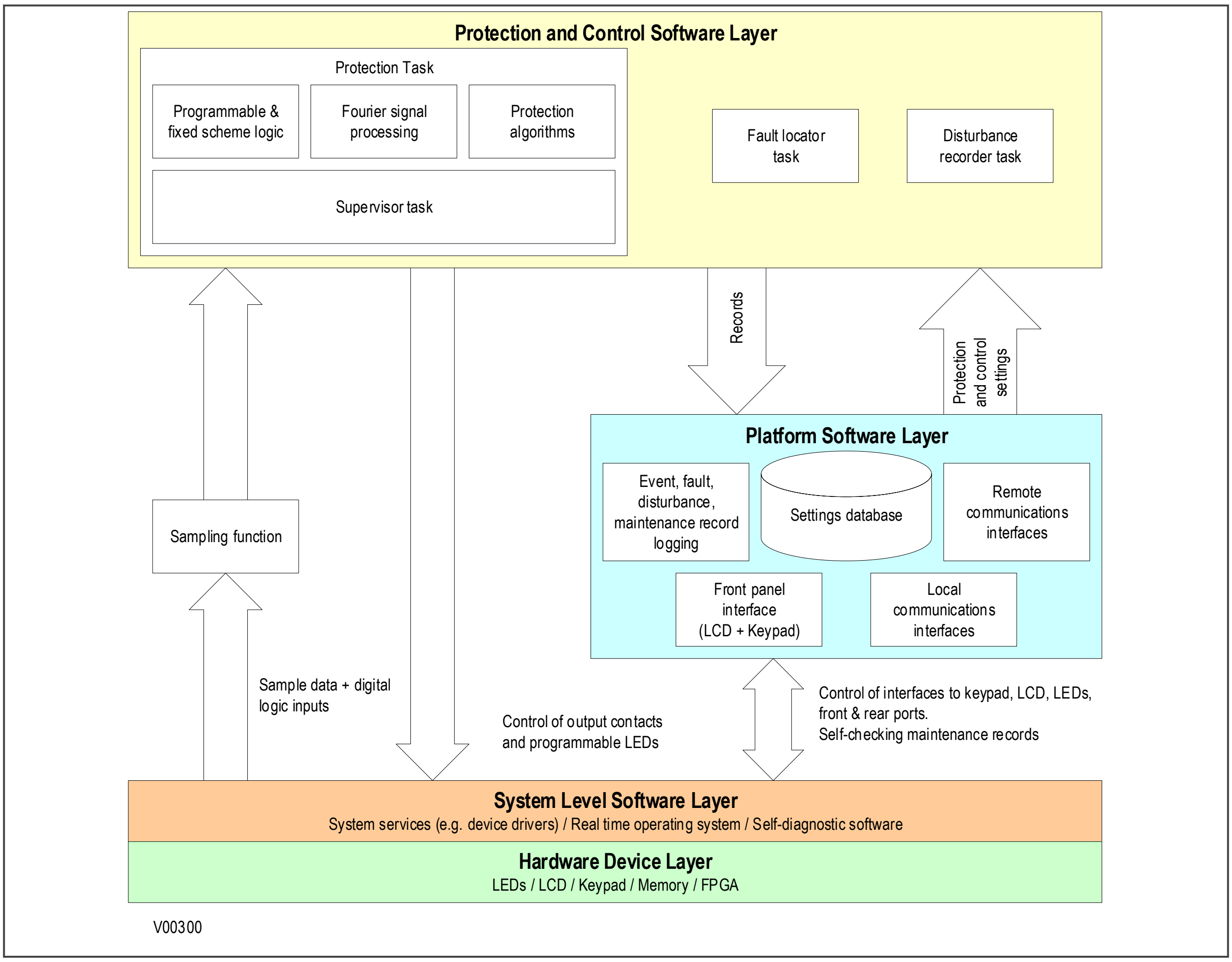


Figure 30: Software Architecture

The software, which executes on the main processor, can be divided into a number of functions as illustrated above. Each function is further broken down into a number of separate tasks. These tasks are then run according to a scheduler. They are run at either a fixed rate or they are event driven. The tasks communicate with each other as and when required.

3 SYSTEM LEVEL SOFTWARE

3.1 REAL TIME OPERATING SYSTEM

The real-time operating system is used to schedule the processing of the various tasks. This ensures that they are processed in the time available and in the desired order of priority. The operating system also plays a part in controlling the communication between the software tasks, through the use of operating system messages.

3.2 SYSTEM SERVICES SOFTWARE

The system services software provides the layer between the 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 things like the booting of the processor and the downloading of the processor code into RAM at startup.

3.3 SELF-DIAGNOSTIC SOFTWARE

The device includes several self-monitoring functions to check the operation of its hardware and software while in service. If there is a problem with the hardware or software, it should be able to detect and report the problem, and attempt to resolve the problem by performing a reboot. In this case, the device would be out of service for a short time, during which the 'Healthy' LED on the front of the device is switched OFF and the watchdog contact at the rear is ON. If the restart fails to resolve the problem, the unit 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 device attempts to store a maintenance record to allow the nature of the problem to be communicated to the user.

The self-monitoring is implemented in two stages: firstly a thorough diagnostic check which is performed on boot-up, and secondly a continuous self-checking operation, which checks the operation of the critical functions whilst it is in service.

3.4 STARTUP SELF-TESTING

The self-testing takes a few seconds to complete, during which time the IED's measurement, recording, control, and protection functions are unavailable. On a successful start-up and self-test, the 'Healthy' state LED on the front of the device is switched on. If a problem is detected during the start-up testing, the device remains out of service until it is manually restored to working order.

The operations that are performed at start-up are:

1. System boot
2. System software initialisation
3. Platform software initialisation and monitoring

3.4.1 SYSTEM BOOT

The integrity of the Flash memory is verified using a checksum before the program code and stored data is loaded into RAM for execution by the processor. When the loading has been completed, the data held in RAM is compared to that held in the Flash memory to ensure that no errors have occurred in the data transfer and that the two are the same. The entry point of the software code in RAM is then called. This is the IED's initialisation code.

3.4.2 SYSTEM LEVEL SOFTWARE INITIALISATION

The initialization process initializes the processor registers and interrupts, starts the watchdog timers (used by the hardware to determine whether the software is still running), starts the real-time operating system and creates and starts the supervisor task. In the initialization process the device checks the following:

- The status of the supercapacitor
- The integrity of the supercapacitor-backed SRAM that is used to store event, fault and disturbance records
- The operation of the LCD controller
- The watchdog operation

At the conclusion of the initialization software the supervisor task begins the process of starting the platform software.

3.4.3 PLATFORM SOFTWARE INITIALISATION AND MONITORING

When starting the platform software, the IED checks the following:

- The integrity of the data held in non-volatile memory (using a checksum)
- The operation of the real-time clock
- The optional IRIG-B function (if applicable)
- The presence and condition of the input board
- The analog data acquisition system (it does this by sampling the reference voltage)

At the successful conclusion of all of these tests the unit is entered into service and the application software is started up.

3.5 CONTINUOUS SELF-TESTING

When the IED 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 and the results are reported to the platform software. The functions that are checked are as follows:

- The Flash memory containing all program code and language text is verified by a checksum.
- The code and constant data held in system memory is checked against the corresponding data in Flash memory to check for data corruption.
- The system memory containing all data other than the code and constant data is verified with a checksum.
- The integrity of the digital signal I/O data from the opto-inputs and the output relay coils is checked by the data acquisition function every time it is executed.
- The operation of the analog data acquisition system is continuously checked by the acquisition function every time it is executed. This is done by sampling the reference voltages.
- The operation of the optional Ethernet board is checked by the software on the main processor card. If the Ethernet board fails to respond an alarm is raised and the card is reset in an attempt to resolve the problem.
- The operation of the optional IRIG-B function is checked by the software that reads the time and date from the board.

In the event that one of the checks detects an error in any of the subsystems, the platform software is notified and it attempts to log a maintenance record.

If the problem is with the IRIG-B board, the device continues in operation. For problems detected in any other area, the device initiates a shutdown and re-boot, resulting in a period of up to 10 seconds when the functionality is unavailable.

A restart should clear most problems that may occur. If, however, the diagnostic self-check detects the same problem that caused the IED to restart, it is clear that the restart has not cleared the problem, and the device takes itself permanently out of service. This is indicated by the ''health-state' LED on the front of the device, which switches OFF, and the watchdog contact which switches ON.

4 PLATFORM SOFTWARE

The platform software has three main functions:

- To control the logging of records generated by the protection software, including alarms, events, faults, and maintenance records
- To store and maintain a database of all of the settings in non-volatile memory
- To provide the internal interface between the settings database and the user interfaces, using the front panel interface and the front and rear communication ports

4.1 RECORD LOGGING

The logging function is used to store all alarms, events, faults and maintenance records. The records are stored in non-volatile memory to provide a log of what has happened. The IED maintains four types of log on a first in first out basis (FIFO). These are:

- Alarms
- Event records
- Fault records
- 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. The platform software is responsible for logging a maintenance record in the event of an IED failure. This includes errors that have been detected by the platform software itself or errors that are detected by either the system services or the protection software function. See the Monitoring and Control chapter for further details on record logging.

4.2 SETTINGS DATABASE

The settings database contains all the settings and data, which are stored in non-volatile memory. The platform software manages the settings database and ensures that only one user interface can modify the settings at any one time. This is a necessary restriction to avoid conflict between different parts of the software during a setting change.

Changes to protection settings and disturbance recorder settings, are first written to a temporary location SRAM memory. This is sometimes called 'Scratchpad' memory. These settings are not written into non-volatile memory immediately. This is because a batch of such changes should not be activated one by one, but as part of a complete scheme. Once the complete scheme has been stored in SRAM, the batch of settings can be committed to the non-volatile memory where they will become active.

4.3 INTERFACES

The settings and measurements database must be accessible from all of the interfaces to allow read and modify operations. The platform software presents the data in the appropriate format for each of the interfaces (LCD display, keypad and all the communications interfaces).

5 PROTECTION AND CONTROL FUNCTIONS

The protection and control software processes all of the protection elements and measurement functions. To achieve this it has to communicate with the system services software, the platform software as well as organise its own operations.

The protection task software has the highest priority of any of the software tasks in the main processor board. This ensures the fastest possible protection response.

The protection and control software provides a supervisory task, which controls the start-up of the task and deals with the exchange of messages between the task and the platform software.

5.1 ACQUISITION OF SAMPLES

After initialization, the protection and control task waits until there are enough samples to process. The acquisition of samples on the main processor board is controlled by a 'sampling function' which is called by the system services software.

This sampling function takes samples from the input module and stores them in a two-cycle FIFO buffer. The sample rate is 24 samples per cycle. This results in a nominal sample rate of 1,200 samples per second for a 50 Hz system and 1,440 samples per second for a 60 Hz system. However the sample rate is not fixed. It tracks the power system frequency as described in the next section.

5.2 FREQUENCY TRACKING

The device provides a frequency tracking algorithm so that there are always 24 samples per cycle irrespective of frequency drift within a certain frequency range (see technical specifications). If the frequency falls outside this range, the sample rate reverts to its default rate of 1200 Hz for 50 Hz or 1440 Hz for 60 Hz.

The frequency tracking of the analog input signals is achieved by a recursive Fourier algorithm which is applied to one of the input signals. It works by detecting a change in the signal's measured phase angle. The calculated value of the frequency is used to modify the sample rate being used by the input module, in order to achieve a constant sample rate per cycle of the power waveform. The value of the tracked frequency is also stored for use by the protection and control task.

The frequency tracks off any voltage or current in the order VA, VB, VC, IA, IB, IC, down to 10%Vn for voltage and 5%In for current.

5.3 DIRECT USE OF SAMPLED VALUES

Most of the IED's protection functionality uses the Fourier components calculated by the device's signal processing software. However RMS measurements and some special protection algorithms available in some products use the sampled values directly.

The disturbance recorder also uses the samples from the input module, in an unprocessed form. This is for waveform recording and the calculation of true RMS values of current, voltage and power for metering purposes.

In the case of special protection algorithms, using the sampled values directly provides exceptionally fast response because you do not have to wait for the signal processing task to calculate the fundamental. You can act on the sampled values immediately.

5.4 FOURIER SIGNAL PROCESSING

When the protection and control task is re-started by the sampling function, it calculates the Fourier components for the analog signals. Although some protection algorithms use some Fourier-derived harmonics (e.g. second harmonic for magnetizing inrush), most protection functions are based on the Fourier-derived fundamental components of the measured analog signals. The Fourier components of the input current and voltage signals are stored in memory so that they can be accessed by all of the protection elements' algorithms.

The Fourier components are calculated using single-cycle Fourier algorithm. This Fourier algorithm always uses the most recent 24 samples from the 2-cycle buffer.

Most protection algorithms use the fundamental component. In this case, the Fourier algorithm extracts the power frequency fundamental component from the signal to produce its magnitude and phase angle. This can be represented in either polar format or rectangular format, depending on the functions and algorithms using it.

The Fourier function acts as a filter, with zero gain at DC and unity gain at the fundamental, but with good harmonic rejection for all harmonic frequencies up to the nyquist frequency. Frequencies beyond this nyquist frequency are known as alias frequencies, which are introduced when the sampling frequency becomes less than twice the frequency component being sampled. However, the Alias frequencies are significantly attenuated by an anti-aliasing filter (low pass filter), which acts on the analog signals before they are sampled. The ideal cut-off point of an anti-aliasing low pass filter would be set at:

$$(\text{samples per cycle}) \times (\text{fundamental frequency})/2$$

At 24 samples per cycle, this would be nominally 600 Hz for a 50 Hz system, or 720 Hz for a 60 Hz system.

The following figure shows the nominal frequency response of the anti-alias filter and the Fourier filter for a 24-sample single cycle fourier algorithm acting on the fundamental component:

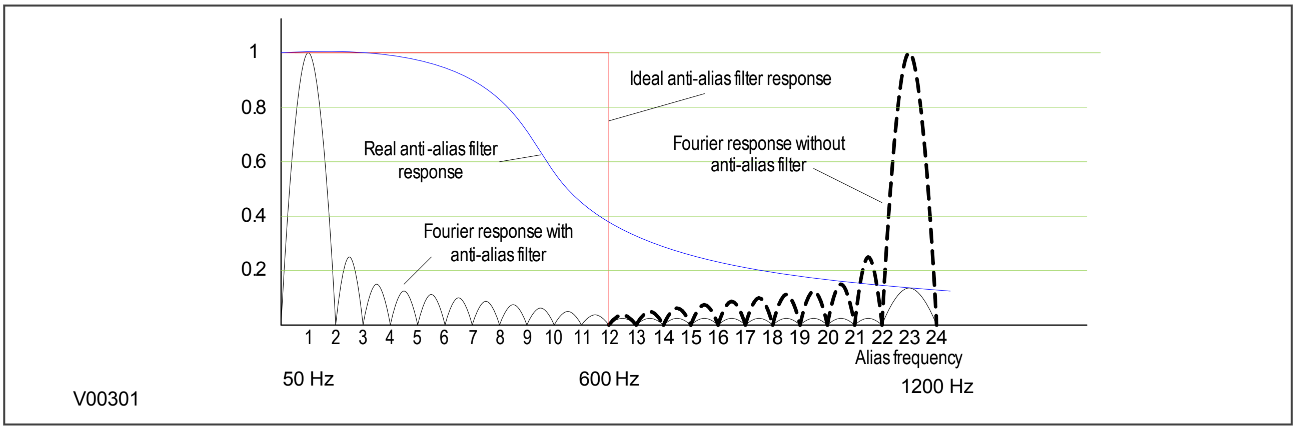


Figure 31: Frequency Response (indicative only)

5.5 PROGRAMMABLE SCHEME LOGIC

The purpose of the programmable scheme logic (PSL) is to allow you to configure your own protection schemes to suit your particular application. This is done with programmable logic gates and delay timers. To allow greater flexibility, different PSL is allowed for each of the four setting groups.

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 protection scheme logic (FSL). The fixed scheme logic provides the 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, and/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 & control software updates the logic delay timers and checks for a change in the PSL input signals every time it runs.

The PSL can be configured to create very complex schemes. Because of this PSL design is achieved by means of a PC support package called the PSL Editor. This is available as part of the settings application software MiCOM S1 Agile, or as a standalone software module.

5.6 EVENT 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 indicate that an event is available to be processed and writes the event data to a fast buffer controlled by the supervisor task. When the supervisor task receives an event record, it instructs the platform software to create the appropriate log in non-volatile memory (backed-up SRAM). The operation of the record logging to backed-up SRAM is slower than the supervisor buffer. This means that the protection software is not delayed waiting for the records to be logged by the platform software. However, in the rare case when a large number of records to be logged are created in a short period of time, it is possible that some will be lost, if the supervisor buffer is full before the platform software is able to create a new log in backed-up SRAM. If this occurs then an event is logged to indicate this loss of information.

Maintenance records are created in a similar manner, with the supervisor task instructing the platform software to log a record when it receives a maintenance record message. However, it is possible that a maintenance record may be triggered by a fatal error in the relay in which case it may not be possible to successfully store a maintenance record, depending on the nature of the problem.

For more information, see the Monitoring and Control chapter.

5.7 DISTURBANCE RECORDER

The disturbance recorder operates as a separate task from the protection and control task. It can record the waveforms of the calibrated analog channels, plus the values of the digital signals. The recording time is user selectable up to a maximum of 10.5 seconds. The disturbance recorder is supplied with data by the protection and control task once per cycle, and collates the received data into the required length disturbance record. The disturbance records can be extracted using application software or the SCADA system, which can also store the data in COMTRADE format, allowing the use of other packages to view the recorded data.

For more information, see the Monitoring and Control chapter.

5.8 FAULT LOCATOR

The fault locator uses 12 cycles of the analog input signals to calculate the fault location. The result is returned to the protection and control task, which includes it in the fault record. The pre-fault and post-fault voltages are also presented in the fault record. When the fault record is complete, including the fault location, the protection and control task sends a message to the supervisor task to log the fault record.

The Fault Locator is not available on all models.

5.9 FUNCTION KEY INTERFACE

The function keys interface directly into the PSL as digital input signals. 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. It 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 thus allowing the function key state to be reinstated after power-up, should power be inadvertently lost.

CHAPTER 5

CONFIGURATION

1 CHAPTER OVERVIEW

Each product has different configuration parameters according to the functions it has been designed to perform. There is, however, a common methodology used across the entire product series to set these parameters.

Some of the communications setup can only be carried out using the HMI, and cannot be carried out using settings applications software. This chapter includes concise instructions of how to configure the device, particularly with respect to the communications setup, as well as a description of the common methodology used to configure the device in general.

This chapter contains the following sections:

2 SETTINGS APPLICATION SOFTWARE

To configure this device you will need to use the Settings Application Software. The settings application software used in this range of IEDs is called MiCOM S1 Agile. It is a collection of software tools, which is used for setting up and managing the IEDs.

Although you can change many settings using the front panel HMI, some of the features cannot be configured without the Settings Application Software; for example the programmable scheme logic, or IEC61850 communications.

If you do not already have a copy of the Settings Application Software, you can obtain it from GE contact centre.

To configure your product, you will need a data model that matches your product. When you launch the Settings Application Software, you will be presented with a panel that allows you to invoke the “Data Model Manager”. This will close the other aspects of the software in order to allow an efficient import of the chosen data model. If you don’t have, or can’t find, the data model relating to your product, please call the GE contact centre.

When you have loaded all the data models you need, you should restart the Settings Application Software and start to create a model of your system using the “System Explorer” panel.

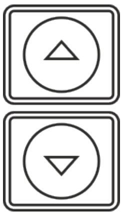
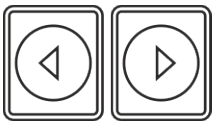
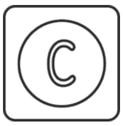
The software is designed to be intuitive, but help is available in an online help system and also the Settings Application Software user guide P40-M&CR-SAS-UG-EN-n, where 'Language' is a 2 letter code designating the language version of the user guide and 'n' is the latest version of the settings application software.

3 USING THE HMI PANEL

Using the HMI, you can:

- Display and modify settings
- View the digital I/O signal status
- Display measurements
- Display fault records
- Reset fault and alarm indications

The keypad provides full access to the device functionality using a range of menu options. The information is displayed on the LCD.

Keys	Description	Function
	Up and down cursor keys	To change the menu level or change between settings in a particular column, or changing values within a cell
	Left and right cursor keys	To change default display, change between column headings, or changing values within a cell
	ENTER key	For changing and executing settings
	Hotkeys	For executing commands and settings for which shortcuts have been defined
	Cancel key	To return to column header from any menu cell
	Read key	To read alarm messages
	Function keys (not all models)	For executing user programmable functions

Note:
As the LCD display has a resolution of 16 characters by 3 lines, some of the information is in a condensed mnemonic form.

3.1 NAVIGATING THE HMI PANEL

The cursor keys are used to navigate the menus. These keys have an auto-repeat function if held down continuously. This can be used to speed up both setting value changes and menu navigation. The longer the key is held pressed, the faster the rate of change or movement.

The navigation map below shows how to navigate the menu items.

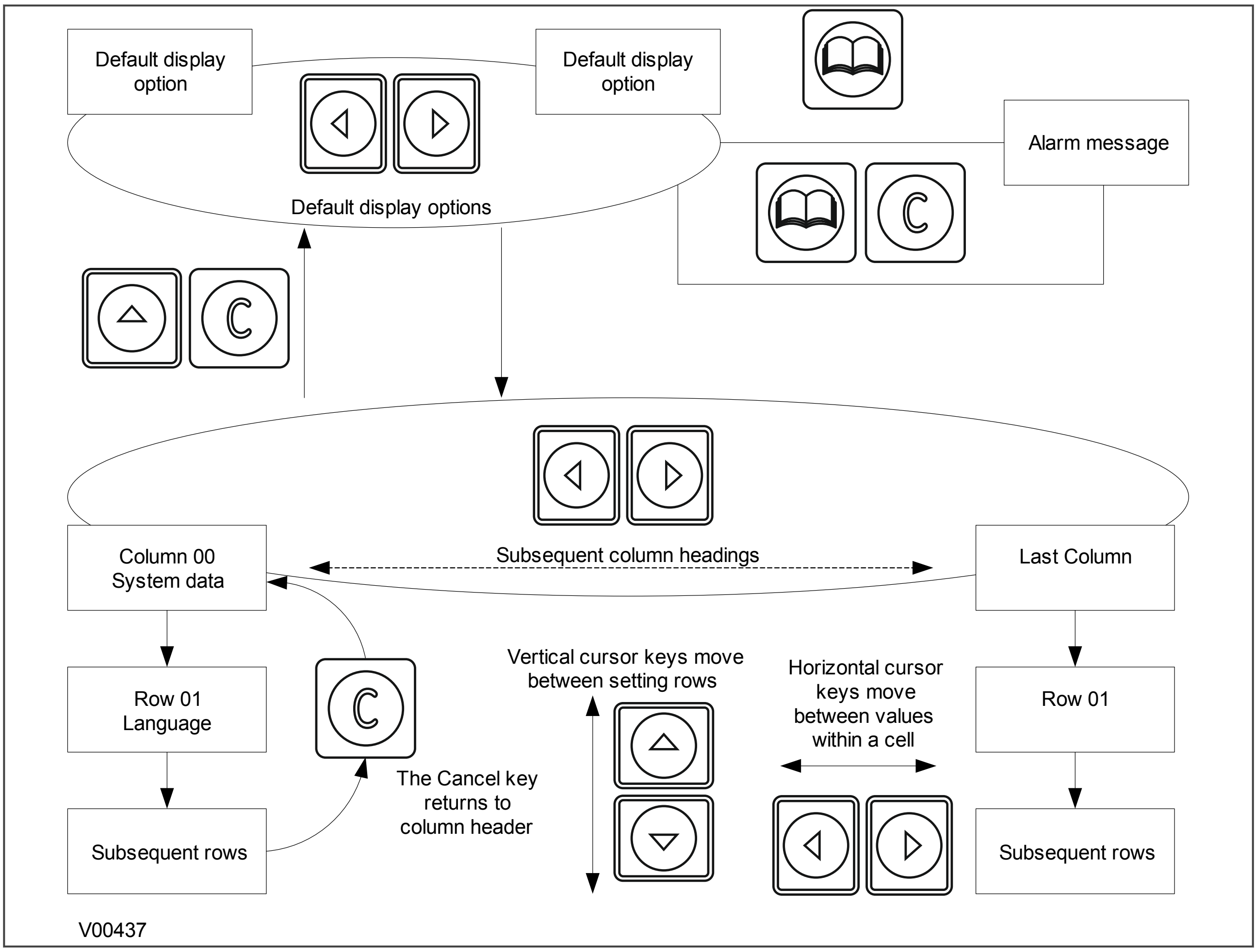


Figure 32: Navigating the HMI

3.2 GETTING STARTED

When you first start the IED, it will go through its power up procedure. After a few seconds it will settle down into one of the top level menus. There are two menus at this level:

- The Alarms menu for when there are alarms present
- The default display menu for when there are no alarms present.

If there are alarms present, the yellow Alarms LED will be flashing and the menu display will read as follows:

```
Alarms / Faults
Present
HOTKEY
```

Even though the device itself should be in full working order when you first start it, an alarm could still be present, for example, if there is no network connection for a device fitted with a network card. If this is the case, you can read the alarm by pressing the 'Read' key.

```
ALARMS
NIC Link Fail
```

If the device is fitted with an Ethernet card, you will first need to connect the device to an active Ethernet network to clear the alarm and get the default display.

If there are other alarms present, these must also be cleared before you can get into the default display menu options.

3.3 DEFAULT DISPLAY

The HMI contains a range of possible options that you can choose to be the default display. The options available are:

NERC Compliant banner

If the device is a cyber-security model, it will provide a NERC-compliant default display. If the device does not contain the cyber-security option, this display option is not available.

```
ACCESS ONLY FOR
AUTHORISED USERS
HOTKEY
```

Date and time

For example:

```
11:09:15
23 Nov 2011
HOTKEY
```

Description (user-defined)

For example:

```
Description
MiCOM P14NB
HOTKEY
```

Plant reference (user-defined)

For example:

```
Plant Reference
MiCOM
HOTKEY
```

Access Level

For example:

```
Access Level
3
HOTKEY
```

In addition to the above, there are also displays for the system voltages, currents, power and frequency etc., depending on the device model.

3.4 DEFAULT DISPLAY NAVIGATION

The following diagram is an example of the default display navigation. In this example, we have used a cyber-secure model. This is an example only and may not apply in its entirety to all models. The actual display options available depend on the exact model.

Use the horizontal cursor keys to step through from one display to the next.

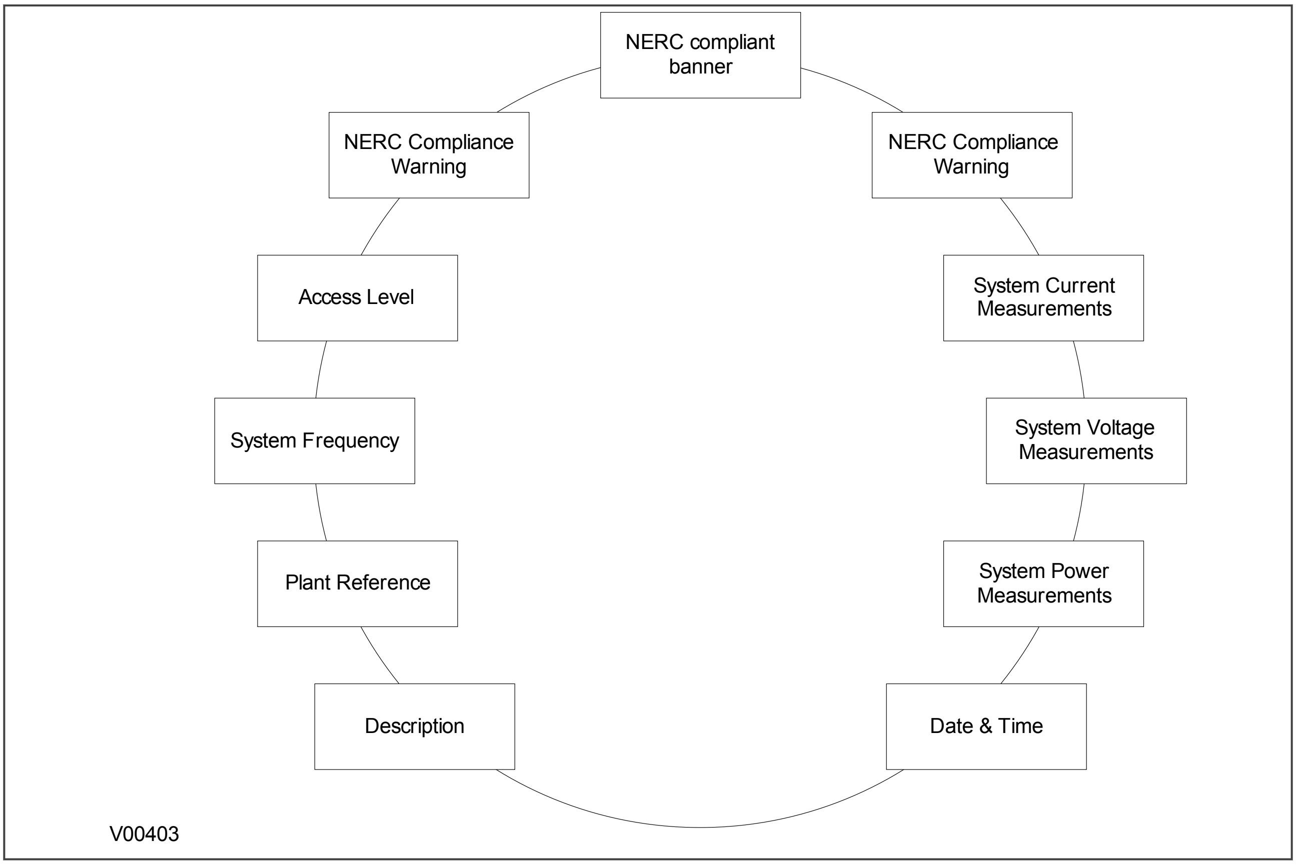


Figure 33: Default display navigation

If the device is cyber-secure but is not yet configured for NERC compliance (see Cyber-security chapter), a warning will appear when moving from the "NERC compliant" banner. The warning message is as follows:

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

You will have to confirm with the **Enter** button before you can go any further.

> *Note:*
> *Whenever the IED has an uncleared alarm the default display is replaced by the text Alarms/ Faults present. You cannot override this default display. However, you can enter the menu structure from the default display, even if the display shows the Alarms/Faults present message.*

3.5 PASSWORD ENTRY

Configuring the default display (in addition to modification of other settings) requires level 3 access. You will be prompted for a password before you can make any changes, as follows. The default level 3 password is AAAA.

```
Enter Password
```

1. A flashing cursor shows which character field of the password can be changed. Press the up or down cursor keys to change each character (tip: pressing the up arrow once will return an upper case "A" as required by the default level 3 password).
2. Use the left and right cursor keys to move between the character fields of the password.
3. Press the **Enter** key to confirm the password. If you enter an incorrect password, an invalid password message is displayed then the display reverts to ***Enter password***. On entering a valid password a message appears indicating that the password is correct and which level of access has been unlocked. If this level is sufficient to edit the selected setting, the display returns to the setting page to allow the edit to continue. If the correct level of password has not been entered, the password prompt page appears again.
4. To escape from this prompt press the **Clear** key. Alternatively, enter the password using the ***Password*** setting in the *SYSTEM DATA* column. If the keypad is inactive for 15 minutes, the password protection of the front panel user interface reverts to the default access level.

To manually reset the password protection to the default level, select ***Password***, then press the CLEAR key instead of entering a password.

> *Note:*
> *In the SECURITY CONFIG column, you can set the maximum number of attemps, the time window in which the failed attempts are counted and the time duration for which the user is blocked.*

3.6 PROCESSING ALARMS AND RECORDS

If there are any alarm messages, they will appear on the default display and the yellow alarm LED flashes. The alarm messages can either be self-resetting or latched. If they are latched, 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 changes 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 cursor keys. 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 the **Clear** key. To return to the display showing alarms or faults present, and leave the alarms uncleared, press the **Read** key.
4. Depending on the password configuration settings, you may need to enter a password before the alarm messages can be cleared.
5. When all alarms are cleared, the yellow alarm LED switches off. If the red LED was on, this will also be switched off.

> *Note:*
> *To speed up the procedure, you can enter the alarm viewer using the* ***Read*** *key and subsequently pressing the* ***Clear*** *key. This goes straight to the fault record display. Press the* ***Clear*** *key again to move straight to the alarm reset prompt, then press the* ***Clear*** *key again to clear all alarms.*

3.7 MENU STRUCTURE

Settings, commands, records and measurements are stored in a local database inside the IED. When using the Human Machine Interface (HMI) it is convenient to visualise the menu navigation system as a table. Each item in the menu is known as a cell, which is accessed by reference to a column and row address. Each column and row is assigned a 2-digit hexadecimal numbers, resulting in a unique 4-digit cell address for every cell in the database. The main menu groups are allocated columns and the items within the groups are allocated rows, meaning a particular item within a particular group is a cell.

Each column contains all related items, for example all of the disturbance recorder settings and records are in the same column.

There are three types of cell:

- Settings: this is for parameters that can be set to different values
- Commands: this is for commands to be executed
- Data: this is for measurements and records to be viewed, which are not settable

> *Note:*
> *Sometimes the term "Setting" is used generically to describe all of the three types.*

The table below, provides an example of the menu structure:

SYSTEM DATA (Col 00)	VIEW RECORDS (Col 01)	MEASUREMENTS 1 (Col 02)	...
Language (Row 01)	"Select Event [0...n]" (Row 01)	IA Magnitude (Row 01)	...
Password (Row 02)	Menu Cell Ref (Row 02)	IA Phase Angle (Row 02)	...
Sys Fn Links (Row 03)	Time & Date (Row 03)	IB Magnitude (Row 03)	...
...	...	...	...

It is convenient to specify all the settings in a single column, detailing the complete Courier address for each setting. The above table may therefore be represented as follows:

Setting	Column	Row	Description
SYSTEM DATA	**00**	**00**	**First Column definition**
Language (Row 01)	00	01	First setting within first column
Password (Row 02)	00	02	Second setting within first column
Sys Fn Links (Row 03)	00	03	Third setting within first column
…	…	…	
VIEW RECORDS	**01**	**00**	**Second Column definition**
Select Event [0…n]	01	01	First setting within second column
Menu Cell Ref	01	02	Second setting within second column
Time & Date	01	03	Third setting within second column
…	…	…	
MEASUREMENTS 1	**02**	**00**	**Third Column definition**
IA Magnitude	02	01	First setting within third column
IA Phase Angle	02	02	Second setting within third column
IB Magnitude	02	03	Third setting within third column
…	…	…	

The first three column headers are common throughout much of the product ranges. However the rows within each of these column headers may differ according to the product type. Many of the column headers are the same for all products within the series. However, there is no guarantee that the addresses will be the same for a particular column header. Therefore you should always refer to the product settings documentation and not make any assumptions.

3.8 CHANGING THE SETTINGS

1. Starting at the default display, press the **Down** cursor key to show the first column heading.
2. Use the horizontal cursor keys to select the required column heading.
3. Use the vertical cursor keys to view the setting data in the column.
4. To return to the column header, either press the Up cursor key for a second or so, 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 Up cursor key or the **Clear** key from any of the column headings. If you use the auto-repeat function of the Up cursor 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. 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 that the value can be changed. You may be prompted for a password first.
7. To change the setting value, press the **Up** and **Down** cursor 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 horizontal cursor keys.

8. Press the **Enter** key to confirm the new setting value or the **Clear** key to discard it. The new setting is automatically discarded if it is not confirmed within 15 seconds.
9. For protection group settings and disturbance recorder settings, the changes must be confirmed before they are used. When all required changes have been entered, return to the column heading level and press the Down cursor key. Before returning to the default display, the following prompt appears.

```
Update settings?
ENTER or CLEAR
```

10. Press the **Enter** key to accept the new settings or press the **Clear** key to discard the new settings.

> *Note:*
> *For the protection group and disturbance recorder settings, if the menu time-out occurs before the changes have been confirmed, the setting values are discarded. Control and support settings, howeverr, are updated immediately after they are entered, without the* ***Update settings?*** *prompt.*

3.9 DIRECT ACCESS (THE HOTKEY MENU)

It can be an onerous process to configure settings using the HMI panel, especially for settings and commands that need to be executed quickly or on a regular basis. The IED provides a pair of keys directly below the LCD display, which can be used to execute specified settings and commands directly.

The functions available for direct access using these keys are:

- Setting group selection
- Control Inputs

These functions are enabled or disabled in the ***Direct Access*** cell in the *CONFIGURATION* column.

3.9.1 SETTING GROUP SELECTION USING HOTKEYS

In some models you can use the hotkey menu to select the settings group. By default, only Setting group 1 is enabled. Other setting groups will only be available if they are first enabled. To be able to select a different setting group, you must first enable them in the *CONFIGURATION* column.

To access the hotkey menu from the default display, you press the key directly below the HOTKEY text on the LCD. The following screen will appear.

```
←User32 STG GP→
HOTKEY MENU
           EXIT
```

Use the right cursor keys to enter the *SETTING GROUP* menu.

```
←Menu User01→
SETTING GROUP 1
Nxt Grp Select
```

Select the setting group with ***Nxt Grp*** and confirm by pressing ***Select***. If neither of the cursor keys is pressed within 20 seconds of entering a hotkey sub menu, the device reverts to the default display.

3.9.2 CONTROL INPUTS

The control inputs are user-assignable functions. You can use the *CTRL I/P CONFIG* column to configure the control inputs for the hotkey menu. In order to do this, use the first setting ***Hotkey Enabled*** cell to enable or disable any of the 32 control inputs. You can then set each control input to latched or pulsed and set its command to `On/Off`, `Set/Reset`, `In/Out`, or `Enabled/Disabled`.

By default, the hotkey is enabled for all 32 control inputs and they are set to `Set/Reset` and are `Latched`.

To access the hotkey menu from the default display, you press the key directly below the HOTKEY text on the LCD. The following screen will appear.

```
←User32 STG GP→
HOTKEY MENU
            EXIT
```

Press the right cursor key twice to get to the first control input, or the left cursor key to get to the last control input.

```
←STP GP User02→
Control Input 1
EXIT SET
```

Now you can execute the chosen function (Set/Reset in this case).

If neither of the cursor keys is pressed within 20 seconds of entering a hotkey sub menu, the device reverts to the default display.

3.10 FUNCTION KEYS

Most products have a number of function keys for programming control functionality using the programmable scheme logic (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 are in the *FUNCTION KEYS* column.

The first cell down in the *FUNCTION KEYS* column is the ***Fn Key Status*** cell. This contains a binary string, which represents the function key commands. Their status can be read from this binary string.

```
FUNCTION KEYS
Fn Key Status
0000000000
```

The next cell down (***Fn Key 1***) allows you to activate or disable the first function key (1). The ***Lock*** setting allows a function key to be locked. This allows function keys that are set to `Toggled` mode and their DDB signal active 'high', to be locked in their active state, 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 functions.

```
FUNCTION KEYS
Fn Key 1
Unlocked
```

The next cell down (***Fn Key 1 Mode***) allows you to set the function key to `Normal` or `Toggled`. In the Toggle mode the function key DDB signal output stays 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 stays energised for as long as the function key is pressed then resets automatically. If required, a minimum pulse width can be programmed by adding a minimum pulse timer to the function key DDB output signal.

```
FUNCTION KEYS
Fn Key 1 Mode
Toggled
```

The next cell down (***Fn Key 1 Label***) allows you to change the label assigned to the function. The default label is `Function key 1` in this case. To change the label you need to press the enter key and then change the text on the bottom line, character by character. This text is displayed when a function key is accessed in the function key menu, or it can be displayed in the PSL.

```
FUNCTION KEYS
Fn Key 1 Label
Function Key 1
```

Subsequent cells allow you to carry out the same procedure as above for the other function keys.

The status of the function keys is stored in non-volatile memory. If the auxiliary supply is interrupted, the status of all the function keys is restored. The IED only recognises a single function key press at a time and a minimum key press duration of approximately 200 ms is required before the key press is recognised. This feature avoids accidental double presses.

4 CONFIGURING THE DATA PROTOCOLS

Different protocols can be used with the various ports. The choice of protocol depends on the chosen model. Each port can support only one protocol at a time. The range of available communication settings depend on which protocol has been chosen.

Depending on the exact model, the following choices may be available:

- Courier over RS485
- Tunneled Courier over Ethernet
- MODBUS over RS485
- DNP3 over RS485
- DNP3 over Ethernet
- IEC 60870-5-103 over RS485
- IEC61850 over Ethernet

> *Note:*
> *Not all protocols are available on all products*

You configure most of the communication settings using the HMI. Depending on the model, you will also need to use the settings applications software to carry out some of the configuration, such as the IEC61850 configurator. Detailed information on configuring the data protocols can be found in the communications chapter.

4.1 COURIER CONFIGURATION

To configure the device:

1. Select the *CONFIGURATION* column and check that the ***Comms settings*** cell is set to `Visible`.
2. Select the *COMMUNICATIONS* column.
3. Move to the first cell down (***RP1 protocol***). This is a non-settable cell, which shows the chosen communication protocol – in this case `Courier`.

```
COMMUNICATIONS
RP1 Protocol
Courier
```

4. Move down to the next cell (***RP1 Address***). This cell controls the address of the RP1 port on the device. Up to 32 IEDs can be connected to one spur. It is therefore necessary for each IED to have a unique address so that messages from the master control station are accepted by one IED only. Courier uses an integer number between 1 and 254 for the Relay Address. It is set to 255 by default, which has to be changed. It is important that no two IEDs share the same address.

```
COMMUNICATIONS
RP1 Address
100
```

5. Move down to the next cell (***RP1 InactivTimer***). This cell controls the inactivity timer. The inactivity timer controls how long the IED waits without receiving any messages on the rear port before revoking any password access that was enabled and discarding any changes. For the rear port this can be set between 1 and 30 minutes.

```
COMMUNICATIONS
RP1 Inactivtimer
10.00 mins.
```

6. If the optional fibre optic connectors are fitted, the ***RP1 PhysicalLink*** cell is visible. This cell controls the physical media used for the communication (Copper or Fibre optic).

```
COMMUNICATIONS
RP1 PhysicalLink
Copper
```

7. Move down to the next cell (***RP1 Card Status***). This cell is not settable. It displays the status of the chosen physical layer protocol for RP1.

```
COMMUNICATIONS
RP1 Card Status
K-Bus OK
```

8. Move down to the next cell (***RP1 Port Config***). This cell controls the type of serial connection. Select between K-Bus or RS485.

```
COMMUNICATIONS
RP1 Port Config
K-Bus
```

9. If using EIA(RS)485, the next cell (***RP1 Comms Mode***) selects the communication mode. The choice is either IEC 60870 FT1.2 for normal operation with 11-bit modems, or 10-bit no parity. If using K-Bus this cell will not appear.

```
COMMUNICATIONS
RP1 Comms Mode
IEC 60870 FT1.2
```

10. If using EIA(RS)485, the next cell down controls the baud rate. Three baud rates are supported; 9600, 19200 and 38400. If using K-Bus this cell will not appear as the baud rate is fixed at 64 kbps.

```
COMMUNICATIONS
RP1 Baud rate
19200
```

4.2 DNP3 CONFIGURATION

To configure the device:

1. Select the *CONFIGURATION* column and check that the ***Comms settings*** cell is set to `Visible`.
2. Select the *COMMUNICATIONS* column.
3. Move to the first cell down (***RP1 protocol***). This is a non-settable cell, which shows the chosen communication protocol – in this case `DNP3.0`.

```
COMMUNICATIONS
RP1 Protocol
DNP3.0
```

4. Move down to the next cell (***RP1 Address***). This cell controls the DNP3.0 address of the IED. Up to 32 IEDs can be connected to one spur, therefore it is necessary for each IED to have a unique address so that messages from the master control station are accepted by only one IED. DNP3.0 uses a decimal number between 1 and 65519 for the Relay Address. It is important that no two IEDs have the same address.

```
COMMUNICATIONS
RP1 Address
1
```

5. Move down to the next cell (***RP1 Baud Rate***). This cell controls the baud rate to be used. Six baud rates are supported by the IED 1200 bps, 2400 bps, 4800 bps, 9600 bps, 19200 bps and 38400 bps. Make sure that the baud rate selected on the IED is the same as that set on the master station.

```
COMMUNICATIONS
RP1 Baud rate
9600 bits/s
```

6. Move down to the next cell (***RP1 Parity***). This cell controls the parity format used in the data frames. The parity can be set to be one of `None`, `Odd` or `Even`. Make sure that the parity format selected on the IED is the same as that set on the master station.

```
COMMUNICATIONS
RP1 Parity
None
```

7. If the optional fibre optic connectors are fitted, the ***RP1 PhysicalLink*** cell is visible. This cell controls the physical media used for the communication (Copper or Fibre optic).

```
COMMUNICATIONS
RP1 PhysicalLink
Copper
```

8. Move down to the next cell (***RP1 Time Sync***). This cell affects the time synchronisation request from the master by the IED. It can be set to `enabled` or `disabled`. If enabled it allows the DNP3.0 master to synchronise the time on the IED.

```
COMMUNICATIONS
RP1 Time Sync
Enabled
```

4.2.1 DNP3 CONFIGURATOR

A PC support package for DNP3.0 is available as part of the supplied settings application software (MiCOM S1 Agile) to allow configuration of the device's DNP3.0 response. The configuration data is uploaded from the device to the PC in a block of compressed format data and downloaded in a similar manner after modification. The new DNP3.0 configuration takes effect 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 MiCOM S1 Agile, the DNP3.0 data is shown in three main folders, one folder each for the point configuration, integer scaling and default variation (data format). The point configuration also includes screens for binary inputs, binary outputs, counters and analogue input configuration.

If the device supports DNP Over Ethernet, the configuration related settings are done in the folder **DNP Over Ethernet**.

4.3 IEC 60870-5-103 CONFIGURATION

To configure the device:

1. Select the *CONFIGURATION* column and check that the ***Comms settings*** cell is set to `Visible`.
2. Select the *COMMUNICATIONS* column.
3. Move to the first cell down (***RP1 protocol***). This is a non-settable cell, which shows the chosen communication protocol – in this case `IEC 60870-5-103`.

```
COMMUNICATIONS
RP1 Protocol
IEC 60870-5-103
```

4. Move down to the next cell (***RP1 Address***). This cell controls the IEC 60870-5-103 address of the IED. Up to 32 IEDs can be connected to one spur. It is therefore necessary for each IED to have a unique address so that messages from the master control station are accepted by one IED only. IEC 60870-5-103 uses an integer number between 0 and 254 for the address. It is important that no two IEDs have the same IEC 60870 5 103 address. The IEC 60870-5-103 address is then used by the master station to communicate with the IED.

```
COMMUNICATIONS
RP1 address
162
```

5. Move down to the next cell (***RP1 Baud Rate***). This cell controls the baud rate to be used. Two baud rates are supported by the IED, `9600 bits/s` and `19200 bits/s`. Make sure that the baud rate selected on the IED is the same as that set on the master station.

```
COMMUNICATIONS
RP1 Baud rate
9600 bits/s
```

6. Move down to the next cell (***RP1 Meas Period***). The next cell down controls the period between IEC 60870-5-103 measurements. The IEC 60870-5-103 protocol allows the IED to supply measurements at regular intervals. The interval between measurements is controlled by this cell, and can be set between 1 and 60 seconds.

```
COMMUNICATIONS
RP1 Meas Period
30.00 s
```

7. If the optional fibre optic connectors are fitted, the ***RP1 PhysicalLink*** cell is visible. This cell controls the physical media used for the communication (Copper or Fibre optic).

```
COMMUNICATIONS
RP1 PhysicalLink
Copper
```

8. The next cell down (***RP1 CS103Blcking***) can be used for monitor or command blocking.

```
COMMUNICATIONS
RP1 CS103Blcking
Disabled
```

9. There are three settings associated with this cell; these are:

Setting:	Description:
Disabled	No blocking selected.
Monitor Blocking	When the monitor blocking DDB Signal is active high, either by energising an opto input or control input, reading of the status information and disturbance records is not permitted. When in this mode the device returns a "Termination of general interrogation" message to the master station.
Command Blocking	When the command blocking DDB signal is active high, either by energising 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 device returns a "negative acknowledgement of command" message to the master station.

4.4 MODBUS CONFIGURATION

To configure the device:

1. Select the *CONFIGURATION* column and check that the ***Comms settings*** cell is set to `Visible`.
2. Select the *COMMUNICATIONS* column.

3. Move to the first cell down (***RP1 protocol***). This is a non settable cell, which shows the chosen communication protocol – in this case `Modbus`.

```
COMMUNICATIONS
RP1 Protocol
Modbus
```

4. Move down to the next cell (***RP1 Address***). This cell controls the Modbus address of the IED. Up to 32 IEDs can be connected to one spur, therefore it is necessary for each IED to have a unique address so that messages from the master control station are accepted by only one IED. Modbus uses a decimal number between 1 and 247 for the Relay Address. It is important that no two IEDs have the same address.

```
COMMUNICATIONS
RP1 Address
1
```

5. Move down to the next cell (***RP1 InactivTimer***). This cell controls the inactivity timer. The inactivity timer controls how long the IED 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.

```
COMMUNICATIONS
RP1 Inactivtimer
10.00 mins
```

6. Move down to the next cell (***RP1 Baud Rate***). This cell controls the baud rate to be used. Six baud rates are supported by the IED 1200 bits/s, 2400 bits/s, 4800 bits/s, 9600 bits/s, 19200 bits/s and 38400 bits/s. Make sure that the baud rate selected on the IED is the same as that set on the master station.

```
COMMUNICATIONS
RP1 Baud rate
9600 bits/s
```

7. Move down to the next cell (***RP1 Parity***). This cell controls the parity format used in the data frames. The parity can be set to be one of `None`, `Odd` or `Even`. Make sure that the parity format selected on the IED is the same as that set on the master station.

```
COMMUNICATIONS
RP1 Parity
None
```

8. Move down to the next cell (***Modbus IEC Time***). This cell controls the order in which the bytes of information are transmitted. There is a choice of Standard or Reverse. When `Standard` is selected the time format complies with IEC 60870-5-4 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.

```
COMMUNICATIONS
Modbus IEC Time
Standard
```

4.5 IEC 61850 CONFIGURATION

You cannot configure the device for IEC 61850 edition 1 using the HMI panel on the product. For this you must use the IEC 61850 Configurator, which is part of the settings application software. If the device is compatible with edition 2, however, you can configure it with the HMI. To configure IEC61850 edition 2 using the HMI, you must first enable the IP From HMI setting, after which you can set the media (copper or fibre), IP address, subnet mask and gateway address.

IEC 61850 allows IEDs to be directly configured from a configuration file. The IED's system configuration capabilities are determined from an IED Capability Description file (ICD), supplied with the product. By using ICD files from the products to be installed, you can design, configure and test (using simulation tools), a substation's entire protection scheme before the products are installed into the substation.

To help with this process, the settings application software provides an IEC 61850 Configurator tool, which allows the pre-configured IEC 61850 configuration file to be imported and transferred to the IED. As well as this, you can manually create configuration files for all products, based on their original IED capability description (ICD file).

Other features include:

- The extraction of configuration data for viewing and editing.
- A sophisticated error checking sequence to validate the configuration data before sending to the IED.

> *Note:*
> *Some configuration data is available in the IEC61850 CONFIG. column, allowing read-only access to basic configuration data.*

4.5.1 IEC 61850 CONFIGURATION BANKS

There are two configuration banks:

- Active Configuration Bank
- Inactive Configuration Bank

Any new configuration sent to the IED is automatically stored in the inactive configuration bank, therefore not immediately affecting the current configuration.

Following an upgrade, the IEC 61850 Configurator tool can be used to transmit a command, which authorises activation of the new configuration contained in the inactive configuration bank. This is done by switching the active and inactive configuration banks. The capability of switching the configuration banks is also available using the *IEC61850 CONFIG.* column of the HMI.

The SCL Name and Revision attributes of both configuration banks are available in the *IEC61850 CONFIG.* column of the HMI.

4.5.2 IEC 61850 NETWORK CONNECTIVITY

Configuration of the IP parameters and SNTP (Simple Network Time Protocol) time synchronisation parameters is performed by the IEC 61850 Configurator tool. If these parameters are not available using an SCL (Substation Configuration Language) file, they must be configured manually.

Every IP address on the Local Area Network must be unique. Duplicate IP addresses result in conflict and must be avoided. Most IEDs check for a conflict on every IP configuration change and at power up and they raise an alarm if an IP conflict is detected.

The IED can be configured to accept data from other networks using the ***Gateway*** setting. If multiple networks are used, the IP addresses must be unique across networks.

5 DATE AND TIME CONFIGURATION

The date and time setting will normally be updated automatically by the chosen UTC (Universal Time Co-ordination) time synchronisation mechanism when the device is in service. You can also set the date and time manually using the ***Date/Time*** cell in the *DATE AND TIME* column.

5.1 USING AN SNTP SIGNAL

When using SNTP to maintain the clock, the IED must first be connected to the SNTP server, which should be energized and functioning.

1. In the *DATE AND TIME* column, check that either the ***Primary Source*** or ***Secondary Source*** setting is set to `SNTP`.
2. Ensure that the IED is receiving valid time synchronisation messages by checking that the ***SNTP Status*** cell reads `Server 1 OK` or `Server 2 OK`.
3. Check that the ***Act. Time Source*** cell reads `SNTP`. This indicates that the IED is using PTP as the source for its time. Note that If IRIG-B or PTP have been selected as the Primary Source, these must first be disconnected before the device can switch to SNTP as the active source.
4. Once the IED is using SNTP as the active time source, adjust the time offset of the universal coordinated time on the SNTP Server equipment, so that local time is displayed.
5. Check that the time, date and month are correct in the ***Date/Time*** cell.

5.2 USING AN IRIG-B SIGNAL

When using IRIG-B to maintain the clock, the IED must first be connected to the timing source equipment (usually a P594/RT430), which should be energized and functioning.

1. In the *DATE AND TIME* column, check that either the ***Primary Source*** or ***Secondary Source*** setting is set to `IRIG-B`.
2. Ensure the IED is receiving the IRIG-B signal by checking that ***IRIG-B Status*** cell reads `Active`
3. Check that the ***Act. Time Source*** cell reads `IRIG-B`. This indicates that the IED is using IRIG-B as the source for its time. Note that If SNTP or PTP have been selected as the Primary Source, these must first be disconnected before the device can switch to IRIG-B as the active source.
4. Once the IED is using IRIG-B as the active time source, adjust the time offset of the universal coordinated time (satellite clock time) on the satellite clock equipment, so that local time is displayed.
5. Check that the time, date and month are correct in the ***Date/Time*** cell. The IRIG-B signal does not contain the current year so this also needs to be set manually in this cell.
6. If the auxiliary supply fails, the time and date are maintained by the supercapacitor. Therefore, when the auxiliary supply is restored, you should not have to set the time and date again. To test this, remove the IRIG-B signal, and then remove the auxiliary supply. Leave the device de-energized for approximately 30 seconds. On re-energization, the time should be correct.
7. Reconnect the IRIG-B signal.

5.3 USING AN IEEE 1588 PTP SIGNAL

When using IEEE 1588 PTP to maintain the clock, the IED must first be connected to the PTP Grandmaster, which should be energized and functioning.

1. In the *DATE AND TIME* column, check that either the ***Primary Source*** or ***Secondary Source*** setting is set to `PTP`.
2. Set the ***Domain Number*** setting. The domain defines which clocks the IED will use for synchronisation. Therefore this number must match the domain used by the other clocks on the network.

3. Ensure that the IED is receiving valid time synchronisation messages by checking that the ***PTP Status*** cell reads `Valid Master`.
4. Check that ***Act. Time Source*** cell reads `PTP`. This indicates that the IED is using PTP as the source for its time. Note that If IRIG-B or SNTP have been selected as the Primary Source, these must first be disconnected before the device can switch to PTP as the active source.
5. Once the IED is using PTP as the active time source, adjust the time offset of the universal coordinated time on the Master Clock equipment, so that local time is displayed.
6. Check that the time, date and month are correct in the ***Date/Time*** cell.

5.4 WITHOUT A TIMING SOURCE SIGNAL

If the time and date is not being maintained by an IRIG-B, PTP or SNTP signal, in the *DATE AND TIME* column, ensure that both the ***Primary Source*** and ***Secondary Source*** are set to `NONE`.

1. Check that ***Act. Time Source*** cell reads `Free Running`.
2. Set the date and time to the correct local time and date using the Date/Time cell or the serial protocol.
3. If the auxiliary supply fails, the time and date are maintained by the supercapacitor. Therefore, when the auxiliary supply is restored, you should not have to set the time and date again. To test this, remove the auxiliary supply. Leave the device de-energized for approximately 30 seconds. On re-energization, the time should be correct.

5.5 TIME ZONE COMPENSATION

The UTC time standard uses Greenwich Mean Time as its standard. Without compensation, the date and time would be displayed on the device irrespective of its location.

You may wish to display the local time corresponding to its geographical location. You can do this with the settings ***LocalTime Enable*** and ***LocalTime Offset***.

The ***LocalTime Enable*** has three setting options; `Disabled`, `Fixed`, and `Flexible`.

With `Disabled`, no local time zone is maintained. Time synchronisation from any interface will be used to directly set the master clock. All times displayed on all interfaces will be based on the master clock with no adjustment.

With `Fixed`, a local time zone adjustment is defined using the ***LocalTime Offset*** setting and all non-IEC 61850 interfaces, which uses the Simple Network Time Protocol (SNTP), are compensated to display the local time.

With `Flexible`, a local time zone adjustment is defined using the ***LocalTime Offset*** setting. The non-local and non-IEC 61850 interfaces can be set to either the UTC zone or the local time zone. The local interfaces are always set to the local time zone and the Ethernet interface is always set to the UTC zone.

The interfaces where you can select between UTC and Local Time are the serial interfaces RP1, RP2 and Tunnelled Courier (if applicable). This is achieved by means of the following settings, each of which can be set to UTC or Local.:

- RP1 Time Zone
- RP2 Time Zone
- Tunnel Time Zone

The ***LocalTime Offset*** setting allows you to enter the local time zone compensation from -12 to + 12 hours at 15 minute intervals.

5.6 DAYLIGHT SAVING TIME COMPENSATION

It is possible to compensate for Daylight Saving time using the following settings

- DST Enable
- DST Offset

- DST Start
- DST Start Day
- DST Start Month
- DST Start Mins
- DST End
- DST End Day
- DST End Month
- DST End Mins

These settings are described in the *DATE AND TIME* settings table in the configuration chapter.

6 PHASE ROTATION

The product provides a facility to maintain correct operation of all the protection functions even when the system is running in a reverse phase sequence. This is achieved by the ***Phase Sequence*** setting in the *SYSTEM CONFIG* column, and is available for all four setting groups.

You can configure the ***Phase Sequence*** setting to `Standard ABC` or `Reverse ABC`. This setting does not perform any internal phase swapping of the analog channels.

The Phase Sequence setting affects the sequence component calculation as follows (In this example, the positive and negative sequence currents are shown. The same principle applies to voltages):

Standard ABC

$$\bar{I}_1 = 1/3(\bar{I}_A + a\bar{I}_B + a^2\bar{I}_C)$$

$$\bar{I}_2 = 1/3(\bar{I}_A + a\bar{I}_B + a^2\bar{I}_C)$$

Reverse ABC

$$\bar{I}_1 = 1/3(\bar{I}_A + a^2\bar{I}_B + a\bar{I}_C)$$

$$\bar{I}_2 = 1/3(\bar{I}_A + a^2\bar{I}_B + a\bar{I}_C)$$

where a is the operator $1\angle 120°$

The phase Sequence setting also affects the directional overcurrent protection as follows:

Standard ABC

- Phase A: Use I_A and V_{BC}
- Phase B: Use I_B and V_{CA}
- Phase C: Use I_C and V_{AB}

Reverse ABC

- Phase A: Use I_A and $-V_{BC}$
- Phase B: Use I_B and $-V_{CA}$
- Phase C: Use I_C and $-V_{AB}$

6.1 CT AND VT REVERSAL

The product also provides VT and CT reversal settings (in the *SYSTEM CONFIG* column), which can be used in applications where some or all of the voltage or current inputs are temporarily reversed, for example in pump storage applications. These settings affect the order of the analog channels in the device and are set to emulate the order of the channels on the power system. So assuming the settings emulate the change in phase configuration on the power system, all the protection functions will naturally operate as per a standard phase rotation system. The phase sequence calculations and the protection functions all remain unchanged.

CHAPTER 6

SUPERVISION

1 CHAPTER OVERVIEW

This chapter describes the supervison functions.

This chapter contains the following sections:

2 VOLTAGE TRANSFORMER SUPERVISION

The Voltage Transformer Supervision (VTS) function is used to detect failure of the AC voltage inputs to the protection. This may be caused by voltage transformer faults, overloading, or faults on the wiring, which usually results in one or more of the voltage transformer fuses blowing.

If there is a failure of the AC voltage input, the IED could misinterpret this as a failure of the actual phase voltages on the power system, which could result in unnecessary tripping of a circuit breaker.

The VTS logic is designed to prevent such a situation by detecting voltage input failures, which are NOT caused by power system phase voltage failure, and automatically blocking associated voltage dependent protection elements. A time-delayed alarm output is available to warn of a VTS condition.

The following scenarios are possible with respect to the failure of the VT inputs.

- Loss of one or two-phase voltages
- Loss of all three-phase voltages under load conditions
- Absence of three-phase voltages upon line energisation

2.1 LOSS OF ONE OR TWO PHASE VOLTAGES

If the power system voltages are healthy, no Negative Phase Sequence (NPS) current will be present. If however, one or two of the AC voltage inputs are missing, there will be Negative Phase Sequence voltage present, even if the actual power system phase voltages are healthy. VTS works by detecting Negative Phase Sequence (NPS) voltage without the presence of Negative Phase Sequence current. So if there is NPS voltage present, but no NPS current, it is certain that there is a problem with the voltage transformers and a VTS block should be applied to voltage dependent protection functions to prevent maloperation. The use of negative sequence quantities ensures correct operation even where three-limb or V-connected VTs are used.

2.2 LOSS OF ALL THREE PHASE VOLTAGES

If all three voltage inputs are lost, there will be no Negative Phase Sequence quantities present, but the device will see that there is no voltage input. If this is caused by a power system failure, there will be a step change in the phase currents. However, if this is not caused by a power system failure, there will be no change in any of the phase currents. So if there is no measured voltage on any of the three phases and there is no change in any of the phase currents, this indicates that there is a problem with the voltage transformers and a VTS block should be applied to voltage dependent protection functions to prevent maloperation.

2.3 ABSENCE OF ALL THREE PHASE VOLTAGES ON LINE ENERGISATION

On line energization there should be a change in the phase currents as a result of loading or line charging current. Under this condition we need an alternative method of detecting three-phase VT failure.

If there is no measured voltage on all three phases during line energization, two conditions might apply:

- A three-phase VT failure
- A close-up three-phase fault.

The first condition would require VTS to block the voltage-dependent functions.

In the second condition, voltage dependent functions should not be blocked, as tripping is required.

To differentiate between these two conditions overcurrent level detectors are used (***VTS I> Inhibit*** and ***VTS I2> Inhibit***). These prevent a VTS block from being issued in case of a genuine fault. These elements should be set in excess of any non-fault based currents on line energisation (load, line charging current, transformer inrush current if applicable), but below the level of current produced by a close-up three-phase fault.

If the line is closed where a three-phase VT failure is present, the overcurrent detector will not operate and a VTS block will be applied. Closing onto a three-phase fault will result in operation of the overcurrent detector and prevent a VTS block being applied.

2.4 VTS IMPLEMENTATION

VTS is implemented in the *SUPERVISION* column of the relevant settings group, under the sub-heading *VT SUPERVISION*.

The following settings are relevant for VT Supervision:

- ***VTS Status***: determines whether the VTS Operate output will be a blocking output or an alarm indication only
- ***VTS Reset Mode***: determines whether the Reset is to be manual or automatic
- ***VTS Time delay***: determines the operating time delay
- ***VTS I> Inhibit***: inhibits VTS operation in the case of a phase overcurrent fault
- ***VTS I2> Inhibit***: inhibits VTS operation in the case of a negative sequence overcurrent fault

VTS is only enabled during a live line condition (as indicated by the pole dead logic) to prevent operation under dead system conditions.

2.5 VTS LOGIC

This logic will only be enabled during a live line condition (as indicated by the pole dead logic) to prevent operation under dead system conditions (i.e. where no voltage will be present and the VTS I> Inhibit overcurrent element will not be picked up).

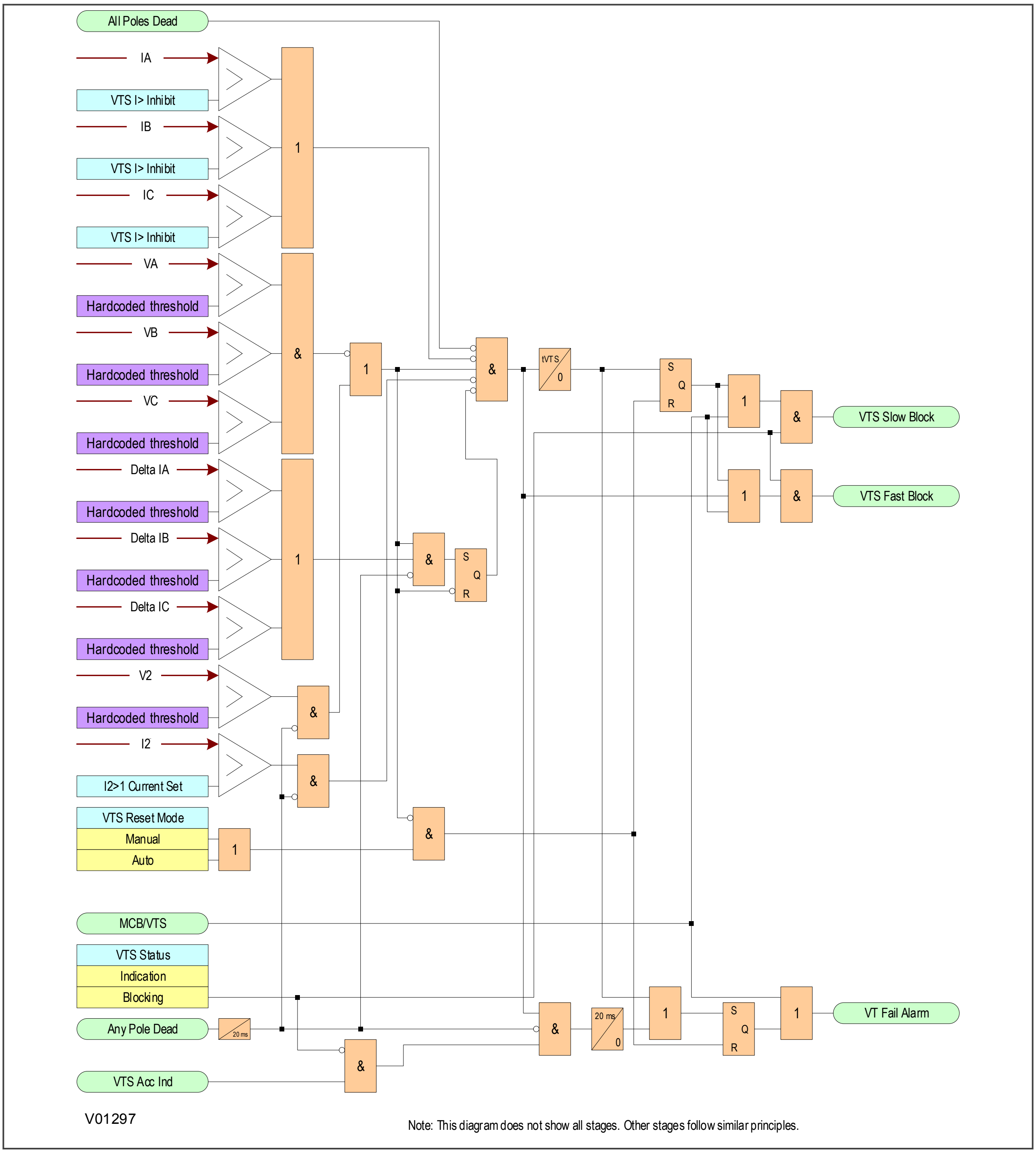


Figure 34: VTS logic

As can be seen from the diagram, the VTS function is inhibited if:

- An All Poles Dead DDB signal is present
- A phase overcurrent condition exists
- A Negative Phase Sequence current exists
- If the phase current changes over the period of 1 cycle

3 CURRENT TRANSFORMER SUPERVISION

The Current Transformer Supervision function (CTS) is used to detect failure of the AC current inputs to the protection. This may be caused by internal current transformer faults, overloading, or faults on the wiring. If there is a failure of the AC current input, the protection could misinterpret this as a failure of the actual phase currents on the power system, which could result in maloperation. Also, an open circuit in the AC current circuits can cause dangerous CT secondary voltages to be generated.

3.1 DIFFERENTIAL CTS IMPLEMENTATION

The differential current transformer supervision function is only available for the transformer differential protection. This function is enabled when the ***Winding Config*** setting is set to `Xformer`.

Differential current transformer supervision is based on the measurement of the ratio of negative sequence current to positive sequence current (I2/I1) for each CT. When this ratio is not zero, one of the following two conditions may be present:

- There is an unbalanced fault
- There is a 1 or 2 phase CT problem

If the I2/I1 ratio is greater than the high set value, ***CTS I2/I1>2*** at all ends, it is almost certainly a genuine fault condition, thus the CTS will not operate. If this ratio is detected at one end only, one of the following conditions may be present:

- A CT problem
- A single end fed fault condition

The positive sequence current I1 is used to confirm whether it is a CT problem or not. If I1 is greater than the setting ***CTS I1*** at all terminals, it must be a CT problem and CTS is allowed to operate. If this condition is detected at only one end, the device assumes it is caused by either an inrush condition or a single-end fed internal fault. In this case, CTS operation is blocked.

The ***CTS status*** setting under the *CT SUPERVISION* sub-heading can be set to either `indication` or `restraint`. In indication mode, the CTS alarm time delay is automatically set to zero. If a CT failure is present, an alarm would be issued without delay, but the differential protection would remain unrestricted. In restraint mode, the differential protection is blocked for 20 ms after CT failure has been detected, after which the restraint region of the bias characteristic increases according to the setting ***Is-CTS*** , which has been defined in the *DIFF PROTECTION* column.

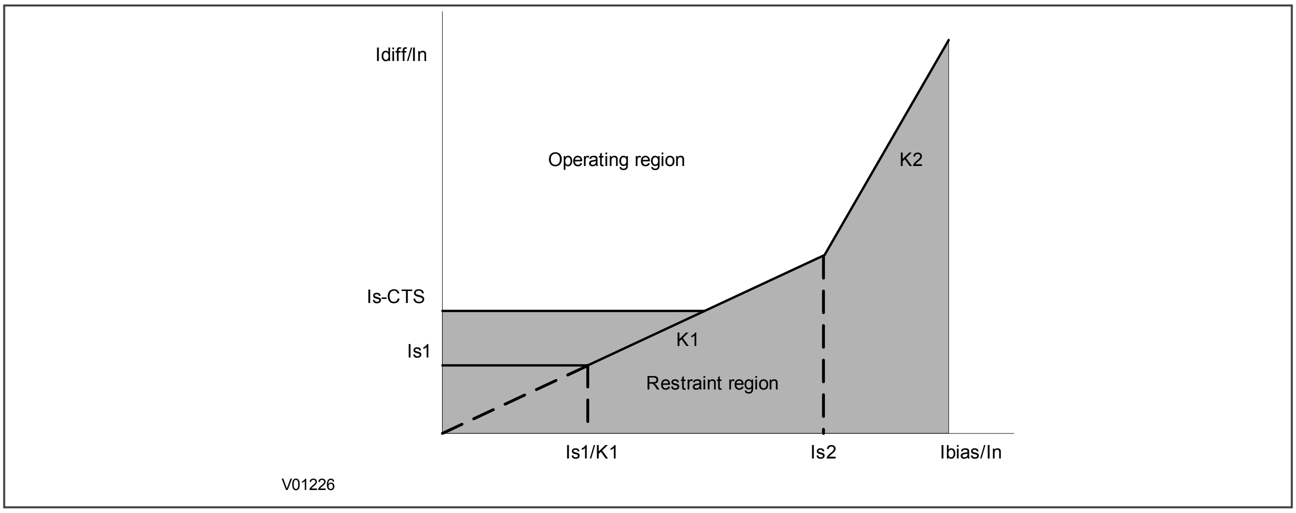


Figure 35: CTS restraint region increase

The low impedance REF, derived earth fault (P341) and NPS overcurrent protections are internally blocked by the CTS when a CT failure is detected in the CT used by each protection function.

The CTS monitors the positive and negative sequence currents of all CTs (2 to 5, depending on the model). A faulty CT is determined if the following conditions are present at the same time:

- The positive sequence current in at least two current inputs exceeds the set release threshold I1 (***CTS I1*** setting under the *SUPERVISON* column). This also means that CTS can only operate if minimum load current of the protected object is present.
- A high set ratio of negative to positive sequence current, ***CTS I2/I1>2***, is exceeded at one end.
- At all other ends the ratio of negative to positive sequence current is less than a low set value, ***CTS I2/I1> 1***, or no significant current is present (positive sequence current is below the release threshold I1).

Only a single or double phase CT failure can be detected by this logic. The probability of symmetrical three-phase CT failures is very low, therefore in practice this is not a significant problem.

3.2 DIFFERENTIAL CTS LOGIC

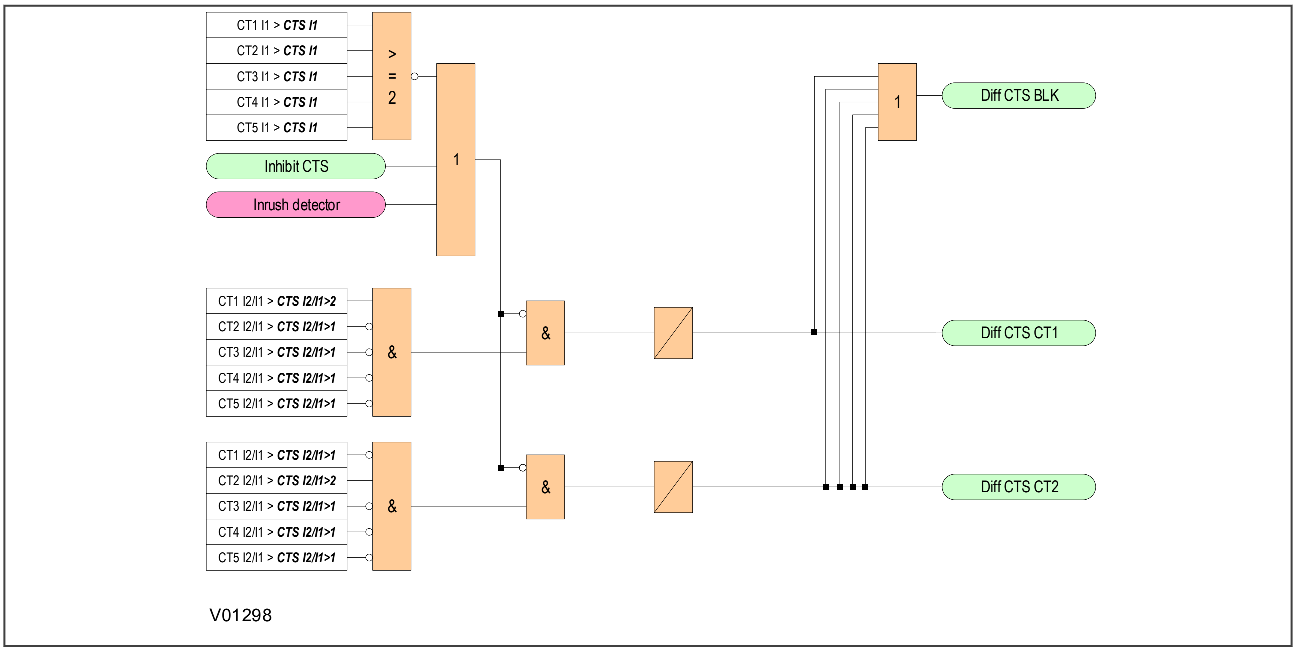


Figure 36: Differential CTS Logic diagram

3.3 APPLICATION NOTES

3.3.1 SETTING GUIDELINES

The differential current transformer supervision function is only available for the transformer differential protection. This function is enabled when the ***Winding Config*** setting is set to `Xformer`.

The positive sequence current in at least two current inputs exceeds the ***CTS I1*** setting. The ***CTS I1*** setting should be below the minimum load current of the protected object. Therefore, 10% of the rated current might be used.

The high set ratio of negative to positive sequence current, ***CTS I2/I1>2***, should be set below the ratio of negative sequence to positive sequence current for the minimum unbalanced fault current. A typical setting of 40% might be used.

The low set ratio of negative to positive sequence current, ***CTS I2/I1>1***, should be set above the maximum load unbalance. In practise, the levels of standing negative phase sequence current present on the system govern this minimum setting. This can be determined from a system study, or by making use of the device's measurement facilities at the commissioning stage. If the latter method is adopted, it is important to take the measurements during maximum system load conditions, to ensure that all single-phase loads are accounted for. A 20% setting might be used.

If the following information is recorded by the relay during commissioning:

$$I_{full\ load} = 500\ A$$

$$I_2 = 50\ A$$

Therefore I2/I1 ratio is given by I2/I1 = 50/500 = 0.1

To allow for tolerances and load variations a setting of 20% of this value may be typical. Therefore set ***CTS I2/I1>1*** = 20%.

Due to the sensitive settings suggested above, a long time delay is necessary to ensure a true CT failure. We recommend using the default setting for this time time delay. After the CTS Time Delay expires (***CTS Time Delay***), the ***CTS Fail Alarm*** is asserted.

4 TRIP CIRCUIT SUPERVISION

In most protection schemes, the trip circuit extends beyond the IED enclosure and passes through components such as links, relay contacts, auxiliary switches and other terminal boards. Such complex arrangements may require dedicated schemes for their supervision.

There are two distinctly separate parts to the trip circuit; the trip path, and the trip coil. The trip path is the path between the IED enclosure and the CB cubicle. This path contains ancillary components such as cables, fuses and connectors. A break in this path is possible, so it is desirable to supervise this trip path and to raise an alarm if a break should appear in this path.

The trip coil itself is also part of the overall trip circuit, and it is also possible for the trip coil to develop an open-circuit fault.

This product supports a number of trip circuit supervision (TCS) schemes.

4.1 TRIP CIRCUIT SUPERVISION SCHEME 1

This scheme provides supervision of the trip coil with the CB open or closed, however, it does not provide supervision of the trip path whilst the breaker is open. The CB status can be monitored when a self-reset trip contact is used. However, this scheme is incompatible with latched trip contacts, as a latched contact will short out the opto-input for a time exceeding the recommended Delayed Drop-off (DDO) timer setting of 400 ms, and therefore does not support CB status monitoring. If you require CB status monitoring, further opto-inputs must be used.

Note:
A 52a CB auxiliary contact follows the CB position. A 52b auxiliary contact is the opposite.

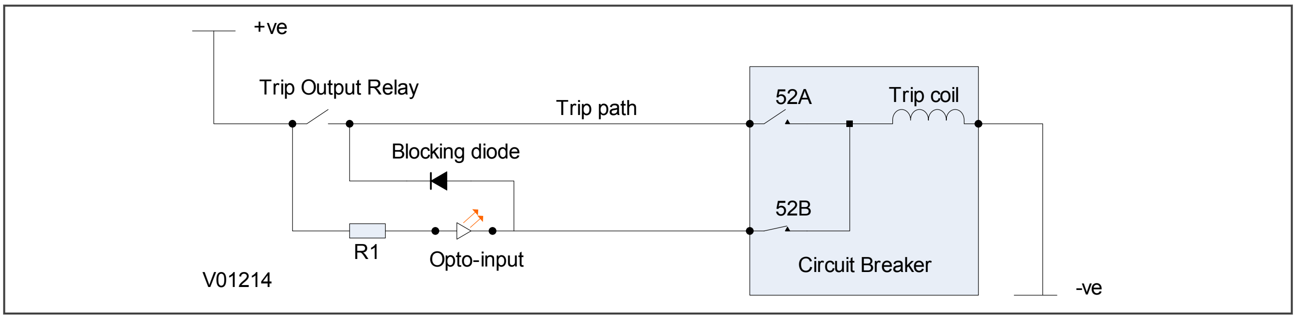


Figure 37: TCS Scheme 1

When the CB is closed, supervision current passes through the opto-input, blocking diode and trip coil. When the CB is open, supervision current flows through the opto-input and into the trip coil via the 52b auxiliary contact. This means that *Trip Coil* supervision is provided when the CB is either closed or open, however *Trip Path* supervision is only provided when the CB is closed. No supervision of the trip path is provided whilst the CB is open (pre-closing supervision). Any fault in the trip path will only be detected on CB closing, after a 400 ms delay.

4.1.1 RESISTOR VALUES

The supervision current is a lot less than the current required by the trip coil to trip a CB. The opto-input limits this supervision current to less than 10 mA. If the opto-input were to be short-circuited however, it could be possible for the supervision current to reach a level that could trip the CB. For this reason, a resistor R1 is often used to limit the current in the event of a short-circuited opto-input. This limits the current to less than 60mA. The table below shows the appropriate resistor value and voltage setting for this scheme.

Trip Circuit Voltage	Opto Voltage Setting with R1 Fitted	Resistor R1 (ohms)
48/54	24/27	1.2k

Trip Circuit Voltage	Opto Voltage Setting with R1 Fitted	Resistor R1 (ohms)
110/125	48/54	2.7k
220/250	110/125	5.2k

Warning:
This Scheme is not compatible with Trip Circuit voltages of less than 48 V.

4.1.2 PSL FOR TCS SCHEME 1

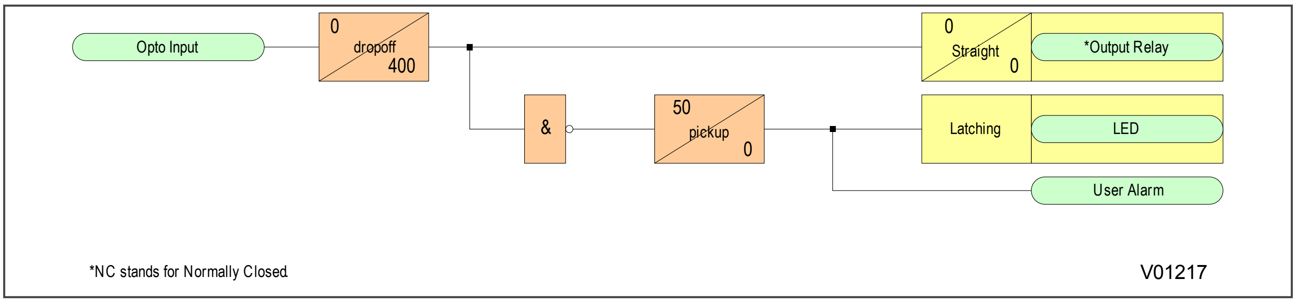


Figure 38: PSL for TCS Scheme 1

The opto-input can be used to drive a Normally Closed Output Relay, which in turn can be used to drive alarm equipment. The signal can also be inverted to drive a latching programmable LED and a user alarm DDB signal.

The DDO timer operates as soon as the opto-input is energised, but will take 400 ms to drop off/reset in the event of a trip circuit failure. The 400 ms delay prevents a false alarm due to voltage dips caused by faults in other circuits or during normal tripping operation when the opto-input is shorted by a self-reset trip contact. When the timer is operated the NC (normally closed) output relay opens and the LED and user alarms are reset.

The 50 ms delay on pick-up timer prevents false LED and user alarm indications during the power up time, following a voltage supply interruption.

4.2 TRIP CIRCUIT SUPERVISION SCHEME 2

This scheme provides supervision of the trip coil with the breaker open or closed but does not provide pre-closing supervision of the trip path. However, using two opto-inputs allows the IED to correctly monitor the circuit breaker status since they are connected in series with the CB auxiliary contacts. This is achieved by assigning one opto-input to the 52a contact and another opto-input to the 52b contact. Provided the ***CB Status*** setting in the *CB CONTROL* column is set to `Both 52A and 52B`, the IED will correctly monitor the status of the breaker. This scheme is also fully compatible with latched contacts as the supervision current will be maintained through the 52b contact when the trip contact is closed.

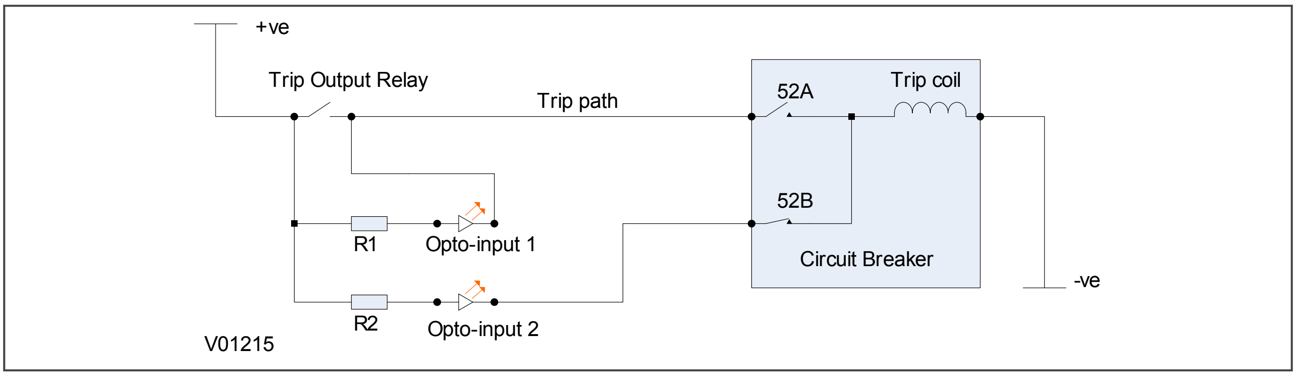


Figure 39: TCS Scheme 2

When the breaker is closed, supervision current passes through opto input 1 and the trip coil. When the breaker is open current flows through opto input 2 and the trip coil. No supervision of the trip path is provided whilst the breaker is open. Any fault in the trip path will only be detected on CB closing, after a 400 ms delay.

4.2.1 RESISTOR VALUES

Optional resistors R1 and R2 can be added to prevent tripping of the CB if either opto-input is shorted. The table below shows the appropriate resistor value and voltage setting for this scheme.

Trip Circuit Voltage	Opto Voltage Setting with R1 Fitted	Resistor R1 and R2 (ohms)
48/54	24/27	1.2k
110/125	48/54	2.7k
220/250	110/125	5.2k

Warning:
This Scheme is not compatible with Trip Circuit voltages of less than 48 V.

4.2.2 PSL FOR TCS SCHEME 2

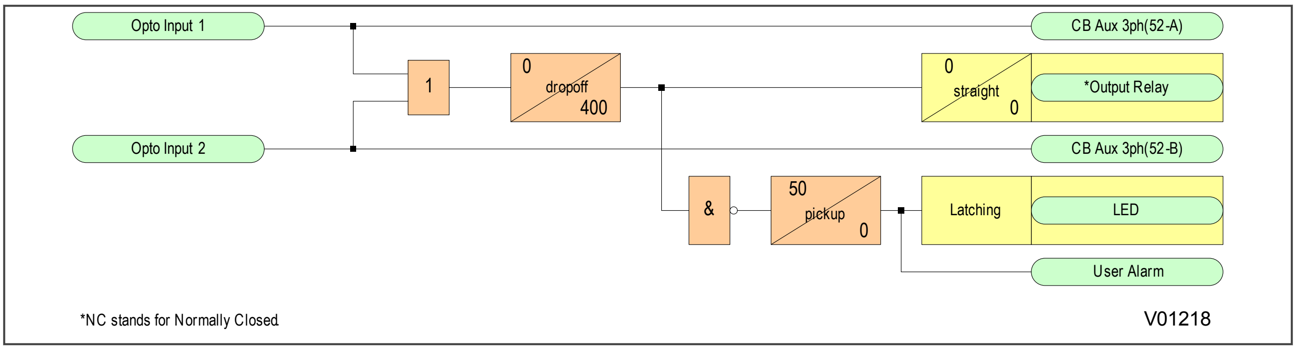


Figure 40: PSL for TCS Scheme 2

In TCS scheme 2, both opto-inputs must be low before a trip circuit fail alarm is given.

4.3 TRIP CIRCUIT SUPERVISION SCHEME 3

TCS Scheme 3 is designed to provide supervision of the trip coil with the breaker open or closed. It provides pre-closing supervision of the trip path. Since only one opto-input is used, this scheme is not compatible with latched trip contacts. If you require CB status monitoring, further opto-inputs must be used.

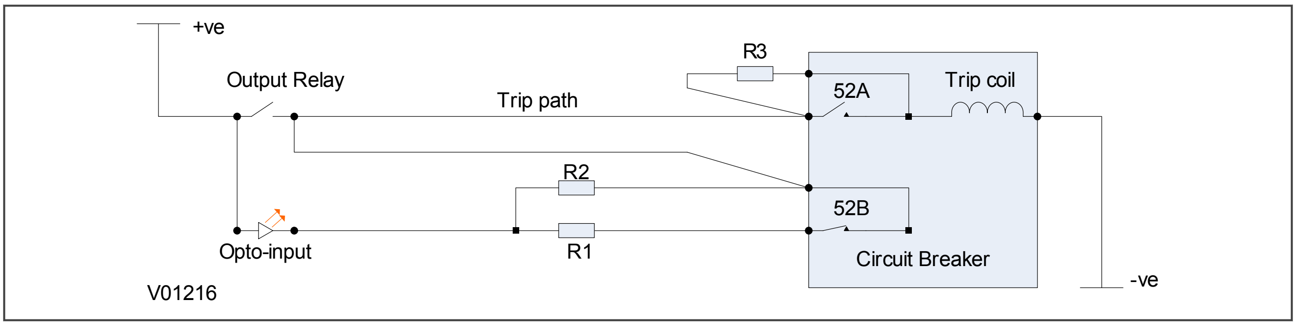


Figure 41: TCS Scheme 3

When the CB is closed, supervision current passes through the opto-input, resistor R2 and the trip coil. When the CB is open, current flows through the opto-input, resistors R1 and R2 (in parallel), resistor R3 and the trip coil. The supervision current is maintained through the trip path with the breaker in either state, therefore providing pre-closing supervision.

4.3.1 RESISTOR VALUES

Resistors R1 and R2 are used to prevent false tripping, if the opto-input is accidentally shorted. However, unlike the other two schemes. This scheme is dependent upon the position and value of these resistors. Removing them would result in incomplete trip circuit monitoring. The table below shows the resistor values and voltage settings required for satisfactory operation.

Trip Circuit Voltage	Opto Voltage Setting with R1 Fitted	Resistor R1 & R2 (ohms)	Resistor R3 (ohms)
48/54	24/27	1.2k	600
110/250	48/54	2.7k	1.2k
220/250	110/125	5.0k	2.5k

Warning:
This Scheme is not compatible with Trip Circuit voltages of less than 48 V.

4.3.2 PSL FOR TCS SCHEME 3

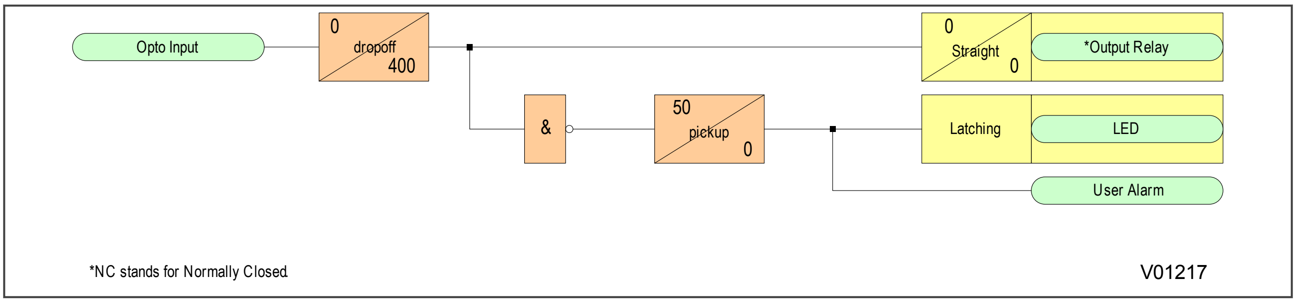


Figure 42: PSL for TCS Scheme 3

CHAPTER 7

COMMUNICATIONS

1 CHAPTER OVERVIEW

This product supports Substation Automation System (SAS), and Supervisory Control and Data Acquisition (SCADA) communication. The support embraces the evolution of communications technologies that have taken place since microprocessor technologies were introduced into protection, control, and monitoring devices which are now ubiquitously known as Intelligent Electronic Devices for the substation (IEDs).

As standard, all products support rugged serial communications for SCADA and SAS applications. By option, any product can support Ethernet communications for more advanced SCADA and SAS applications.

This chapter contains the following sections:

2 COMMUNICATION INTERFACES

The products have a number of standard and optional communication interfaces. The standard and optional hardware and protocols are summarised below:

Port	Availability	Physical layer	Use	Data Protocols
Front	Standard	USB Type B	Local settings	Courier
Rear Port 1 (RP1 copper)	Standard	RS232 / RS485 / K-Bus	SCADA Remote settings	Courier, MODBUS, IEC60870-5-103, DNP3.0 (order option)
Rear Port 1 (RP1 fibre)	Optional	Fibre	SCADA Remote settings	Courier, MODBUS, IEC60870-5-103, DNP3.0 (order option)
Rear Port 2 (RP2)	Optional	RS232 / RS485 / K-Bus	SCADA Remote settings	SK4: Courier only SK5: InterMicom only
Ethernet	Optional	Ethernet	IEC 61850 Remote settings	IEC 61850, Courier (tunnelled)

Note:
Optional communications boards are always fitted into slot A.

Note:
It is only possible to fit one optional communications board, therefore RP2 and Ethernet communications are mutually exclusive.

3 SERIAL COMMUNICATION

The physical layer standards that are used for serial communications for SCADA purposes are:

- EIA(RS)485 (often abbreviated to RS485)
- K-Bus (a proprietary customization of RS485)

USB is used for local communication with the IED (for transferring settings and downloading firmware updates).

RS485 is similar to RS232 but for longer distances and it allows daisy-chaining and multi-dropping of IEDs.

K-Bus is a proprietary protocol quite similar to RS485, but it cannot be mixed on the same link as RS485. Unlike RS485, K-Bus signals applied across two terminals are not polarised.

It is important to note that these are not data protocols. They only describe the physical characteristics required for two devices to communicate with each other.

For a description of the K-Bus standard see K-Bus (on page114) and GE's K-Bus interface guide reference R6509.

A full description of the RS485 is available in the published standard.

3.1 USB FRONT PORT

The USB interface uses the proprietary Courier protocol for local communication with the MiCOM S1 Agile settings application software.

This is intended for temporary local connection and is not suitable for permanent connection. This interface uses a fixed baud rate of 19200 bps, 11-bit frame (8 data bits, 1 start bit, 1 stop bit, even parity bit), and a fixed device address of '1'.

The USB interface is a Type B connector. Normally a Type A to Type B USB cable will be required to communicate between MiCOM S1 Agile and the IED.

3.2 EIA(RS)485 BUS

The RS485 two-wire connection provides a half-duplex, fully isolated serial connection to the IED. The connection is polarized but 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, then it is possible that the two-wire connection is reversed.

The RS485 bus must be terminated at each end with 120 Ω 0.5 W terminating resistors between the signal wires.

The RS485 standard requires that each device be directly connected to the actual bus. Stubs and tees are forbidden. Loop bus and Star topologies are not part of the RS485 standard and are also forbidden.

Two-core screened twisted pair cable should be used. The final cable specification is dependent on the application, although a multi-strand 0.5 mm^2 per core is normally adequate. The total cable length must not exceed 1000 m. It is important to avoid circulating currents, which can cause noise and interference, especially when the cable runs between buildings. For this reason, the screen should be continuous and connected to ground at one end only, normally at the master connection point.

The RS485 signal is a differential signal and there is no signal ground connection. If a signal ground connection is present in the bus cable then it must be ignored. At no stage should this be connected to the cable's screen or to the product’s chassis. This is for both safety and noise reasons.

It may 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 turn from receive mode to transmit mode. This may be because the master is waiting in receive mode, 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 consequently not responding. Symptoms of this are; poor response times (due to retries), increasing message error counts, erratic communications, and in the worst case, complete failure to communicate.

3.2.1 EIA(RS)485 BIASING REQUIREMENTS

Biasing requires that the signal lines be 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 to prevent noise being injected.

> *Note:*
> *Some devices may be able to provide the bus bias, in which case external components would not be required.*

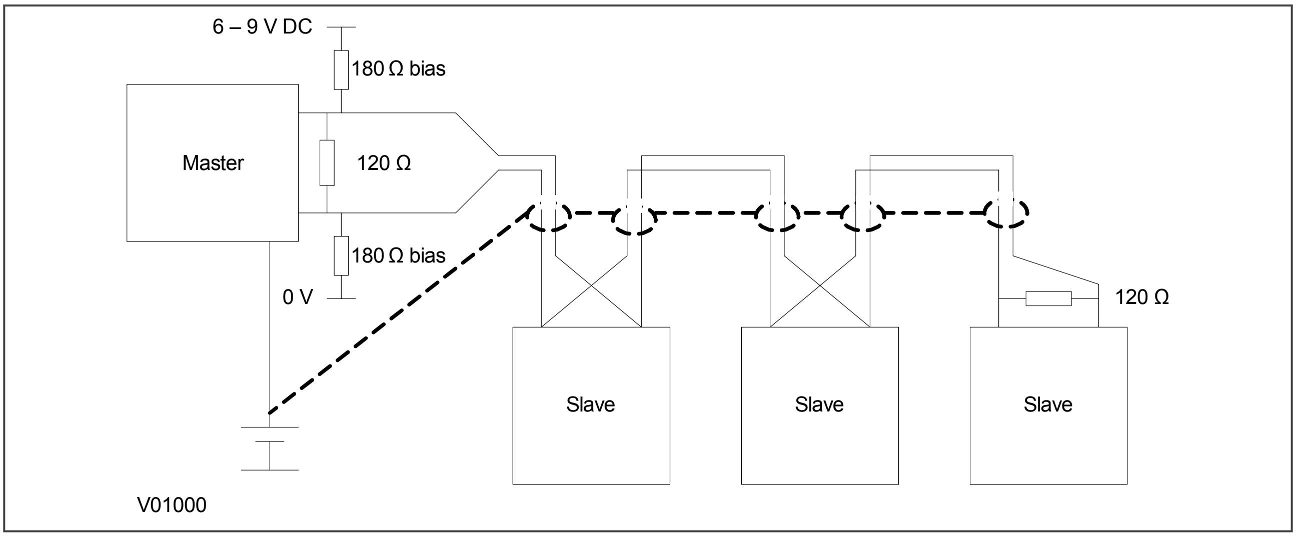


Figure 43: RS485 biasing circuit

> **Warning:**
> **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.**

3.3 K-BUS

K-Bus is a robust signalling method based on RS485 voltage levels. K-Bus incorporates message framing, based on a 64 kbps synchronous HDLC protocol with FM0 modulation to increase speed and security.

The rear interface is used to provide a permanent connection for K-Bus, which allows multi-drop connection.

A K-Bus spur consists of up to 32 IEDs connected together in a multi-drop arrangement using twisted pair wiring. The K-Bus twisted pair connection is non-polarised.

It is not possible to use a standard EIA(RS)232 to EIA(RS)485 converter to convert IEC 60870-5 FT1.2 frames to K-Bus. A protocol converter, namely the KITZ101, KITZ102 or KITZ201, must be used for this purpose. Please consult GE for information regarding the specification and supply of KITZ devices. The following figure demonstrates a typical K-Bus connection.

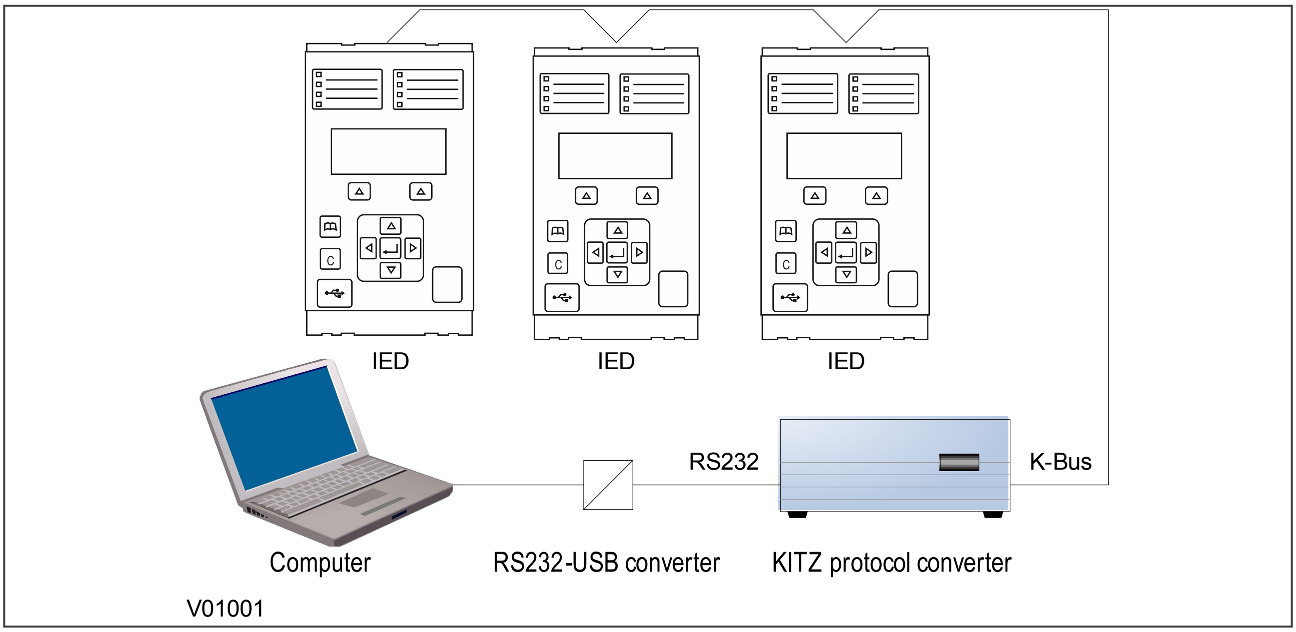


Figure 44: Remote communication using K-Bus

> *Note:*
> *An RS232-USB converter is only needed if the local computer does not provide an RS232 port.*

Further information about K-Bus is available in the publication R6509: K-Bus Interface Guide, which is available on request.

4 STANDARD ETHERNET COMMUNICATION

The type of Ethernet board depends on the chosen model. The available boards and their features are described in the Hardware Design chapter of this manual.

The Ethernet interface is required for IEC 61850. With this protocol, the Ethernet interface offers communication with the settings application software for remote configuration and record extraction.

Fibre optic connection is recommended for use in permanent connections in a substation environment, as it offers advantages in terms of noise rejection. The fibre optic port provides 100 Mbps communication and uses type BFOC 2.5 (ST) connectors. Fibres should be suitable for 1300 nm transmission and be multimode 50/125 µm or 62.5/125 µm.

Connection can also be made to a 10Base-T or a 100Base-TX Ethernet switch using the RJ45 port.

5 REDUNDANT ETHERNET COMMUNICATION

Redundancy is required where a single point of failure cannot be tolerated. It is required in critical applications such as substation automation. Redundancy acts as an insurance policy, providing an alternative route if one route fails.

Ethernet communication redundancy is available for most GE products, using a Redundant Ethernet Board (REB). The REB is a Network Interface Card (NIC), which incorporates an integrated Ethernet switch. The board provides two Ethernet transmitter/receiver pairs.

In addition to the two Ethernet transmitter/receiver pairs, the REB provides link activity indication in the form of LEDs, link fail indication in the form of watchdog contacts, and a dedicated time synchronisation input.

The dedicated time synchronisation input is designed to connect to an IRIG-B signal. Both modulated and un-modulated IRIG-B formats are supported according to the selected option. Simple Network Time Protocol (SNTP) is supported over the Ethernet communications.

5.1 SUPPORTED PROTOCOLS

A range of Redundant Ethernet Boards are available to support different protocols for different requirements. One of the key requirements of substation redundant communications is "bumpless" redundancy. This means the ability to transfer from one communication path to another without noticeable consequences. Standard protocols of the time could not meet the demanding requirements of network availability for substation automation solutions. Switch-over times were unacceptably long. For this reason, companies developed proprietary protocols. More recently, however, standard protocols, which support bumpless redundancy (namely PRP and HSR) have been developed and ratified.

As well as supporting standard non-bumpless protocols such as RSTP, the REB was originally designed to support bumpless redundancy, using proprietary protocols (SHP, DHP) before the standard protocols became available. Since then, variants have been produced for the newer standard protocols.

REB variants for each of the following protocols are available:

- PRP (Parallel Redundancy Protocol)
- HSR (High-availability Seamless Redundancy)
- RSTP (Rapid Spanning Tree Protocol)
- Failover

> *Note:*
> *The protocol you require must be selected at the time of ordering.*

5.2 PARALLEL REDUNDANCY PROTOCOL

PRP (Parallel Reundancy Protocol) is defined in IEC 62439-3. PRP provides bumpless redundancy and meets the most demanding needs of substation automation. The PRP implementation of the REB is compatible with any standard PRP device.

PRP uses two independent Ethernet networks operating in parallel. PRP systems are designed so that there should be no common point of failure between the two networks, so the networks have independent power sources and are not connected together directly.

Devices designed for PRP applications have two ports attached to two separate networks and are called Doubly Attached Nodes (DAN). A DAN has two ports, one MAC address and one IP address.

The sending node replicates each frame and transmits them over both networks. The receiving node processes the frame that arrives first and discards the duplicate. Therefore there is no distinction between the working and backup path. The receiving node checks that all frames arrive in sequence and that frames are correctly received on both ports.

Devices such as printers that have a single Ethernet port can be connected to either of the networks but will not directly benefit from the PRP principles. Such devices are called Singly Attached Nodes (SAN). For devices with a single Ethernet port that need to connect to both LANs, this can be achieved by employing Ethernet Redundancy Boxes (sometimes abbreviated to RedBox). Devices with a single Ethernet port that connect to both LANs by means of a RedBox are known as Virtual DAN (VDAN).

The figure below summarises DAN, SAN, VDAN, LAN, and RedBox connectivity.

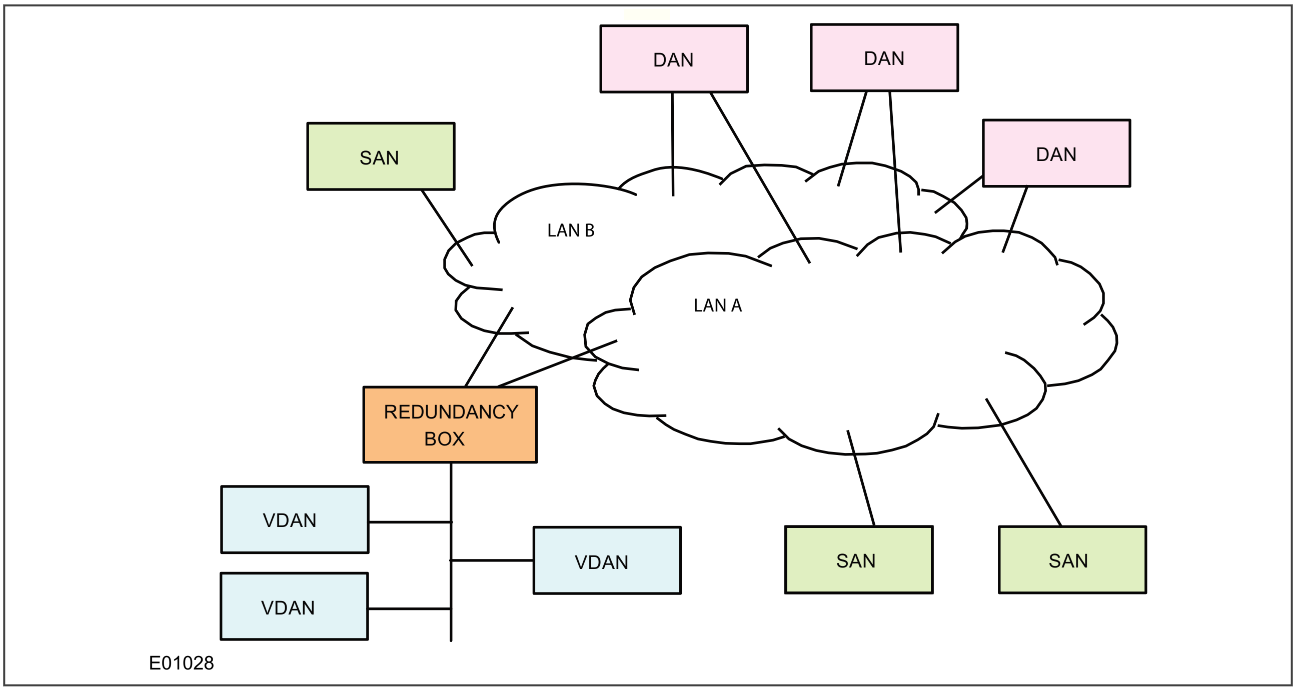


Figure 45: IED attached to separate LANs

In a DAN, both ports share the same MAC address so it does not affect the way devices talk to each other in an Ethernet network (Address Resolution Protocol at layer 2). Every data frame is seen by both ports.

When a DAN sends a frame of data, the frame is duplicated on both ports and therefore on both LAN segments. This provides a redundant path for the data frame if one of the segments fails. Under normal conditions, both LAN segments are working and each port receives identical frames.

5.3 HIGH-AVAILABILITY SEAMLESS REDUNDANCY (HSR)

HSR is standardized in IEC 62439-3 (clause 5) for use in ring topology networks. Similar to PRP, HSR provides bumpless redundancy and meets the most demanding needs of substation automation. HSR has become the reference standard for ring-topology networks in the substation environment. The HSR implementation of the redundancy Ethernet board (REB) is compatible with any standard HSR device.

HSR works on the premise that each device connected in the ring is a doubly attached node running HSR (referred to as DANH). Similar to PRP, singly attached nodes such as printers are connected via Ethernet Redundancy Boxes (RedBox).

5.3.1 HSR MULTICAST TOPOLOGY

When a DANH is sending a multicast frame, the frame (C frame) is duplicated (A frame and B frame), and each duplicate frame A/B is tagged with the destination MAC address and the sequence number. The frames A and B differ only in their sequence number, which is used to identify one frame from the other. Each frame is sent to the network via a separate port. The destination DANH receives two identical frames, removes the HSR tag of the first frame received and passes this (frame D) on for processing. The other duplicate frame is discarded. The nodes forward frames from one port to the other unless it was the node that injected it into the ring.

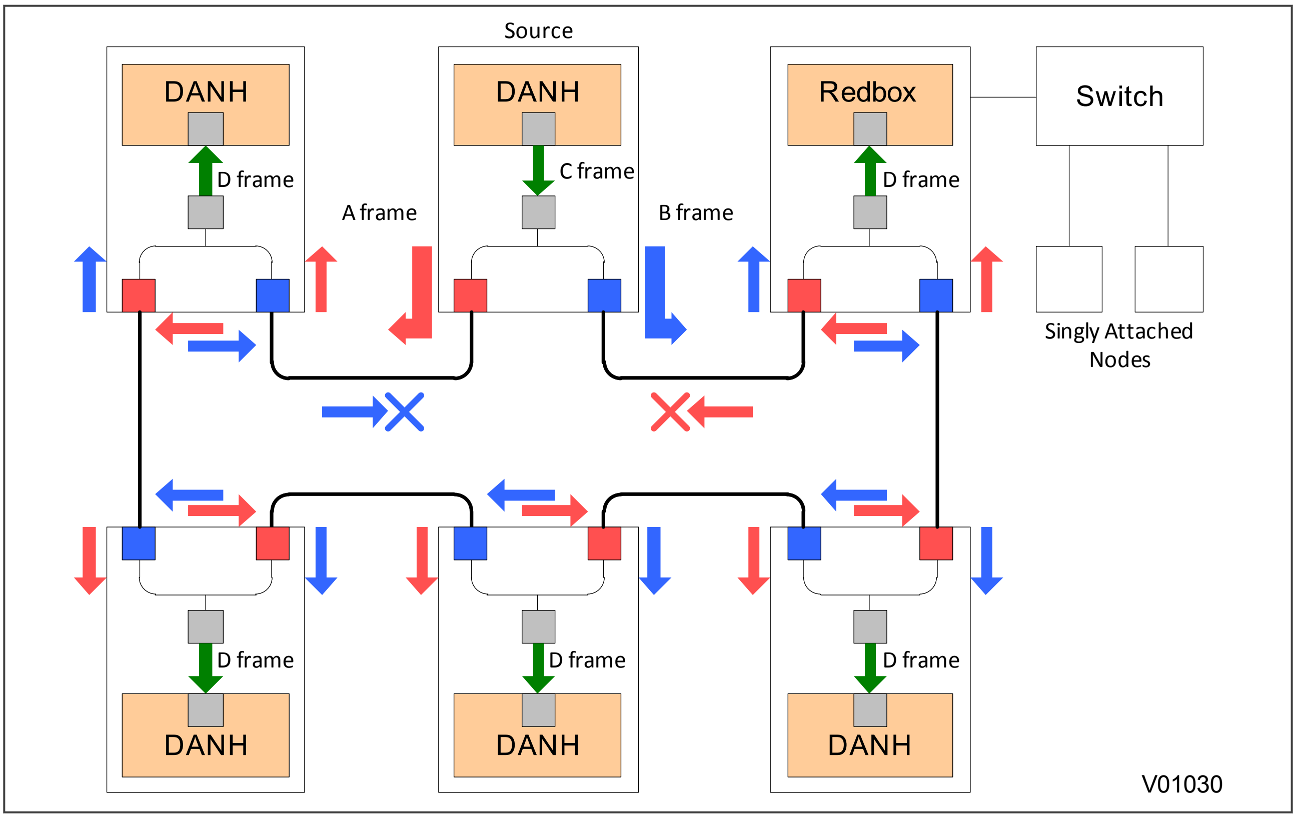


Figure 46: HSR multicast topology

Only about half of the network bandwidth is available in HSR for multicast or broadcast frames because both duplicate frames A & B circulate the full ring.

5.3.2 HSR UNICAST TOPOLOGY

With unicast frames, there is just one destination and the frames are sent to that destination alone. All non-recipient devices simply pass the frames on. They do not process them in any way. In other words, D frames are produced only for the receiving DANH. This is illustrated below.

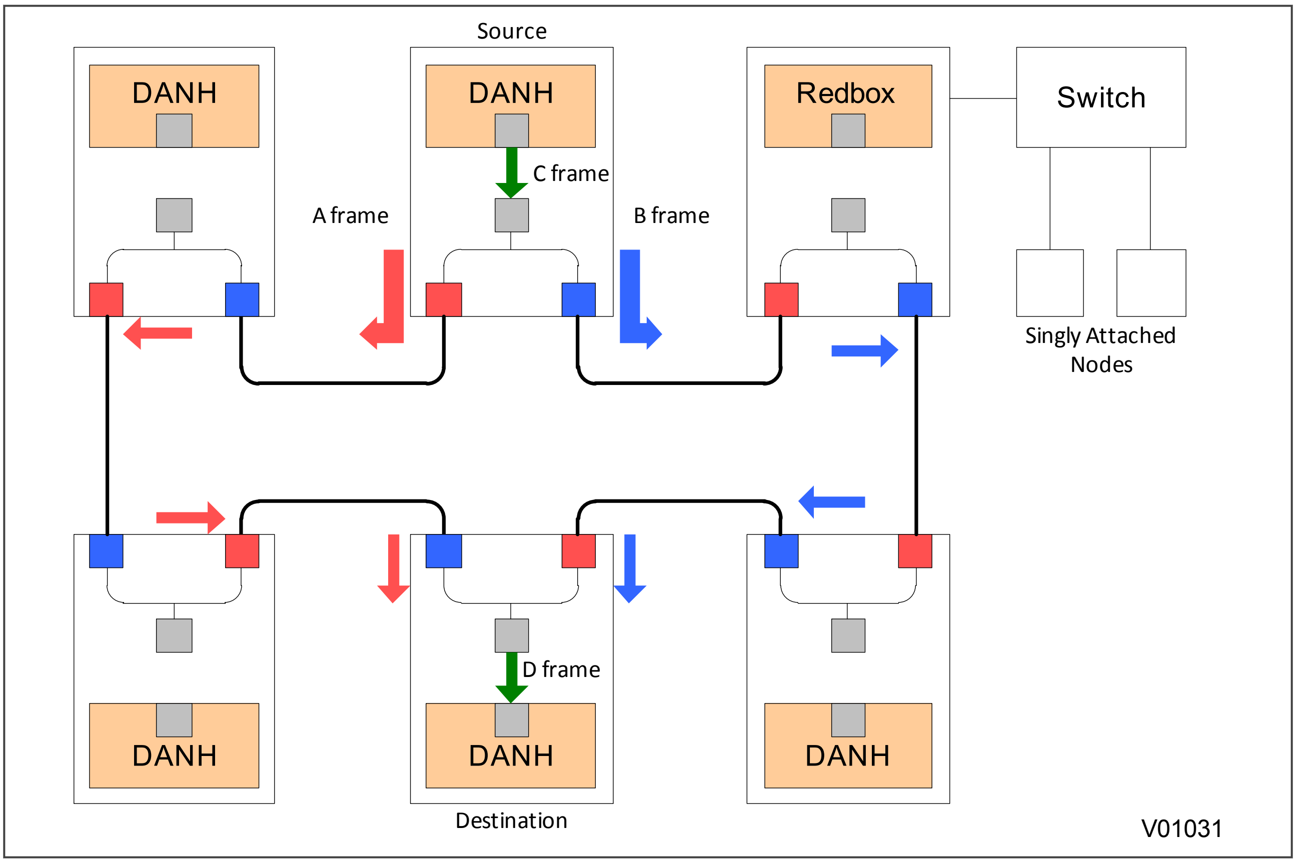


Figure 47: HSR unicast topology

For unicast frames, the whole bandwidth is available as both frames A & B stop at the destination node.

5.3.3 HSR APPLICATION IN THE SUBSTATION

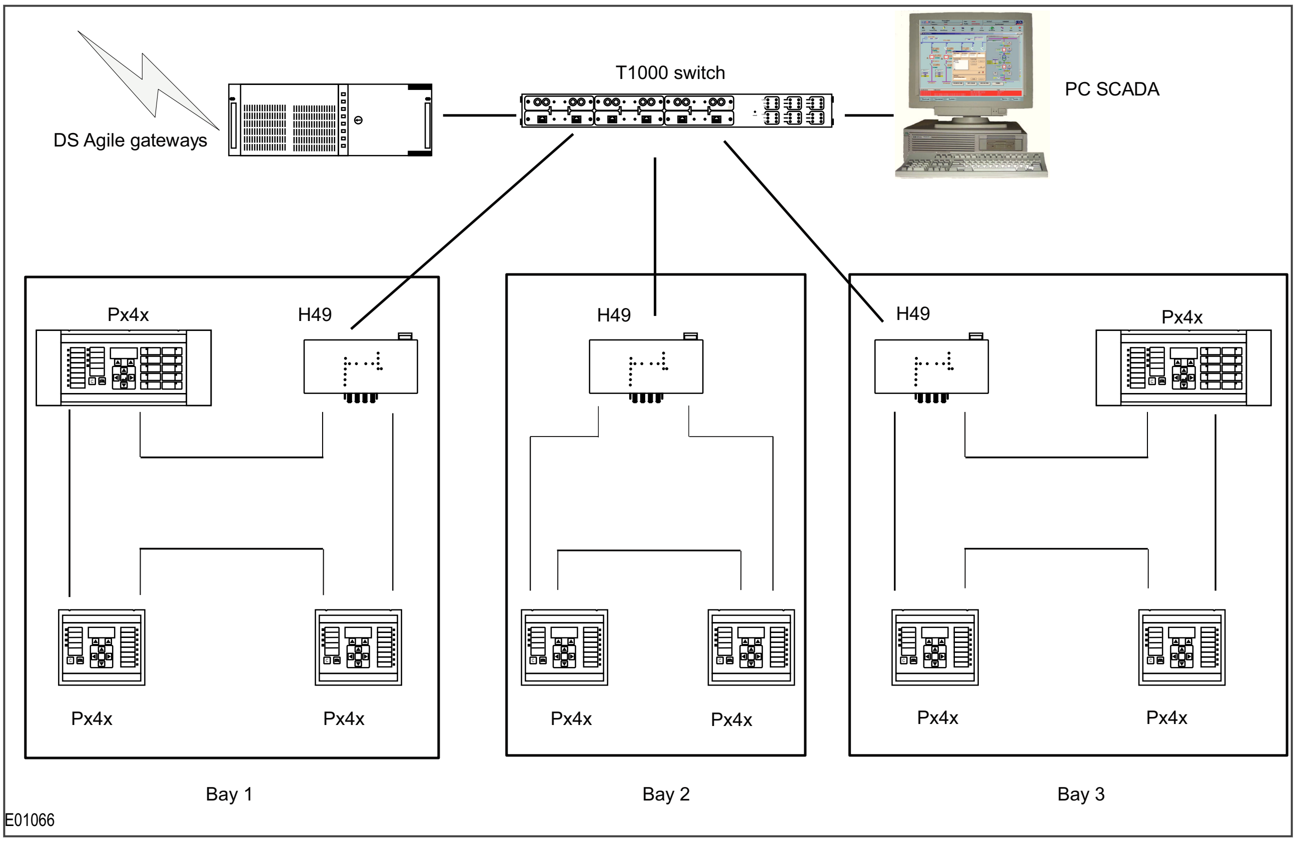


Figure 48: HSR application in the substation

5.4 RAPID SPANNING TREE PROTOCOL

RSTP is a standard used to quickly reconnect a network fault by finding an alternative path. It stops network loops whilst enabling redundancy. It can be used in star or ring connections as shown in the following figure.

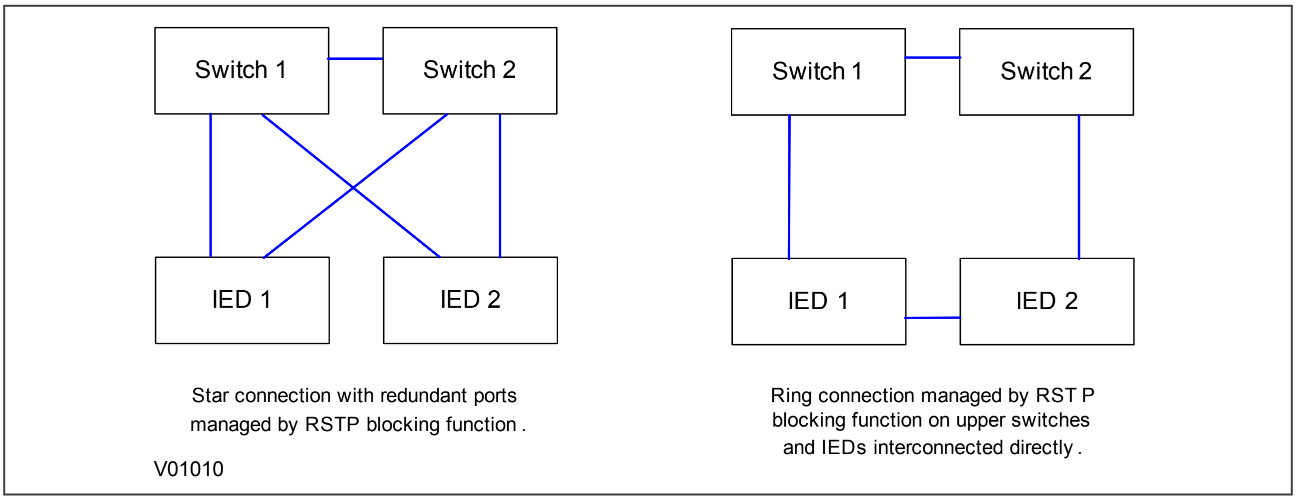


Figure 49: IED attached to redundant Ethernet star or ring circuit

The RSTP implementation in this product is compatible with any devices that use RSTP.

RSTP can recover network faults quickly, but the fault recovery time depends on the number of devices on the network and the network topology. A typical figure for the fault recovery time is 300ms. Therefore, RSTP cannot achieve the “bumpless” redundancy that some other protocols can.

Refer to IEEE 802.1D 2004 standard for detailed information about the opration of the protocol.

5.5 FAILOVER

Failover is a simple redundancy mechanism that is not tied to any protocol. It works by selecting a main port and a switching time that can be as low as 2 seconds. When the main port link fails, the redundant port becomes physically active. At no point are both ports physically active, which means it can be used on any redundant or non-redundant network.

5.6 CONFIGURING IP ADDRESSES

An IP address is a logical address assigned to devices in a computer network that uses the Internet Protocol (IP) for communication between nodes. IP addresses are stored as binary numbers but they are represented using Decimal Dot Notation, where four sets of decimal numbers are separated by dots as follows:

XXX.XXX.XXX.XXX

For example:

10.86.254.85

An IP address in a network is usually associated with a subnet mask. The subnet mask defines which network the device belongs to. A subnet mask has the same form as an IP address.

For example:

255.255.255.0

Both the IED and the REB each have their own IP address. The following diagram shows the IED as IP1 and the REB as IP2.

> *Note:*
> *IP1 and IP2 are different but use the same subnet mask.*

The REB IP address (IP2) must be configured through the Ethernet network.

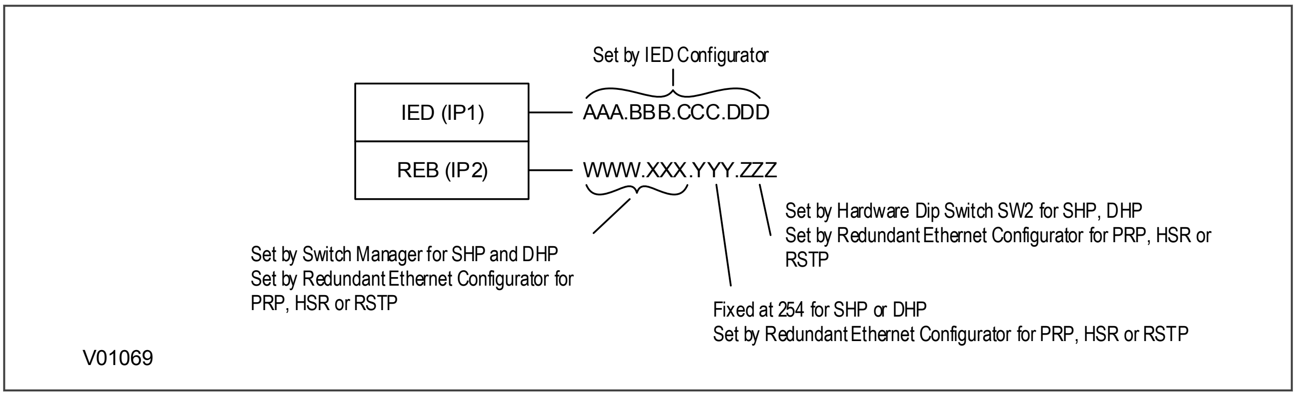


Figure 50: IED and REB IP address configuration

5.6.1 CONFIGURING THE IED IP ADDRESS

If you are using IEC 61850, set the IED IP1 address using the IEC 61850 Configurator software. In the IEC 61850 Configurator, set **Media** to **Single Copper or Redundant Fibre** for all Redundant Ethernet Board variants.

5.6.2 CONFIGURING THE REB IP ADDRESS

The board IP address must be configured before connecting the IED to the network to avoid an IP address conflict. The way you configure the IP address depends on the redundancy protocol you have chosen.

PRP/HSR/RSTP/Failover

From S1 Agile 2.0.1. onwards cards that support the PRP/HSR/RSTP/Failover protocols in any of the combinations are configured using the Redundant Ethernet Configurator software tool. If you are using a ZN008700X card only this tool supports it. If using S1 Agile 1.4.2 or older you will need to use the PRP/HSR Configurator for PRP and/or HSR, and the RSTP Configurator for RSTP cards.

5.7 REDUNDANT ETHERNET CONFIGURATOR

The Redundant Ethernet Configurator tool is intended for MiCOM Px4x IEDs with redundant Ethernet using PRP (Parallel Redundancy Protocol), or HSR (High-availability Seamless Redundancy). This tool is used to identify IEDs, switch between PRP and HSR or configure their parameters, configure the redundancy IP address, or configure the SNTP IP address.

5.7.1 CONNECTING THE IED TO A PC

Connect the IED to the PC on which the Configurator tool is used. This connection is done through an Ethernet switch or through a media converter.

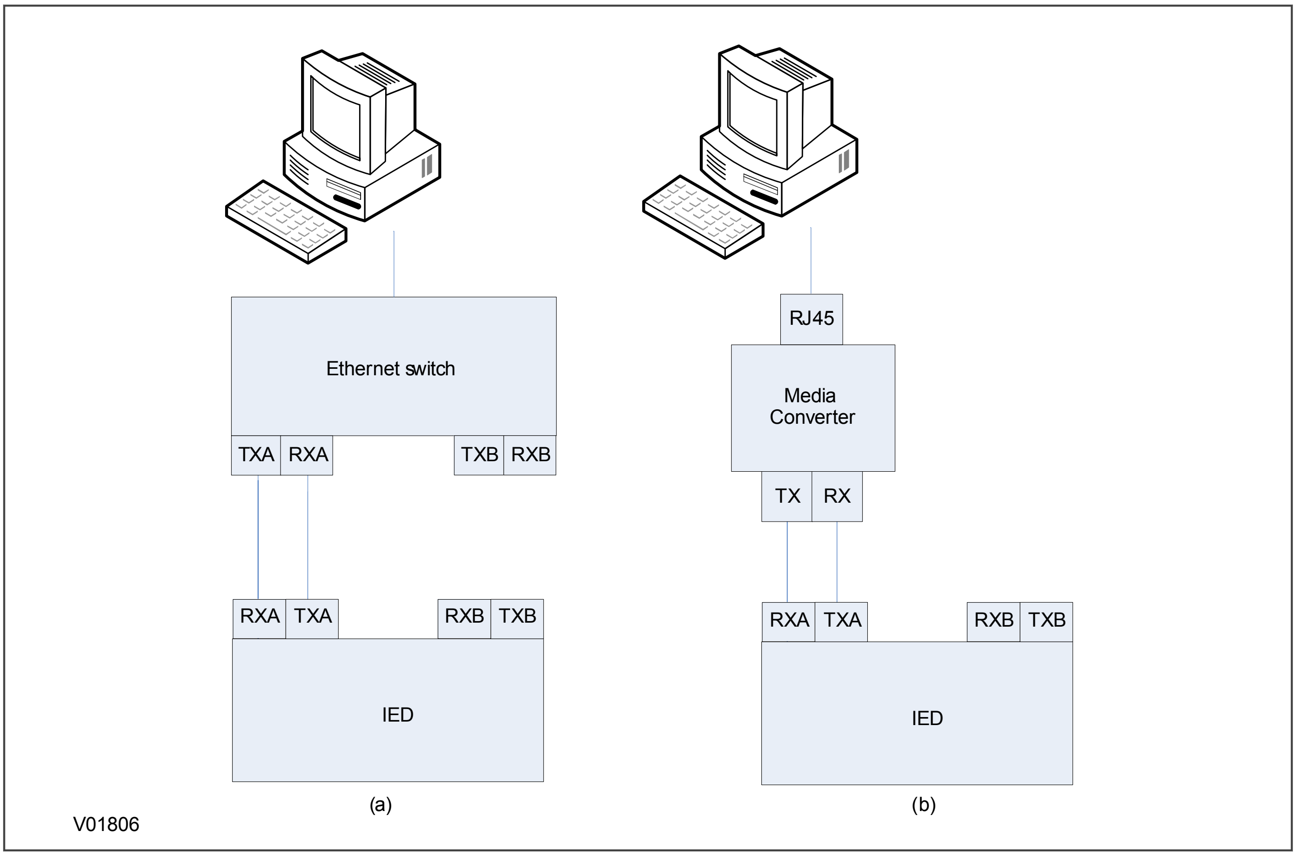


Figure 51: Connection using (a) an Ethernet switch and (b) a media converter

5.7.2 INSTALLING THE CONFIGURATOR

To install the configurator:

1. Double click the Configurator installer.
2. Click Next and follow the on-screen instructions.

5.7.3 STARTING THE CONFIGURATOR

To start the configurator:

1. Select the Configurator from the Windows **Programs** menu.
2. The Login screen appears. For user mode login, enter the **Login name** as **User** and click **OK** with no password.
3. If the login screen does not appear, check all network connections.
4. The main window appears. In the bottom right-hand corner of the main window, click the **Language** button to select the language.
5. The **Network Board** drop-down list shows the Network Board, IP Address and MAC Address of the PC in which the Configurator is running

5.7.4 PRP/HSR DEVICE IDENTIFICATION

To configure the redundant Ethernet board, go to the main window and click the **Identify Device** button. A list of devices are shown with the following details:

- Device address
- MAC address
- Version number of the firmware
- SNTP IP address
- Date & time of the real-time clock, from the board.

Select the device you wish to configure. The MAC address of the selected device is highlighted.

5.7.5 SELECTING THE DEVICE MODE

You must now select the device mode that you wish to use. This will be either PRP or HSR. To do this, select the appropriate radio button then click the Update button. You will be asked to confirm a device reboot. Click OK to confirm

5.7.6 PRP/HSR IP ADDRESS CONFIGURATION

To change the network address component of the IP address:

1. From the main window click the **IP Config** button. The **Device setup** screen appears.
2. Enter the required board IP address and click **OK**. This is the redundancy network address, not the IEC 61850 IP address.
3. The board network address is updated and displayed in the main window.

5.7.7 SNTP IP ADDRESS CONFIGURATION

To configure the SNTP server IP address:

1. From the main window click the **SNTP Config** button. The **Device setup** screen appears.
2. Enter the required **MAC SNTP address** and server **IP SNTP Address**. Click **OK**.
3. The updated MAC and IP SNTP addresses appear in the main screen.

5.7.8 CHECK FOR CONNECTED EQUIPMENT

To check what devices are connected to the device being monitored:

1. From the main window, select the device.
2. Click the **Equipment** button.
3. At the bottom of the main window, a box shows the ports where devices are connected and their MAC addresses.

5.7.9 PRP CONFIGURATION

To view or configure the PRP Parameters:

1. Ensure that you have set the device mode to **PRP**.
2. Click the **PRP/HSR Configuration** button. The **PRP Configuration Parameters** screen appears.
3. To view the available parameters, click the **Get PRP Parameters** button.
4. To change the parameters, click the **Set Parameters** button and modify their values.

If you need to restore the default values of the parameters, click the **Restore Defaults** button.

The configurable parameters are as follows:

- **Multicast Address**: Use this field to configure the multicast destination address. All DANPs in the network must be configured to operate with the same multicast address for the purpose of network supervision.
- **Node Forget Time**: This is the time after which a node entry is cleared in the nodes table.
- **Life Check Interval**: This defines how often a node sends a PRP_Supervision frame. All DANPs shall be configured with the same Life Check Interval.

5.7.10 HSR CONFIGURATION

To view or configure the HSR Parameters:

1. Click the **PRP/HSR Configuration** button. The **HSR Configuration Parameters** screen appears.
2. To view the available parameters in the board that is connected, click the **Get HSR Parameters** button.
3. To change the parameters, click the **Set HSR Parameters** button and modify their values.

If you need to restore the default values of the parameters, click the **Restore Defaults** button.

The configurable parameters are as follows:

- **Multicast Address**: Use this field to configure the multicast destination address. All DANPs in the network must be configured to operate with the same multicast address for the purpose of network supervision.
- **Node Forget Time**: This is the time after which a node entry is cleared in the nodes table.
- **Life Check Interval**: This defines how often a node sends a PRP Supervision frame. All DANPs must be configured with the same Life Check Interval.
- **Proxy Node Table Forget Time**: This is the time after which a node entry is cleared in the ProxyTable
- **Proxy Node Table Max Entries**: This is the maximum number of entries in the ProxyTable
- **Entry Forget Time**: This is the time after which an entry is removed from the duplicates
- **Node Reboot Interval**: This is the minimum time during which a node that reboots remains silent

5.7.11 FILTERING DATABASE

The Filtering Database is used to determine how frames are forwarded or filtered across the on-board Ethernet switch. Filtering information specifies the set of ports to which frames received from a specific port are forwarded. The Ethernet switch examines each received frame to see if the frame's destination address matches a source address listed in the Filtering Database. If there is a match, the device uses the filtering/forwarding information for that source address to determine how to forward or filter the frame. Otherwise the frame is forwarded to all the ports in the Ethernet switch (broadcast).

General tab

The Filtering Database contains two types of entry; static and dynamic. The Static Entries are the source addresses entered by an administrator. The Dynamic Entries are the source addresses learnt by the switch process. The Dynamic Entries are removed from the Filtering Database after the Ageing Time. The Database holds a maximum of 1024 entries.

1. To access the forwarding database functions, if required, click the Filtering Database button in the main window.
2. To view the Forwarding Database Size, Number of Static Entries and Number of Dynamic Entries, click **Read Database Info**.
3. To set the Aging Time, enter the number of seconds in the text box and click the Set button.

Filtering Entries tab

The Filtering Database configuration pages are used to view, add or delete entries from the Filtering Database. This feature is available only for the administrator. This Filtering Database is mainly used during the testing to verify the PRP/HSR functionality. To add an entry in the forwarding database, click the **Filtering Entries** tab. Configure as follows:

1. Select the Port Number and MAC Address
2. Set the Entry type (Dynamic or Static)
3. Set the cast type (Unicast or Multicast)
4. Set theMGMT and Rate Limit
5. Click the **Create** button. The new entry appears in the forwarding database.

To delete an entry from the forwarding database, select the entry and click the **Delete Entry** button.

Goose Filtering tab

This page configures the source MACs from which GOOSE messages will be allowed or blocked. The filtering can be configured by either the MAC address range boxes or by selecting or unselecting the individual MAC addresses in the MAC table. After you have defined the addresses to be allowed or blocked you need to update the table and apply the filter:

- **Update Table:** This updates the MAC table according to the filtering range entered in the MAC address range boxes.
- **Apply Filter:** This applies the filtering configuration in the MAC table to the HSR/PRP board.

5.7.12 END OF SESSION

To finish the session:

1. In the main window, click the **Quit** button, a new screen appears.
2. If a database backup is required, click **Yes**, a new screen appears.
3. Click the **...** button to browse the path. Enter the name in the text box.

5.8 RSTP CONFIGURATOR

The RSTP Configurator tool is intended for MiCOM Px4x IEDs with redundant Ethernet using RSTP (Rapid Spanning Tree Protocol). This tool is used to identify IEDs, configure the redundancy IP address, configure the SNTP IP address and configure the RSTP parameters.

5.8.1 CONNECTING THE IED TO A PC

Connect the IED to the PC on which the Configurator tool is used. This connection is done through an Ethernet switch or through a media converter.

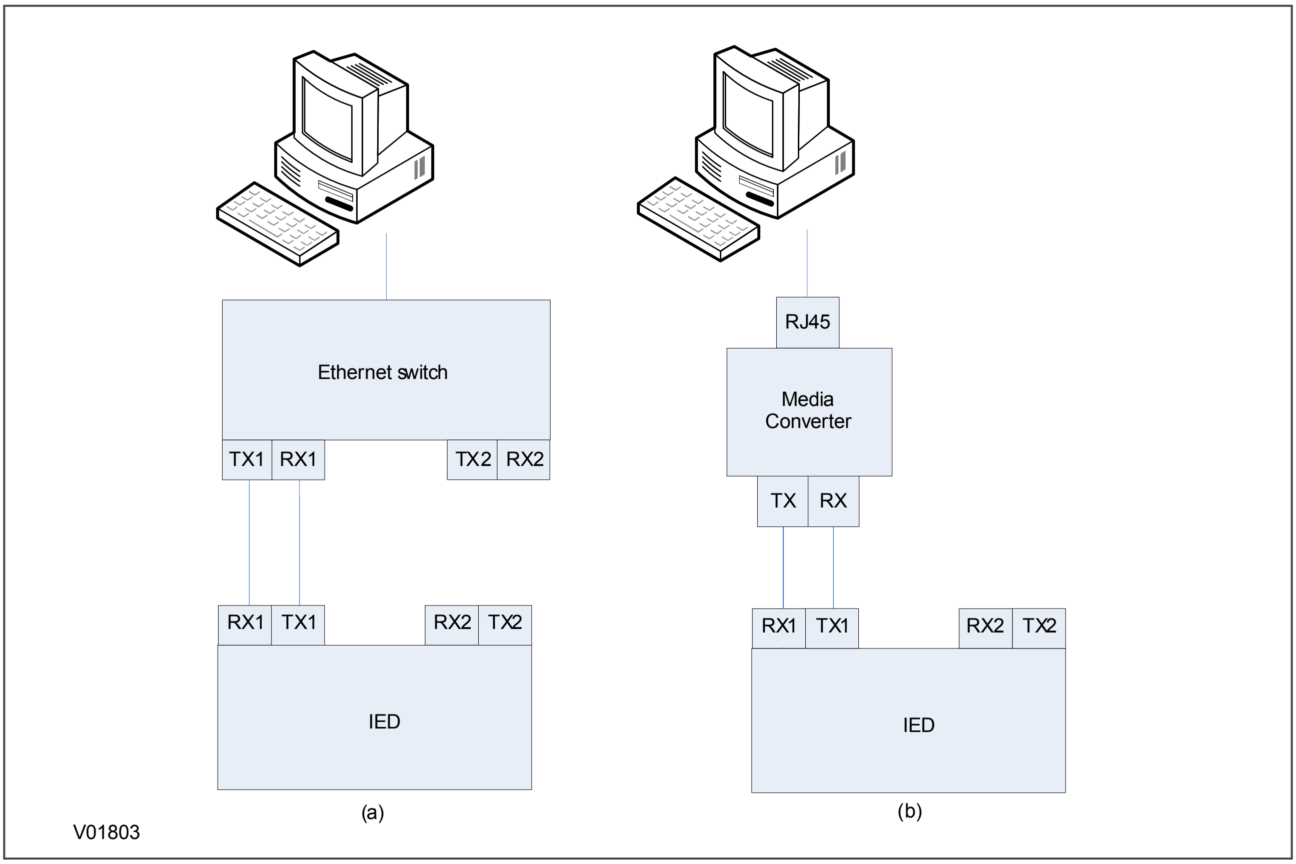


Figure 52: Connection using (a) an Ethernet switch and (b) a media converter

5.8.2 INSTALLING THE CONFIGURATOR

To install the configurator:

1. Double click the Configurator installer.
2. Click Next and follow the on-screen instructions.

5.8.3 STARTING THE CONFIGURATOR

To start the configurator:

1. Select the Configurator from the Windows **Programs** menu.
2. The Login screen appears. For user mode login, enter the **Login name** as **User** and click **OK** with no password.
3. If the login screen does not appear, check all network connections.
4. The main window appears. In the bottom right-hand corner of the main window, click the **Language** button to select the language.
5. The **Network Board** drop-down list shows the Network Board, IP Address and MAC Address of the PC in which the Configurator is running

5.8.4 RSTP DEVICE IDENTIFICATION

To configure the redundant Ethernet board, go to the main window and click **Identify Device**.

> *Note:*
> *Due to the time needed to establish the RSTP protocol, wait 25 seconds between connecting the PC to the IED and clicking the Identify Device button.*

The redundant Ethernet board connected to the PC is identified and its details are listed.

- Device address
- MAC address
- Version number of the firmware
- SNTP IP address
- Date & time of the real-time clock, from the board.

5.8.5 RSTP IP ADDRESS CONFIGURATION

To change the network address component of the IP address,

1. From the main window click the **IP Config** button.
2. The **Device Setup** screen appears showing the **IP Base Address**. This is the board redundancy network address, not the IEC 61850 IP address.
3. Enter the required board IP address.
4. Click **OK**. The board network address is updated and displayed in the main window.

5.8.6 SNTP IP ADDRESS CONFIGURATION

To configure the SNTP server IP address:

1. From the main window click the **SNTP Config** button. The **Device setup** screen appears.
2. Enter the required **MAC SNTP address** and server **IP SNTP Address**. Click **OK**.
3. The updated MAC and IP SNTP addresses appear in the main screen.

5.8.7 CHECK FOR CONNECTED EQUIPMENT

To check what devices are connected to the device being monitored:

1. From the main window, select the device.
2. Click the **Equipment** button.
3. At the bottom of the main window, a box shows the ports where devices are connected and their MAC addresses.

5.8.8 RSTP CONFIGURATION

1. To view or configure the RSTP Bridge Parameters, from the main window, click the device address to select the device. The selected device MAC address appears highlighted.
2. Click the **RSTP Configuration** button. The **RSTP Configuration** screen appears.
3. To view the available parameters in the board that is connected, click the **Get RSTP Parameters** button.
4. To set the configurable parameters such as Bridge Max Age, Bridge Hello Time, Bridge Forward Delay, and Bridge Priority, modify the parameter values according to the following table and click **Set RSTP Parameters**.

S.No	Parameter	Default value (second)	Minimum value (second)	Maximum value (second)
1	Bridge Max Age	20	6	40
2	Bridge Hello Time	2	1	10

S.No	Parameter	Default value (second)	Minimum value (second)	Maximum value (second)
3	Bridge Forward Delay	15	4	30
4	Bridge Priority	32768	0	61440

5.8.8.1 BRIDGE PARAMETERS

To read the RSTP bridge parameters from the board,

1. From the main window click the device address to select the device. The **RSTP Configuration** window appears and the default tab is **Bridge Parameters**.
2. Click the **Get RSTP Parameters** button. This displays all the RSTP bridge parameters from the Ethernet board.
3. To modify the RSTP parameters, enter the values and click **Set RSTP Parameters**.
4. To restore the default values, click **Restore Default** and click **Set RSTP Parameters**.

The grayed parameters are read-only and cannot be modified.

> *Note:*
> *When assigning the bridge priority, make sure the root of the network is the Ethernet switch, not the IEDs. This reduces the number of hops to reach all devices in the network. Also make sure the priority values for all IEDs are higher than that of the switch.*

5.8.8.2 PORT PARAMETERS

This function is useful if you need to view the parameters of each port.

1. From the main window, click the device address to select the device. The **RSTP Configuration** window appears.
2. Select the **Port Parameters** tab, then click **Get Parameters** to read the port parameters. Alternatively, select the port numbers to read the parameters.

5.8.8.3 PORT STATES

This is used to see which ports of the board are enabled or disabled.

1. From the main window, click the device address to select the device. The **RSTP Configuration** window appears.
2. Select the **Port States** tab then click the **Get Port States** button. This lists the ports of the Ethernet board. A tick shows they are enabled.

5.8.8.4 FAILOVER CONFIGURATION

To view or configure the Failover Parameters:

Click the **Failover Configuration** button. The **Failover Configuration** screen appears.

1. To view the available parameters in the board that is connected, click the **Get Failover Parameters** button.
2. To change the parameters, click the **Set Failover Parameters** button and modify their values.

If you need to restore the default values of the parameters, click the **Restore Defaults** button. The configurable parameters are as follows:

- Port A and Port B select your main port for the Failover (Port A is the port at the top of your REB).
- The Failover time defines how long it takes for the redundancy switch over to trigger. The minimum value is 2s.

5.8.8.5 END OF SESSION

To finish the session:

1. In the main window, click the **Quit** button, a new screen appears.
2. If a database backup is required, click **Yes**, a new screen appears.
3. Click the **...** button to browse the path. Enter the name in the text box.

6 DATA PROTOCOLS

The products supports a wide range of protocols to make them applicable to many industries and applications. The exact data protocols supported by a particular product depend on its chosen application, but the following table gives a list of the data protocols that are typically available.

SCADA data protocols

Data Protocol	Layer 1 protocol	Description
Courier	USB, K-Bus, RS232, RS485, Ethernet	Standard for SCADA communications developed by GE.
MODBUS	RS485	Standard for SCADA communications developed by Modicon.
IEC 60870-5-103	RS485	IEC standard for SCADA communications
DNP 3.0	RS485	Standard for SCADA communications
IEC 61850	Ethernet	IEC standard for substation automation. Facilitates interoperability.

The relationship of these protocols to the lower level physical layer protocols are as follows:

Data Protocols	IEC 60870-5-103 MODBUS DNP3.0 Courier	IEC 61850 Courier	Courier	Courier	Courier
Data Link Layer	EIA(RS)485	Ethernet	EIA(RS)232	K-Bus	USB
Physical Layer	Copper or Optical Fibre				USB Type B

6.1 COURIER

This section should provide sufficient detail to enable understanding of the Courier protocol at a level required by most users. For situations where the level of information contained in this manual is insufficient, further publications (R6511 and R6512) containing in-depth details about the protocol and its use, are available on request.

Courier is an GE proprietary communication protocol. Courier uses a standard set of commands to access a database of settings and data in the IED. This allows a master to communicate with a number of slave devices. The application-specific elements are contained in the database rather than in the commands used to interrogate it, meaning that the master station does not need to be preconfigured. Courier also provides a sequence of event (SOE) and disturbance record extraction mechanism.

6.1.1 PHYSICAL CONNECTION AND LINK LAYER

Courier can be used with four physical layer protocols: USB, K-Bus, EIA(RS)232 or EIA(RS)485.

Several connection options are available for Courier

- The front USB port (for connection to Settings application software on, for example, a laptop)
- Rear Port 1 (RP1) - for permanent SCADA connection via RS485 or K-Bus
- Optional fibre port (RP1 in slot A) - for permanent SCADA connection via optical fibre
- Optional Rear Port 2 (RP2) - for permanent SCADA connection via RS485, K-Bus, or RS232

For either of the rear ports, both the IED address and baud rate can be selected using the front panel menu or by the settings application software.

6.1.2 COURIER DATABASE

The Courier database is two-dimensional and resembles a table. 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 (0000 to FFFF Hexadecimal. Addresses in the database are specified as hexadecimal values, for example, 0A02 is column 0A 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 product-specific menu databases contain the complete database definition.

6.1.3 SETTINGS CATEGORIES

There are two main categories of settings in protection IEDs:

- Control and support settings
- Protection settings

With the exception of the Disturbance Recorder settings, changes made to the control and support settings are implemented immediately and stored in non-volatile memory. Changes made to the Protection settings and the Disturbance Recorder settings are stored in 'scratchpad' memory and are not immediately implemented. These need to be committed by writing to the ***Save Changes*** cell in the *CONFIGURATION* column.

6.1.4 SETTING CHANGES

Courier provides two mechanisms for making setting changes. Either method can be used for editing any of the settings in the database.

Method 1

This uses a combination of three commands to perform a settings change:

First, enter Setting mode: This checks that the cell is settable and returns the limits.

1. Preload Setting: This places a new value into 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.
2. Execute Setting: This confirms the setting change. If the change is valid, a positive response is returned. If the setting change fails, an error response is returned.
3. 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 extracted 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.

Method 2

The Set Value command can be used to change a setting directly. 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. This method is therefore most suitable for off-line setting editors such as MiCOM S1 Agile, or for issuing preconfigured control commands.

6.1.5 EVENT EXTRACTION

You can extract events either automatically (rear serial port only) or manually (either serial port). For automatic extraction, all events are extracted in sequential order using the Courier event mechanism. This includes fault and maintenance data if appropriate. The manual approach allows you to select events, faults, or maintenance data as desired.

6.1.5.1 AUTOMATIC EVENT RECORD EXTRACTION

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, non-extracted event can be extracted from the IED using the ***Send Event*** command. The IED responds with the event data.

Once an event has been extracted, the ***Accept Event*** command can be used to confirm that the event has been successfully extracted. When 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.

6.1.5.2 MANUAL EVENT RECORD EXTRACTION

The *VIEW RECORDS* column (location 01) is used for manual viewing of event, fault, and maintenance records. The contents of this column depend on the nature of the record selected. You can select events by event number and directly select a fault or maintenance record by number.

Event Record Selection ('Select Event' cell: 0101)

This cell can be set the number of stored events. For simple event records (Type 0), cells 0102 to 0105 contain the event details. A single cell is used to represent each of the event fields. If the event selected is a fault or maintenance record (Type 3), the remainder of the column contains the additional information.

Fault Record Selection ('Select Fault' cell: 0105)

This cell can be used to select a fault record directly, using a value between 0 and 4 to select one of up to five stored fault records. (0 is the most recent fault and 4 is the oldest). The column then contains the details of the fault record selected.

Maintenance Record Selection ('Select Maint' cell: 01F0)

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, the number associated with a particular record changes when a new event or fault occurs.

Event Types

The IED generates events under certain circumstances such as:

- Change of state of output contact
- Change of state of opto-input
- Protection element operation
- Alarm condition
- Setting change
- Password entered/timed-out

Event Record Format

The IED returns the following fields when the Send Event command is invoked:

- Cell reference
- Time stamp
- Cell text
- Cell value

The Menu Database contains tables of possible events, and shows how the contents of the above fields are interpreted. Fault and Maintenance records return a Courier Type 3 event, which contains the above fields plus two additional fields:

- Event extraction column
- Event number

These events contain additional information, which is extracted from the IED using column B4. Row 01 contains a ***Select Record*** setting that allows the fault or 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 IED by uploading the text and data from the column.

6.1.6 DISTURBANCE RECORD EXTRACTION

The stored disturbance records are accessible through the Courier interface. The records are extracted using column (B4).

The ***Select Record*** cell can be used to select the record to be extracted. Record 0 is the oldest non-extracted record. Older records which have been already been extracted are assigned positive values, while younger records are assigned negative values. To help automatic extraction through the rear port, the IED sets the ***Disturbance*** bit of the ***Status*** byte, whenever there are non-extracted disturbance records.

Once a record has been selected, using the above cell, the time and date of the record can be read from the ***Trigger Time*** cell (B402). The disturbance record can be extracted using the block transfer mechanism from cell B40B and saved in the COMTRADE format. The settings application software software automatically does this.

6.1.7 PROGRAMMABLE SCHEME LOGIC SETTINGS

The programmable scheme logic (PSL) settings can be uploaded from and downloaded to the IED using the block transfer mechanism.

The following cells are used to perform the extraction:

- ***Domain*** cell (B204): Used to select either PSL settings (upload or download) or PSL configuration data (upload only)
- ***Sub-Domain*** cell (B208): Used to select the Protection Setting Group to be uploaded or downloaded.
- ***Version*** cell (B20C): Used on a download to check the compatibility of the file to be downloaded.
- ***Transfer Mode*** cell (B21C): Used to set up the transfer process.
- ***Data Transfer*** cell (B120): Used to perform upload or download.

The PSL settings can be uploaded and downloaded to and from the IED using this mechanism. The settings application software must be used to edit the settings. It also performs checks on the validity of the settings before they are transferred to the IED.

6.1.8 TIME SYNCHRONISATION

The time and date can be set using the time synchronization feature of the Courier protocol. The device will correct for the transmission delay. The time synchronization message may be sent as either a global command or to any individual IED address. If the time synchronization message is sent to an individual address, then the device will respond with a confirm message. If sent as a global command, the (same) command must be sent twice. A time synchronization Courier event will be generated/produced whether the time-synchronization message is sent as a global command or to any individual IED address.

If the clock is being synchronized using the IRIG-B input then it will not be possible to set the device time using the Courier interface. An attempt to set the time using the interface will cause the device to create an event with the current date and time taken from the IRIG-B synchronized internal clock.

6.1.9 COURIER CONFIGURATION

To configure the device:

1. Select the *CONFIGURATION* column and check that the ***Comms settings*** cell is set to `Visible`.
2. Select the *COMMUNICATIONS* column.
3. Move to the first cell down (***RP1 protocol***). This is a non-settable cell, which shows the chosen communication protocol – in this case `Courier`.

```
COMMUNICATIONS
RP1 Protocol
Courier
```

4. Move down to the next cell (***RP1 Address***). This cell controls the address of the RP1 port on the device. Up to 32 IEDs can be connected to one spur. It is therefore necessary for each IED to have a unique address so that messages from the master control station are accepted by one IED only. Courier uses an integer number between 1 and 254 for the Relay Address. It is set to 255 by default, which has to be changed. It is important that no two IEDs share the same address.

```
COMMUNICATIONS
RP1 Address
100
```

5. Move down to the next cell (***RP1 InactivTimer***). This cell controls the inactivity timer. The inactivity timer controls how long the IED waits without receiving any messages on the rear port before revoking any password access that was enabled and discarding any changes. For the rear port this can be set between 1 and 30 minutes.

```
COMMUNICATIONS
RP1 Inactivtimer
10.00 mins.
```

6. If the optional fibre optic connectors are fitted, the ***RP1 PhysicalLink*** cell is visible. This cell controls the physical media used for the communication (Copper or Fibre optic).

```
COMMUNICATIONS
RP1 PhysicalLink
Copper
```

7. Move down to the next cell (***RP1 Card Status***). This cell is not settable. It displays the status of the chosen physical layer protocol for RP1.

```
COMMUNICATIONS
RP1 Card Status
K-Bus OK
```

8. Move down to the next cell (***RP1 Port Config***). This cell controls the type of serial connection. Select between K-Bus or RS485.

```
COMMUNICATIONS
RP1 Port Config
K-Bus
```

9. If using EIA(RS)485, the next cell (***RP1 Comms Mode***) selects the communication mode. The choice is either IEC 60870 FT1.2 for normal operation with 11-bit modems, or 10-bit no parity. If using K-Bus this cell will not appear.

```
COMMUNICATIONS
RP1 Comms Mode
IEC 60870 FT1.2
```

10. If using EIA(RS)485, the next cell down controls the baud rate. Three baud rates are supported; 9600, 19200 and 38400. If using K-Bus this cell will not appear as the baud rate is fixed at 64 kbps.

```
COMMUNICATIONS
RP1 Baud rate
19200
```

6.2 IEC 60870-5-103

The specification IEC 60870-5-103 (Telecontrol Equipment and Systems Part 5 Section 103: Transmission Protocols), defines the use of standards IEC 60870-5-1 to IEC 60870-5-5, which were designed for communication with protection equipment

This section describes how the IEC 60870-5-103 standard is applied to the Px40 platform. It is not a description of the standard itself. The level at which this section is written assumes that the reader is already familiar with the IEC 60870-5-103 standard.

This section should provide sufficient detail to enable understanding of the standard at a level required by most users.

The IEC 60870-5-103 interface is a master/slave interface with the device as the slave device. The device conforms to compatibility level 2, as defined in the IEC 60870-5-103.standard.

The following IEC 60870-5-103 facilities are supported by this interface:

- Initialization (reset)
- Time synchronization
- Event record extraction
- General interrogation
- Cyclic measurements
- General commands
- Disturbance record extraction
- Private codes

6.2.1 PHYSICAL CONNECTION AND LINK LAYER

Two connection options are available for IEC 60870-5-103:

- Rear Port 1 (RP1) - for permanent SCADA connection via RS485
- Optional fibre port (RP1 in slot A) - for permanent SCADA connection via optical fibre

If the optional fibre optic port is fitted, a menu item appears in which the active port can be selected. However the selection is only effective following the next power up.

The IED address and baud rate can be selected using the front panel menu or by the settings application software.

6.2.2 INITIALISATION

Whenever the device has been powered up, or if the communication parameters have been changed a reset command is required to initialize the communications. The device will respond to either of the two reset commands; Reset CU or Reset FCB (Communication Unit or Frame Count Bit). The difference between the two commands is that the Reset CU command will clear any unsent messages in the transmit buffer, whereas the Reset FCB command does not delete any messages.

The device will respond to the reset command with an identification message ASDU 5. The Cause of Transmission (COT) of this response will be either Reset CU or Reset FCB depending on the nature of the reset command. The content of ASDU 5 is described in the IEC 60870-5-103 section of the Menu Database, available from GE separately if required.

In addition to the above identification message, it will also produce a power up event.

6.2.3 TIME SYNCHRONISATION

The time and date can be set using the time synchronization feature of the IEC 60870-5-103 protocol. The device will correct for the transmission delay as specified in IEC 60870-5-103. If the time synchronization message is sent as a send/confirm message then the device will respond with a confirm message. A time synchronization Class 1 event will be generated/produced whether the time-synchronization message is sent as a send confirm or a broadcast (send/no reply) message.

If the clock is being synchronized using the IRIG-B input then it will not be possible to set the device time using the IEC 60870-5-103 interface. An attempt to set the time via the interface will cause the device to create an event with the current date and time taken from the IRIG-B synchronized internal clock.

6.2.4 CONFIGURABLE IEC 60870-5-103 SIGNAL LIST

From Software Version 91 onwards, there is a setting cell which allows the IEC 60870-5-103 private range signals to be selected and de-selected from IEC 60870-5-103 communication.

The IEC 60870-5-103 standard (compatible range) signals, that are provided according to the relay type and implementation, are always enabled. These signals cannot be disabled.

This setting cell is ***Config Mode*** in the *PROTOCOL CFG* column.

There are two settings associated with this cell. These are:

Setting:	Description:
Fixed	In this mode, the IED behaviour for IEC 60870-5-103 protocol is identical to pre-Software Version 91 IEDs. All the implemented signals (IEC 60870-5-103 compatible range and private range signals) are enabled for IEC 60870-5-103 communication. The COT behaviour will be according to the device IEC 60870-5-103 profile. This mode is provided for backward compatibility. This is the default setting.
Std+UserConfig	In this mode, the user can select which IEC 60870-5-103 private range signals are enabled for IEC 60870-5-103 communication. The selection is done using DDB mask setting cells in the *PROTOCOL CFG* column. The DDB mask value controls only the signal selection (enabled or disabled) for IEC 60870-5-103 communication. It does not modify the COT behaviour of the signals. The COT behaviour of the private range signals will be according to the device IEC 60870-5-103 profile. By default, only IEC 60870-5-103 standard signals are enabled. All private range signals are disabled.

When the ***Config Mode*** cell is set to `Std+UserConfig`, the DDB masks become visible in the *PROTOCOL CFG* column. These masks function in a similar way to the DDB masks in the *RECORD CONTROL* column. Editing these masks controls the DDB signals that are enabled for communication of the equivalent IEC 60870-5-103 private range signal, as listed in the IEC 60870-5-103 profile in the Menu Database.

Within these masks, only individual DDBs that are equivalent to IEC 60870-5-103 private range signals are editable. By default, all of the individual DDBs that are equivalent to IEC 60870-5-103 private range signals are set to 0 (zero), that is disabled for communication. Setting any individual DDB to 1 (one), enables the equivalent IEC 60870-5-103 private range signal for communication.

Within these masks, individual DDBs that are either equivalent to IEC 60870-5-103 standard range signals, or do not have any equivalent IEC 60870-5-103 private range signal, are not editable.

6.2.5 SPONTANEOUS EVENTS

Events are categorized using the following information:

- Function type
- Information Number

The IEC 60870-5-103 profile in the Menu Database contains a complete listing of all events produced by the device.

From Software Version 91 onwards, the IEC 60870-5-103 private range signals can be individually selected for spontaneous communication, by settting the ***Config Mode*** cell to `Std+UserConfig`, and configuring the DDB masks as required.

6.2.6 GENERAL INTERROGATION (GI)

The GI request can be used to read the status of the device, the function numbers, and information numbers that will be returned during the GI cycle. These are shown in the IEC 60870-5-103 profile in the Menu Database.

From Software Version 91 onwards, the IEC 60870-5-103 private range signals can be individually selected for GI reporting, by setting the ***Config Mode*** cell to `Std+UserConfig`, and configuring the DDB masks as required.

6.2.7 CYCLIC MEASUREMENTS

The device will produce measured values using ASDU 9 on a cyclical basis, this can be read from the device using a Class 2 poll (note ADSU 3 is not used). The rate at which the device produces new measured values can be controlled using the measurement period setting. This setting can be edited from the front panel menu or using MiCOM S1 Agile. It is active immediately following a change.

The device transmits its measurands at 2.4 times the rated value of the analogue value.

6.2.8 COMMANDS

A list of the supported commands is contained in the Menu Database. The device will respond to other commands with an ASDU 1, with a cause of transmission (COT) indicating 'negative acknowledgement'.

6.2.9 TEST MODE

It is possible to disable the device output contacts to allow secondary injection testing to be performed using either the front panel menu or the front serial port. The IEC 60870-5-103 standard interprets this as 'test mode'. An event will be produced to indicate both entry to and exit from test mode. Spontaneous events and cyclic measured data transmitted whilst the device is in test mode will have a COT of 'test mode'.

6.2.10 DISTURBANCE RECORDS

The disturbance records are stored in uncompressed format and can be extracted using the standard mechanisms described in IEC 60870-5-103.

> *Note:*
> *IEC 60870-5-103 only supports up to 8 records.*

6.2.11 COMMAND/MONITOR BLOCKING

The device supports a facility to block messages in the monitor direction (data from the device) and also in the command direction (data to the device). Messages can be blocked in the monitor and command directions using one of the two following methods

- The menu command ***RP1 CS103Blcking*** in the *COMMUNICATIONS* column
- The DDB signals Monitor Blocked and Command Blocked

6.2.12 IEC 60870-5-103 CONFIGURATION

To configure the device:

1. Select the *CONFIGURATION* column and check that the ***Comms settings*** cell is set to `Visible`.
2. Select the *COMMUNICATIONS* column.
3. Move to the first cell down (***RP1 protocol***). This is a non-settable cell, which shows the chosen communication protocol – in this case `IEC 60870-5-103`.

```
COMMUNICATIONS
RP1 Protocol
IEC 60870-5-103
```

4. Move down to the next cell (***RP1 Address***). This cell controls the IEC 60870-5-103 address of the IED. Up to 32 IEDs can be connected to one spur. It is therefore necessary for each IED to have a unique address so that messages from the master control station are accepted by one IED only. IEC 60870-5-103 uses an integer number between 0 and 254 for the address. It is important that no two IEDs have the same IEC 60870 5 103 address. The IEC 60870-5-103 address is then used by the master station to communicate with the IED.

```
COMMUNICATIONS
RP1 address
162
```

5. Move down to the next cell (***RP1 Baud Rate***). This cell controls the baud rate to be used. Two baud rates are supported by the IED, `9600 bits/s` and `19200 bits/s`. Make sure that the baud rate selected on the IED is the same as that set on the master station.

```
COMMUNICATIONS
RP1 Baud rate
9600 bits/s
```

6. Move down to the next cell (***RP1 Meas Period***). The next cell down controls the period between IEC 60870-5-103 measurements. The IEC 60870-5-103 protocol allows the IED to supply measurements at regular intervals. The interval between measurements is controlled by this cell, and can be set between 1 and 60 seconds.

```
COMMUNICATIONS
RP1 Meas Period
30.00 s
```

7. If the optional fibre optic connectors are fitted, the ***RP1 PhysicalLink*** cell is visible. This cell controls the physical media used for the communication (Copper or Fibre optic).

```
COMMUNICATIONS
RP1 PhysicalLink
Copper
```

8. The next cell down (***RP1 CS103Blcking***) can be used for monitor or command blocking.

```
COMMUNICATIONS
RP1 CS103Blcking
Disabled
```

9. There are three settings associated with this cell; these are:

Setting:	Description:
Disabled	No blocking selected.
Monitor Blocking	When the monitor blocking DDB Signal is active high, either by energising an opto input or control input, reading of the status information and disturbance records is not permitted. When in this mode the device returns a "Termination of general interrogation" message to the master station.
Command Blocking	When the command blocking DDB signal is active high, either by energising 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 device returns a "negative acknowledgement of command" message to the master station.

6.3 MODBUS

This section describes how the MODBUS standard is applied to the Px40 platform. It is not a description of the standard itself. The level at which this section is written assumes that the reader is already familiar with the MODBUS standard.

The MODBUS protocol is a master/slave protocol, defined and administered by the MODBUS Organization For further information on MODBUS and the protocol specifications, please see the Modbus web site (www.modbus.org).

6.3.1 PHYSICAL CONNECTION AND LINK LAYER

Two connection options are available for MODBUS

- Rear Port 1 (RP1) - for permanent SCADA connection via RS485
- Optional fibre port (RP1 in slot A) - for permanent SCADA connection via optical fibre

The MODBUS interface uses 'RTU' mode communication rather than 'ASCII' mode as this provides more efficient use of the communication bandwidth. This mode of communication is defined by the MODBUS standard.

The IED address and baud rate can be selected using the front panel menu or by the settings application software.

When using a serial interface, the data format is: 1 start bit, 8 data bits, 1 parity bit with 1 stop bit, or 2 stop bits (a total of 11 bits per character).

6.3.2 MODBUS FUNCTIONS

The following MODBUS function codes are supported:

- 01: Read Coil Status
- 02: Read Input Status
- 03: Read Holding Registers
- 04: Read Input Registers
- 06: Preset Single Register

- 08: Diagnostics
- 11: Fetch Communication Event Counter
- 12: Fetch Communication Event Log
- 16: Preset Multiple Registers 127 max

These are interpreted by the MiCOM IED in the following way:

- 01: Read status of output contacts (0xxxx addresses)
- 02: Read status of opto inputs (1xxxx addresses)
- 03: Read setting values (4xxxx addresses)
- 04: Read measured values (3xxxx addresses
- 06: Write single setting value (4xxxx addresses)
- 16: Write multiple setting values (4xxxx addresses)

6.3.3 RESPONSE CODES

MCode	MODBUS Description	MiCOM Interpretation
01	Illegal Function Code	The function code transmitted is not supported by the slave.
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 then all changes within the request are discarded and this error response will be 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 within range. Other values transmitted within the same packet will be executed if inside range.
06	Slave Device Busy	The write command cannot be implemented due to the database being locked by another interface. This response is also produced if the software is busy executing a previous request.

6.3.4 REGISTER MAPPING

The device supports the following memory page references:

- Memory Page: Interpretation
- 0xxxx: Read and write access of the output relays
- 1xxxx: Read only access of the opto inputs
- 3xxxx: Read only access of data
- 4xxxx: Read and write access of settings

where xxxx represents the addresses available in the page (0 to 9999).

A complete map of the MODBUS addresses supported by the device is contained in the relevant menu database, which is available on request.

Note:
The "extended memory file" (6xxxx) is not supported.

Note:
MODBUS convention is to document register addresses as ordinal values whereas the actual protocol addresses are literal values. The MiCOM relays begin their register addresses at zero. Therefore, the first register in a memory page is register address zero. The second register is register address 1 and so on.

> *Note:*
> *The page number notation is not part of the address.*

6.3.5 EVENT EXTRACTION

The device supports two methods of event extraction providing either automatic or manual extraction of the stored event, fault, and maintenance records.

6.3.5.1 AUTOMATIC EVENT RECORD EXTRACTION

The automatic extraction facilities allow all types of record to be extracted as they occur. Event records are extracted in sequential order including any fault or maintenance data that may be associated with the event.

The MODBUS master can determine whether the device has any events stored that have not yet been extracted. This is performed by reading the status register 30001 (G26 data type). If the event bit of this register is set then the device has non-extracted events available. To select the next event for sequential extraction, the master station writes a value of 1 to the record selection register 40400 (G18 data type). The event data together with any fault/ maintenance data can be read from the registers specified below. Once the data has been read, the event record can be marked as having been read by writing a value of '2' to register 40400.

6.3.5.2 MANUAL EVENT RECORD EXTRACTION

There are three registers available to manually select stored records and three read-only registers allowing the number of stored records to be determined.

- 40100: Select Event
- 40101: Select Fault
- 40102: Select Maintenance Record

For each of the above registers a value of 0 represents the most recent stored record. The following registers can be read to indicate the numbers of the various types of record stored.

- 30100: Number of stored records
- 30101: Number of stored fault records
- 30102: Number of stored maintenance records

Each fault or maintenance record logged causes an event record to be created. If this event record is selected, the additional registers allowing the fault or maintenance record details will also become populated.

6.3.5.3 RECORD DATA

The location and format of the registers used to access the record data is the same whether they have been selected using either automatic or manual extraction.

Event Description	MODBUS Address	Length	Comments
Time and Date	30103	4	See G12 data type description
Event Type	30107	1	See G13 data type description
Event Value	30108	2	Nature of value depends on event type. This will contain the status as a binary flag for contact, opto-input, alarm, and protection events.

Event Description	MODBUS Address	Length	Comments
MODBUS Address	30110	1	This indicates the MODBUS register address where the change occurred. Alarm 30011 Relays 30723 Optos 30725 Protection events – like the relay and opto addresses this will map onto the MODBUS address of the appropriate DDB status register depending on which bit of the DDB the change occurred. These will range from 30727 to 30785. For platform events, fault events and maintenance events the default is 0.
Event Index	30111	1	This register will contain the DDB ordinal for protection events or the bit number for alarm events. The direction of the change will be indicated by the most significant bit; 1 for 0 – 1 change and 0 for 1 – 0 change.
Additional Data Present	30112	1	0 means that there is no additional data. 1 means fault record data can be read from 30113 to 30199 (number of registers depends on the product). 2 means maintenance record data can be read from 30036 to 30039.

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 independently clear the stored relay event/fault and maintenance records. This register also provides an option to reset the device indications, which has the same effect on the relay as pressing the clear key within the alarm viewer using the HMI panel menu.

6.3.6 DISTURBANCE RECORD EXTRACTION

The IED provides facilities for both manual and automatic extraction of disturbance records.

Records extracted over MODBUS from Px40 devices are presented in COMTRADE format. This involves extracting an ASCII text configuration file and then extracting a binary data file.

Each file is extracted by reading a series of data pages from the IED The data page is made up of 127 registers, giving a maximum transfer of 254 bytes per page.

The following set of registers is presented to the master station to support the extraction of uncompressed disturbance records:

MODBUS registers

MODBUS Register	Name	Description
3x00001	Status register	Provides the status of the relay 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' on b4 indicates the presence of a disturbance
3x00800	No of stored disturbances	Indicates the total number of disturbance records currently stored in the relay, both extracted and non-extracted.
3x00801	Unique identifier of the oldest disturbance record	Indicates the unique identifier value for the oldest disturbance record stored in the relay. This is an integer value used in conjunction with the 'Number of stored disturbances' value to calculate a value for manually selecting records.

MODBUS Register	Name	Description
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 Number of stored disturbances - 1, is added to the identifier of the oldest record to generate the identifier of the required record.
4x00400	Record selection command register	This register is used during the extraction process and has a number of commands. These are: b0: Select next event b1: Accept event b2: Select next disturbance record b3: Accept disturbance record b4: Select next page of disturbance data b5: Select data file
3x00930 - 3x00933	Record time stamp	These registers return the timestamp of the disturbance record.
3x00802	No of registers in data page	This register informs the master station of the number of registers in the data page that are populated.
3x00803 - 3x00929	Data page registers	These 127 registers are used to transfer data from the relay to the master station. They are 16-bit unsigned integers.
3x00934	Disturbance record status register	The disturbance record status register is used during the extraction process to indicate to the master station when data is ready for extraction. See next table.
4x00251	Data file format selection	This is used to select the required data file format. This is reserved for future use.

> *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).*

The disturbance record status register will report one of the following values:

Disturbance record states

State	Description
Idle	This will be the state reported when no record is selected; such as after power on or after a record has been marked as extracted.
Busy	The relay is currently processing data.
Page ready	The data page has been populated and the master station can now safely read the data.
Configuration complete	All of the configuration data has been read without error.
Record complete	All of the disturbance data has been extracted.
Disturbance overwritten	An error occurred during the extraction process where the disturbance being extracted was overwritten by a new record.
No non-extracted disturbances	An attempt was made by the master station to automatically select the next oldest non-extracted disturbance when all records have been extracted.
Not a valid disturbance	An attempt was made by the master station to manually select a record that did not exist in the relay.
Command out of sequence	The master station issued a command to the relay that was not expected during the extraction process.

6.3.6.1 MANUAL EXTRACTION PROCEDURE

The procedure used to extract a disturbance manually is shown below. The manual method of extraction does not allow for the acceptance of disturbance records.

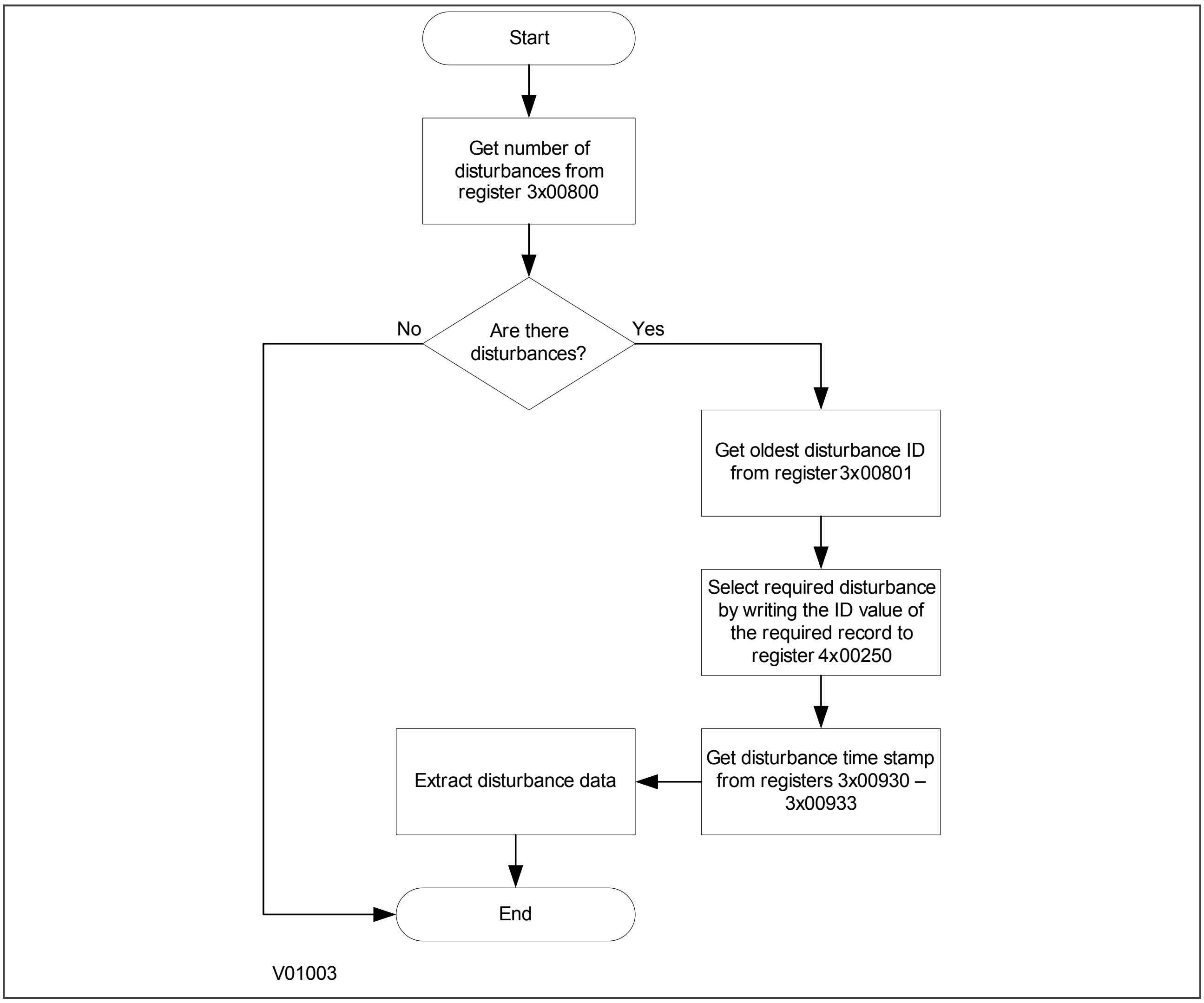


Figure 53: Manual selection of a disturbance record

6.3.6.2 AUTOMATIC EXTRACTION PROCEDURE

There are two methods that can be used for automatically extracting disturbances:

Method 1

Method 1 is simpler and is better at extracting single disturbance records (when the disturbance recorder is polled regularly).

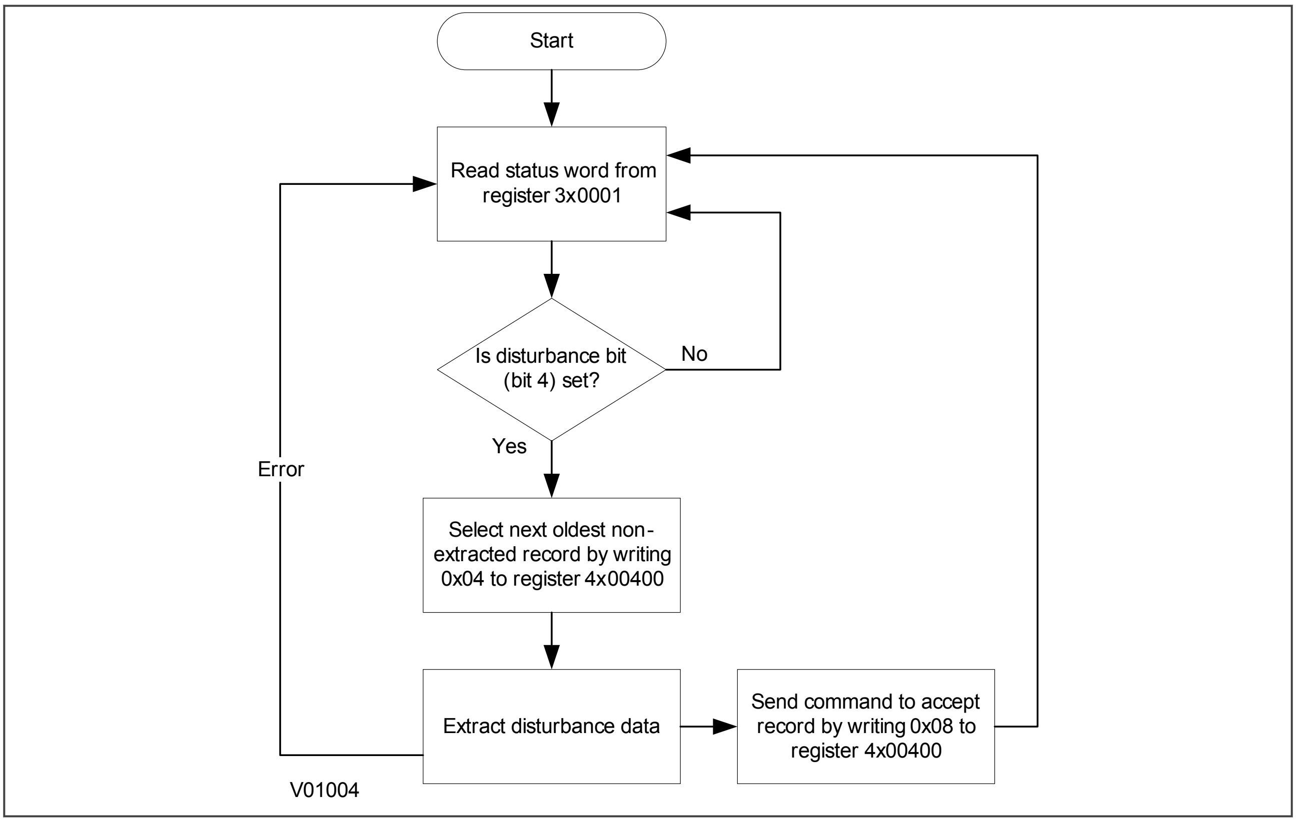


Figure 54: Automatic selection of disturbance record - method 1

Method 2

Method 2 is more complex to implement but is more efficient at extracting large quantities of disturbance records. This may be useful when the disturbance recorder is polled only occasionally and therefore may have many stored records.

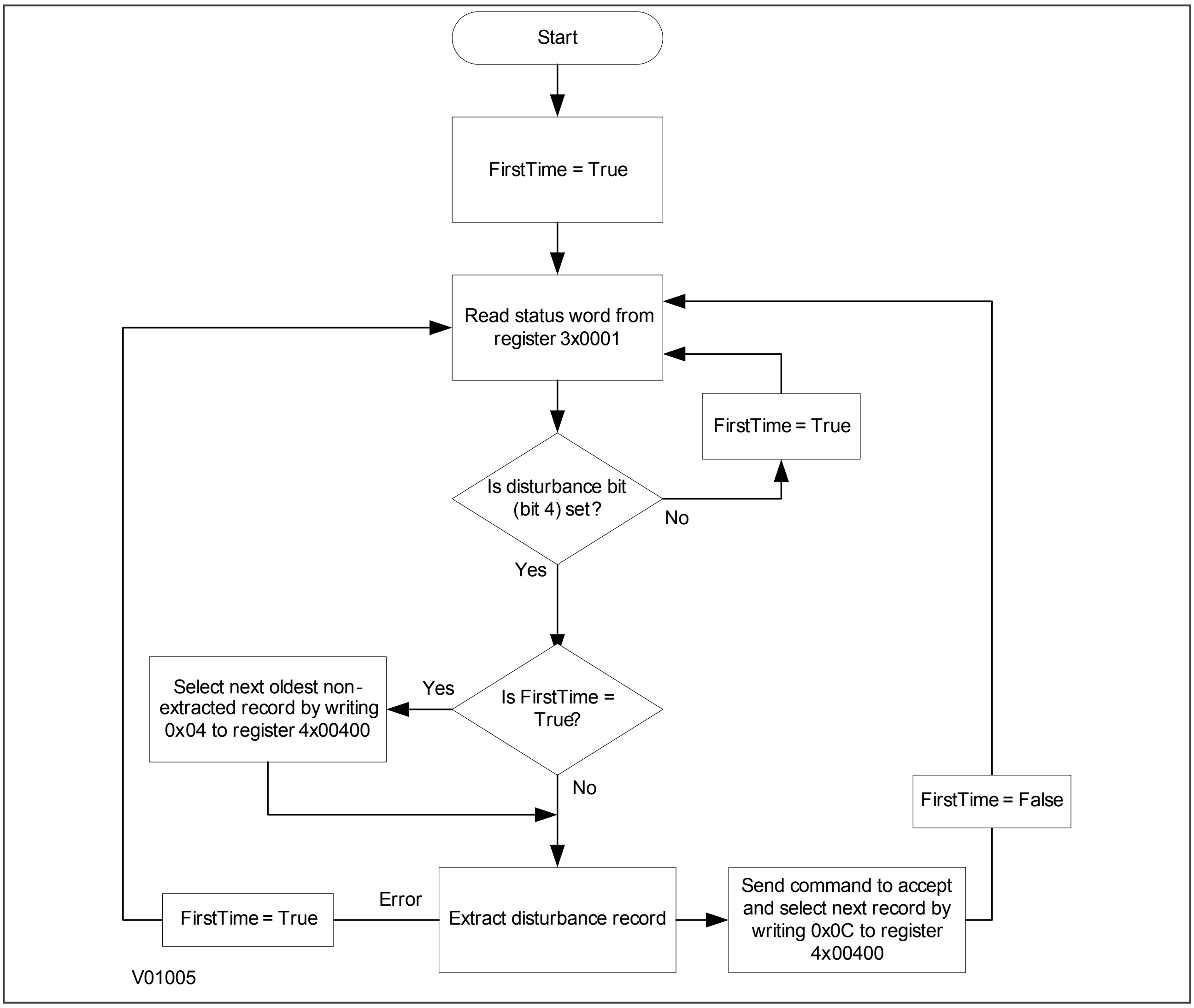


Figure 55: Automatic selection of disturbance record - method 2

6.3.6.3 EXTRACTING THE DISTURBANCE DATA

The extraction of the disturbance record is a two-stage process that involves extracting the configuration file first and then the data file. The configuration file must be extracted first, followed by the data file:

Extracting the Comtrade configuration file

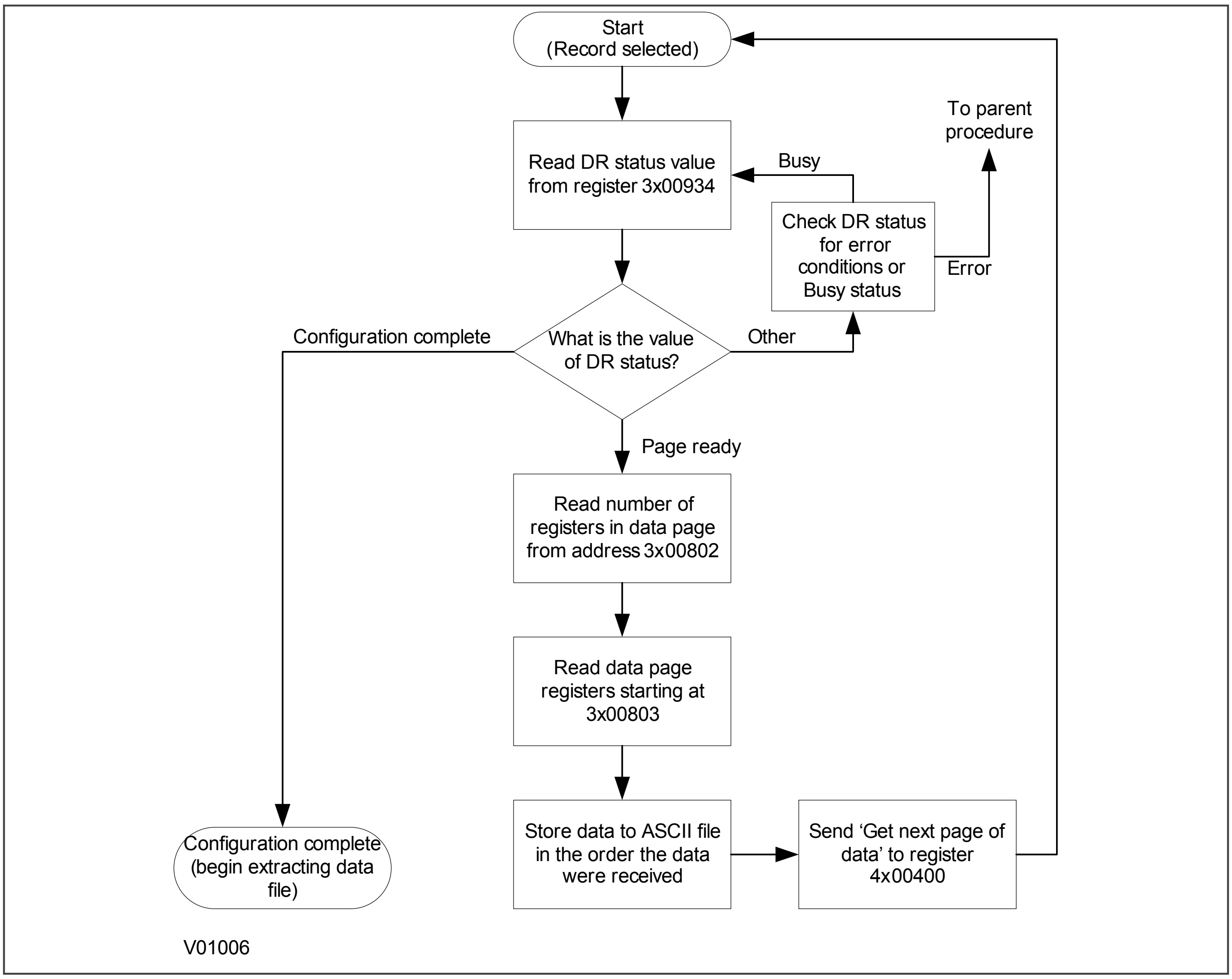


Figure 56: Configuration file extraction

Extracting the comtrade data file

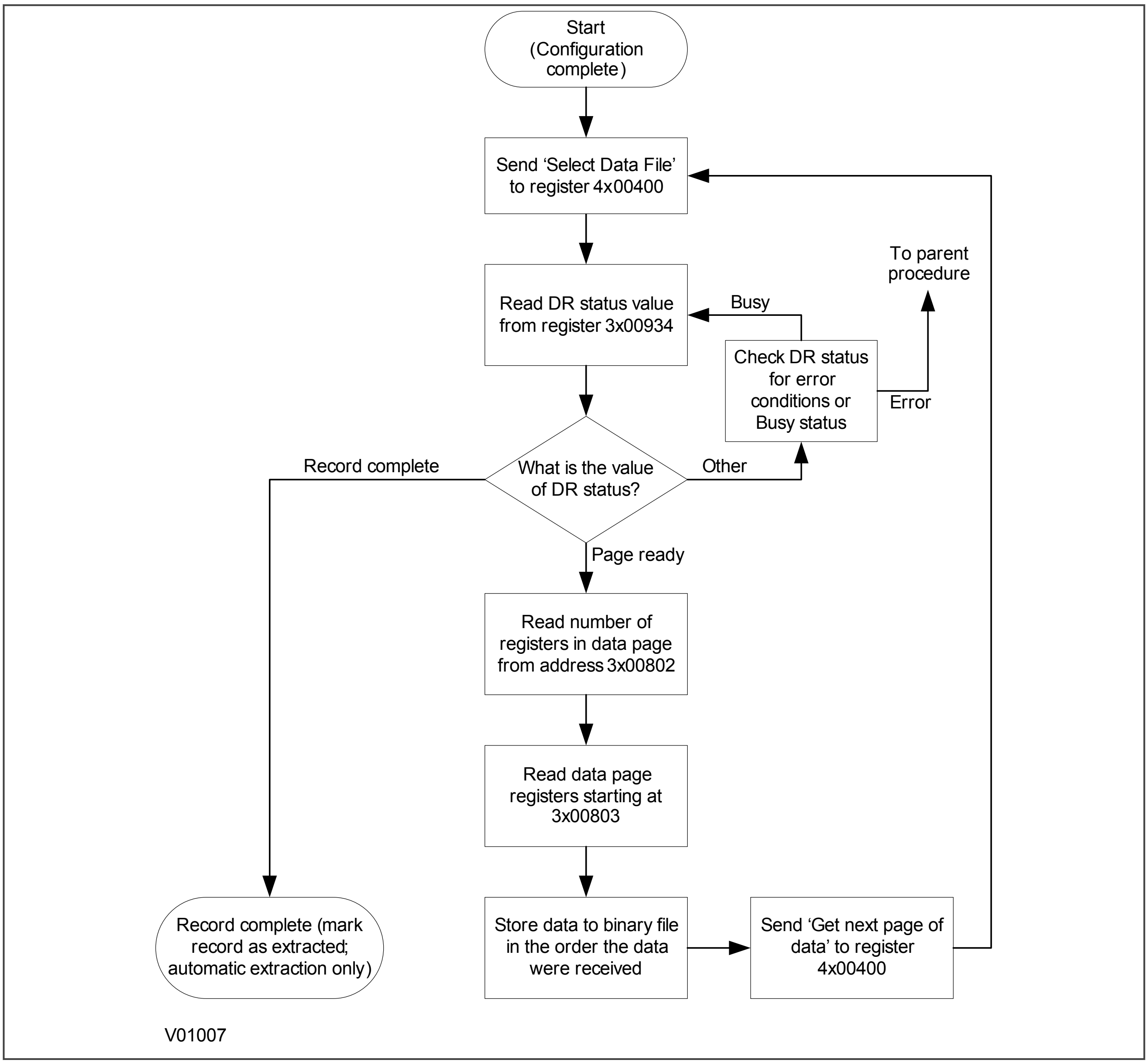


Figure 57: Data file extraction

During the extraction of the COMTRADE files, an error may occur, which will be reported on the DR Status register 3x00934. In this case, you must take action to re-start the record extraction or to abort according to the table below.

Value	State	Description
0	Idle	This will be the state reported when no record is selected; such as after power on or after a record has been marked as extracted.
1	Busy	The relay is currently processing data.
2	Page ready	The data page has been populated and the master station can now safely read the data.
3	Configuration complete	All of the configuration data has been read without error.
4	Record complete	All of the disturbance data has been extracted.
5	Disturbance overwritten	An error occurred during the extraction process where the disturbance being extracted was overwritten by a new record.

Value	State	Description
6	No unextracted disturbances	An attempt was made by the master station to automatically select the next oldest unextracted disturbance when all records have been extracted.
7	Not a valid disturbance	An attempt was made by the master station to manually select a record that did not exist in the relay.
8	Command out of sequence	The master station issued a command to the relay that was not expected during the extraction process.

6.3.7 SETTING CHANGES

All the IED settings are 4xxxx page addresses. 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 first address for a multi-register write must be a valid address. If there are unmapped addresses within the range being written to, the data associated with these addresses will be discarded.
- If a write operation is performed with values that are out of range, the illegal data response will be produced. Valid setting values within the same write operation will be executed.
- If a write operation is performed, which attempts to change registers requiring a higher level of password access than is currently enabled then all setting changes in the write operation will be discarded.

6.3.8 PASSWORD PROTECTION

The following registers are available to control password protection:

Function	MODBUS Registers
Password entry	4x00001 to 4x00002 and 4x20000 to 4x20003
Setting to change password level 1 (4 character)	4x00023 to 4x00024
Setting to change password level 1 (8 character)	4x20008 to 4x20011
Setting to change password level 2	4x20016 to 4x20019
Setting to change password level 3	4x20024 to 4x20027
Can be read to indicate current access level	3x00010

6.3.9 PROTECTION AND DISTURBANCE RECORDER SETTINGS

Setting changes to either of these areas are stored in a scratchpad area and will not be used by the IED unless confirmed. Register 40405 can be used either to confirm or abort the setting changes within the scratchpad area.

The IED supports four groups of protection settings. The MODBUS addresses for each of the four groups are repeated within the following address ranges.

- Group 1: 4x1000 - 4x2999
- Group 2: 4x3000 - 4x4999
- Group 3: 4x5000 - 4x6999
- Group 4: 4x7000 - 4x8999

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 4x0402.
- 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 4x0407.

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 4x0405.

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.

6.3.10 TIME SYNCHRONISATION

The date-time data type G12 allows *real* date and time information to be conveyed to a resolution of 1 ms. The structure of the data type is compliant with the IEC 60870-5-4 **Binary Time 2a** format.

The seven bytes of the date/time frame are packed into four 16-bit registers and are transmitted in sequence starting from byte 1. This is followed by a null byte, making eight bytes in total.

Register data is usually transmitted starting with the highest-order byte. Therefore byte 1 will be in the high-order byte position followed by byte 2 in the low-order position for the first register. The last register will contain just byte 7 in the high order position and the low order byte will have a value of zero.

G12 date & time data type structure

	Bit Position							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
1	m7	m6	m5	m4	m3	m2	m1	m0
2	m15	m14	m13	m12	m11	m10	m9	m8
3	IV	R	I5	I4	I3	I2	I1	I0
4	SU	R	R	H4	H3	H2	H1	H0
5	W2	W1	W0	D4	D3	D2	D1	D0
6	R	R	R	R	M3	M2	M1	M0
7	R	Y6	Y5	Y4	Y3	Y2	Y1	Y0

Key to table:

- m = milliseconds: 0 to 59,999
- I = minutes: 0 to 59
- H = hours: 0 to 23
- W = day of the week: 1 to 7 starting from Monday
- D = day of the month: 1 to 31
- M = month of the year: 1 to 12 starting from January
- Y = year of the century: 0 to 99
- R = reserved: 0
- SU = summertime: 0 = GMT, 1 = summertime
- IV = invalid: 0 = invalid value, 1 = valid value

Since the range of the data type is only 100 years, the century must be deduced. The century is calculated as the one that will produce 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 date.

The invalid bit has two applications:

- It can indicate that the date-time information is considered inaccurate, but is the best information available.
- It can indicate that the 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.

The day of the week field is optional and if not calculated will be set to zero.

The concept of time zone is not catered for by this data type and hence by the relay. It is up to the end user to determine the time zone. Normal practice is to use UTC (universal co-ordinated time).

6.3.11 POWER AND ENERGY MEASUREMENT DATA FORMATS

The power and energy measurements are available in two data formats:

Data Type G29: an integer format using 3 registers

Data Type G125: a 32 bit floating point format using 2 registers

The G29 registers are listed in the first part of the *MEASUREMENTS 2* column of the Courier database. The G125 equivalents appear at the end of the *MEASUREMENTS 2* column.

Data type G29

Data type G29 consists of three registers:

The first register is the per unit (or normalised) power or energy measurement. It is a signed 16 bit quantity. This register is of Data Type G28.

The second and third registers contain a multiplier to convert the per unit value to a real value. These are unsigned 32-bit quantities. These two registers together are of Data Type G27.

Thee overall power or energy value conveyed by the G29 data type is therefore G29 = G28 x G27.

The IED calculates the G28 per unit power or energy value as:

G28 = (measured secondary quantity/CT *secondary)(110V/(VT secondary)*.

Since data type G28 is a signed 16-bit integer, its dynamic range is constrained to +/- 32768. You should take this limitation into consideration for the energy measurements, as the G29 value will saturate a long time before the equivalent G125 does.

The associated G27 multiplier is calculated as:

G27 = (CT primary)(VT primary/110V) when primary value measurements are selected

and

G27 = (CT secondary)(VT secondary/110V) 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, we only recommend using G29 values 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 of Data Type G29

Assuming the CT/VT configurations are as follows:

- Main VT Primary 6.6 kV
- Main VT Secondary 110 V
- Phase CT Primary 3150 A
- Phase CT Secondary 1 A

The Three-phase Active Power displayed on the measurement panel on the front display of the IED would be 21.94 MW

The registers related to the Three-phase Active Power are: 3x00327, 3x00328, 3x00329

Register Address	Data read from these registers	Format of the data
3x00327	116	G28
3x00328	2	G27

Register Address	Data read from these registers	Format of the data
3x00329	57928	G27

The Equivalent G27 value = [2^{16} * Value in the address 3x00328 + Value in the address 3x00329] = 216*2 + 57928 = 189000

The Equivalent value of power G29 = G28 * Equivalent G27 =116 * 189000 =21.92 MW

> *Note:*
> *The above calculated value (21.92 MW) is same as the power value measured on the front panel display.*

Data type G125

Data type G125 is a short float IEEE754 floating point format, which occupies 32 bits in two consecutive registers. The high order byte of the format is in the first (low order) register and the low order byte in the second register.

The value of the G125 measurement is as accurate as the IED's ability to resolve the measurement after it has applied the secondary or primary scaling factors. It does not suffer from the truncation errors or dynamic range limitations associated with the G29 data format.

6.3.12 MODBUS CONFIGURATION

To configure the device:

1. Select the *CONFIGURATION* column and check that the ***Comms settings*** cell is set to `Visible`.
2. Select the *COMMUNICATIONS* column.
3. Move to the first cell down (***RP1 protocol***). This is a non settable cell, which shows the chosen communication protocol – in this case `Modbus`.

```
COMMUNICATIONS
RP1 Protocol
Modbus
```

4. Move down to the next cell (***RP1 Address***). This cell controls the Modbus address of the IED. Up to 32 IEDs can be connected to one spur, therefore it is necessary for each IED to have a unique address so that messages from the master control station are accepted by only one IED. Modbus uses a decimal number between 1 and 247 for the Relay Address. It is important that no two IEDs have the same address.

```
COMMUNICATIONS
RP1 Address
1
```

5. Move down to the next cell (***RP1 InactivTimer***). This cell controls the inactivity timer. The inactivity timer controls how long the IED 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.

```
COMMUNICATIONS
RP1 Inactivtimer
10.00 mins
```

6. Move down to the next cell (***RP1 Baud Rate***). This cell controls the baud rate to be used. Six baud rates are supported by the IED 1200 bits/s, 2400 bits/s, 4800 bits/s, 9600 bits/s, 19200 bits/s and 38400 bits/s. Make sure that the baud rate selected on the IED is the same as that set on the master station.

```
COMMUNICATIONS
RP1 Baud rate
9600 bits/s
```

7. Move down to the next cell (***RP1 Parity***). This cell controls the parity format used in the data frames. The parity can be set to be one of `None`, `Odd` or `Even`. Make sure that the parity format selected on the IED is the same as that set on the master station.

```
COMMUNICATIONS
RP1 Parity
None
```

8. Move down to the next cell (***Modbus IEC Time***). This cell controls the order in which the bytes of information are transmitted. There is a choice of Standard or Reverse. When `Standard` is selected the time format complies with IEC 60870-5-4 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.

```
COMMUNICATIONS
Modbus IEC Time
Standard
```

6.4 DNP 3.0

This section describes how the DNP 3.0 standard is applied in the product. It is not a description of the standard itself. The level at which this section is written assumes that the reader is already familiar with the DNP 3.0 standard.

The descriptions given here are intended to accompany the device profile document that is included in the Menu Database document. The DNP 3.0 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 DNP 3.0 implementation. This is the standard format DNP 3.0 document that specifies which objects; variations and qualifiers are supported. The device profile document also specifies what data is available from the device using DNP 3.0. The IED operates as a DNP 3.0 slave and supports subset level 2, as described in the DNP 3.0 standard, plus some of the features from level 3.

The DNP 3.0 protocol is defined and administered by the DNP Users Group. For further information on DNP 3.0 and the protocol specifications, please see the DNP website (www.dnp.org).

6.4.1 PHYSICAL CONNECTION AND LINK LAYER

DNP 3.0 can be used with EIA(RS)485.

Several connection options are available for DNP 3.0

- Rear Port 1 (RP1) - for permanent SCADA connection via RS485
- Optional fibre port (RP1 in slot A) - for permanent SCADA connection via optical fibre

The baud rate can be selected using the front panel menu or by the settings application software.

When using a serial interface, the data format is: 1 start bit, 8 data bits, 1 stop bit and optional configurable parity bit.

6.4.2 OBJECT 1 BINARY INPUTS

Object 1, binary inputs, contains information describing the state of signals in the IED, which mostly form part of the digital data bus (DDB). In general these include the state of the output contacts and opto-inputs, alarm signals, and protection start and trip signals. The ‘DDB number’ column in the device profile document provides the DDB numbers for the DNP 3.0 point data. These can be used to cross-reference to the DDB definition list. See the relevant 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.

6.4.3 OBJECT 10 BINARY OUTPUTS

Object 10, binary outputs, contains commands that can be operated using DNP 3.0. Therefore the points accept commands of type pulse on (null, trip, close) and latch on/off as detailed in the device profile in the relevant 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.

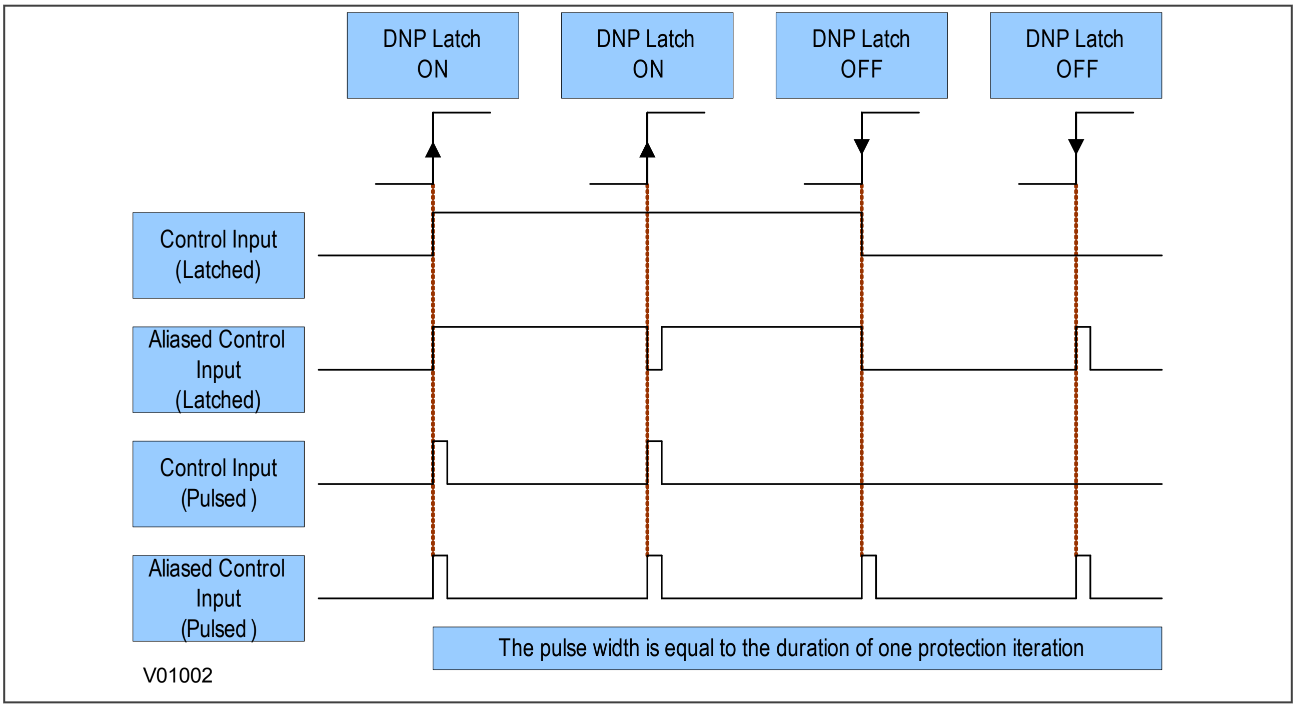


Figure 58: Control input behaviour

Many of the IED’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

6.4.4 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.

6.4.5 OBJECT 30 ANALOGUE INPUT

Object 30, analogue inputs, contains information from the IED'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 IED's CT and VT ratios), and this is settable in the *COMMUNICATIONS* column in the IED. 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 analogue measurement that is unavailable when it is read is reported as offline. For example, the frequency would be offline if the current and voltage frequency is outside the tracking range of the IED. All Object 30 points are reported as secondary values in DNP 3.0 (with respect to CT and VT ratios).

6.4.6 OBJECT 40 ANALOGUE 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 IED 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.

6.4.7 OBJECT 50 TIME SYNCHRONISATION

Function codes 1 (read) and 2 (write) are supported for Object 50 (time and date) variation 1. The DNP Need Time function (the duration of time waited before requesting another time sync from the master) is supported, and is configurable in the range 1 - 30 minutes.

If the clock is being synchronized using the IRIG-B input then it will not be possible to set the device time using the Courier interface. An attempt to set the time using the interface will cause the device to create an event with the current date and time taken from the IRIG-B synchronized internal clock.

6.4.8 DNP3 DEVICE PROFILE

This section describes the specific implementation of DNP version 3.0 within GE MiCOM P40 Agile IEDs for both compact and modular ranges.

The devices use the DNP 3.0 Slave Source Code Library version 3 from Triangle MicroWorks Inc.

This document, in conjunction with the DNP 3.0 Basic 4 Document Set, and the DNP Subset Definitions Document, provides complete information on how to communicate with the devices using the DNP 3.0 protocol.

This implementation of DNP 3.0 is fully compliant with DNP 3.0 Subset Definition Level 2. It also contains many Subset Level 3 and above features.

6.4.8.1 DNP3 DEVICE PROFILE TABLE

The following table provides the device profile in a similar format to that defined in the DNP 3.0 Subset Definitions Document. While it is referred to in the DNP 3.0 Subset Definitions as a “Document”, it is just one component of a total interoperability guide. This table, in combination with the subsequent Implementation and Points List tables should provide a complete interoperability/configuration guide for the device.

The following table provides the device profile in a similar format to that defined in the DNP 3.0 Subset Definitions Document. While it is referred to in the DNP 3.0 Subset Definitions as a "Document", it is just one component of a total interoperability guide. This table, in combination with the subsequent Implementation and Points List tables should provide a complete interoperability/configuration guide for the device.

DNP 3.0 Device Profile Document	
Vendor Name:	GE
Device Name:	MiCOM P40Agile Protection Relays – compact and modular range
Models Covered:	All models
Highest DNP Level Supported*: *This is the highest DNP level FULLY supported. Parts of level 3 are also supported	For Requests: Level 2 For Responses: Level 2
Device Function:	Slave
Notable objects, functions, and/or qualifiers supported in addition to the highest DNP levels supported (the complete list is described in the DNP 3.0 Implementation Table): For static (non-change event) object requests, request qualifier codes 00 and 01 (start-stop), 07 and 08 (limited quantity), and 17 and 28 (index) are supported in addition to the request qualifier code 06 (no range (all points)) Static object requests sent with qualifiers 00, 01, 06, 07, or 08 will be responded with qualifiers 00 or 01 Static object requests sent with qualifiers 17 or 28 will be responded with qualifiers 17 or 28 For change-event object requests, qualifiers 17 or 28 are always responded 16-bit and 32-bit analogue change events with time may be requested The read function code for Object 50 (time and date) variation 1 is supported Analogue Input Deadbands, Object 34, variations 1 through 3, are supported Floating Point Analogue Output Status and Output Block Objects 40 and 41 are supported Sequential file transfer, Object 70, variations 2 through 7, are supported Device Attribute Object 0 is supported	
Maximum Data Link Frame Size (octets):	Transmitted: 292 Received: 292
Maximum Application Fragment Size (octets)	Transmitted: Configurable (100 to 2048). Default 2048 Received: 249
Maximum Data Link Retries:	Fixed at 2
Maximum Application Layer Retries:	None
Requires Data Link Layer Confirmation:	Configurable to Never or Always
Requires Application Layer Confirmation:	When reporting event data (Slave devices only) When sending multi-fragment responses (Slave devices only)
Timeouts while waiting for:	
Data Link Confirm:	Configurable
Complete Application Fragment:	None
Application Confirm:	Configurable
Complete Application Response:	None
Others:	
Data Link Confirm Timeout:	Configurable from 0 (Disabled) to 120s, default 10s.
Application Confirm Timeout:	Configurable from 1 to 120s, default 2s.

DNP 3.0 Device Profile Document	
Select/Operate Arm Timeout:	Configurable from 1 to 10s, default 10s.
Need Time Interval (Set IIN1-4):	Configurable from 1 to 30, default 10min.
Application File Timeout	60 s
Analog Change Event Scan Period:	Fixed at 0.5s
Counter Change Event Scan Period	Fixed at 0.5s
Frozen Counter Change Event Scan Period	Fixed at 1s
Maximum Delay Measurement Error:	2.5 ms
Time Base Drift Over a 10-minute Interval:	7 ms
Sends/Executes Control Operations:	
Write Binary Outputs:	Never
Select/Operate:	Always
Direct Operate:	Always
Direct Operate - No Ack:	Always
Count > 1	Never
Pulse On	Always
Pulse Off	Sometimes
Latch On	Always
Latch Off	Always
Queue	Never
Clear Queue	Never
Note: Paired Control points will accept Pulse On/Trip and Pulse On/Close, but only single point will accept the Pulse Off control command.	
Reports Binary Input Change Events when no specific variation requested:	Configurable to send one or the other
Reports time-tagged Binary Input Change Events when no specific variation requested:	Binary input change with time
Sends Unsolicited Responses:	Never
Sends Static Data in Unsolicited Responses:	Never No other options are permitted
Default Counter Object/Variation:	Configurable, Point-by-point list attached Default object: 20 Default variation: 1
Counters Roll Over at:	32 bits
Sends multi-fragment responses:	Yes
Sequential File Transfer Support:	
Append File Mode	No
Custom Status Code Strings	No
Permissions Field	Yes
File Events Assigned to Class	No
File Events Send Immediately	Yes
Multiple Blocks in a Fragment	No
Max Number of Files Open	1

6.4.8.2 DNP3 IMPLEMENTATION TABLE

The implementation table provides a list of objects, variations and control codes supported by the device:

Object			Request (Library will parse)				Response (Library will respond with)			
Object Number	Variation Number	Description	Function Codes (dec)		Qualifier Codes (hex)		Function Codes (dec)		Qualifier Codes (hex)	
1	0	Binary Input (Variation 0 is used to request default variation)	1 22	(read) (assign class)	00, 01 06 07, 08 17, 27, 28	(start-stop) (no range, or all) (limited qty) (index)				
1	1 (default - see note 1)	Binary Input	1	(read)	00, 01 06 07, 08 17, 27, 28	(start-stop) (no range, or all) (limited qty) (index)	129	response	00, 01 17, 28	(start-stop) (index - see note 2)
1	2	Binary Input with Flag	1	(read)	00, 01 06 07, 08 17, 28	(start-stop) (no range, or all) (limited qty) (index)	129	response	00, 01 17, 28	(start-stop) (index - see note 2)
2	0	Binary Input Change - Any Variation	1	(read)	06 07, 08	(no range, or all) (limited qty)				
2	1	Binary Input Change without Time	1	(read)	06 07, 08	(no range, or all) (limited qty)	129	response	17, 28	(index)
2	2	Binary Input Change with Time	1	(read)	06 07, 08	(no range, or all) (limited qty)	129	response	17, 28	(index)
10	0	Binary Output Status - Any Variation	1	(read)	00, 01 06 07, 08 17, 27, 28	(start-stop) (no range, or all) (limited qty) (index)				
10	2 (default - see note 1)	Binary Output Status	1	(read)	00, 01 06 07, 08 17, 28	(start-stop) (no range, or all) (limited qty) (index)	129	response	00, 01 17, 28	(start-stop) (index - see note 2)
12	1	Control Relay Output Block	3 4 5 6	(select) (operate) (direct op) (dir. op, noack)	17, 28	(index)	129	response		echo of request
20	0	Binary Counter - Any Variation	1 22	(read) (assign class)	00, 01 06 07, 08 17, 27, 28	(start-stop) (no range, or all) (limited qty) (index)				
			7 8 9 10	(freeze) (freeze noack) (freeze clear) (frz. cl. Noack)	00, 01 06 07, 08	(start-stop) (no range, or all) (limited qty)				
20	1	32-Bit Binary Counter with Flag	1	(read)	00, 01 06 07, 08 17, 27, 28	(start-stop) (no range, or all) (limited qty) (index)	129	response	00, 01 17, 28	(start-stop) (index - see note 2)
20	2	16-Bit Binary Counter with Flag	1	(read)	00, 01 06 07, 08 17, 27, 28	(start-stop) (no range, or all) (limited qty) (index)	129	response	00, 01 17, 28	(start-stop) (index - see note 2)
20	5 (default - see note 1)	32-Bit Binary Counter without Flag	1	(read)	00, 01 06 07, 08 17, 27, 28	(start-stop) (no range, or all) (limited qty) (index)	129	response	00, 01 17, 28	(start-stop) (index - see note 2)
20	6	16-Bit Binary Counter without Flag	1	(read)	00, 01 06 07, 08 17, 27, 28	(start-stop) (no range, or all) (limited qty) (index)	129	response	00, 01 17, 28	(start-stop) (index - see note 2)
21	0	Frozen Counter - Any Variation	1	(read)	00, 01 06 07, 08 17, 27, 28	(start-stop) (no range, or all) (limited qty) (index)				
21	1	32-Bit Frozen Counter with Flag	1	(read)	00, 01 06 07, 08 17, 27, 28	(start-stop) (no range, or all) (limited qty) (index)	129	response	00, 01 17, 28	(start-stop) (index - see note 2)

Object			Request (Library will parse)				Response (Library will respond with)			
Object Number	Variation Number	Description	Function Codes (dec)		Qualifier Codes (hex)		Function Codes (dec)		Qualifier Codes (hex)	
21	2	16-Bit Frozen Counter with Flag	1	(read)	00, 01 06 07, 08 17, 27, 28	(start-stop) (no range, or all) (limited qty) (index)	129	response	00, 01 17, 28	(start-stop) (index - see note 2)
21	5	32-Bit Frozen Counter with Time of Freeze	1	(read)	00, 01 06 07, 08 17, 27, 28	(start-stop) (no range, or all) (limited qty) (index)	129	response	00, 01 17, 28	(start-stop) (index - see note 1)
21	6	16-Bit Frozen Counter with Time of Freeze	1	(read)	00, 01 06 07, 08 17, 27, 28	(start-stop) (no range, or all) (limited qty) (index)	129	response	00, 01 17, 28	(start-stop) 17, 28 (index - see note 1)
21	9 (default - see note 1)	32-Bit Frozen Counter without Flag	1	(read)	00, 01 06 07, 08 17, 27, 28	(start-stop) (no range, or all) (limited qty) (index)	129	response	00, 01 17, 28	(start-stop) (index - see note 2)
21	10	16-Bit Frozen Counter without Flag	1	(read)	00, 01 06 07, 08 17, 27, 28	(start-stop) (no range, or all) (limited qty) (index)	129	response	00, 01 17, 28	(start-stop) (index - see note 2)
`22	0	Counter Change Event - Any Variation	1	(read)	06 07, 08	(no range, or all) (limited qty)				
22	1 (default - see note 1)	32-Bit Counter Change Event without Time	1	(read)	06 07, 08	(no range, or all) (limited qty)	129	response	17, 28	(index)
22	2	16-Bit Counter Change Event without Time	1	(read)	06 07, 08	(no range, or all) (limited qty)	129	response	17, 28	(index)
22	5	32-Bit Counter Change Event with Time	1	(read)	06 07, 08	(no range, or all) (limited qty)	129	response	17, 28	(index)
22	6	16-Bit Counter Change Event with Time	1	(read)	06 07, 08	(no range, or all) (limited qty)	129	response	17, 28	(index)
23	0	Frozen Counter Event (Variation 0 is used to request default variation)	1	(read)	06 07, 08	(no range, or all) (limited qty)				
23	1 (default - see note 1)	32-Bit Frozen Counter Event	1	(read)	06 07, 08	(no range, or all) (limited qty)	129	response	17, 28	(index)
23	2	16-Bit Frozen Counter Event	1	(read)	06 07, 08	(no range, or all) (limited qty)	129	response	17, 28	(index)
23	5	32-Bit Frozen Counter Event with Time	1	(read)	06 07, 08	(no range, or all) (limited qty)	129	response	17, 28	(index)
23	6	16-Bit Frozen Counter Event with Time	1	(read)	06 07, 08	(no range, or all) (limited qty)	129	response	17, 28	(index)
30	0	Analog Input - Any Variation	1 22	(read) (assign class)	00, 01 06 07, 08 17, 27, 28	(start-stop) (no range, or all) (limited qty) (index)				
30	1	32-Bit Analog Input	1	(read)	00, 01 06 07, 08 17, 27, 28	(start-stop) (no range, or all) (limited qty) (index)	129	response	00, 01 17, 28	(start-stop) (index - see note 2)
30	2	16-Bit Analog Input	1	(read)	00, 01 06 07, 08 17, 27, 28	(start-stop) (no range, or all) (limited qty) (index)	129	response	00, 01 17, 28	(start-stop) (index - see note 2)
30	3 (default - see note 1)	32-Bit Analog Input without Flag	1	(read)	00, 01 06 07, 08 17, 27, 28	(start-stop) (no range, or all) (limited qty) (index)	129	response	00, 01 17, 28	(start-stop) (index - see note 2)
30	4	16-Bit Analog Input without Flag	1	(read)	00, 01 06 07, 08 17, 27, 28	(start-stop) (no range, or all) (limited qty) (index)	129	response	00, 01 17, 28	(start-stop) (index - see note 2)
30	5	Short floating point	1	(read)	00, 01 06 07, 08 17, 27, 28	(start-stop) (no range, or all) (limited qty) (index)	129	response	00, 01 17, 28	(start-stop) (index - see note 2)

Object			Request (Library will parse)				Response (Library will respond with)			
Object Number	Variation Number	Description	Function Codes (dec)		Qualifier Codes (hex)		Function Codes (dec)		Qualifier Codes (hex)	
32	0	Analog Change Event - Any Variation	1	(read)	06 07, 08	(no range, or all) (limited qty)				
32	1 (default - see note 1)	32-Bit Analog Change Event without Time	1	(read)	06 07, 08	(no range, or all) (limited qty)	129	response	17, 28	(index)
32	2	16-Bit Analog Change Event without Time	1	(read)	06 07, 08	(no range, or all) (limited qty)	129	response	17, 28	(index)
32	3	32-Bit Analog Change Event with Time	1	(read)	06 07, 08	(no range, or all) (limited qty)	129	response	17, 28	(index)
32	4	16-Bit Analog Change Event with Time	1	(read)	06 07, 08	(no range, or all) (limited qty)	129	response	17, 28	(index)
32	5	Short floating point Analog Change Event without Time	1	(read)	06 07, 08	(no range, or all) (limited qty)	129	response	17, 28	(index)
32	7	Short floating point Analog Change Event with Time	1	(read)	06 07, 08	(no range, or all) (limited qty)	129	response	17, 28	(index)
34	0	Analog Input Deadband (Variation 0 is used to request default variation)	1	(read)	00, 01 06 07, 08 17, 27, 28	(start-stop) (no range, or all) (limited qty) (index)				
34	1	16 Bit Analog Input Deadband	1	(read)	00, 01 06 07, 08 17, 27, 28	(start-stop) (no range, or all) (limited qty) (index)	129	response	00, 01 17, 28	(start-stop) (index - see note 2)
			2	(write)	00, 01 07, 08 17, 27, 28	(start-stop) (limited qty) (index)				
34	2 (default - see note 1)	32 Bit Analog Input Deadband	1	(read)	00, 01 06 07, 08 17, 27, 28	(start-stop) (no range, or all) (limited qty) (index)	129	response	00, 01 17, 28	(start-stop) (index - see note 2)
			2	(write)	00, 01 07, 08 17, 27, 28	(start-stop) (limited qty) (index)				
34	3	Short Floating Point Analog Input Deadband	1	(read)	00, 01 06 07, 08 17, 27, 28	(start-stop) (no range, or all) (limited qty) (index)	129	response	00, 01 17, 28	(start-stop) (index - see note 2)
			2	(write)	00, 01 07, 08 17, 27, 28	(start-stop) (limited qty) (index)				
40	0	Analog Output Status (Variation 0 is used to request default variation)	1	(read)	00, 01 06 07, 08 17, 27, 28	(start-stop) (no range, or all) (limited qty) (index)				
40	1 (default - see note 1)	32-Bit Analog Output Status	1	(read)	00, 01 06 07, 08 17, 27, 28	(start-stop) (no range, or all) (limited qty) (index)	129	response	00, 01 17, 28	(start-stop) (index - see note 2)
40	2	16-Bit Analog Output Status	1	(read)	00, 01 06 07, 08 17, 27, 28	(start-stop) (no range, or all) (limited qty) (index)	129	response	00, 01 17, 28	(start-stop) (index - see note 2)
40	3	Short Floating Point Analog Output Status	1	(read)	00, 01 06 07, 08 17, 27, 28	(start-stop) (no range, or all) (limited qty) (index)	129	response	00, 01 17, 28	(start-stop) (index - see note 2)
41	1	32-Bit Analog Output Block	3 4 5 6	(select) (operate) (direct op) (dir. op, noack)	17, 28 27	(index) (index)	129	response		echo of request
41	2	16-Bit Analog Output Block	3 4 5 6	(select) (operate) (direct op) (dir. op, noack)	17, 28 27	(index) (index)	129	response		echo of request

Object			Request (Library will parse)				Response (Library will respond with)			
Object Number	Variation Number	Description	Function Codes (dec)		Qualifier Codes (hex)		Function Codes (dec)		Qualifier Codes (hex)	
41	3	Short Floating Point Analog Output Block	3 4 5 6	(select) (operate) (direct op) (dir. op, noack)	17, 27, 28	(index)	129	response		echo of request
50	1 (default - see note 1)	Time and Date	1	(read)	07	(limited qty = 1)	129	response	07	(limited qty = 1)
			2	(write)	07	(limited qty = 1)				
60	0	Not defined								
60	1	Class 0 Data	1	(read)	06	(no range, or all)				
60	2	Class 1 Data	1	(read)	06 07, 08	(no range, or all) (limited qty)				
			22	(assign class)	06	(no range, or all)				
60	3	Class 2 Data	1	(read)	06 07, 08	(no range, or all) (limited qty)				
			22	(assign class)	06	(no range, or all)				
60	4	Class 3 Data	1	(read)	06 07, 08	(no range, or all) (limited qty)				
			22	(assign class)	06	(no range, or all)				
70	0	File Event - Any Variation	1	(read)	06 07, 08	(no range, or all) (limited qty)				
			22	(assign class)	06	(no range, or all)				
70	2	File Authentication	29	(authenticate)	5b	(free-format)	129	response		5B (free-format)
70	3	File Command	25 27	(open) (delete)	5b	(free-format)				
70	4	File Command Status	26 30	(close) (abort)	5b	(free-format)	129	response		5B (free-format)
70	5	File Transfer	1	(read)	5b	(free-format)	129	response		5B (free-format)
70	6	File Transfer Status					129	response		5B (free-format)
70	7	File Descriptor	28	(get file info)	5b	(free-format)	129	response		5B (free-format)
80	1	Internal Indications	1	(read)	00, 01	(start-stop)	129	response	00, 01	(start-stop)
		No Object (function code only)	13	(cold restart)						
		No Object (function code only)	14	(warm restart)						
		No Object (function code only)	23	(delay meas.)						

Note:
A Default variation refers to the variation responded to when variation 0 is requested and/or in class 0, 1, 2, or 3 scans.

Note:
For static (non-change-event) objects, qualifiers 17 or 28 are only responded to when a request is sent with qualifiers 17 or 28, respectively. Otherwise, static object requests sent with qualifiers 00, 01, 06, 07, or 08, will be responded to with qualifiers 00 or 01. For change-event objects, qualifiers 17 or 28 are always responded to.

6.4.8.3 DNP3 INTERNAL INDICATIONS

The following table lists the DNP3.0 Internal Indications (IIN) and identifies those that are supported by the device.

The IIN form an information element used to convey the internal states and diagnostic results of a device. This information can be used by a receiving station to perform error recovery or other suitable functions. The IIN is a two-octet field that follows the function code in all responses from the device. When a request cannot be processed due to formatting errors or the requested data is not available, the IIN is always returned with the appropriate bits set.

Bit	Indication	Description	Supported
Octet 1			
0	All stations message received	Set when a request is received with the destination address of the all stations address (6553510). It is cleared after the next response (even if a response to a global request is required). This IIN is used to let the master station know that a "broadcast" message was received by the relay.	Yes
1	Class 1 data available	Set when data that has been configured as Class 1 data is ready to be sent to the master. The master station should request this class data from the relay when this bit is set in a response.	Yes
2	Class 2 data available	Set when data that has been configured as Class 2 data is ready to be sent to the master. The master station should request this class data from the relay when this bit is set in a response.	Yes
3	Class 3 data available	Set when data that has been configured as Class 3 data is ready to be sent to the master. The master station should request this class data from the relay when this bit is set in a response.	Yes
4	Time-synchronization required	The relay requires time synchronization from the master station (using the Time and Date object). This IIN is cleared once the time has been synchronized. It can also be cleared by explicitly writing a 0 into this bit of the Internal Indication object.	Yes
5	Local	Set when some or all of the relays digital output points (Object 10/12) are in the Local state. That is, the relays control outputs are NOT accessible through the DNP protocol. This IIN is clear when the relay is in the Remote state. That is, the relays control outputs are fully accessible through the DNP protocol.	No
6	Device in trouble	Set when an abnormal condition exists in the relay. This IIN is only used when the state cannot be described by a combination of one or more of the other IIN bits.	No
7	Device restart	Set when the device software application restarts. This IIN is cleared when the master station explicitly writes a 0 into this bit of the Internal Indications object.	Yes
Octet 2			
0	Function code not implemented	The received function code is not implemented within the relay.	Yes
1	Requested object(s) unknown	The relay does not have the specified objects or there are no objects assigned to the requested class. This IIN should be used for debugging purposes and usually indicates a mismatch in device profiles or configuration problems.	Yes
2	Out of range	Parameters in the qualifier, range or data fields are not valid or out of range. This is a 'catch-all' for application request formatting errors. It should only be used for debugging purposes. This IIN usually indicates configuration problems.	Yes
3	Buffer overflow	Event buffer(s), or other application buffers, have overflowed. The master station should attempt to recover as much data as possible and indicate to the user that there may be lost data. The appropriate error recovery procedures should be initiated by the user.	Yes

Bit	Indication	Description	Supported
4	Already executing	The received request was understood but the requested operation is already executing.	
5	Bad configuration	Set to indicate that the current configuration in the relay is corrupt. The master station may download another configuration to the relay.	Yes
6	Reserved	Always returned as zero.	
7	Reserved	Always returned as zero.	

6.4.8.4 DNP3 RESPONSE STATUS CODES

When the device processes Control Relay Output Block (Object 12) requests, it returns a set of status codes; one for each point contained within the original request. The complete list of codes appears in the following table:

Code Number	Identifier Name	Description
0	Success	The received request has been accepted, initiated, or queued.
1	Timeout	The request has not been accepted because the 'operate' message was received after the arm timer (Select Before Operate) timed out. The arm timer was started when the select operation for the same point was received.
2	No select	The request has not been accepted because no previous matching 'select' request exists. (An 'operate' message was sent to activate an output that was not previously armed with a matching 'select' message).
3	Format error	The request has not been accepted because there were formatting errors in the control request ('select', 'operate', or 'direct operate').
4	Not supported	The request has not been accepted because a control operation is not supported for this point.
5	Already active	The request has not been accepted because the control queue is full or the point is already active.
6	Hardware error	The request has not been accepted because of control hardware problems.
7	Local	The request has not been accepted because local access is in progress.
8	Too many operations	The request has not been accepted because too many operations have been requested.
9	Not authorized	The request has not been accepted because of insufficient authorization.
127	Undefined	The request not been accepted because of some other undefined reason.

Note:
Code numbers 10 through to 126 are reserved for future use.

6.4.9 DNP3 CONFIGURATION

To configure the device:

1. Select the *CONFIGURATION* column and check that the ***Comms settings*** cell is set to `Visible`.
2. Select the *COMMUNICATIONS* column.
3. Move to the first cell down (***RP1 protocol***). This is a non-settable cell, which shows the chosen communication protocol – in this case *DNP3.0*.

```
COMMUNICATIONS
RP1 Protocol
DNP3.0
```

4. Move down to the next cell (***RP1 Address***). This cell controls the DNP3.0 address of the IED. Up to 32 IEDs can be connected to one spur, therefore it is necessary for each IED to have a unique address so that messages from the master control station are accepted by only one IED. DNP3.0 uses a decimal number between 1 and 65519 for the Relay Address. It is important that no two IEDs have the same address.

```
COMMUNICATIONS
RP1 Address
1
```

5. Move down to the next cell (***RP1 Baud Rate***). This cell controls the baud rate to be used. Six baud rates are supported by the IED 1200 bps, 2400 bps, 4800 bps, 9600 bps, 19200 bps and 38400 bps. Make sure that the baud rate selected on the IED is the same as that set on the master station.

```
COMMUNICATIONS
RP1 Baud rate
9600 bits/s
```

6. Move down to the next cell (***RP1 Parity***). This cell controls the parity format used in the data frames. The parity can be set to be one of `None`, `Odd` or `Even`. Make sure that the parity format selected on the IED is the same as that set on the master station.

```
COMMUNICATIONS
RP1 Parity
None
```

7. If the optional fibre optic connectors are fitted, the ***RP1 PhysicalLink*** cell is visible. This cell controls the physical media used for the communication (Copper or Fibre optic).

```
COMMUNICATIONS
RP1 PhysicalLink
Copper
```

8. Move down to the next cell (***RP1 Time Sync***). This cell affects the time synchronisation request from the master by the IED. It can be set to `enabled` or `disabled`. If enabled it allows the DNP3.0 master to synchronise the time on the IED.

```
COMMUNICATIONS
RP1 Time Sync
Enabled
```

6.4.9.1 DNP3 CONFIGURATOR

A PC support package for DNP3.0 is available as part of the supplied settings application software (MiCOM S1 Agile) to allow configuration of the device's DNP3.0 response. The configuration data is uploaded from the device to the PC in a block of compressed format data and downloaded in a similar manner after modification. The new DNP3.0 configuration takes effect 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 MiCOM S1 Agile, the DNP3.0 data is shown in three main folders, one folder each for the point configuration, integer scaling and default variation (data format). The point configuration also includes screens for binary inputs, binary outputs, counters and analogue input configuration.

If the device supports DNP Over Ethernet, the configuration related settings are done in the folder **DNP Over Ethernet**.

6.5 IEC 61850

This section describes how the IEC 61850 standard is applied to GE products. It is not a description of the standard itself. The level at which this section is written assumes that the reader is already familiar with the IEC 61850 standard.

IEC 61850 is the international standard for Ethernet-based communication in substations. It enables integration of all protection, control, measurement and monitoring functions within a substation, and additionally provides the means for interlocking and inter-tripping. It combines the convenience of Ethernet with the security that is so essential in substations today.

There are two editions of most parts of the IEC 61850 standard; edition 1 and edition 2. The edition which this product supports depends on the Software Version.

From Software Version 90 onwards, it is possible to select between edition 1 and edition 2. Switching between edition 1 and edition 2 is described in the Selection of the IEC 61850 Edition section.

An additional section detailing the enhancements in edition 2 models is documented later in this chapter, if applicable.

6.5.1 BENEFITS OF IEC 61850

The standard provides:

- Standardised models for IEDs and other equipment within the substation
- Standardised communication services (the methods used to access and exchange data)
- Standardised formats for configuration files
- Peer-to-peer communication

The standard adheres to the requirements laid out by the ISO OSI model and therefore provides complete vendor interoperability and flexibility on the transmission types and protocols used. This includes mapping of data onto Ethernet, which is becoming more and more widely used in substations, in favour of RS485. Using Ethernet in the substation offers many advantages, most significantly including:

- Ethernet allows high-speed data rates (currently 100 Mbps, rather than tens of kbps or less used by most serial protocols)
- Ethernet provides the possibility to have multiple clients
- Ethernet is an open standard in every-day use
- There is a wide range of Ethernet-compatible products that may be used to supplement the LAN installation (hubs, bridges, switches)

6.5.2 IEC 61850 INTEROPERABILITY

A major benefit of IEC 61850 is interoperability. IEC 61850 standardizes the data model of substation IEDs, which allows interoperability between products from multiple vendors.

An IEC 61850-compliant device may be interoperable, but this does not mean it is interchangeable. You cannot simply replace a product from one vendor with that of another without reconfiguration. However the terminology is pre-defined and anyone with prior knowledge of IEC 61850 should be able to integrate a new device very quickly without having to map all of the new data. IEC 61850 brings improved substation communications and interoperability to the end user, at a lower cost.

6.5.3 THE IEC 61850 DATA MODEL

The data model of any IEC 61850 IED can be viewed as a hierarchy of information, whose nomenclature and categorization is defined and standardized in the IEC 61850 specification.

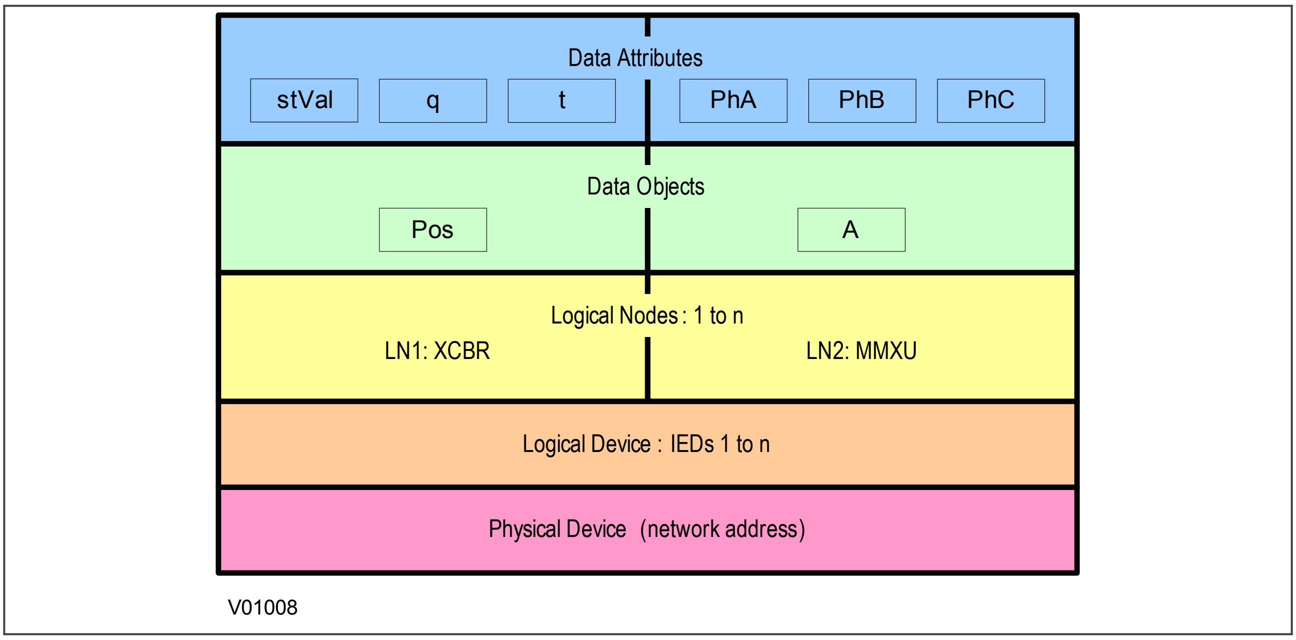


Figure 59: Data model layers in IEC 61850

The levels of this hierarchy can be described as follows:

Data Frame format

Layer	Description
Physical Device	Identifies the actual IED within 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 within the Physical Device. For the MiCOM IEDs, 5 Logical Devices exist: Control, Measurements, Protection, Records, System.
Wrapper/Logical Node Instance	Identifies the major functional areas within 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 you will be presented with. For example, Pos (position) of Logical Node type XCBR.
Data Attribute	This is the actual data (measurement value, status, description, etc.). For example, stVal (status value) indicating actual position of circuit breaker for Data Object type Pos of Logical Node type XCBR.

6.5.4 IEC 61850 IN MICOM IEDS

IEC 61850 is implemented by use of a separate Ethernet card. This Ethernet card manages the majority of the IEC 61850 implementation and data transfer to avoid any impact on the performance of the protection functions.

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 bay computer (MiCOM C264)
- An HMI
- An MMS browser, with which the full data model can be retrieved from the IED, without any prior knowledge of the IED

The IEC 61850 compatible interface standard provides capability for the following:

- Read access to measurements
- Refresh of all measurements at a standard rate.
- Generation of non-buffered and buffered reports on change of status or measurement
- SNTP time synchronization over an Ethernet link. (This is used to synchronize the IED's internal real time clock.
- GOOSE peer-to-peer communication
- Disturbance record extraction by IEC 61850 MMS file transfer. The record is extracted as an ASCII format COMTRADE file
- Controls (Direct and Select Before Operate)

Note:
Setting changes are not supported in the current IEC 61850 implementation. Currently these setting changes are carried out using the settings application software.

6.5.5 IEC 61850 DATA MODEL IMPLEMENTATION

The data model naming adopted in the IEDs has been standardised for consistency. Therefore the Logical Nodes are allocated to one of the five Logical Devices, as appropriate.

The data model is described in the Model Implementation Conformance Statement (MICS) document, which is available as a separate document.

6.5.6 IEC 61850 COMMUNICATION SERVICES IMPLEMENTATION

The IEC 61850 communication services which are implemented in the IEDs are described in the Protocol Implementation Conformance Statement (PICS) document, which is available as a separate document.

6.5.7 IEC 61850 PEER-TO-PEER (GOOSE) COMMUNICATIONS

The implementation of IEC 61850 Generic Object Oriented Substation Event (GOOSE) enables faster communication between IEDs offering the possibility for a fast and reliable system-wide distribution of input and output data values. The GOOSE model uses multicast services to deliver event information. Multicast messaging means that messages are sent to selected devices on the network. The receiving devices can specifically accept frames from certain devices and discard frames from the other devices. It is also known as a publisher-subscriber system. When a device detects a change in one of its monitored status points it publishes a new message. Any device that is interested in the information subscribes to the data it contains.

6.5.8 GOOSE MESSAGE VALIDATION

Whenever a new GOOSE message is received its validity is checked before the dataset is decoded and used to update the Programmable Scheme Logic. As part of the validation process a check is made for state and sequence number anomalies. If an anomaly is detected, the 'out-of-order' GOOSE message is discarded. When a message is discarded the last valid message remains active until a new valid GOOSE message is received or its validity period (TAL) expires.

Out-of-order GOOSE message indicators and reporting are provided to the subscriber via the IEC61850 LGOS logical node.

6.5.9 MAPPING GOOSE MESSAGES TO VIRTUAL INPUTS

Each GOOSE signal contained in a subscribed GOOSE message can be mapped to any of the 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.

An IED can subscribe to all GOOSE messages but only the following data types can be decoded and mapped to a virtual input:

- BOOLEAN
- BSTR2
- INT16
- INT32
- INT8
- UINT16
- UINT32
- UINT8

6.5.9.1 IEC 61850 GOOSE CONFIGURATION

All GOOSE configuration is performed using the IEC 61850 Configurator tool available in the MiCOM S1 Agile software application.

All GOOSE publishing configuration can be found under the **GOOSE Publishing** tab in the configuration editor window. All GOOSE subscription configuration parameters are under the **External Binding** tab in the configuration editor window.

Settings to enable GOOSE signalling and to apply Test Mode are available using the HMI.

6.5.10 ETHERNET FUNCTIONALITY

IEC 61850 **Associations** are unique and made between the client and server. If Ethernet connectivity is lost for any reason, the associations are lost, and will need to be re-established by the client. The IED has a **TCP_KEEPALIVE** function to monitor each association, and terminate any which are no longer active.

The IED allows the re-establishment of associations without disruption of its operation, even after its power has been removed. As the IED acts as a server in this process, the client must request the association. Uncommitted settings are cancelled when power is lost, and reports requested by connected clients are reset. The client must re-enable these when it next creates the new association to the IED.

6.5.11 IEC 61850 CONFIGURATION

You cannot configure the device for IEC 61850 edition 1 using the HMI panel on the product. For this you must use the IEC 61850 Configurator, which is part of the settings application software. If the device is compatible with edition 2, however, you can configure it with the HMI. To configure IEC61850 edition 2 using the HMI, you must first enable the IP From HMI setting, after which you can set the media (copper or fibre), IP address, subnet mask and gateway address.

IEC 61850 allows IEDs to be directly configured from a configuration file. The IED's system configuration capabilities are determined from an IED Capability Description file (ICD), supplied with the product. By using ICD files from the products to be installed, you can design, configure and test (using simulation tools), a substation's entire protection scheme before the products are installed into the substation.

To help with this process, the settings application software provides an IEC 61850 Configurator tool, which allows the pre-configured IEC 61850 configuration file to be imported and transferred to the IED. As well as this, you can manually create configuration files for all products, based on their original IED capability description (ICD file).

Other features include:

- The extraction of configuration data for viewing and editing.
- A sophisticated error checking sequence to validate the configuration data before sending to the IED.

Note:
Some configuration data is available in the IEC61850 CONFIG. column, allowing read-only access to basic configuration data.

6.5.11.1 IEC 61850 CONFIGURATION BANKS

There are two configuration banks:

- Active Configuration Bank
- Inactive Configuration Bank

Any new configuration sent to the IED is automatically stored in the inactive configuration bank, therefore not immediately affecting the current configuration.

Following an upgrade, the IEC 61850 Configurator tool can be used to transmit a command, which authorises activation of the new configuration contained in the inactive configuration bank. This is done by switching the active and inactive configuration banks. The capability of switching the configuration banks is also available using the *IEC61850 CONFIG.* column of the HMI.

The SCL Name and Revision attributes of both configuration banks are available in the *IEC61850 CONFIG.* column of the HMI.

6.5.11.2 IEC 61850 NETWORK CONNECTIVITY

Configuration of the IP parameters and SNTP (Simple Network Time Protocol) time synchronisation parameters is performed by the IEC 61850 Configurator tool. If these parameters are not available using an SCL (Substation Configuration Language) file, they must be configured manually.

Every IP address on the Local Area Network must be unique. Duplicate IP addresses result in conflict and must be avoided. Most IEDs check for a conflict on every IP configuration change and at power up and they raise an alarm if an IP conflict is detected.

The IED can be configured to accept data from other networks using the ***Gateway*** setting. If multiple networks are used, the IP addresses must be unique across networks.

6.5.12 IEC 61850 EDITION 2

Many parts of the IEC 61850 standard have now been released as the second edition. This offers some significant enhancements including:

- Improved interoperability
- Many new logical nodes
- Better defined testing; it is now possible to perform off-line testing and simulation of functions

Edition 2 implementation requires use of version 3.8 of the IEC 61850 configurator, which is installed with version 2.0.1 of MiCOM S1 Agile.

6.5.12.1 BACKWARD COMPATIBILITY

IEC61850 System - Backward compatibility

An Edition 1 IED can operate with an Edition 2 IEC 61850 system, provided that the Edition 1 IEDs do not subscribe to GOOSE messages with data objects or data attributes which are only available in Edition 2.

The following figure explains this concept:

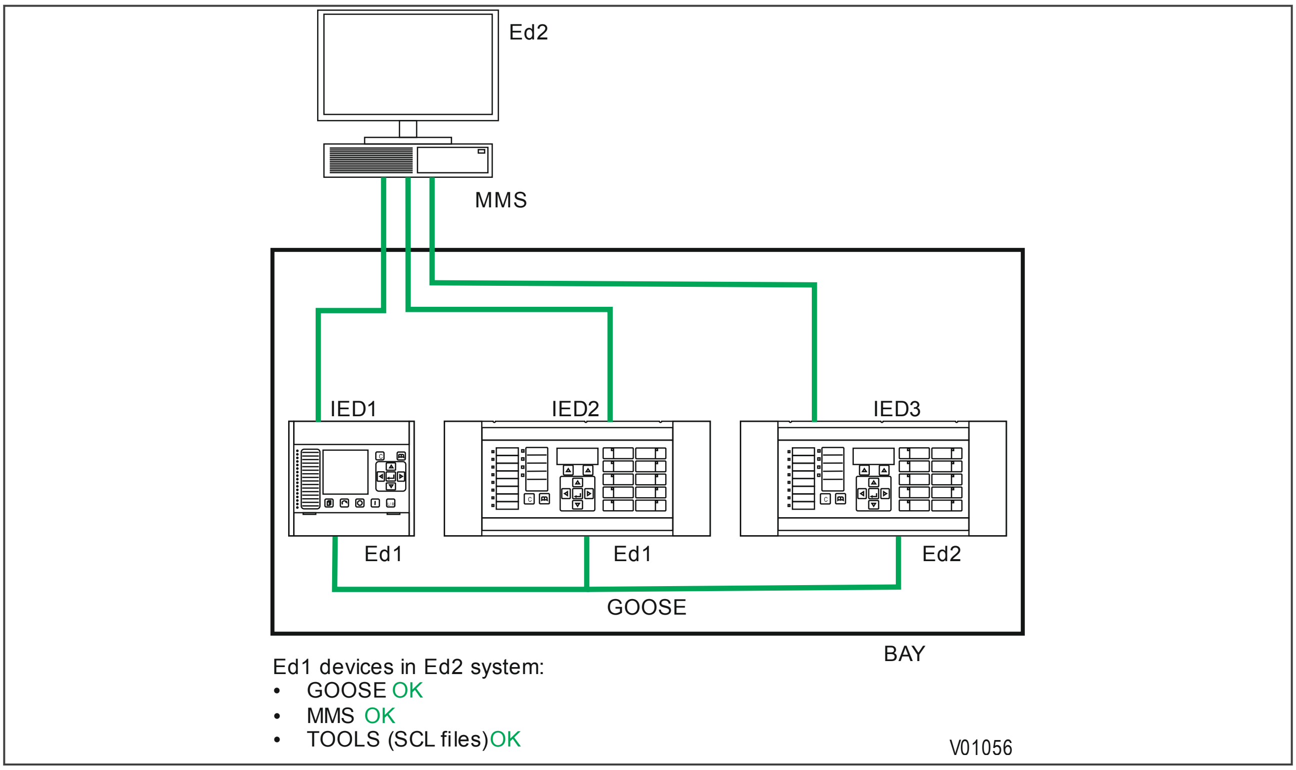


Figure 60: Edition 2 system - backward compatibility

An Edition 2 IED cannot normally operate within an Edition 1 IEC 61850 system. An Edition 2 IED can work for GOOSE messaging in a mixed system, providing the client is compatible with Edition 2.

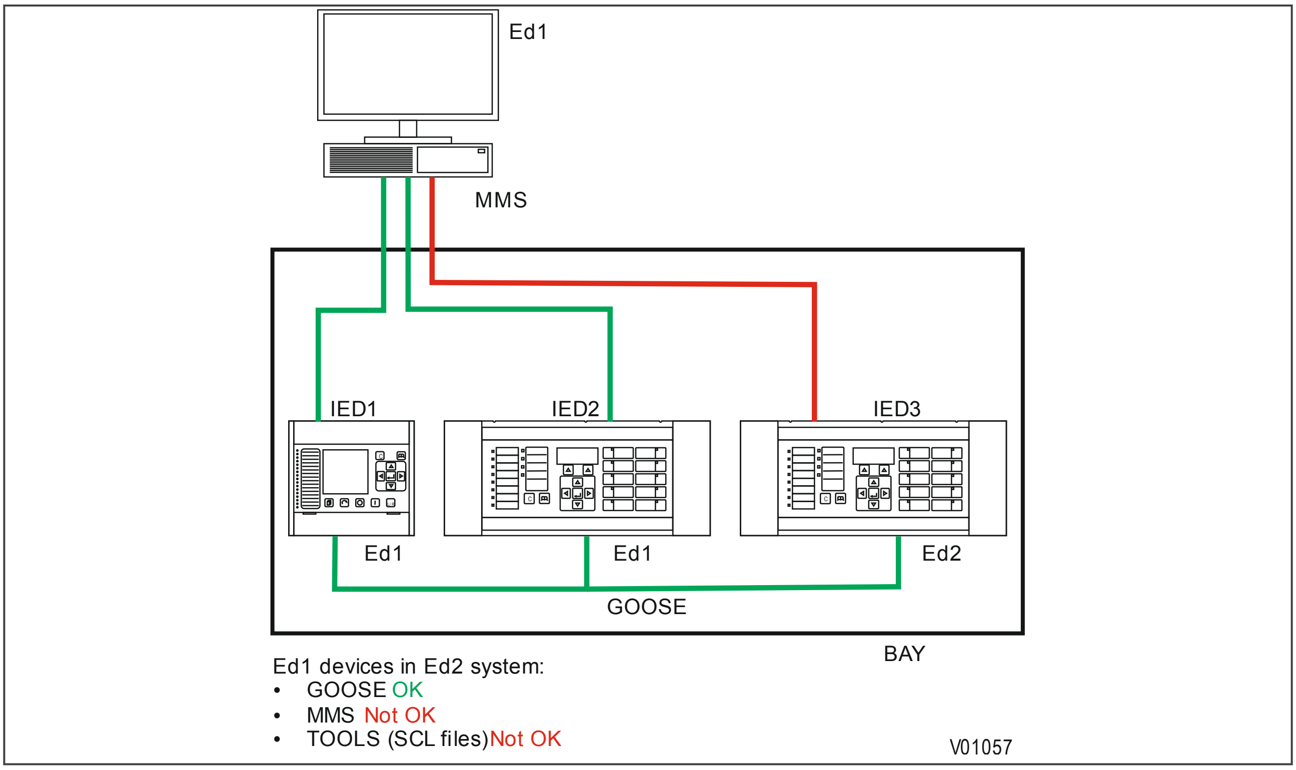


Figure 61: Edition 1 system - forward compatibility issues

6.5.12.2 EDITION-2 COMMON DATA CLASSES

The following common data classes (CDCs) are new to Edition 2 and therefore should not be used in GOOSE control blocks in mixed Edition 1 and Edition 2 systems

- Histogram (HST)
- Visible string status (VSS)
- Object reference setting (ORG)
- Controllable enumerated status (ENC)
- Controllable analogue process value (APC)
- Binary controlled analogue process value (BAC)
- Enumerated status setting (ENG)
- Time setting group (TSG)
- Currency setting group (CUG)
- Visible string setting (VSG)
- Curve shape setting (CSG)

Of these, only ENS and ENC types are available from a MiCOM P40 IED when publishing GOOSE messages, so Data Objects using these Common Data Classes should not be published in mixed Edition 1 and Edition 2 systems.

For compatibility between Edition 1 and Edition 2 IEDs, SCL files using SCL schema version 2.1 must be used. For a purely Edition 2 system, use the schema version 3.1.

6.5.12.3 STANDBY PROTECTION REDUNDANCY

With digital substation architectures, measurements can be shared freely on the process bus across the substation and between different devices without any additional wiring. This is because there are no longer any electrical connections to instruments transformers that restrict the location of IEDs.

The new IEC 61850 Edition 2 test modes enable the introduction of standby protection IEDs at any location within the substation, which has access to both station and process buses. In the case of failure, these devices can temporarily replace the protection functions inside other IEDs.

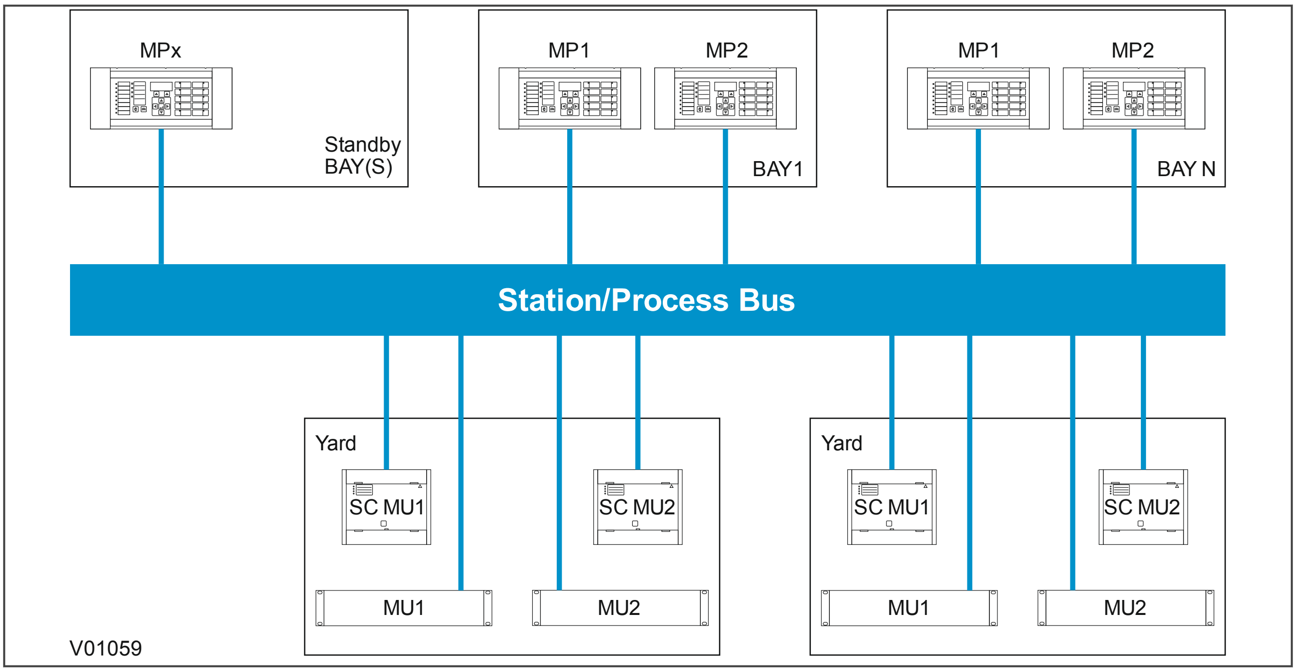


Figure 62: Example of Standby IED

See the example below. If a failure occurs in the Bay 1 protection IED (MP2), we could disable this device and activate a standby protection IED to replace its functionality.

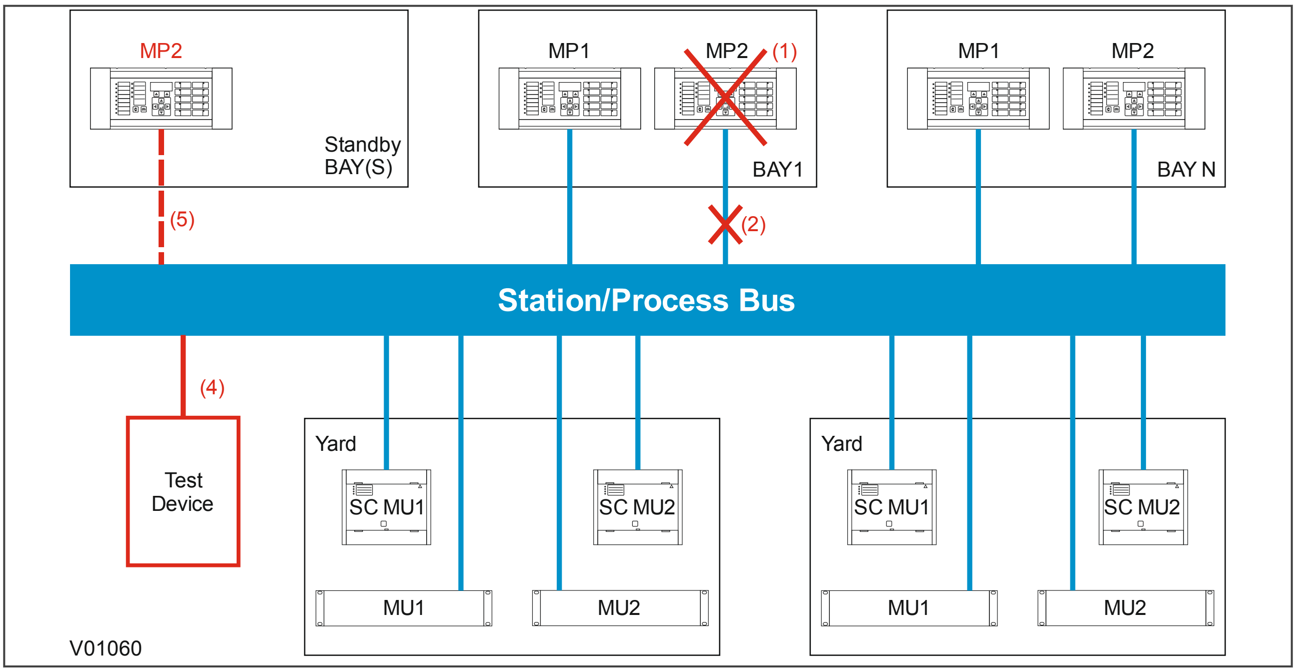


Figure 63: Standby IED Activation Process

The following sequence would occur under this scenario:

1. During the installation phase, a spare standby IED is installed in the substation. This can remain inactive, until it is needed to replace functions in one of several bays. The device is connected to the process bus, but does not have any subscriptions enabled.
2. If a failure occurs (in this example, bay 1), first isolate the faulty device by disabling its process bus and station bus interfaces. You do this by turning off the attached network interfaces.
3. Retrieve the configuration that the faulty device normally uses, and load this into the standby redundant IED.
4. Place the IED into the "Test Blocked" mode, as defined in IEC 61850-7-4 Edition Two. This allows test signals to be injected into the network, which will check that the configuration is correct. GOOSE signals issued by the device will be flagged as "test" so that subscribing switchgear controllers know not to trip during this testing. In this way the protection can be tested all the way up to the switchgear control merging units without having to operate primary circuit breakers, or by carrying out any secondary injection.
5. Take the standby IED out of "Test-Blocked" mode and activate it so that it now replaces the protection functions that were disabled from the initial device failure.

The standby IED reduces downtime in the case of device failure, as protection functions can be restored quickly before the faulted device is replaced.

7 READ ONLY MODE

With IEC 61850 and Ethernet/Internet communication capabilities, security has become an important issue. For this reason, all relevant GE IEDs have been adapted to comply with the latest cyber-security standards.

In addition to this, a facility is provided which allows you to enable or disable the communication interfaces. This feature is available for products using Courier, IEC 60870-5-103, or IEC 61850.

7.1 IEC 60870-5-103 PROTOCOL BLOCKING

If Read-Only Mode is enabled for RP1 or RP2 with IEC 60870-5-103, the following commands are blocked at the interface:

- Write parameters (=change setting) (private ASDUs)
- General Commands (ASDU20), namely:
  - INF16 auto-recloser on/off
  - INF19 LED reset
  - Private INFs (for example: CB open/close, Control Inputs)

The following commands are still 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 Synchronisation (ASDU6)
- General Commands (ASDU20), namely:
  - INF23 activate characteristic 1
  - INF24 activate characteristic 2
  - INF25 activate characteristic 3
  - INF26 activate characteristic 4

Note:
For IEC 60870-5-103, Read Only Mode function is different from the existing Command block feature.

7.2 COURIER PROTOCOL BLOCKING

If Read-Only Mode is enabled for RP1 or RP2 with Courier, the following commands are blocked at the interface:

- 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

The following commands are still allowed:

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

7.3 IEC 61850 PROTOCOL BLOCKING

If Read-Only Mode is enabled for the Ethernet interfacing with IEC 61850, the following commands are blocked at the interface:

- All controls, including:
    - Enable/disable protection
    - Operate Control Inputs
    - CB operations (Close/Trip, Lock)
    - Reset LEDs

The following commands are still allowed:

- Read statuses, measurands
- Generate reports
- Extract disturbance records
- Time synchronisation
- Change active setting group

7.4 READ-ONLY SETTINGS

The following settings are available for enabling or disabling Read Only Mode.

- RP1 Read Only
- RP2 Read Only (only for products that have RP2)
- NIC Read Only (where Ethernet is available)

7.5 READ-ONLY DDB SIGNALS

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

- RP1 Read Only
- RP2 Read Only (only for products that have RP2)
- NIC Read Only (where Ethernet is available)

Using the PSL, these signals can be activated by opto-inputs, Control Inputs and function keys if required.

8 TIME SYNCHRONISATION

In modern protection schemes it is necessary to synchronise the IED's real time clock so that events from different devices can be time stamped and placed in chronological order. This is achieved in various ways depending on the chosen options and communication protocols.

- Using the IRIG-B input (if fitted)
- Using the SNTP time protocol (for Ethernet IEC 61850 versions)
- Using IEEE 1588 Precision Time Protocol (PTP)
- By using the time synchronisation functionality inherent in the data protocols

8.1 DEMODULATED IRIG-B

IRIG stands for Inter Range Instrumentation Group, which is a standards body responsible for standardising different time code formats. There are several different formats starting with IRIG-A, followed by IRIG-B and so on. The letter after the "IRIG" specifies the resolution of the time signal in pulses per second (PPS). IRIG-B, the one which we use has a resolution of 100 PPS. IRIG-B is used when accurate time-stamping is required.

The following diagram shows a typical GPS time-synchronised substation application. The satellite RF signal is picked up by a satellite dish and passed on to receiver. The receiver receives the signal and converts it into time signal suitable for the substation network. IEDs in the substation use this signal to govern their internal clocks and event recorders.

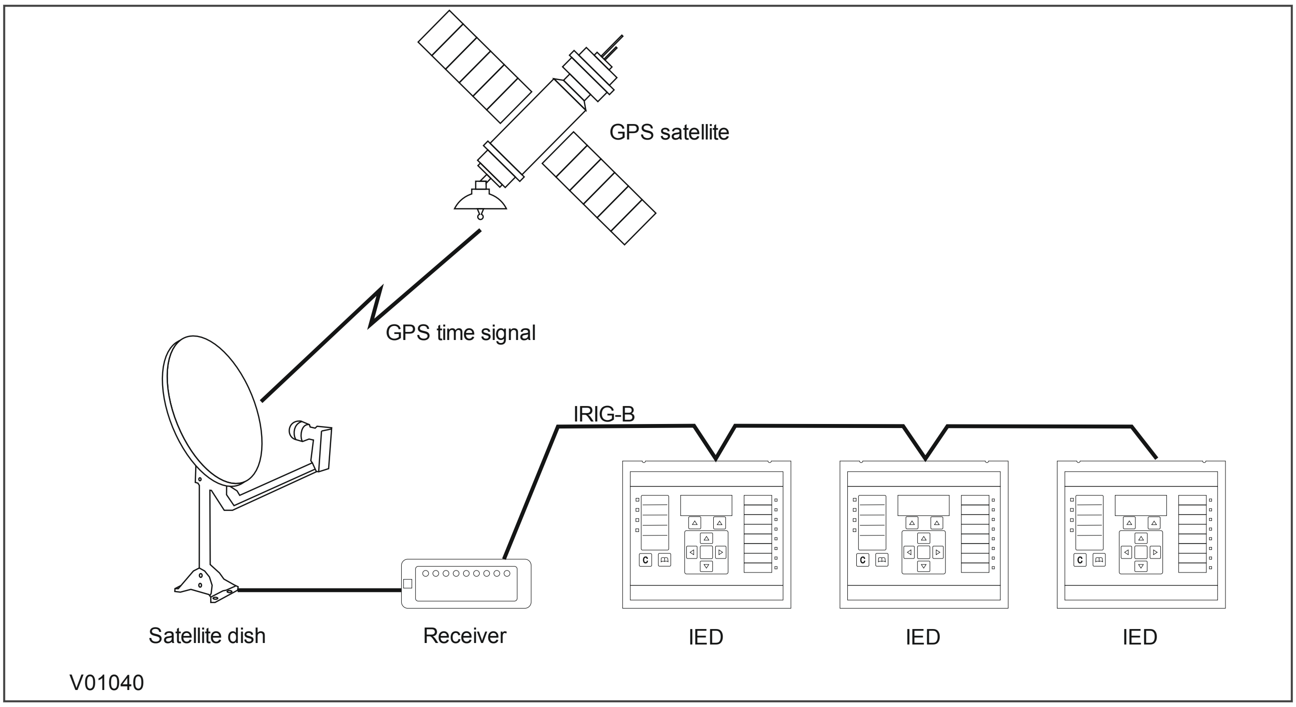


Figure 64: GPS Satellite timing signal

The IRIG-B time code signal is a sequence of one second time frames. Each frame is split up into ten 100 mS slots as follows:

- Time-slot 1: Seconds
- Time-slot 2: Minutes

- Time-slot 3: Hours
- Time-slot 4: Days
- Time-slot 5 and 6: Control functions
- Time-slots 7 to 10: Straight binary time of day

The first four time-slots define the time in BCD (Binary Coded Decimal). Time-slots 5 and 6 are used for control functions, which control deletion commands and allow different data groupings within the synchronisation strings. Time-slots 7-10 define the time in SBS (Straight Binary Second of day).

8.1.1 IRIG-B IMPLEMENTATION

Depending on the chosen hardware options, the product can be equipped with an IRIG-B input for time synchronisation purposes. The IRIG-B interface is implemented either on a dedicated card, or together with other communication functionality such as Ethernet. The IRIG-B connection is presented by a connector is a BNC connector. IRIG-B signals are usually presented as an RF-modulated signal. There are two types of input to our IRIG-B boards: demodulated or modulated. A board that accepts a demodulated input is used where the IRIG-B signal has already been demodulated by another device before being fed to the IED. A board that accepts a modulated input has an on-board demodulator.

To set the device to use IRIG-B, use the setting ***IRIG-B Sync*** cell in the *DATE AND TIME* column.

The IRIG-B status can be viewed in the ***IRIG-B Status*** cell in the *DATE AND TIME* column.

8.2 SNTP

SNTP is used to synchronise the clocks of computer systems over packet-switched, variable-latency data networks, such as IP. SNTP can be used as the time synchronisation method for models using IEC 61850 over Ethernet.

The device is synchronised by the main SNTP server. This is achieved by entering the IP address of the SNTP server into the IED using the IEC 61850 Configurator software described in the settings application software manual. A second server is also configured with a different IP address for backup purposes.

This function issues an alarm when there is a loss of time synchronisation on the SNTP server. This could be because there is no response or no valid clock signal.

The HMI menu does not contain any configurable settings relating to SNTP, as the only way to configure it is using the IEC 61850 Configurator. However it is possible to view some parameters in the *COMMUNICATIONS* column under the sub-heading SNTP parameters. Here you can view the SNTP server addresses and the SNTP poll rate in the cells ***SNTP Server 1***, ***SNTP Server 2*** and ***SNTP Poll rate*** respectively.

The SNTP time synchronisation status is displayed in the ***SNTP Status*** cell in the *DATE AND TIME* column.

8.3 IEEE 1588 PRECISION TIME PROTOCOL

The MiCOM P40 modular products support the IEEE C37.238 (Power Profile) of IEEE 1588 Precision Time Protocol (PTP) as a slave-only clock. This can be used to replace or supplement IRIG-B and SNTP time synchronisation so that the IED can be synchronised using Ethernet messages from the substation LAN without any additional physical connections being required.

A dedicated DDB signal (***PTP Failure***) his provided to indicate failure of failure of PTP.

8.3.1 ACCURACY AND DELAY CALCULATION

A time synchronisation accuracy of within 5 ms is possible. Both peer-to-peer or end-to-end mode delay measurement can be used.

In peer-to-peer mode, delays are measured between each link in the network and are compensated for. This provides greater accuracy, but requires that every device between the Grand Master and Slaves supports the peer-to-peer delay measurement.

In end-to-end mode, delays are only measured between each Grand Master and Slave. The advantage of this mode is that the requirements for the switches on the network are lower; they do not need to independently calculate delays. The main disadvantage is that more inaccuracy is introduced, because the method assumes that forward and reverse delays are always the same, which may not always be correct.

When using end-to-end mode, the IED can be connected in a ring or line topology using RSTP or Self Healing Protocol without any additional Transparent Clocks. But because the IED is a slave-only device, additional inaccuracy is introduced. The additional error will be less than 1ms for a network of eight devices.

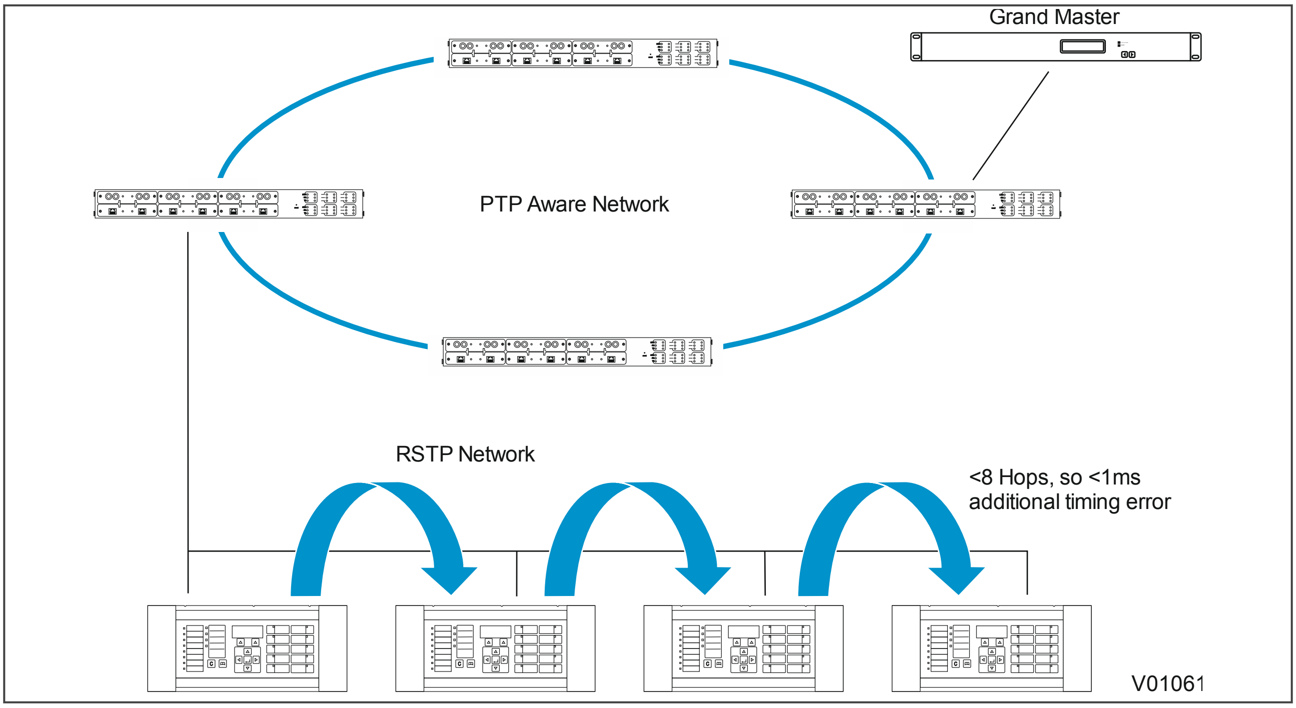


Figure 65: Timing error using ring or line topology

8.3.2 PTP DOMAINS

PTP traffic can be segregated into different domains using Boundary Clocks. These allow different PTP clocks to share the same network while maintaining independent synchronisation within each grouped set.

8.4 TIME SYNCHRONISATION USING THE COMMUNICATION PROTOCOLS

All communication protocols have in-built time synchronisation mechanisms. If an external time synchronisation mechanism such as IRIG-B, SNTP, or IEEE 1588 PTP is not used to synchronise the devices, the time synchronisation mechanism within the relevant serial protocol is used. The real time is usually defined in the master station and communicated to the relevant IEDs via one of the rear serial ports using the chosen protocol. It is also possible to define the time locally using settings in the *DATE AND TIME* column.

The time synchronisation for each protocol is described in the relevant protocol description section.

CHAPTER 8

CYBER-SECURITY

1 OVERVIEW

In the past, substation networks were traditionally isolated and the protocols and data formats used to transfer information between devices were often proprietary.

For these reasons, the substation environment was very secure against cyber-attacks. The terms used for this inherent type of security are:

- Security by isolation (if the substation network is not connected to the outside world, it cannot be accessed from the outside world).
- Security by obscurity (if the formats and protocols are proprietary, it is very difficult to interpret them).

The increasing sophistication of protection schemes, coupled with the advancement of technology and the desire for vendor interoperability, has resulted in standardisation of networks and data interchange within substations. Today, devices within substations use standardised protocols for communication. Furthermore, substations can be interconnected with open networks, such as the internet or corporate-wide networks, which use standardised protocols for communication. This introduces a major security risk making the grid vulnerable to cyber-attacks, which could in turn lead to major electrical outages.

Clearly, there is now a need to secure communication and equipment within substation environments. This chapter describes the security measures that have been put in place for our range of Intelligent Electronic Devices (IEDs).

> *Note:*
> *Cyber-security compatible devices do not enforce NERC compliance, they merely facilitate it. It is the responsibility of the user to ensure that compliance is adhered to as and when necessary.*

This chapter contains the following sections:

2 THE NEED FOR CYBER-SECURITY

Cyber-security provides protection against unauthorised disclosure, transfer, modification, or destruction of information or information systems, whether accidental or intentional. To achieve this, there are several security requirements:

- Confidentiality (preventing unauthorised access to information)
- Integrity (preventing unauthorised modification)
- Availability / Authentication (preventing the denial of service and assuring authorised access to information)
- Non-repudiation (preventing the denial of an action that took place)
- Traceability / Detection (monitoring and logging of activity to detect intrusion and analyse incidents)

The threats to cyber-security may be unintentional (e.g. natural disasters, human error), or intentional (e.g. cyber-attacks by hackers).

Good cyber-security can be achieved with a range of measures, such as closing down vulnerability loopholes, implementing adequate security processes and procedures and providing technology to help achieve this.

Examples of vulnerabilities are:

- Indiscretions by personnel (users keep passwords on their computer)
- Bad practice (users do not change default passwords, or everyone uses the same password to access all substation equipment)
- Bypassing of controls (users turn off security measures)
- Inadequate technology (substation is not firewalled)

Examples of availability issues are:

- Equipment overload, resulting in reduced or no performance
- Expiry of a certificate preventing access to equipment

To help tackle these issues, standards organisations have produced various standards. Compliance with these standards significantly reduces the threats associated with lack of cyber-security.

3 STANDARDS

There are several standards, which apply to substation cyber-security. The standards currently applicable to GE IEDs are NERC and IEEE1686.

Standard	Country	Description
NERC CIP (North American Electric Reliability Corporation)	USA	Framework for the protection of the grid critical Cyber Assets
BDEW (German Association of Energy and Water Industries)	Germany	Requirements for Secure Control and Telecommunication Systems
ANSI ISA 99	USA	ICS oriented then Relevant for EPU completing existing standard and identifying new topics such as patch management
IEEE 1686	International	International Standard for substation IED cyber-security capabilities
IEC 62351	International	Power system data and Comm. protocol
ISO/IEC 27002	International	Framework for the protection of the grid critical Cyber Assets
NIST SP800-53 (National Institute of Standards and Technology)	USA	Complete framework for SCADA SP800-82and ICS cyber-security
CPNI Guidelines (Centre for the Protection of National Infrastructure)	UK	Clear and valuable good practices for Process Control and SCADA security

3.1 NERC COMPLIANCE

The North American Electric Reliability Corporation (NERC) created a set of standards for the protection of critical infrastructure. These are known as the CIP standards (Critical Infrastructure Protection). These were introduced to ensure the protection of 'Critical Cyber Assets', which control or have an influence on the reliability of North America's electricity generation and distribution systems.

These standards have been compulsory in the USA for several years now. Compliance auditing started in June 2007, and utilities face extremely heavy fines for non-compliance.

NERC CIP standards

CIP standard	Description
CIP-002-1 Critical Cyber Assets	Define and document the Critical Assets and the Critical Cyber Assets
CIP-003-1 Security Management Controls	Define and document the Security Management Controls required to protect the Critical Cyber Assets
CIP-004-1 Personnel and Training	Define and Document Personnel handling and training required protecting Critical Cyber Assets
CIP-005-1 Electronic Security	Define and document logical security perimeters where Critical Cyber Assets reside. Define and document measures to control access points and monitor electronic access
CIP-006-1 Physical Security	Define and document Physical Security Perimeters within which Critical Cyber Assets reside
CIP-007-1 Systems Security Management	Define and document system test procedures, account and password management, security patch management, system vulnerability, system logging, change control and configuration required for all Critical Cyber Assets
CIP-008-1 Incident Reporting and Response Planning	Define and document procedures necessary when Cyber-security Incidents relating to Critical Cyber Assets are identified
CIP-009-1 Recovery Plans	Define and document Recovery plans for Critical Cyber Assets

3.1.1 CIP 002

CIP 002 concerns itself with the identification of:

- Critical assets, such as overhead lines and transformers
- Critical cyber assets, such as IEDs that use routable protocols to communicate outside or inside the Electronic Security Perimeter; or are accessible by dial-up

Power utility responsibilities:	GE's contribution:
Create the list of the assets	We can help the power utilities to create this asset register automatically. We can provide audits to list the Cyber assets

3.1.2 CIP 003

CIP 003 requires the implementation of a cyber-security policy, with associated documentation, which demonstrates the management's commitment and ability to secure its Critical Cyber Assets.

The standard also requires change control practices whereby all entity or vendor-related changes to hardware and software components are documented and maintained.

Power utility responsibilities:	GE's contribution:
To create a Cyber-security Policy	We can help the power utilities to have access control to its critical assets by providing centralized Access control. We can help the customer with its change control by providing a section in the documentation where it describes changes affecting the hardware and software.

3.1.3 CIP 004

CIP 004 requires that personnel with authorized cyber access or authorized physical access to Critical Cyber Assets, (including contractors and service vendors), have an appropriate level of training.

Power utility responsibilities:	GE's contribution:
To provide appropriate training of its personnel	We can provide cyber-security training

3.1.4 CIP 005

CIP 005 requires the establishment of an Electronic Security Perimeter (ESP), which provides:

- The disabling of ports and services that are not required
- Permanent monitoring and access to logs (24x7x365)
- Vulnerability Assessments (yearly at a minimum)
- Documentation of Network Changes

Power utility responsibilities:	GE's contribution:
To monitor access to the ESP To perform the vulnerability assessments To document network changes	To disable all ports not used in the IED To monitor and record all access to the IED

3.1.5 CIP 006

CIP 006 states that Physical Security controls, providing perimeter monitoring and logging along with robust access controls, must be implemented and documented. All cyber assets used for Physical Security are considered critical and should be treated as such:

Power utility responsibilities:	GE's contribution:
Provide physical security controls and perimeter monitoring. Ensure that people who have access to critical cyber assets don't have criminal records.	GE cannot provide additional help with this aspect.

3.1.6 CIP 007

CIP 007 covers the following points:

- Test procedures
- Ports and services
- Security patch management
- Antivirus
- Account management
- Monitoring
- An annual vulnerability assessment should be performed

Power utility responsibilities:	GE's contribution:
To provide an incident response team and have appropriate processes in place	Test procedures, we can provide advice and help on testing. Ports and services, our devices can disable unused ports and services Security patch management, we can provide assistance Antivirus, we can provide advise and assistance Account management, we can provide advice and assistance Monitoring, our equipment monitors and logs access

3.1.7 CIP 008

CIP 008 requires that an incident response plan be developed, including the definition of an incident response team, their responsibilities and associated procedures.

Power utility responsibilities:	GE's contribution:
To provide an incident response team and have appropriate processes in place.	GE cannot provide additional help with this aspect.

3.1.8 CIP 009

CIP 009 states that a disaster recovery plan should be created and tested with annual drills.

Power utility responsibilities:	GE's contribution:
To implement a recovery plan	To provide guidelines on recovery plans and backup/restore documentation

3.2 IEEE 1686-2013

IEEE 1686-2013 is an IEEE Standard for substation IEDs' cyber-security capabilities. It proposes practical and achievable mechanisms to achieve secure operations.

The following features described in this standard apply:

- Passwords are 8 characters long and can contain upper-case, lower-case, numeric and special characters.
- Passwords are never displayed or transmitted to a user.

- IED functions and features are assigned to different password levels. The assignment is fixed.
- The audit trail is recorded, listing events in the order in which they occur, held in a circular buffer.
- Records contain all defined fields from the standard and record all defined function event types where the function is supported.
- No password defeat mechanism exists. Instead a secure recovery password scheme is implemented.
- Unused ports (physical and logical) may be disabled.

4 CYBER-SECURITY IMPLEMENTATION

General Electric 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.

From Software Version 90 onwards, the MiCOM P40 Agile products provide enhanced security through the following features:

- An Authentication, Authorization, Accounting (AAA) Remote Authentication Dial-In User Service (RADIUS) client that is managed centrally, enables user attribution, provides accounting of all user activities, and uses secure standards based on strong cryptography for authentication and credential protection. In other words, this option uses a RADIUS.
- Server for user authentication. There is provision for both remote (RADIUS) and local (device) authentication.
- A Role-Based Access Control (RBAC) system that provides a permission model that allows access to the device operations and configurations based on specific roles and individual user accounts configured on the AAA server. That is, Administrator, Engineer, Operator, and Viewer roles are used.
- Security event reporting through both proprietary event logs and the Syslog protocol for supporting Security Information Event Management (SIEM) systems for centralised cybersecurity monitoring.
- Encryption of passwords – stored within the IED, in network messages between the MiCOM S1 Agile software and the IED, and in network messages between the RADIUS server and the IED (subject to the RADIUS server configuration).

4.1 INITIAL SETUP

The requirements for initial setup of the IED for cyber-security and RBAC will depend on:

1. which interfaces, if any, the cyber-security is required,
2. the intended authentication method, as defined in the setting ***Auth. Method***' in *SECURITY CONFIG* column (see the Authentication methods section).

When the authentication method is configured as `Device Only`, there are four pre-defined usernames, **VIEWER**, **OPERATOR, ENGINEER**, and **ADMINISTRATOR** that align with the **VIEWER**, **OPERATOR**, **ENGINEER** and **ADMINISTRATOR** roles (see the Device Users section).

When the authentication method is configured as 'Server Only' or 'Server + Device', users must be set up on the Radius server (see the RADIUS users section). These users are separate from the pre-defined Device users. RADIUS server information must be configured in the IED to connect to the RADIUS server(s) for Server authentication (see the RADIUS server settings section). It is recommended that the Radius shared secret be changed from the default (see the RADIUS client-server validation section).

Whatever the authentication method, it is strongly recommended that the password for the Administrator be changed from the default. Changing the passwords for the other roles is optional.

5 ROLES AND PERMISSIONS

5.1 ROLES

The P40 Agile products provide 4 specific roles to which individual user accounts can be configured:

- VIEWER (Level 0) Read some, Write minimal
- OPERATOR (Level 1) Read All, Write Few
- ENGINEER (Level 2) Read All, Write Some
- ADMINISTRATOR (Level 3) Read All, Write All

Only one role of one type is allowed to be logged in at a time. For example, one Operator can be logged in but not a second Operator at the same time. This prevents subsets of settings from being changed at the same time.

Roles are mapped to Access Level definitions:

VIEWER - No password required - Read access to Security features, Model Number, Serial Number, S/W version, Description, Plant reference, Security code (UI Only), Encryption key (UI Only), User Banner and security related cells. This role will allow maximum concurrent access provided by P40. Viewer is the default role

OPERATOR – Operator password required - Read access to all data and settings. Write access to Primary/ Secondary selector, Operator password setting, Password reset cell and log extraction cells (record selector). This role will not allow concurrent access.

ENGINEER – Engineer password required - Read access to all data and settings. Write access to Reset demands and counters. This role will not allow concurrent access.

ADMINISTRATOR – Administrator password required - Read access to all data and settings. Write access to All settings, PSL, IED Config, Security settings (port disabling etc). This role can enable the bypass mode and forcefully logout any other role. This role will not allow concurrent access.

The IED defines the following roles with reference to the roles defined by IEC 62351-8.

P40 Roles	IEC 62351- 8 Roles	Access Level
VIEWER	VIEWER	Level 0
OPERATOR	OPERATOR	Level 1
ENGINEER	ENGINEER	Level 2
ADMINISTRATOR	SECADM + SECAUD	Level 3

By default, the IED is delivered with default factory roles account and passwords. These default passwords are shown in the below table.

Role	Default Password
ADMINISTRATOR	ChangeMe1#
ENGINEER	ChangeMe1#
OPERATOR	ChangeMe1#
VIEWER	NA

Note:
It is strongly recommended that the password for the Administrator be changed from the default. Changing the passwords for the other roles is optional.

Administrators have the following rights as well:

- Setting the Bypass mode
- Forcefully logging out any other role
- Setting Authentication Method

'Firmware lock' is not supported by the P40 Agile IED. Firmware upgrade is not managed by the main software. The process involves using a dedicated firmware loading software tool. There is no access or control to this process via the main product firmware.

5.2 PERMISSIONS

Authentication and authorization are two different processes. An authenticated user cannot perform any action on the IED unless a privilege has been explicit granted to him/her to do so. This is the concept of “least privileges” access.

Privileges must be granted to users through roles. A role is a collection of privileges, and roles are granted to users. Each user is associated to only one role. The privilege/role matrix is stored on the IED. This is known as Role-Based-Access Control (RBAC).

On successful user authentication, the IED will load the user’s role list. If the user’s role changes, the user must logout and log back in to exercise his/her privileges.

Existing User level/permission mapping in P40 are:

Role	Meaning	Read Operation	Write Operation
VIEWER	Read Some Write Minimal	SYSTEM DATA column: Description Plant Reference Model Number Serial Number S/W Ref. Access Level Security Feature SECURITY CONFIG column: User Banner Attempts Remain Blk Time Remain Fallback PW level Security Code (UI only)	Password Entry LCD Contrast (UI only)
OPERATOR	Read All Write Few	All data and settings are readable. Poll Measurements	All items writeable at "Viewer". Select Event, Main and Fault (upload) Extract Events (e.g. via MiCOM S1 Agile)
ENGINEER	Read All Write Some	All data and settings are readable. Poll Measurements	All items writeable at "Operator". Setting Cells that change visibility (Visible/Invisible). Setting Values (Primary/Secondary) selector Commands: Reset Indication Reset Demand Reset Statistics Reset CB Data / counters

Role	Meaning	Read Operation	Write Operation
ADMINISTRATOR	Read All Write All	All data and settings are readable. Poll Measurements	All items writeable at "Engineer". Change all Setting cells Operations: Extract and download Setting file. Extract and download PSL Extract and download MCL (IEC 61850) Extraction of Disturbance Recorder Courier/Modbus Accept Event (auto event extraction, e.g. via AE2R) Commands: Change Active Group setting Close / Open CB Change Comms device address. Set Date & Time Switch MCL banks / Switch Conf. Bank in UI (IEC 61850) Enable / Disable Device ports (in SECURITY CONFIG column) All password settings Bypass Enable/disable Change Authentication Method

The table below shows the predefined permissions assignment for the predefined Roles according to IEC 62351-8

Role	View	Read	Dataset	Report	File Read	File Write	File Mngt	Control	Config.	Setting Group	Security
VIEWER	x			x							
OPERATOR	x	x		x				x			
ENGINEER	x	x	x	x		x	x		x		
ADMINISTRATOR	x	x	x	x	x	x	x	x	x	x	x

The table below shows the predefined permissions description according to IEC 62351-8

Permission	Description
VIEW	Allows the subject/role to discover what objects are present within a Logical Device by presenting the type ID of those objects.
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
FILEMNGT	Allows the role to transfer files to the Logical-Device, as well as delete existing files on the Logical-Device
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
SECURITY	Allows a subject/role to perform security functions at both a Server/Service Access Point and Logical-Device basis

6 AUTHENTICATION

6.1 AUTHENTICATION METHODS

The IED supports Bypass (no authentication), Device authentication and Server authentication.

Authentication Method	Description
Bypass Auth.	IED does not provide security, any user (Local/Remote) can login to the IED. IED does not validate user and password. In this case, there is no need to enter user-id and password to login.
Device Only	IED allows role access using local authentication.
Server Only	IED uses RADIUS server to validate access.
Server + Device	IED uses server authentication to validate user first. And it allows fallback to device authentication if the RADIUS server(s) are unavailable.

If ***Bypass Auth.*** is enabled, the IED ignores the ***Auth. Method*** setting.

The ***Auth. Method*** setting offers the following options for user authentication:

- *`Server + Device`* (This is the default setting for IEC 61850+Courier; IEC 61850+103; DNP3OE - where applicable)
- *`Device Only`* (This is the default setting for Courier/IEC 60870-5-103/Modbus/DNP3)
- *`Server Only`*

Only an **ADMINISTRATOR** role may change the ***Auth. Method*** setting. If Administrator changes it, the role remains logged in. But only when the user log-out, their access-level is revoked.

If Authentication method is *`Server Only`* and RADIUS Server IP addresses are configured, no device user has access to the IED (only the RADIUS users will have access). Only the RADIUS Administrator role will be able to switch to "Server and Device auth". When the setting is “Server Only” but RADIUS Server IP are not configured (both Primary & Secondary are 0.0.0.0), the IED will automatically fall back to Device authentication.

When Authentication method is *`Server Only`*, if the RADIUS server(s) are unavailable, the user should first take actions to recover the RADIUS connection. If both RADIUS servers ultimately failed to recover, the user should follow the password reset procedure to reset the ***Auth. Method*** setting to *`Device Only`*.

6.2 BYPASS

In ***Bypass Auth.*** mode, the IED does not provide security - any user can login. IED does not validate user and password. The bypass security feature provides an easier access, with no authentication and encryption for situations when this is considered safe. Only the Administrator can enable Bypass mode.

There are five modes for authentication bypass:

1. *`Disabled`* – no interfaces in ***Bypass Auth.*** mode (normal authentication is active)
2. *`Local & Remote`*
    a. Front Panel;
    b. Front Port
    c. Rear Ports
    d. Ethernet

3. `Local` – will bypass authentication for
    a. Front Panel;
    b. Front Port
4. `Remote` – will bypass authentication for
    a. Ethernet
    b. Rear Ports
5. `HMI-Only` – will bypass authentication only for front panel

Bypass authentication for Bypass mode:	Front panel	Front Port	Rear Port	Ethernet
`Disabled`				
`Local & Remote`	X	X	X	X
`Local`	X	X		
`Remote`			X	X
`HMI-Only`	X			

The DDB signal ***Security Bypass*** is available to indicate that the IED is in ***Bypass Auth.*** mode.

6.3 LOGIN

A user can only login through the following methods:

- Front Panel User Interface
- Using MiCOM S1 Agile, connected to either the Front Port, Rear Port 1 or 2, or NIC (Ethernet) interface.

The interfaces/protocols implemented in P40 are listed in the following table.

The product supports both RBAC (with `Server + Device` authentication) and original Access Level. The Courier Interfaces / HMI use the RBAC whilst other protocols such as Modbus, IEC 60870-5-103, DNP3 use the original Access Level to authenticate.

The following table shows different product variants that supports different protocols on Rear ports and Network port.

Local Access	Front Port	Rear Port (1/2)	NIC (Ethernet) Port	Supported Auth. mechanism
HMI Courier	Courier	Courier	-	Device
HMI Courier	Courier	Courier	IEC 61850 + SNMP + Courier tunnel	Server and Device
HMI Courier	Courier	Modbus (no server, device auth only, old access levels)	-	Device Old Access level for Modbus
HMI Courier	Courier	IEC 60870-5-103 (no server, device auth only, old access levels)	-	Device Old Access level for 103
HMI Courier	Courier	IEC 60870-5-103 (no server, device auth only, old access levels)	IEC 61850 + SNMP + Courier tunnel	Server and Device Old Access level for 103
HMI Courier	Courier	DNP3 (no server, device auth only, old access levels)	-	Device Old Access level for DNP3
HMI Courier	Courier	Courier	DNP3 + SNMP + Courier tunnel	Server and Device Old Access level for DNP3

6.3.1 FRONT PANEL LOGIN

Front panel User Interface supports both Device authentication and Server authentication. The P40 gives the user the option to enter a username in HMI panel.

The user can type their password in the password cell.

For Device authentication, the user must enter one of the pre-defined usernames **VIEWER**, **OPERATOR**, **ENGINEER**, **ADMINISTRATOR**. The user can scroll through these names using either of the hotkeys. Users must then enter their password.

For Server authentication, the user can enter any valid pre-defined Radius server username. Using the front panel User Interface, the user can change the displayed character type (digit, uppercase letter, lowercase letter, special character) by either of the hotkeys. For ease of typing, it is preferable to do Server authentication login using MiCOM S1 Agile.

After successful log in, a confirmation message is displayed, showing the logged in username. For example:

```
LOGIN SUCCESS
OPERATOR
```

6.3.2 MICOM S1 LOGIN

When the user attempts to login, MiCOM S1 Agile will prompt the user with a login dialog box that contains a username text entry field and a password text entry field. The username field is a combo-dropdown style text field that includes the fixed usernames (**Administrator**, **Engineer**, **Operator**, **Viewer**) for Device authentication – the user can pick one of these if they wish, or type any other pre-defined username for Radius authentication in the textbox.

6.3.3 WARNING BANNER

After successful authentication and authorisation to access the IED, MiCOM S1 Agile will display a security warning banner to the user.

If **I Agree** is selected, the integrated authentication and authorisation is completed. Selecting **I Disagree** causes the program to close and the login user to logout.

6.3.4 LOGIN FAILED

When Device authentication fails, a failure message is displayed:

```
LOGIN FAILED
```

For front panel authentication, this is shown for 2 seconds on the LCD.

For S1 Agile authentication, this is a pop-up dialog that the user must click to acknowledge.

6.4 USER SESSIONS

Open sessions will be automatically closed by the IED after a configurable session timeout.

The inactivity timer configuration setting defines the period of time that the IED waits in idleness before a logged in user is automatically logged out.

If there is any data change that does not commit to IED, the data change is discarded when user logged out. If there is any access that does not finish, the access will fail when user logged out. Front panel will display the default page when user reaches the defined inactivity time.

If the keypad is inactive for configured UI inactivity timer, user logout message is displayed. And front panel user interface reverts to the Viewer access level.

Currently in the P40, the inactivity timer for both front port and HMI is fixed to 15 minutes. Already, ***RP1 InactivTimer*** and ***RP2 InactivTimer*** settings control the inactivity timer for RP1 and RP2. There are two new settings to support configurable inactivity timer for front port and front panel user interface:

- ***FP InactvTimer***
- ***UI InactivTimer***

Administrator, Operator and Engineer roles will accept only one session to the device at one time. Only Viewer allows 4 concurrent sessions at one time.

Only one user session is allowed from all the access methods mentioned below:

- Front Panel Push buttons
- Front Port (serial) FP1
- Rear Port 1 (RP1)
- Rear Port 2 (RP2)
- Ethernet Port (NIC)

Setting Name	Description	Min	Max	Default	Units	Minimum Permissions
Attempts Limit	Number of failed authentications before the device blocks subsequent authentication attempts for the lockout period. A value of 0 means Lockout is disabled.	0 (lockout disabled)	99	3	-	Administrator
Lockout Period	The period of time in seconds a user is prevented from logging in, after being locked out.	1	5940	5	sec	Administrator
FP InactivTimer	FP Inactivity Timer is the time of idleness on Front Port before a logged in user is automatically logged out and revert the access level to the viewer role	0 (no Inactivity Timeout)	30	10	min	Administrator
UI InactivTimer	UI Inactivity Timer is the time of idleness on Front Panel before a logged in user is automatically logged out and revert the access level to the viewer role	0 (no Inactivity Timeout)	30	10	min	Administrator

The recommended settings for ***Attempts Limit*** is *3* and ***Lockout Period*** is *5 sec* to discourage brute force attacks. If the Lockout period is too large, anybody can lockout Device users.

6.5 USER LOCKING POLICY

A local user locking policy is implemented for Device access:

- This user locking policy applies to both Device users.
- The account is unlocked at the first successful login after the ***Lockout Period***
- By default, if the user consecutively fails to login 3 times, the user account will be locked for 3 minutes.

Each user account records how long it has been locked if the account is locked.

Each user account records how many times it has consecutively failed to login. User account failed times include all interfaces login attempts. For example, if the ***Attempts Limit*** setting is *3* and the operator failed to login from front panel 2 times, and they changed to login from the Courier interface, but failed again, then the Operator would be locked out.

When the IED is powered on, these ***Attempts Limit*** counter resets to zero.

When the user account exceeds the ***Attempts Limit*** it is locked for ***Lockout period***, at that time ***Attempt limit*** resets to zero.

The locked user account will be unlocked automatically, after the configured “Lockout Period” is expired.

All user accounts need to wait until the lockout period expires. No user can unlock the locked account.

If the locked account attempts to login the IED from the Front Panel, the following text is displayed (example):

```
OPERATOR
IS LOCKED
```

Usernames are specific to each user account, such as **Engineer**, **Operator** and **Administrator** for Device authentication.

When supporting both RBAC enabled interfaces and non-RBAC interfaces (such as Modbus), the P40 handles features such as user-locking feature as follows

- If an RBAC user exceeds the invalid password limit, that user gets locked for all the interfaces.
- On a non-RBAC interface, if an Access Level exceeds the invalid password limit, P40 only blocks that.

6.6 LOGOUT

Each user should ***Log out*** after reading or configuring the IED.

Both S1 Agile and the Front Panel provide a one-step logout.

The user can only log out from the front panel, if they logged in from the front panel. If the user logged in from S1 Agile, they have to logout from S1 Agile.

6.6.1 FRONT PANEL LOGOUT

Go up to the top of the menu tree. When you are at the Column Heading level and you press the Up button, you may be prompted to log out with the following display:

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

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

```
LOGGED OUT <ROLE
NAME>
LOGGED OUT
ADMINISTRATOR
```

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

```
LOGOUT CANCELLED
ADMINISTRATOR
```

6.6.2 MICOM S1 LOGOUT

Right-click on the device name in the System Explorer panel in MiCOM S1 Agile and select **Log Off**.

In the Log Off confirmation dialog, click **Yes**.

6.7 DEVICE USERS

For device authentication, the user must enter one of the pre-defined usernames **VIEWER**, **OPERATOR**, **ENGINEER**, or **ADMINISTRATOR**. This means that device users and roles are same in the P40, and therefore there can be only one user for each role.

6.8 PASSWORD POLICY

Cyber-security requires strong passwords and validation for NERC compliance.

The NERC password complexity policy requires an alpha-numeric password (for all accesses, front panel, and network/local port) that meets the following **mandatory** requirements:

1. Passwords cannot contain the user's account name or parts of the user's full name that exceed two consecutive characters.
2. Passwords must be at least eight characters in length, but not exceed 16 characters in length.
3. Passwords must contain characters from all four categories:
   a. English uppercase characters (A through Z).
   b. English lowercase characters (a through z).
   c. Numeric (digits 0 through 9).
   d. Special non-alphanumeric characters (such as @,!,#,{, but not limited to only those)

For Device authentication, the IED will enforce that configured passwords meet these requirements.

For Server authentication, the password complexity and user locking policy is defined in the external Radius server.

6.9 CHANGE PASSWORD

In the Device authentication mode, **VIEWER** does not have a password associated with it.

The password can be changed either from the front panel User Interface, or from MiCOM S1 Agile using the **Change/Set Password** option in the **Supervise Device** dialog box.

Caution:
It is recommended that user passwords are changed periodically.

6.10 RADIUS

When the ***Auth. Method*** setting is configured as `Server Only` or `Server + Device`, a user must log in with a username and password that has been predefined on the Radius server.

This log in can be performed from any interface, as described in the Login section. The IED will authenticate the user to the active RADIUS server, over the Ethernet connection.

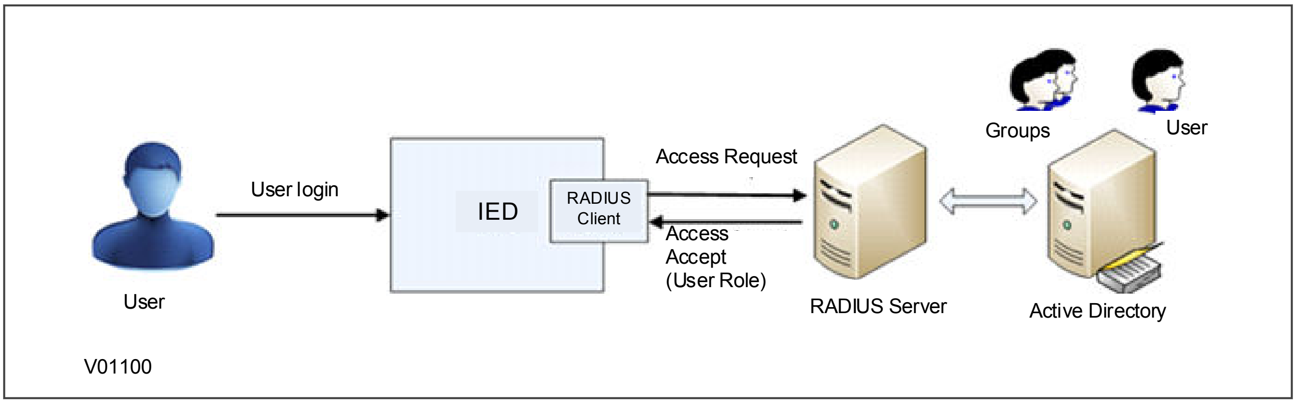


Figure 66: RADIUS server/client communication

6.10.1 RADIUS USERS

For Server authentication, RADIUS users and passwords are created in the server (in the Active Directory).

The username must consist of uppercase letters (A to Z) and digits (0 to 9) only. No lowercase letters or special characters are allowed.

Each RADIUS user must have a password that meets the password policy of the Active Directory (not the password policy of the P40) and have one of the four roles assigned in the Active Directory.

The number of RADIUS users is not limited by the IED.

RADIUS password changes are done in the Active Directory (after password expiration).

6.10.2 RADIUS CLIENT

Two Radius servers are supported by the IED in the configuration for redundancy. The IED will try each in sequence until one responds.

The IED will first try server 1 up to the configured number of retries, leaving a request timeout between each request. If, after this point there is still no valid answer from server 1, the IED will switch to server 2 and repeat for up to the configured number of retries.

If the number of retries for the second server is exceeded, the IED will give up entirely on Server authentication. If Authentication Method is *Server + Device*, the IED will fallback to Device authentication. A **RADIUS Server unavailable** security event is also logged under this condition.

The RADIUS implementation supports the following authentication protocols:

- EAP-TTLS-MSCHAP2
- PAP
- EAP-PEAP-MSCHAP2
- PAP EAP-TTLS-PAP (Default)

The RADIUS implementation queries the Role ID vendor attribute and establish the logged in user security context with that role.

RADIUS Config.	Value
Vendor ID	2910
Vendor Attribute	1
P40 Role Values	
Administrator	3
Engineer	2
Operator	1
Viewer	0

6.10.3 RADIUS SERVER SETTINGS

The following RADIUS server information must be configured in the IED to connect to the RADIUS server(s) for Server authentication.

Setting Name	Description	Min	Max	Default	Units	Minimum Permissions
RADIUS Pri IP	IP address of Server 1. Default value indicates no Primary Radius server is configured, and so Radius is disabled.	0.0.0.0	255.255.255.255	0.0.0.0	-	Administrator
RADIUS Sec IP	IP address of Server 2. Default value indicates no Secondary Radius server is configured	0.0.0.0	255.255.255.255	0.0.0.0	-	Administrator
RADIUS Auth Port	Radius authentication port	1	65535	1812	-	Administrator

Setting Name	Description	Min	Max	Default	Units	Minimum Permissions
RADIUS Security	Authentication protocol to be used by Radius server.	EAP-TTLS-MSCHAP2 PAP EAP-PEAP-MSCHAP2 PAP EAP-TTLS-PAP		PAP EAP-TTLS-PAP	-	Administrator
RADIUS Timeout	Timeout in seconds between re-transmission requests	1	900	2	sec	Administrator
RADIUS Retries	Number of retries before giving up	1	99	10	-	Administrator
RADIUS Secret	Shared Secret used in authentication. It is only displayed as asterisks.	1 character	16 characters	ChangeMe1#	-	Administrator

The data cell ***RADIUS Status*** indicates the status of the currently-selected RADIUS server. This will display either *Disabled*, *Server OK*, or *Failed*.

6.10.4 RADIUS ACCOUNTING

Radius accounting is not supported by the IED. The user can achieve accounting through syslog (see the SYSLOG section).

6.10.5 RADIUS CLIENT-SERVER VALIDATION

Client-server validation is achieved using a shared secret. The IED must be configured with the ***RADIUS Secret*** setting to match the shared secret configured in the RADIUS server. It is recommended (but not enforced) that this setting meets the P40 password requirements.

Note:
It is recommended that the shared secret be changed from the default before using Radius authentication.

The IED does not support exchange of CA certificates. The RADIUS server may send a certificate but the IED will not verify it.

6.11 RECOVERY

6.11.1 RESTORE TO LOCAL FACTORY DEFAULT

The ***Restore Defaults*** setting is available to facilitate NERC CIP compliance requirements for decommissioning critical cyber devices. Only the **Administrator** role can change this setting.

The ***Restore Defaults*** setting under the *CONFIGURATION* column is used to restore a setting group to factory default settings.

0 = *No Operation*

1 = *All Settings*

2 = *Setting Group 1*

3 = *Setting Group 2*

4 = *Setting Group 3*

5 = *Setting Group 4*

To restore the default values to the settings in any setting group, set the ***Restore Defaults*** setting to the relevant Group number. Alternatively, it is possible to set the ***Restore Defaults*** setting to *All Settings* to restore the default values to all the IEDs settings, not only one setting group.

> *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.*

Data (events, DR, fault records, protection counters etc) is left untouched. When decommissioning critical cyber IEDs, users may want to clear all data and events as well.

6.11.2 PASSWORD RESET PROCEDURE

If you mislay a devices password (if Administrator forgets their password), the passwords can be reset to default using a recovery password. To obtain the recovery password you must contact the Contact Centre and supply the Serial Number and the security code. The Contact Centre will use these items to generate a Recovery Password.

The security code is a 16-character string of uppercase characters. It is a read-only parameter. The device generates its own security code randomly. A new code is generated under the following conditions:

- On power up
- Whenever settings are set back to default
- On expiry of validity timer (see below)
- When the recovery password is entered

This reset procedure can be only accomplished through front panel exclusively and cannot be done over any other interface. As soon as the security code is displayed on the front panel User Interface, a validity timer is started. This validity timer is set to 72 hours and is not configurable. This provides enough time for the Contact Centre to manually generate and send a recovery password. The Service Level Agreement (SLA) for recovery password generation is one working day, so 72 hours is sufficient time, even allowing for closure of the Contact Centre over weekends and bank holidays.

The procedure is:

The security code is displayed on confirmation. The validity timer is then started. The security code can only be read from the front panel.

This reset procedure can be only accomplished through front panel exclusively and cannot be done over the Ethernet/serial port, but only when physically present in front of the IED. In the event of losing all passwords (if the Administrator forgets their password) the user could reset the IED to default passwords, following the procedure below:

1. User navigates to ***Security Code*** cell in *SECURITY CONFIG* column
2. To prevent accidental reading of the IED ***Security Code***, the cell will initially display a warning message:

```
PRESS ENTER TO
READ SEC. CODE
```

3. Press Enter to read the ***Security Code***.
4. User sends an email to the Contact Centre providing the full IED serial number and displayed ***Security Code***, using a recognisable corporate email account
5. Contact Centre emails the user with 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.
6. User logs in with the username **ADMINISTRATOR** and the recovery password in to the ***Password*** setting in *SYSTEM DATA* column.

7. Then IED will prompt

```
RESET PASSWORD?
ENTER or CLEAR
```

8. Press Enter to continue the reset procedure
9. If the recovery password successfully validates, the default passwords are restored for each access level for Device authentication.
10. Change ***Auth. Method*** setting to `Server + Device` if applicable.

> *Note:*
> *Restoring passwords to defaults does not affect any other settings and does not provoke reboot of the IED. The protection and control functions of the IED are always maintained.*

6.11.3 ACCESS LEVEL DDBS

The current level of access for each interface is available for use in the Programming Scheme Logic (PSL) as these DDB signals:

- ***HMI Access Lvl 1***
- ***HMI Access Lvl 2***
- ***FPort AccessLvl1***
- ***FPort AccessLvl2***
- ***RPrt1 AccessLvl1***
- ***RPrt1 AccessLvl2***
- ***RPrt2 AccessLvl1***
- ***RPrt2 AccessLvl2***

Each pair of DDB signals indicates the access level as follows:

- Level 1 off, Level 2 off = 0
- Level 1 on, Level 2 off = 1
- Level 1 off, Level 2 on = 2
- Level 1 on, Level 2 on = 3

KEY:

HMI = Human Machine Interface

FPort = Front Port

RPrt = Rear Port

Lvl = Level

6.12 DISABLING PHYSICAL PORTS

It is possible to disable unused physical ports. A level 3 password 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
```

The following ports can be disabled, depending on the model.

- Front port (***Front Port*** setting)
- Rear port 1 (***Rear Port 1*** setting)
- Rear port 2 (***Rear Port 2*** setting)
- Ethernet port (***Ethernet Port*** setting)

> *Note:*
> *It is not possible to disable a port from which the disabling port command originates.*
> *We do not generally advise disabling the physical Ethernet port.*

6.13 DISABLING LOGICAL PORTS

It is possible to disable unused logical ports. A level 3 password is needed to perform this action.

> *Note:*
> *The port disabling setting cells are not provided in the settings file. It is only possible to do this using the HMI front panel.*

The following protocols can be disabled:

- IEC 61850 (***IEC 61850*** setting)
- DNP3 Over Ethernet (***DNP3 OE*** setting)--where available
- Courier Tunnelling (***Courier Tunnel*** setting)

> *Note:*
> *If any of these protocols are enabled or disabled, the Ethernet card will reboot.*

7 SECURITY EVENT MANAGEMENT

To implement NERC-compliant cyber-security, a range of security events are logged in the Security Event file.

7.1 SECURITY EVENTS: COURIER

Event Value	Display
PASSWORD LEVEL UNLOCKED	USER LOGGED IN ON {int} LEVEL {n}
PASSWORD LEVEL RESET	USER LOGGED OUT ON {int} LEVEL {n}
PASSWORD SET BLANK	P/WORD SET BLANK BY {int} LEVEL {p}
PASSWORD SET NON-COMPLIANT	P/WORD NOT-NERC BY {int} LEVEL {p}
PASSWORD MODIFIED	PASSWORD CHANGED BY {int} LEVEL {p}
PASSWORD ENTRY BLOCKED	PASSWORD BLOCKED ON {int}
PASSWORD ENTRY UNBLOCKED	P/WORD UNBLOCKED ON {int}
INVALID PASSWORD ENTERED	INV P/W ENTERED ON <int}
PASSWORD EXPIRED	P/WORD EXPIRED ON {int}
PASSWORD ENTERED WHILE BLOCKED	P/W ENT WHEN BLK ON {int}
RECOVERY PASSWORD ENTERED	RCVY P/W ENTERED ON {int}
IED SECURITY CODE READ	IED SEC CODE RD ON {int}
IED SECURITY CODE TIMER EXPIRED	IED SEC CODE EXP -
PORT DISABLED	PORT DISABLED BY {int} PORT {prt}
PORT ENABLED	PORT ENABLED BY {int} PORT {prt}
DEF. DISPLAY NOT NERC COMPLIANT	DEF DSP NOT-NERC
PSL SETTINGS DOWNLOADED	PSL STNG D/LOAD BY {int} GROUP {grp}
DNP SETTINGS DOWNLOADED	DNP STNG D/LOAD BY {int}
TRACE DATA DOWNLOADED	TRACE DAT D/LOAD BY {int}
IEC 61850 CONFIG DOWNLOADED	IED CONFG D/LOAD BY {int}
USER CURVES DOWNLOADED	USER CRV D/LOAD BY {int} GROUP {crv}

Event Value	Display
PSL CONFIG DOWNLOADED	PSL CONFG D/LOAD BY {int} GROUP {grp}
SETTINGS DOWNLOADED	SETTINGS D/LOAD BY {int} GROUP {grp}
PSL SETTINGS UPLOADED	PSL STNG UPLOAD BY {int} GROUP {grp}
DNP SETTINGS UPLOADED	DNP STNG UPLOAD BY {int}
TRACE DATA UPLOADED	TRACE DAT UPLOAD BY {int}
IEC 61850 CONFIG UPLOADED	IED CONFG UPLOAD BY {int}
USER CURVES UPLOADED	USER CRV UPLOAD BY {int} GROUP {crv}
PSL CONFIG UPLOADED	PSL CONFG UPLOAD BY {int} GROUP {grp}
SETTINGS UPLOADED	SETTINGS UPLOAD BY {int} GROUP {grp}
EVENTS HAVE BEEN EXTRACTED	EVENTS EXTRACTED BY {int} {nov} EVNTS
ACTIVE GROUP CHANGED	ACTIVE GRP CHNGE BY {int} GROUP {grp}
CS SETTINGS CHANGED	C & S CHANGED BY {int}
DR SETTINGS CHANGED	DR CHANGED BY {int}
SETTING GROUP CHANGED	SETTINGS CHANGED BY {int} GROUP {grp}
POWER ON	POWER ON -
SOFTWARE_DOWNLOADED	S/W DOWNLOADED -

where:

- int is the interface definition (UI, FP, RP1, RP2, TNL, TCP)
- prt is the port ID (FP, RP1, RP2, TNL, DNP3, IEC, ETHR)
- grp is the group number (1, 2, 3, 4)
- crv is the Curve group number (1, 2, 3, 4)
- n is the new access level (0, 1, 2, 3)
- p is the password level (1, 2, 3)
- nov is the number of events (1 – nnn)

Each new event has an incremented unique number, therefore missing events appear as gap in the sequence. The unique identifier forms part of the event record that is read or uploaded from the IED.

> *Note:*
> *It is no longer possible to clear Event, Fault, Maintenance, and Disturbance Records.*

7.2 SYSLOG

Security events are also logged to a remote syslog server.

All login and logout attempts from local and central authentication, whether successful or failed, are logged. The contents of each successful or failed, login and logout security event include a specific username.

The security log cannot be cleaned by any of the available roles.

The contents of each login and/or logout security event include the relevant interface. The following interfaces are supported:

Interface	Abbr.
Front Port	FP
Rear Port 1	RP1
Rear Port 2	RP2
Ethernet	NET
Front Panel	UI

The following events are available to be logged to the syslog server:

<table>
<tr><th>Event Categorisation</th><th>Severity</th></tr>
<tr><td>Login - Authentication successful</td><td>Informational (6)</td></tr>
<tr><td>Login - Authentication Failure</td><td>Informational (6)</td></tr>
<tr><td>Logout</td><td>Informational (6)</td></tr>
<tr><td>RADIUS Server Unavailable</td><td>Alert (1)</td></tr>
<tr><td>Session timeout</td><td>Informational (6)</td></tr>
<tr><td>Account Locked</td><td>Notice (5)</td></tr>
<tr><td>User accessed while locked</td><td>Notice (5)</td></tr>
<tr><td>ByPass Activate</td><td>Notice (5)</td></tr>
<tr><td>ByPass Deactivate</td><td>Notice (5)</td></tr>
<tr><td>Password Change</td><td>Notice (5)</td></tr>
<tr><td>Recovery password is entered to reset the passwords</td><td>Notice (5)</td></tr>
<tr><td>Settings / Configuration Changed</td><td>Notice (5)</td></tr>
<tr><td>Settings / Configuration uploaded
(to S1 Agile)</td><td>Notice (5)</td></tr>
<tr><td>Event Records uploaded</td><td>Notice (5)</td></tr>
<tr><td>Default settings restored</td><td>Notice (5)</td></tr>
<tr><td rowspan="4">Active Setting Group Changed</td><td>Notice (5)</td></tr>
<tr><td>Notice (5)</td></tr>
<tr><td>Notice (5)</td></tr>
<tr><td>Notice (5)</td></tr>
<tr><td rowspan="3">Default user curves restored</td><td>Notice (5)</td></tr>
<tr><td>Notice (5)</td></tr>
<tr><td>Notice (5)</td></tr>
</table>

7.3 SYSLOG CLIENT

The IED supports security event reporting through the Syslog protocol for supporting Security Information Event Management (SIEM) systems for centralized cyber security Monitoring over UDP protocol.

The IED is a Syslog client that supports two Syslog servers. The following settings are available in the *COMMUNICATIONS* column.

Setting Name	Description	Min	Max	Default	Units	Min. Permission
SysLog Pri IP	The IP address of the target Syslog server (Primary)	0.0.0.0	223.255.255.254	0.0.0.0	-	Administrator
SysLog Sec IP	The IP address of the target Syslog server (Secondary)	0.0.0.0	223.255.255.254	0.0.0.0	-	Administrator
SysLog Port	The UDP port number of the target Syslog server	1	65535	514	-	Administrator

7.4 SYSLOG FUNCTIONALITY

The P40 supports the RFC 5424 UDP protocol.

The table below shows the format of a Syslog event.

Header	<PRIVAL>1 YYYY-MM-DDTHH:mm:ss.fffZ IEDName userlog - MSGID	
	PRIVAL	32 + [event severity] 32 is derived from the facility number 4 (meaning security/authorization messages) Event severity is derived from the received message.
	YYYY	4 Digit year; i.e. 2018 Derived from the received message timestamp.
	MM	2 Digit month; 01 to 12 (for January to December). Derived from the received message timestamp.
	DD	2 Digit day of month; 01 to 31 (depending upon the month) Derived from the received message timestamp.
	HH	2 Digit hour of day; 00 to 23 Derived from the received message timestamp.
	mm	2 Digit count of minutes elapsed in the current hour; 00 to 59 Derived from the received message timestamp.
	ss	2 Digit count of seconds elapsed in the current minute; 00 to 59 Derived from the received message timestamp.
	fff	3 Digit fraction of seconds (millisecond resolution); 0 to 999 Derived from the received message timestamp.
	IP Addr	IP Address assigned to the Ethernet Board.
	MSGID	Unique message type identity Derived from the received message event type.
Data (common)	[timeQuality tzKnown=X]	
	X	Timezone quality attribute for event timestamp (in header) 0; indicating Local Time offset and DST settings are not enabled (i.e. timestamp is UTC)

Data (Platform event)	[gePlatformEvt channel=IFACE accessLevel=AL evtid=UUID extra=EDATA] DETAIL	
	IFACE	Channel access type Copied from the received message interface name.
	AL	Access Level Copied from the received message access level.
	UUID	Unique event identification Copied from the received message unique id.
	EDATA	Extra event data – meaning of which is specific to the event type (see MSGID in header) Copied from the received message extra info.
	DETAIL	Event details. Derived from the received message event text and value.
Data (Enhanced event)	[geUserInfo channel=IFACE loginId=USER] DETAIL	
	IFACE	Channel access type Copied from the received message interface name.
	USER	Logged in username who generated the event Copied from the received message user id.
	DETAIL	Event details. Copied from the received message event text.
Formatted Examples:	<38>1 2018-02-06T11:46:32.074Z Feeder1 userlog - 5120 [timeQuality tzKnown=0][gePlatformEvt channel=UI accessLevel=3 evtid=4 extra=0] User Logged In on UI Level 3User Logged In on UI Level 3 <38>1 2018-02-06T11:46:32.074Z Feeder1 userlog - 9999 [timeQuality tzKnown=0][geUserInfo channel=UI loginId=user1] Login - Authentication successful	

Sample Syslog messages are shown below:

Event	Access Method	Syslog Message (As from Syslog Server)
Authentication Successful	UI	04-17-2019 14:43:32 Auth.Info 192.168.1.30 1 1994-01-23T21:34:06.102Z 192.168.1.30 userlog - 9999 [timeQuality tzKnown=0][geUserInfo channel=FP loginid=ADMINISTRATOR] Login - Authentication successful
Authentication Failure	Serial	04-19-201913:36:08Auth.Info192.168.1.301 1994-01-25T20:26:42.872Z 192.168.1.30 userlog - 9999 [timeQuality tzKnown=0][geUserInfo channel=RP1 loginid=ENGINEER] Login - Authentication fail
Network Login Success	Courier Tunnel (device authentication)	04-17-201915:29:20Auth.Info192.168.1.301 1994-01-23T22:19:58.168Z 192.168.1.30 userlog - 9999 [timeQuality tzKnown=0][geUserInfo channel=NET loginid=ENGINEER] Login - Authentication successful
Logout	Serial	04-19-201913:52:08Auth.Info192.168.1.301 1994-01-25T20:42:42.782Z 192.168.1.30 userlog - 9999 [timeQuality tzKnown=0][geUserInfo channel=RP1 loginid=ADMINISTRATOR] Logout
Radius Unavailable	FP	04-18-201912:40:14Auth.Alert192.168.1.301 1994-01-24T19:30:55.839Z 192.168.1.30 userlog - 5163 [timeQuality tzKnown=0][gePlatformEvt channel=FP accessLevel=0 evtid=3715 extra=0] RADIUS UnAvailbl
Bypass Activated	FP	04-18-201912:39:19Auth.Warning192.168.1.301 1994-01-24T19:30:00.573Z 192.168.1.30 userlog - 9998 [timeQuality tzKnown=0][geUserInfo channel=FP loginid=ADMINISTRATOR] ByPass Activated
Settings modified	Courier Tunnel	04-18-201911:52:35Auth.Notice192.168.1.301 1994-01-24T18:43:16.537Z 192.168.1.30 userlog - 5149 [timeQuality tzKnown=0][gePlatformEvt channel=NET accessLevel=3 evtid=3677 extra=0] Settings Upload By TNL

CHAPTER 9

INSTALLATION

1 CHAPTER OVERVIEW

This chapter provides information about installing the product.

This chapter contains the following sections:

2 HANDLING THE GOODS

Our products are of robust construction but require careful treatment before installation on site. This section discusses the requirements for receiving and unpacking the goods, as well as associated considerations regarding product care and personal safety.

Caution:
Before lifting or moving the equipment you should be familiar with the Safety Information chapter of this manual.

2.1 RECEIPT OF THE GOODS

On receipt, ensure the correct product has been delivered. Unpack the product immediately to ensure there has been no external damage in transit. If the product has been damaged, make a claim to the transport contractor and notify us promptly.

For products not intended for immediate installation, repack them in their original delivery packaging.

2.2 UNPACKING THE GOODS

When unpacking and installing the product, take care not to damage any of the parts and make sure that additional components are not accidentally left in the packing or lost. Do not discard any CDROMs or technical documentation (where included). These should accompany the unit to its destination substation and put in a dedicated place.

The site should be well lit to aid inspection, clean, dry and reasonably free from dust and excessive vibration. This particularly applies where installation is being carried out at the same time as construction work.

2.3 STORING THE GOODS

If the unit is not installed immediately, store it in a place free from dust and moisture in its original packaging. Keep any dehumidifier bags included in the packing. The dehumidifier crystals lose their efficiency if the bag is exposed to ambient conditions. Restore the crystals before replacing it in the carton. Ideally regeneration should be carried out in a ventilating, circulating oven at about 115°C. Bags should be placed on flat racks and spaced to allow circulation around them. The time taken for regeneration will depend on the size of the bag. If a ventilating, circulating oven is not available, when using an ordinary oven, open the door on a regular basis to let out the steam given off by the regenerating silica gel.

On subsequent unpacking, make sure that any dust on the carton does not fall inside. Avoid storing in locations of high humidity. In locations of high humidity the packaging may become impregnated with moisture and the dehumidifier crystals will lose their efficiency.

The device can be stored between –25° to +70°C for unlimited periods or between -40°C to + 85°C for up to 96 hours (see technical specifications).

To avoid deterioration of electrolytic capacitors, power up units that are stored in a de-energised state once a year, for one hour continuously.

2.4 DISMANTLING THE GOODS

If you need to dismantle the device, always observe standard ESD (Electrostatic Discharge) precautions. The minimum precautions to be followed are as follows:

- Use an antistatic wrist band earthed to a suitable earthing point.
- Avoid touching the electronic components and PCBs.

3 MOUNTING THE DEVICE

The products are dispatched either individually or as part of a panel or rack assembly.

Individual products are normally supplied with an outline diagram showing the dimensions for panel cut-outs and hole centres.

The products are designed so the fixing holes in the mounting flanges are only accessible when the access covers are open.

If you use a P991 or MMLG test block with the product, when viewed from the front, position the test block on the right-hand side of the associated product. This minimises the wiring between the product and test block, and allows the correct test block to be easily identified during commissioning and maintenance tests.

3.1 FLUSH PANEL MOUNTING

Panel-mounted devices are flush mounted into panels using M4 SEMS Taptite self-tapping screws with captive 3 mm thick washers (also known as a SEMS unit).

Caution:
Do not use conventional self-tapping screws, because they have larger heads and could damage the faceplate.

Alternatively, you can use tapped holes if the panel has a minimum thickness of 2.5 mm.

For applications where the product needs to be semi-projection or projection mounted, a range of collars are available.

If several products are mounted in a single cut-out in the panel, mechanically group them horizontally or vertically into rigid assemblies before mounting in the panel.

Caution:
Do not fasten products with pop rivets because this makes them difficult to remove if repair becomes necessary.

3.2 RACK MOUNTING

Panel-mounted variants can also be rack mounted using single-tier rack frames (our part number FX0021 001), as shown in the figure below. These frames are designed with dimensions in accordance with IEC 60297 and are supplied pre-assembled ready to use. On a standard 483 mm (19 inch) 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. Attach the products by their mounting flanges using M4 Taptite self-tapping screws with captive 3 mm thick washers (also known as a SEMS unit).

Caution:
Risk of damage to the front cover molding. Do not use conventional self-tapping screws, including those supplied for mounting MiDOS products 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.

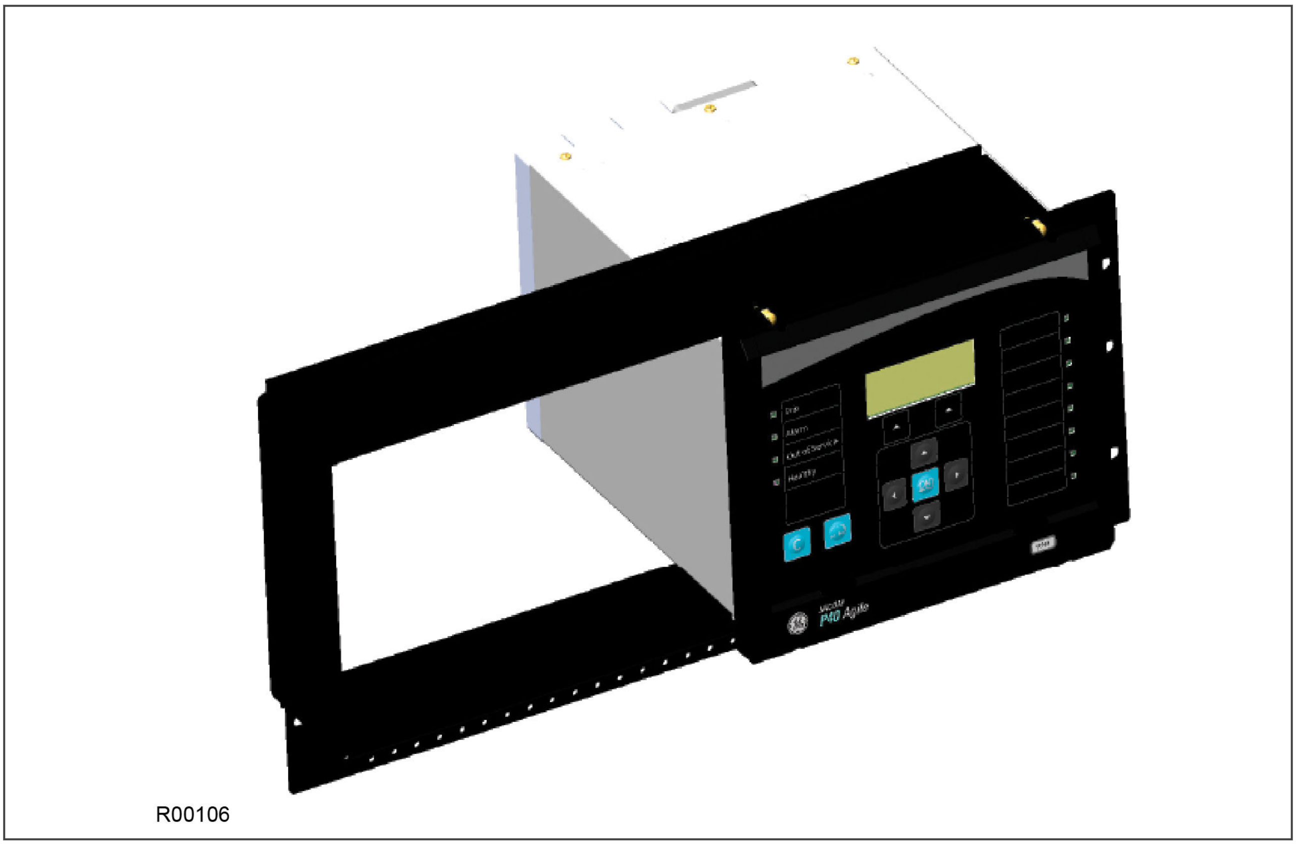


Figure 67: Rack mounting of products

Products can be mechanically grouped into single tier (4U) or multi-tier arrangements using the rack frame. This enables schemes using products from different product ranges to be pre-wired together before mounting.

Use blanking plates to fill any empty spaces. The spaces may be used for installing future products or because the total size is less than 80TE on any tier. Blanking plates can also be used to mount ancillary components. The part numbers are as follows:

Case size summation	Blanking plate part number
5TE	GJ2028 001
10TE	GJ2028 002
15TE	GJ2028 003
20TE	GJ2028 004
25TE	GJ2028 005
30TE	GJ2028 006
35TE	GJ2028 007
40TE	GJ2028 008
60TE	GJ2028 012
80TE	GJ2028 016

4 CABLES AND CONNECTORS

This section describes the type of wiring and connections that should be used when installing the device. For pin-out details please refer to the Hardware Design chapter or the wiring diagrams.

> **Caution:**
> **Before carrying out any work on the equipment you should be familiar with the Safety Section and the ratings on the equipment's rating label.**

4.1 TERMINAL BLOCKS

The device may use one or more of the terminal block types shown in the following diagram. The terminal blocks are fastened to the rear panel with screws.

- Heavy duty (HD) terminal blocks for CT and VT circuits
- Medium duty (MD) terminal blocks for the power supply, relay outputs and rear communications port
- MiDOS terminal blocks for CT and VT circuits
- RTD/CLIO terminal block for connection to analogue transducers

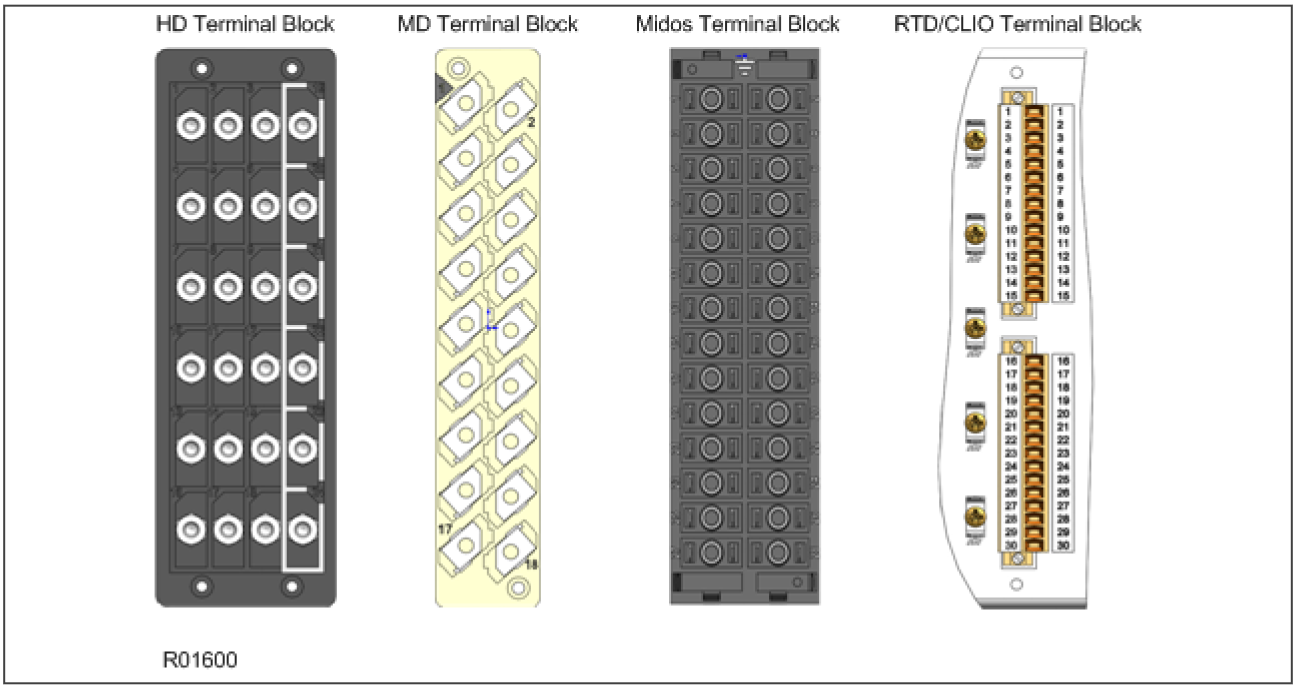


Figure 68: Terminal block types

MiCOM products 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 terminal.

If required, M4 90° crimp ring terminals can be supplied in three different sizes depending on wire size. Each type is available in bags of 100.

Part number	Wire size	Insulation color
ZB9124 901	0.25 - 1.65 mm^2 (22 – 16 AWG)	Red
ZB9124 900	1.04 - 2.63 mm^2 (16 – 14 AWG)	Blue

Note:
IP2x shields and side cover panels may be fitted to provide IP20 ingress protection for MiCOM terminal blocks. The shields and covers can be attached during installation or retrofitted to upgrade existing installations. The shields are supplied with four language fitting instructions, publication number: IP2x-TM-4L-n (where n is the current issue number). For more information, contact your local sales office or our worldwide Contact Centre.

4.2 POWER SUPPLY CONNECTIONS

These should be wired with 1.5 mm PVC insulated multi-stranded copper wire terminated with M4 ring terminals.

The wire should have a minimum voltage rating of 300 V RMS.

Caution:
Protect the auxiliary power supply wiring with a maximum 16 A high rupture capacity (HRC) type NIT or TIA fuse.

4.3 EARTH CONNNECTION

Every device must be connected to the cubicle earthing bar using the M4 earth terminal.

Use a wire size of at least 2.5 mm^2 terminated with a ring terminal.

Due to the physical limitations of the ring terminal, the maximum wire size you can use is 6.0 mm^2 using ring terminals that are not pre-insulated. If using pre insulated ring terminals, the maximum wire size is reduced to 2.63 mm^2 per ring terminal. If you need a greater cross-sectional area, use two wires in parallel, each terminated in a separate ring terminal.

The wire should have a minimum voltage rating of 300 V RMS.

Note:
To prevent any possibility of electrolytic action between brass or copper ground conductors and the rear panel of the product, precautions should be taken to isolate them from one another. This could be achieved in several ways, including placing a nickel-plated or insulating washer between the conductor and the product case, or using tinned ring terminals.

4.4 CURRENT TRANSFORMERS

Current transformers would generally be wired with 2.5 mm^2 PVC insulated multi-stranded copper wire terminated with M4 ring terminals.

Due to the physical limitations of the ring terminal, the maximum wire size you can use is 6.0 mm^2 using ring terminals that are not pre-insulated. If using pre insulated ring terminals, the maximum wire size is reduced to 2.63 mm^2 per ring terminal. If you need a greater cross-sectional area, use two wires in parallel, each terminated in a separate ring terminal.

The wire should have a minimum voltage rating of 300 V RMS.

Caution:
Current transformer circuits must never be fused.

> *Note:*
> *If there are CTs present, spring-loaded shorting contacts ensure that the terminals into which the CTs connect are shorted before the CT contacts are broken.*

> *Note:*
> *For 5A CT secondaries, we recommend using 2 x 2.5 mm^2 PVC insulated multi-stranded copper wire.*

4.5 VOLTAGE TRANSFORMER CONNECTIONS

Voltage transformers should be wired with 2.5 mm^2 PVC insulated multi-stranded copper wire terminated with M4 ring terminals.

The wire should have a minimum voltage rating of 300 V RMS.

4.6 WATCHDOG CONNECTIONS

These should be wired with 1 mm PVC insulated multi-stranded copper wire terminated with M4 ring terminals.

The wire should have a minimum voltage rating of 300 V RMS.

4.7 EIA(RS)485 AND K-BUS CONNECTIONS

For connecting the EIA(RS485) / K-Bus ports, use 2-core screened cable with a maximum total length of 1000 m or 200 nF total cable capacitance.

To guarantee the performance specifications, you must ensure continuity of the screen, when daisy chaining the connections.

Two-core screened twisted pair cable should be used. It is important to avoid circulating currents, which can cause noise and interference, especially when the cable runs between buildings. For this reason, the screen should be continuous and connected to ground at one end only, normally at the master connection point.

The K-Bus signal is a differential signal and there is no signal ground connection. If a signal ground connection is present in the bus cable then it must be ignored. At no stage should this be connected to the cable's screen or to the product's chassis. This is for both safety and noise reasons.

A typical cable specification would be:

- Each core: 16/0.2 mm^2 copper conductors, PVC insulated
- Nominal conductor area: 0.5 mm^2 per core
- Screen: Overall braid, PVC sheathed

4.8 IRIG-B CONNECTION

The IRIG-B input and BNC connector have a characteristic impedance of 50 ohms. We recommend that connections between the IRIG-B equipment and the product are made using coaxial cable of type RG59LSF with a halogen free, fire retardant sheath.

4.9 OPTO-INPUT CONNECTIONS

These should be wired with 1 mm^2 PVC insulated multi-stranded copper wire terminated with M4 ring terminals.

Each opto-input has a selectable preset ½ cycle filter. This makes the input immune to noise induced on the wiring. This can, however slow down the response. If you need to switch off the ½ cycle filter, either use double pole switching on the input, or screened twisted cable on the input circuit.

Caution:
Protect the opto-inputs and their wiring with a maximum 16 A high rupture capacity (HRC) type NIT or TIA fuse.

4.10 OUTPUT RELAY CONNECTIONS

These should be wired with 1 mm PVC insulated multi-stranded copper wire terminated with M4 ring terminals.

4.11 ETHERNET METALLIC CONNECTIONS

If the device has a metallic Ethernet connection, it can be connected to either a 10Base-T or a 100Base-TX Ethernet hub. Due to noise sensitivity, we recommend this type of connection only for short distance connections, ideally where the products and hubs are in the same cubicle. For increased noise immunity, CAT 6 (category 6) STP (shielded twisted pair) cable and connectors can be used.

The connector for the Ethernet port is a shielded RJ-45. The pin-out is as follows:

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

4.12 ETHERNET FIBRE CONNECTIONS

We recommend the use of fibre-optic connections for permanent connections in a substation environment. The 100 Mbps fibre optic port uses type ST connectors (one for Tx and one for Rx), compatible with 50/125 µm or 62.5/125 µm multimode fibres at 1300 nm wavelength.

Note:
For models equipped with redundant Ethernet connections the product must be partially dismantled to set the fourth octet of the second IP address. This ideally, should be done before installation.

4.13 USB CONNECTION

The IED has a type B USB socket inside the bottom compartment. A standard USB printer cable (type A one end, type B the other end) can be used to connect a local PC to the IED. This cable is the same as that used for connecting a printer to a PC.

4.14 GPS FIBRE CONNECTION

Some products use a GPS 1 PPS timing signal. If applicable, this is connected to a fibre-optic port on the coprocessor board in slot B. The fibre-optic port uses an ST type connector, compatible with fibre multimode 50/125 µm or 62.5/125 µm – 850 nm.

4.15 FIBRE COMMUNICATION CONNECTIONS

The fibre optic port consists of one or two channels using ST type connectors (one for Tx and one for Rx). The type of fibre used depends on the option selected.

850 nm and 1300 nm multimode systems use 50/125 µm or 62.5/125 µm multimode fibres. 1300 nm and 1550 nm single mode systems use 9/125 µm single mode fibres.

4.16 RTD CONNECTIONS

Resistance Temperature Detector (RTD) inputs use screw clamp connectors. The connection block is situated at the rear of the IED. It can accept wire sizes from 0.1 mm^2 to 1.5 mm^2. The connections between the IED 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 V RMS.

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 where the cable is joined to the RTD.

The screen of each cable must only be earthed (grounded) at one end, preferably at the IED end and must be continuous. Multiple earthing (grounding) of the screen can cause circulating current to flow along the screen. This induces noise and is also unsafe.

You should minimize the noise pick-up in the RTD cables by keeping them close to earthed (grounded) metal casings and avoid 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 mm2 per core
- Screen: Nickel-plated copper wire braid heat resistant PVC sheathed

The following extract may be useful in defining cable recommendations for the RTDs:

Noise pick up by cables can be categorized into three types:

- Resistive
- Capacitive
- Inductive

Resistive coupling requires an electrical connection to the noise source. Assuming the wire and cable insulation are in good condition and the junctions are clean, this can be dismissed. Capacitive coupling requires sufficient capacitance to the noise source. This is a function of the dielectric strength between the signal cable on the noise source and the power of the noise source. Inductive coupling occurs when the signal cable is adjacent to a wire carrying the noise or it is exposed to a radiated EMF.

Standard screened cable is normally used to protect against capacitively-coupled noise. However for this to be effective, the screen should only be bonded to the system ground at one point. Otherwise a current could flow and the noise would be coupled into the signal wires of the cable. There are different types of screening available, but the most commonly used are aluminium foil wrap, or 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 inductive coupling requires careful cable routing and magnetic shielding. The latter can be achieved with steel-armoured cable and steel cable trays. The cable armour must be grounded at both ends so the EMF of the induced current cancels the field of the noise source and shields the cables conductors from it. However, the system ground must be designed such that it does not bridge two isolated ground systems. This could be hazardous and defeat the objectives of the original grounding design. The cable should be laid in the cable trays as close as possible to the metal of the tray. 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 IED terminals. The best types of cable are those provided by the RTD manufacturers. These are usually three conductors, known as a triad, which are screened with foil. Such triad cables are available in armoured forms as well as multi-triad armoured forms.

4.17 CLIO CONNECTIONS

Current Loop Inputs and Outputs (CLIO) use screw clamp connectors. The connection block is situated at the rear of the IED. It can accept wire sizes from 0.1 mm^2 to 1.5 mm^2. We recommend screened cable, and it should have a minimum voltage rating of 300 V RMS.

5 CASE DIMENSIONS

Not all products are available in all case sizes.

5.1 CASE DIMENSIONS 40TE

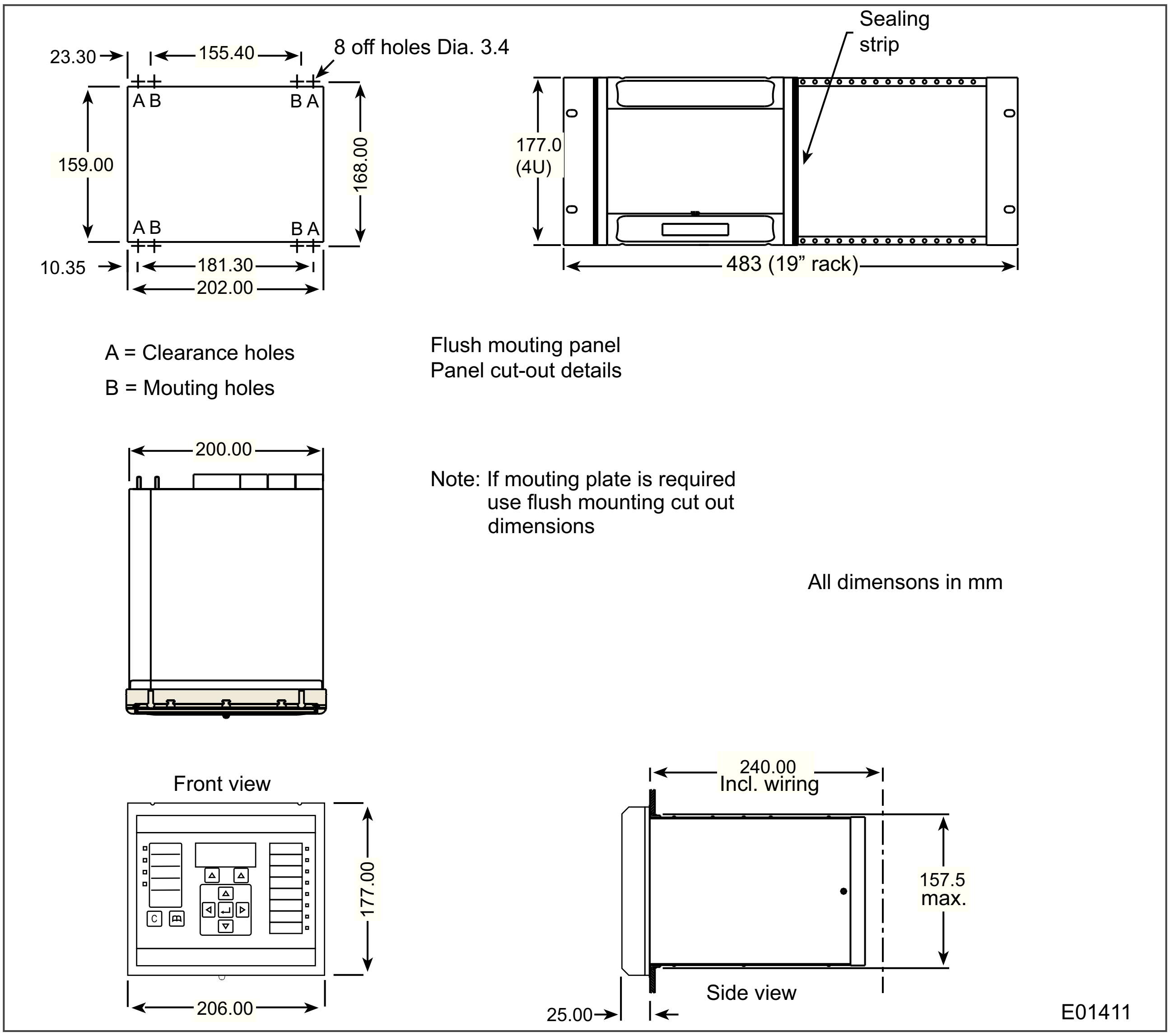


Figure 69: 40TE case dimensions

5.2 CASE DIMENSIONS 60TE

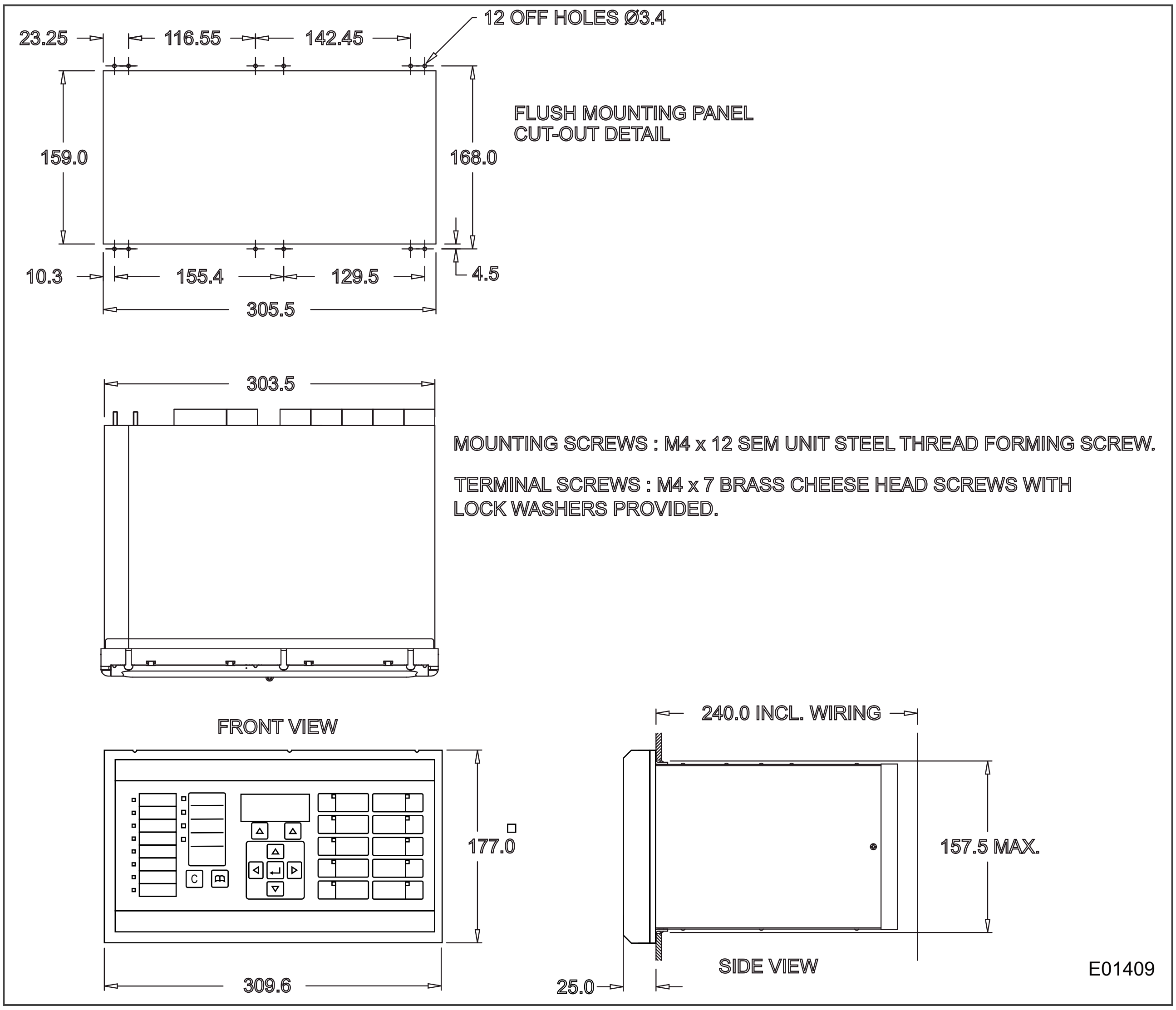


Figure 70: 60TE case dimensions

5.3 CASE DIMENSIONS 80TE

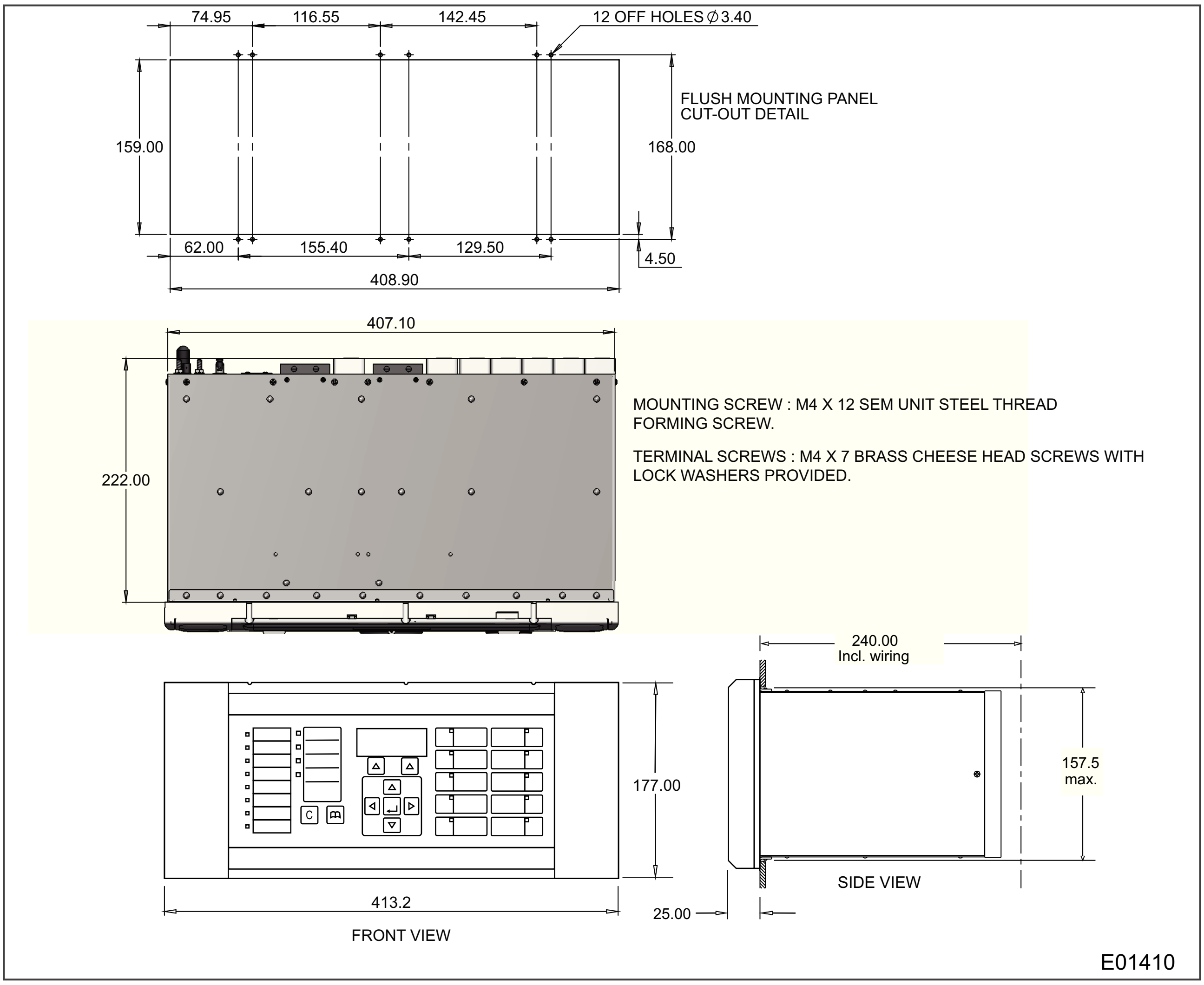


Figure 71: 80TE case dimensions

CHAPTER 10

COMMISSIONING INSTRUCTIONS

1 CHAPTER OVERVIEW

This chapter contains the following sections:

2 GENERAL GUIDELINES

GE IEDs are self-checking devices and will raise an alarm in the unlikely event of a failure. This is why the commissioning tests are less extensive than those for non-numeric electronic devices or electro-mechanical relays.

To commission the devices, you (the commissioning engineer) do not need to test every function. You need only verify that the hardware is functioning correctly and that the application-specific software settings have been applied. You can check the settings by extracting them using the settings application software, or by means of the front panel interface (HMI panel).

The menu language is user-selectable, so you can change it for commissioning purposes if required.

Note:
Remember to restore the language setting to the customer's preferred language on completion.

Caution:
Before carrying out any work on the equipment you should be familiar with the contents of the Safety Section or Safety Guide SFTY/4LM as well as the ratings on the equipment's rating label.

Warning:
With the exception of the CT shorting contacts check, do not disassemble the device during commissioning.

3 COMMISSIONING TEST MENU

The IED provides several test facilities under the *COMMISSION TESTS* menu heading. There are menu cells that allow you to monitor the status of the opto-inputs, output relay contacts, internal Digital Data Bus (DDB) signals and user-programmable LEDs. This section describes these commissioning test facilities.

3.1 OPTO I/P STATUS CELL (OPTO-INPUT STATUS)

This cell can be used to monitor the status of the opto-inputs while they are sequentially energised with a suitable DC voltage. The cell is a binary string that displays the status of the opto-inputs where '1' means energised and '0' means de-energised. If you move the cursor along the binary numbers, the corresponding label text is displayed for each logic input.

3.2 RELAY O/P STATUS CELL (RELAY OUTPUT STATUS)

This cell can be used to monitor the status of the relay outputs. The cell is a binary string that displays the status of the relay outputs where '1' means energised and '0' means de-energised. If you move the cursor along the binary numbers, the corresponding label text is displayed for each relay output.

The cell indicates the status of the output relays when the IED is in service. You can check for relay damage by comparing the status of the output contacts with their associated bits.

> *Note:*
> *When the **Test Mode** cell is set to `Contacts Blocked`, the relay output status indicates which contacts would operate if the IED was in-service. It does not show the actual status of the output relays, as they are blocked.*

3.3 TEST MODE CELL

This cell allows you to perform secondary injection testing. It also lets you test the output contacts directly by applying menu-controlled test signals.

To go into test mode, select the `Test Mode` option in the ***Test Mode*** cell. This takes the IED out of service causing an alarm condition to be recorded and the ***Out of Service*** LED to illuminate. This also freezes any information stored in the *CB CONDITION* column. In IEC 60870-5-103 versions, it changes the Cause of Transmission (COT) to Test Mode.

In Test Mode, the output contacts are still active. To disable the output contacts you must select the `Contacts Blocked` option.

Once testing is complete, return the device back into service by setting the ***Test Mode*** Cell back to `Disabled`.

> **Caution:**
> **When the cell is in Test Mode, the Scheme Logic still drives the output relays, which could result in tripping of circuit breakers. To avoid this, set the *Test Mode* cell to `Contacts Blocked`.**

> *Note:*
> *`Test mode` and `Contacts Blocked` mode can also be selected by energising an opto-input mapped to the Test Mode signal, and the Contact Block signal respectively.*

3.4 TEST PATTERN CELL

The ***Test Pattern*** cell is used to select the output relay contacts to 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 and '0' to not operate it.

3.5 CONTACT TEST CELL

When the `Apply Test` command in this cell is issued, the contacts set for operation change state. Once 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 by issuing the `Remove Test` command. The command text on the LCD will show ***No Operation*** after the `Remove Test` command has been issued.

> *Note:*
> *When the **Test Mode** cell is set to* `Contacts Blocked` *the **Relay O/P Status** cell does not show the current status of the output relays and therefore cannot be used to confirm operation of the output relays. Therefore it will be necessary to monitor the state of each contact in turn.*

3.6 TEST LEDS CELL

When the `Apply Test` command in this cell is issued, the user-programmable LEDs illuminate for approximately 2 seconds before switching off, and the command text on the LCD reverts to ***No Operation***.

3.7 RED AND GREEN LED STATUS CELLS

These cells contain binary strings that indicate which of the user-programmable red and green LEDs are illuminated when accessing from a remote location. A '1' indicates that a particular LED is illuminated.

> *Note:*
> *When the status in both **Red LED Status** and **Green LED Status** cells is '1', this indicates the LEDs illumination is yellow.*

3.8 PSL VERIFICIATION

3.8.1 TEST PORT STATUS CELL

This cell displays the status of the DDB signals that have been allocated in the ***Monitor Bit*** cells. If you move the cursor along the binary numbers, the corresponding DDB signal text string is 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 IED. This allows you to test the Programmable Scheme Logic (PSL).

3.8.2 MONITOR BIT 1 TO 8 CELLS

The eight Monitor Bit cells allows you to select eight DDB signals that can be observed in the Test Port Status cell or downloaded via the front port.

Each Monitor Bit cell can be assigned to a particular DDB signal. You set it by entering the required DDB signal number from the list of available DDB signals.

The pins of the monitor/download port used for monitor bits are as follows:

Monitor Bit	1	2	3	4	5	6	7	8
Monitor/Download Port Pin	11	12	15	13	20	21	23	24

The signal ground is available on pins 18, 19, 22 and 25.

Caution:
The monitor/download port is not electrically isolated against induced voltages on the communications channel. It should therefore only be used for local communications.

4 COMMISSIONING EQUIPMENT

Specialist test equipment is required to commission this product. We recognise three classes of equipment for commissioning :

- Recommended
- Essential
- Advisory

Recommended equipment constitutes equipment that is both necessary, and sufficient, to verify correct performance of the principal protection functions.

Essential equipment represents the minimum necessary to check that the product includes the basic expected protection functions and that they operate within limits.

Advisory equipment represents equipment that is needed to verify satisfactory operation of features that may be unused, or supplementary, or which may, for example, be integral to a distributed control/automation scheme. Operation of such features may, perhaps, be more appropriately verified as part of a customer defined commissioning requirement, or as part of a system-level commissioning regime.

4.1 RECOMMENDED COMMISSIONING EQUIPMENT

The minimum recommended equipment is a multifunctional three-phase AC current and voltage injection test set featuring :

- Controlled three-phase AC current and voltage sources,
- Transient (dynamic) switching between pre-fault and post-fault conditions (to generate delta conditions),
- Dynamic impedance state sequencer (capable of sequencing through 4 impedance states),
- Integrated or separate variable DC supply (0 - 250 V)
- Integrated or separate AC and DC measurement capabilities (0-440V AC, 0-250V DC)
- Integrated and/or separate timer,
- Integrated and/or separate test switches.

In addition, you will need :

- A portable computer, installed with appropriate software to liaise with the equipment under test (EUT). Typically this software will be proprietary to the product's manufacturer (for example MiCOM S1 Agile).
- Suitable electrical test leads.
- Electronic or brushless insulation tester with a DC output not exceeding 500 V
- Continuity tester
- Verified application-specific settings files

4.2 ESSENTIAL COMMISSIONING EQUIPMENT

As an absolute minimum, the following equipment is required:

- AC current source coupled with AC voltage source
- Variable DC supply (0 - 250V)
- Multimeter capable of measuring AC and DC current and voltage (0-440V AC, 0-250V DC)
- Timer
- Test switches
- Suitable electrical test leads
- Continuity tester

4.3 ADVISORY TEST EQUIPMENT

Advisory test equipment may be required for extended commissioning procedures:

- Current clamp meter
- Multi-finger test plug:
    - P992 for test block type P991
    - MMLB for test block type MMLG blocks
- Electronic or brushless insulation tester with a DC output not exceeding 500 V
- KITZ K-Bus - EIA(RS)232 protocol converter for testing EIA(RS)485 K-Bus port
- EIA(RS)485 to EIA(RS)232 converter for testing EIA(RS)485 Courier/MODBUS/IEC60870-5-103/DNP3 port
- A portable printer (for printing a setting record from the portable PC) and or writeable, detachable memory device.
- Phase angle meter
- Phase rotation meter
- Fibre-optic power meter.
- Fibre optic test leads (minimum 2). 10m minimum length, multimode 50/125 µm or 62.5µm terminated with BFOC (ST) 2.5 connectors for testing the fibre-optic RP1 port.

5 PRODUCT CHECKS

These product checks are designed to ensure that the device has not been physically damaged prior to commissioning, is functioning correctly and that all input quantity measurements are within the stated tolerances.

If the application-specific settings have been applied to the IED prior to commissioning, you should make a copy of the settings. This will allow you to restore them at a later date if necessary. This can be done by:

- Obtaining a setting file from the customer.
- Extracting the settings from the IED itself, using a portable PC with appropriate setting software.

If the customer has changed the password that prevents unauthorised changes to some of the settings, either the revised password should be provided, or the original password restored before testing.

Note:
If the password has been lost, a recovery password can be obtained from GE.

5.1 PRODUCT CHECKS WITH THE IED DE-ENERGISED

Warning:
The following group of tests should be carried out without the auxiliary supply being applied to the IED and, if applicable, with the trip circuit isolated.

The current and voltage transformer connections must be isolated from the IED for these checks. If a P991 test block is provided, the required isolation can be achieved by inserting test plug type P992. This open circuits all wiring routed through the test block.

Before inserting the test plug, you should check the scheme diagram to ensure that this will not cause damage or a safety hazard (the test block may, for example, be associated with protection current transformer circuits). The sockets in the test plug, which correspond to the current transformer secondary windings, must be linked before the test plug is inserted into the test block.

Warning:
Never open-circuit the secondary circuit of a current transformer since the high voltage produced may be lethal and could damage insulation.

If a test block is not provided, the voltage transformer supply to the IED should be isolated by means of the panel links or connecting blocks. The line current transformers should be short-circuited and disconnected from the IED terminals. Where means of isolating the auxiliary supply and trip circuit (for example isolation links, fuses and MCB) are provided, these should be used. If this is not possible, the wiring to these circuits must be disconnected and the exposed ends suitably terminated to prevent them from being a safety hazard.

5.1.1 VISUAL INSPECTION

Warning:
Check the rating information under the top access cover on the front of the IED.

Warning:
Check that the IED being tested is correct for the line or circuit.

Warning:
Record the circuit reference and system details.

Warning:
Check the CT secondary current rating and record the CT tap which is in use.

Carefully examine the IED to see that no physical damage has occurred since installation.

Ensure that the case earthing connections (bottom left-hand corner at the rear of the IED case) are used to connect the IED to a local earth bar using an adequate conductor.

5.1.2 CURRENT TRANSFORMER SHORTING CONTACTS

Check the current transformer shorting contacts to ensure that they close when the heavy-duty terminal block is disconnected from the current input board.

The heavy-duty terminal blocks are fastened to the rear panel using four crosshead screws. These are located two at the top and two at the bottom.

Note:
Use a magnetic bladed screwdriver to minimise the risk of the screws being left in the terminal block or lost.

Pull the terminal block away from the rear of the case and check with a continuity tester that all the shorting switches being used are closed.

5.1.3 INSULATION

Insulation resistance tests are only necessary during commissioning if explicitly requested.

Isolate all wiring from the earth and test the insulation with an electronic or brushless insulation tester at a DC voltage not exceeding 500 V. Terminals of the same circuits should be temporarily connected together.

The insulation resistance should be greater than 100 MΩ at 500 V.

On completion of the insulation resistance tests, ensure all external wiring is correctly reconnected to the IED.

5.1.4 EXTERNAL WIRING

Caution:
Check that the external wiring is correct according to the relevant IED and scheme diagrams. Ensure that phasing/phase rotation appears to be as expected.

5.1.5 WATCHDOG CONTACTS

Using a continuity tester, check that the Watchdog contacts are in the following states:

Terminals	Contact state with product de-energised
11 - 12 on power supply board	Closed
13 - 14 on power supply board	Open

5.1.6 POWER SUPPLY

Depending on its nominal supply rating, the IED can be operated from either a DC only or an AC/DC auxiliary supply. The incoming voltage must be within the operating range specified below.

Without energising the IED measure the auxiliary supply to ensure it is within the operating range.

Nominal supply rating DC	Nominal supply rating AC RMS	DC operating range	AC operating range
24 - 54 V	N/A	19 to 65 V	N/A
48 - 125 V	30 - 100 V	37 to 150 V	24 - 110 V
110 - 250 V	100 - 240 V	87 to 300 V	80 to 265 V

Note:
The IED can withstand an AC ripple of up to 12% of the upper rated voltage on the DC auxiliary supply.

Warning:
Do not energise the IED or interface unit using the battery charger with the battery disconnected as this can irreparably damage the power supply circuitry.

Caution:
Energise the IED only if the auxiliary supply is within the specified operating ranges. 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 IED.

5.2 PRODUCT CHECKS WITH THE IED ENERGISED

Warning:
The current and voltage transformer connections must remain isolated from the IED for these checks. The trip circuit should also remain isolated to prevent accidental operation of the associated circuit breaker.

The following group of tests verifies that the IED hardware and software is functioning correctly and should be carried out with the supply applied to the IED.

5.2.1 WATCHDOG CONTACTS

Using a continuity tester, check that the Watchdog contacts are in the following states when energised and healthy.

Terminals	Contact state with product energised
11 - 12 on power supply board	Open
13 - 14 on power supply board	Closed

5.2.2 TEST LCD

The Liquid Crystal Display (LCD) is designed to operate in a wide range of substation ambient temperatures. For this purpose, the IEDs have an ***LCD Contrast*** setting. The contrast is factory pre-set, but it may be necessary to adjust the contrast to give the best in-service display.

To change the contrast, you can increment or decrement the ***LCD Contrast*** cell in the *CONFIGURATION* column.

Caution:
Before applying a contrast setting, make sure that it will not make the display so light or dark such that menu text becomes unreadable. It is possible to restore the visibility of a display by downloading a setting file, with the LCD Contrast set within the typical range of 7 - 11.

5.2.3 DATE AND TIME

The date and time is stored in memory, which is backed up by a supercapacitor.

The method for setting the date and time depends on whether an IRIG-B signal is being used or not. The IRIG-B signal will override the time, day and month settings, but not the initial year setting. For this reason, you must ensure you set the correct year, even if the device is using IRIG-B to maintain the internal clock.

You set the Date and Time by one of the following methods:

- Using the front panel to set the ***Date and Time*** cells respectively
- By sending a courier command to the ***Date/Time*** cell (Courier reference 0801)

Note:
If the auxiliary supply fails, the time and date will be maintained by the supercapacitor. Therefore, when the auxiliary supply is restored, you should not have to set the time and date again. To test this, remove the IRIG-B signal, and then remove the auxiliary supply. Leave the device de-energised for approximately 30 seconds. On re energisation, the time should be correct.

When using IRIG-B to maintain the clock, the IED must first be connected to the satellite clock equipment (usually a P594/RT430), which should be energised and functioning.

1. Set the IRIG-B Sync cell in the *DATE AND TIME* column to `Enabled`.
2. Ensure the IED is receiving the IRIG-B signal by checking that cell IRIG-B Status reads `Active`.
3. Once the IRIG-B signal is active, adjust the time offset of the universal co coordinated time (satellite clock time) on the satellite clock equipment so that local time is displayed.
4. Check that the time, date and month are correct in the Date/Time cell. The IRIG-B signal does not contain the current year so it will need to be set manually in this cell.
5. Reconnect the IRIG-B signal.

If the time and date is not being maintained by an IRIG-B signal, ensure that the IRIG-B Sync cell in the *DATE AND TIME* column is set to `Disabled`.

1. Set the date and time to the correct local time and date using Date/Time cell or using the serial protocol.

5.2.4 TEST LEDS

On power-up, all LEDs should first flash yellow. Following this, the green "Healthy" LED should illuminate indicating that the device is healthy.

The IED's non-volatile memory stores the states of the alarm, the trip, and the user-programmable LED indicators (if configured to latch). These indicators may also illuminate when the auxiliary supply is applied.

If any of these LEDs are ON then they should be reset before proceeding with further testing. If the LEDs successfully reset (the LED goes off), no testing is needed for that LED because it is obviously operational.

5.2.5 TEST ALARM AND OUT-OF-SERVICE LEDS

The alarm and out of service LEDs can be tested using the *COMMISSION TESTS* menu column.

1. Set the ***Test Mode*** cell to `Contacts Blocked`.
2. Check that the out of service LED illuminates continuously and the alarm LED flashes.

It is not necessary to return the ***Test Mode*** cell to `Disabled` at this stage because the test mode will be required for later tests.

5.2.6 TEST TRIP LED

The trip LED can be tested by initiating a manual circuit breaker trip. However, the trip LED will operate during the setting checks performed later. Therefore no further testing of the trip LED is required at this stage.

5.2.7 TEST USER-PROGRAMMABLE LEDS

To test these LEDs, set the Test LEDs cell to `Apply Test`. Check that all user-programmable LEDs illuminate.

5.2.8 TEST OPTO-INPUTS

This test checks that all the opto-inputs on the IED are functioning correctly.

The opto-inputs should be energised one at a time. For terminal numbers, please see the external connection diagrams in the "Wiring Diagrams" chapter. Ensuring correct polarity, connect the supply voltage to the appropriate terminals for the input being tested.

The status of each opto-input can be viewed using either the ***Opto I/P Status*** cell in the *SYSTEM DATA* column, or the ***Opto I/P Status*** cell in the *COMMISSION TESTS* column.

A '1' indicates an energised input and a '0' indicates a de-energised input. When each opto-input is energised, one of the characters on the bottom line of the display changes to indicate the new state of the input.

5.2.9 TEST OUTPUT RELAYS

This test checks that all the output relays are functioning correctly.

1. Ensure that the IED is still in test mode by viewing the ***Test Mode*** cell in the *COMMISSION TESTS* column. Ensure that it is set to `Contacts Blocked`.
2. The output relays should be energised one at a time. To select output relay 1 for testing, set the Test Pattern cell as appropriate.
3. Connect a continuity tester across the terminals corresponding to output relay 1 as shown in the external connection diagram.
4. To operate the output relay set the Contact Test cell to `Apply Test`.
5. Check the operation with the continuity tester.
6. Measure the resistance of the contacts in the closed state.
7. Reset the output relay by setting the Contact Test cell to `Remove Test`.
8. Repeat the test for the remaining output relays.
9. Return the IED to service by setting the Test Mode cell in the *COMMISSION TESTS* menu to `Disabled`.

5.2.10 RTD INPUTS

This test checks that all the RTD inputs are functioning correctly, if the RTD board is fitted.

Please refer to the wiring diagrams for details of the terminal connections.

1. You should connect a 100 ohm resistor across each RTD in turn. The resistor needs to have a very small tolerance (0.1%). You must connect the RTD common return terminal to the correct RTD input, otherwise the device will report an RTD error.
2. Check that the corresponding temperature displayed in the *MEASUREMENTS 3* column of the menu is 0°C +/-2°C. This range takes into account the 0.1% resistor tolerance and device accuracy of +/-1°C. If a resistor of lower accuracy is used during testing, the acceptable setting range needs to be increased.

5.2.11 CURRENT LOOP OUTPUTS

This test checks that all the current loop outputs are functioning correctly, if the board is fitted.

Please refer to the wiring diagrams for details of the terminal connections. Note that for the current loop outputs, the physical connection of the 1 mA output is different from that of the other types.

1. Enable the current loop output to be tested.
2. Note the current loop output type (***CLO Type***) for the application.
3. Note the current loop output parameter (***CLO Parameter***)
4. Note the current loop output minimum and maximum settings (***CLO Minimum*** and ***CLO Maximum***)
5. Apply the appropriate analog input quantity to match the ***CLO Parameter*** at a value equal to (CLO maximum + CLO minimum)/2. The current loop output should be at 50% of its maximum rated output.
6. Using a precision resistive current shunt and a high-resolution voltmeter, check that the current loop output is at 50% of its maximum rated output according to the range as follows:

   0.5 mA (0 to 1 mA CLO)

   5 mA (0 to 10 mA CLO)

   10 mA (0 to 20, 4 to 20 mA CLO)
7. The accuracy should be within +/-0.5% of full scale + meter accuracy.

5.2.12 CURRENT LOOP INPUTS

This test checks that all the current loop inputs are functioning correctly, if the board is fitted.

Please refer to the wiring diagrams for details of the terminal connections. Note that for the current loop inputs, the physical connection of the 1 mA input is different from that of the other types.

You can use an accurate DC current source to apply various current levels to the current loop inputs. One approach to this is to use a current loop output as a DC current sources. If you stimulate the current loop output by applying an appropriate signal to the input to which it has been assigned with the ***CLO Parameter*** setting, you will get an appropriate DC signal if the output is enabled.

1. Enable the current loop input to be tested.
2. Note the CLIx minimum and maximum settings and the CLIx Input type for the application.
3. Apply a DC current to the current loop input at 50% of the CLI input maximum range, 0.5 mA (0 to 1 mA CLI), 5 mA (0 to 10 mA CLI) or 10 mA (0 to 20, 4 to 20 mA CLI).
4. Check the accuracy of the current loop input using the CLIO Input 1/2/3/4 cells in the *MEASUREMENTS 3* column. The display should show (CLIx maximum + CLIx minimum)/2 +/-1% full scale accuracy.

5.2.13 TEST SERIAL COMMUNICATION PORT RP1

You need only perform this test if the IED is to be accessed from a remote location with a permanent serial connection to the communications port. The scope of this test does not extend to verifying operation with connected equipment beyond any supplied protocol converter. It verifies operation of the rear communication port (and if applicable the protocol converter) and varies according to the protocol fitted.

5.2.13.1 CHECK PHYSICAL CONNECTIVITY

The rear communication port RP1 is presented on terminals 16, 17 and 18 of the power supply terminal block. Screened twisted pair cable is used to make a connection to the port. The cable screen should be connected to pin 16 and pins 17 and 18 are for the communication signal:

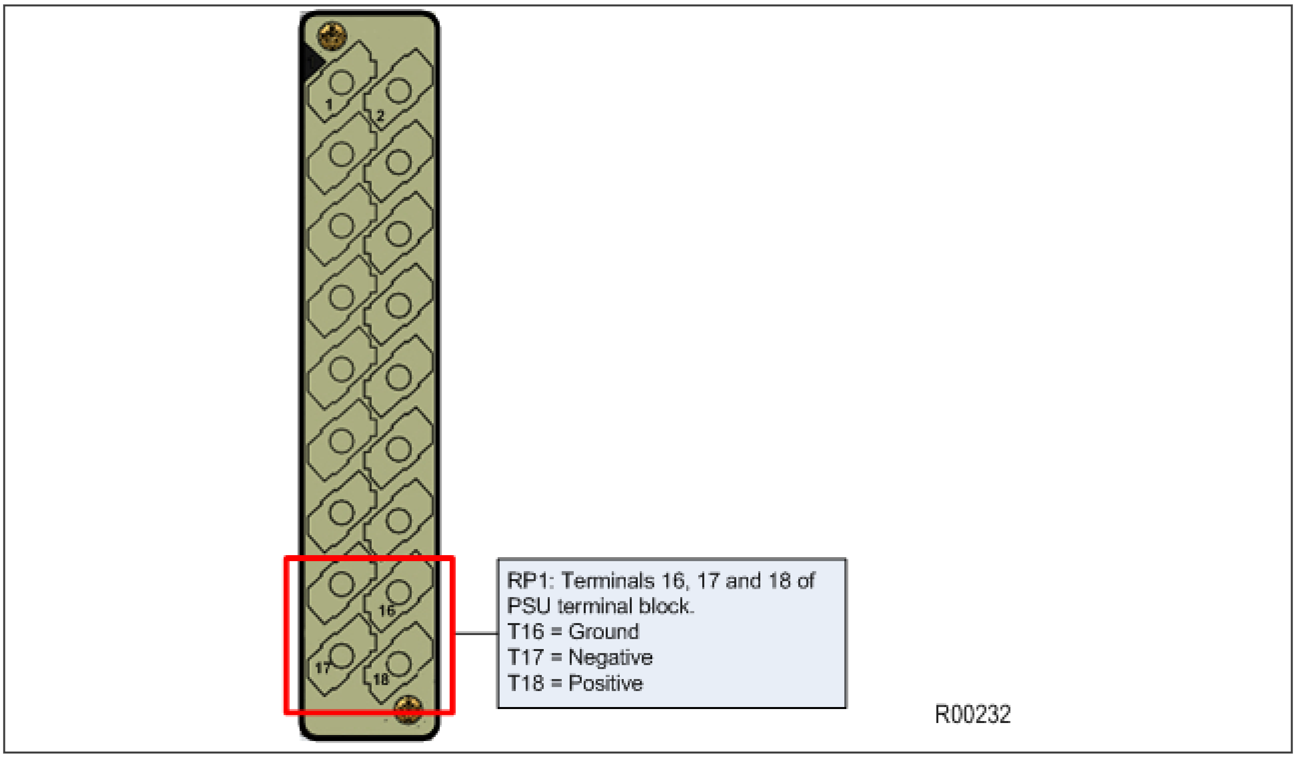


Figure 72: RP1 physical connection

For K-Bus applications, pins 17 and 18 are not polarity sensitive and it does not matter which way round the wires are connected. EIA(RS)485 is polarity sensitive, so you must ensure the wires are connected the correct way round (pin 18 is positive, pin 17 is negative).

If K-Bus is being used, a Kitz protocol converter (KITZ101, KITZ102 OR KITZ201) will have been installed to convert the K-Bus signals into RS232. Likewise, if RS485 is being used, an RS485-RS232 converter will have been installed. In the case where a protocol converter is being used, a laptop PC running appropriate software (such as MiCOM S1 Agile) can be connected to the incoming side of the protocol converter. An example for K-bus to RS232 conversion is shown below. RS485 to RS232 would follow the same principle, only using a RS485-RS232 converter. Most modern laptops have USB ports, so it is likely you will also require a RS232 to USB converter too.

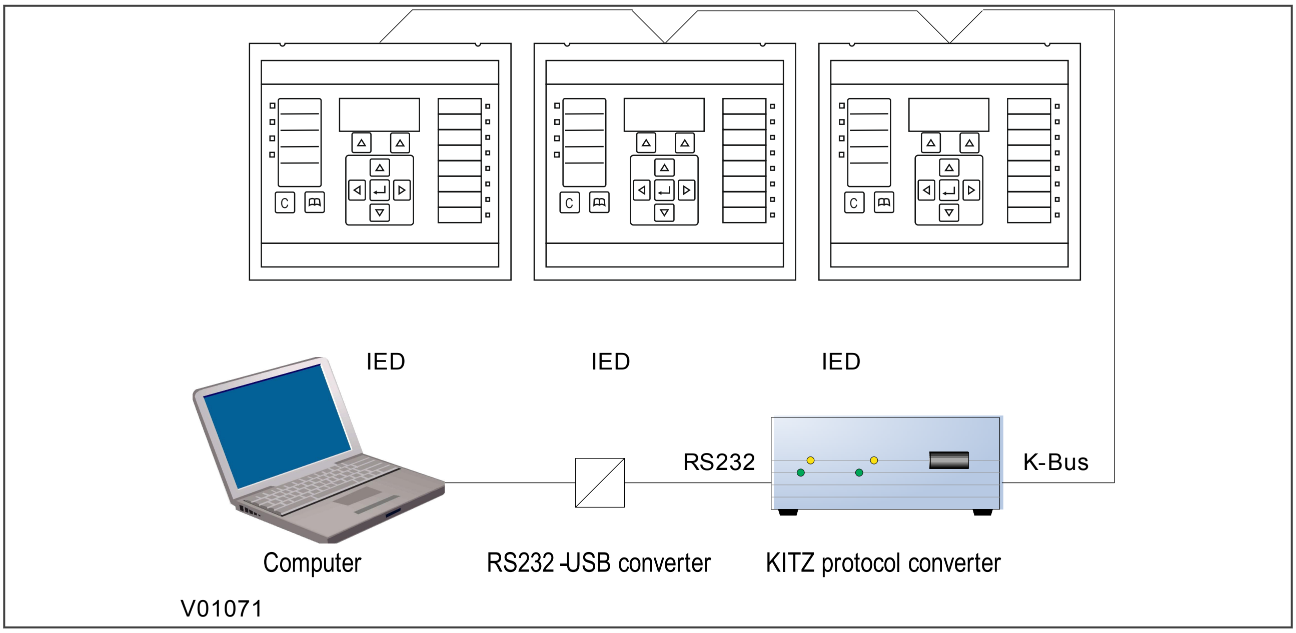


Figure 73: Remote communication using K-bus

Fibre Connection

Some models have an optional fibre optic communications port fitted (on a separate communications board). The communications port to be used is selected by setting the Physical Link cell in the *COMMUNICATIONS* column, the values being `Copper` or `K-Bus` for the RS485/K-bus port and `Fibre Optic` for the fibre optic port.

5.2.13.2 CHECK LOGICAL CONNECTIVITY

The logical connectivity depends on the chosen data protocol, but the principles of testing remain the same for all protocol variants:

1. Ensure that the communications baud rate and parity settings in the application software are set the same as those on the protocol converter.
2. For Courier models, ensure that you have set the correct RP1 address
3. Check that communications can be established with this IED using the portable PC/Master Station.

5.2.14 TEST SERIAL COMMUNICATION PORT RP2

RP2 is an optional second serial port board providing additional serial connectivity. It provides two 9-pin D-type serial port connectors SK4 and SK5. Both ports are configured as DTE (Date Terminal Equipment) ports. That means they can be connected to communications equipment such as a modem with a straight-through cable.

SK4 can be configured as an EIA(RS232), EIA(RS485), or K-Bus connection for Courier protocol only, whilst SK5 is fixed to EIA(RS)232 for InterMiCOM signalling only.

It is not the intention of this test to verify the operation of the complete communication link between the IED and the remote location, just the IED's rear communication port and, if applicable, the protocol converter.

The only checks that need to be made are as follows:

1. Set the ***RP2 Port Config*** cell in the *COMMUNICATIONS* column to the required physical protocol; (K-Bus, EIA(RS)485, or EIA(RS)232.
2. Set the IED's Courier address to the correct value (it must be between 1 and 254).

5.2.15 TEST ETHERNET COMMUNICATION

For products that employ Ethernet communications, we recommend that testing be limited to a visual check that the correct ports are fitted and that there is no sign of physical damage.

If there is no board fitted or the board is faulty, a NIC link alarm will be raised (providing this option has been set in the ***NIC Link Report*** cell in the *COMMUNICATIONS* column).

5.3 SECONDARY INJECTION TESTS

Secondary injection testing is carried out to verify the integrity of the VT and CT readings. All devices leave the factory set for operation at a system frequency of 50 Hz. If operation at 60 Hz is required, you must set this in the Frequency cell in the *SYSTEM DATA* column.

The PMU must be installed and connected to a 1pps fibre optic synchronising signal and a demodulated IRIG-B signal, provided by a device such as a P594 or a REASON RT430.

Connect the current and voltage outputs of the test set to the appropriate terminals of the first voltage and current channel and apply nominal voltage and current with the current lagging the voltage by 90 degrees.

5.3.1 TEST CURRENT INPUTS

This test verifies that the current measurement inputs are configured correctly.

1. Using secondary injection test equipment such as an Omicron, apply and measure nominal rated current to each CT in turn.
2. Check its magnitude using a multi-meter or test set readout. Check this value against the value displayed on the HMI panel (usually in *MEASUREMENTS 1* column).
3. Record the displayed value. The measured current values will either be in primary or secondary Amperes. If the Local Values cell in the *MEASURE'T SETUP* column is set to `Primary`, the values displayed should be equal to the applied current multiplied by the corresponding current transformer ratio (set in the *CT AND VT RATIOS* column). If the Local Values cell is set to Secondary, the value displayed should be equal to the applied current.

> *Note:*
> *If a PC connected to the IED using the rear communications port is being used to display the measured current, the process will be similar. However, the setting of the Remote Values cell in the MEASURE'T SETUP column will determine whether the displayed values are in primary or secondary Amperes.*

The measurement accuracy of the IED is +/- 1%. However, an additional allowance must be made for the accuracy of the test equipment being used.

5.3.2 TEST VOLTAGE INPUTS

This test verifies that the voltage measurement inputs are configured correctly.

1. Using secondary injection test equipment, apply and measure the rated voltage to each voltage transformer input in turn.
2. Check its magnitude using a multimeter or test set readout. Check this value against the value displayed on the HMI panel (usually in *MEASUREMENTS 1* column).
3. Record the value displayed. The measured voltage values will either be in primary or secondary Volts. If the Local Values cell in the *MEASURE'T SETUP* column is set to `Primary`, the values displayed should be equal to the applied voltage multiplied by the corresponding voltage transformer ratio (set in the *CT AND VT RATIOS* column). If the Local Values cell is set to Secondary, the value displayed should be equal to the applied voltage.

> *Note:*
> *If a PC connected to the IED using the rear communications port is being used to display the measured current, the process will be similar. However, the setting of the Remote Values cell in the MEASURE'T SETUP column will determine whether the displayed values are in primary or secondary Amperes.*

The measurement accuracy of the IED is +/- 1%. However, an additional allowance must be made for the accuracy of the test equipment being used.

6 SETTING CHECKS

The setting checks ensure that all of the application-specific settings (both the IED's function and programmable scheme logic settings) have been correctly applied.

> *Note:*
> *If applicable, 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 two different methods of applying the settings to the IED

- Transferring settings to the IED from a pre-prepared setting file using MiCOM S1 Agile
- Enter the settings manually using the IED's front panel HMI

6.1.1 TRANSFERRING SETTINGS FROM A SETTINGS FILE

This is the preferred method for transferring function settings. It is much faster and there is a lower margin for error.

1. Connect a PC running the Settings Application Software to the IED's front port, or a rear Ethernet port. Alternatively connect to the rear Courier communications port, using a KITZ protocol converter if necessary.
2. Power on the IED
3. Enter the IP address of the device if it is Ethernet enabled
4. Right-click the appropriate device name in the System Explorer pane and select **Send**
5. In the **Send to** dialog select the setting files and click **Send**

> *Note:*
> *The device name may not already exist in the system shown in **System Explorer**. In this case, perform a **Quick Connect** to the IED, then manually add the settings file to the device name in the system. Refer to the Settings Application Software help for details of how to do this.*

6.1.2 ENTERING SETTINGS USING THE HMI

1. Starting at the default display, press the Down cursor key to show the first column heading.
2. Use the horizontal cursor keys to select the required column heading.
3. Use the vertical cursor keys to view the setting data in the column.
4. To return to the column header, either press the Up cursor key for a second or so, or press the **Cancel** key once. It is only possible to move across columns at the column heading level.
5. To return to the default display, press the Up cursor key or the Cancel key from any of the column headings. If you use the auto-repeat function of the Up cursor 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. 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 that the value can be changed. You may be prompted for a password first.
7. To change the setting value, press the vertical cursor 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 left and right cursor keys.

8. Press the **Enter** key to confirm the new setting value or the **Clear** key to discard it. The new setting is automatically discarded if it is not confirmed within 15 seconds.
9. For protection group settings and disturbance recorder settings, the changes must be confirmed before they are used. When all required changes have been entered, return to the column heading level and press the down cursor key. Before returning to the default display, the following prompt appears.

```
Update settings?
ENTER or CLEAR
```

10. Press the **Enter** key to accept the new settings or press the **Clear** key 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.
It is not possible to change the PSL using the IED's front panel HMI.

Caution:
Where the installation needs application-specific PSL, the relevant .psl files, must be transferred to the IED, for each and every setting group that will be used. If you do not do this, the factory default PSL will still be resident. This may have severe operational and safety consequences.

Note:
To see the complete set of protection tests in the Setting Checks section refer to manual P34x/EN M/Ia8, software version 38 & 72.

7 IEC 61850 EDITION 2 TESTING

7.1 USING IEC 61850 EDITION 2 TEST MODES

In a conventional substation, functionality typically resides in a single device. It is usually easy to physically isolate these functions, as the hardwired connects can simply be removed. Within a digital substation architecture however, functions may be distributed across many devices. This makes isolation of these functions difficult, because there are no physical wires that can be disconnected on a Ethernet network. Logical isolation of the various functions is therefore necessary.

With devices that support IEC 61850 Edition 2, it is possible to use a test mode to conduct online testing, which helps with the situation. The advantages of this are as follows:

- The device can be placed into a test mode, which can disable the relay outputs when testing the device with test input signals.
- Specific protection and control functions can be logically isolated.
- GOOSE messages can be tagged so that receiving devices can recognise they are test signals.
- An IED receiving simulated GOOSE or Sampled Value messages from test devices can differentiate these from normal process messages, and be configured to respond appropriately.

7.1.1 IED TEST MODE BEHAVIOUR

Test modes define how the device responds to test messages, and whether the relay outputs are activated or not. You can select the mode of operation by:

- Using the front panel HMI, with the setting ***IED Test Mode*** under the *COMMISSION TESTS* column.
- Using an IEC 61850 control service to ***System/LLN0.Mod***
- Using an opto-input via PSL with the signal ***Block Contacts***

The following table summarises the IED behaviour under the different modes:

IED Test Mode Setting	Result
`Disabled`	• Normal IED behaviour
`Test`	• Protection remains enabled • Output from the device is still active • IEC 61850 message output has the 'quality' parameter set to 'test' • The device only responds to IEC61850 MMS messages from the client with the 'test' flag set
`Contacts Blocked`	• Protection remains enabled • Output from the device is disabled • IEC 61850 message output has quality set to 'test' • The device only responds to IEC 61850 MMS messages from the client with the 'test' flag set

Setting the Test or Contacts Blocked mode puts the whole IED into test mode. The IEC 61850 data object ***Beh*** in all Logical Nodes (except LPHD and any protection Logical Nodes that have Beh = 5 (off) due to the function being disabled) will be set to 3 (test) or 4 (test/blocked) as applicable.

7.1.2 SAMPLED VALUE TEST MODE BEHAVIOUR

The SV Test Mode defines how the device responds to test sampled value messages. You can select the mode of operation by using the front panel HMI, with the setting ***SV Test Mode*** under the *IEC 61850-9.2LE* column.

The following table summarises the behaviour for sampled values under the different modes:

SV Test Mode Setting	Result
`Disabled`	• Normal IED behaviour • All sampled value data frames received with an IEC 61850 Test quality bit set are treated as invalid • The IED will display the measurement values for sampled values with the Simulated flag set but the protection elements within the IED will be blocked
`Enabled`	• All sampled value data frames received are treated as good, no matter if they have an IEC 61850-9-2 Simulated flag set or not

7.2 SIMULATED INPUT BEHAVIOUR

Simulated GOOSE messages and sampled value streams can be used during testing.

The ***Subscriber Sim*** setting in the *COMMISSION TESTS* column controls whether a device listens to simulated signals or to real ones. An IEC 61850 control service to System/LPHD.Sim can also be used to change this value.

The device may be presented with both real signals and test signals. An internal state machine is used to control how the device switches between signals:

- The IED will continue subscribing to the 'real' GOOSE1 (in green) until it receives the first simulated GOOSE 1 (in red). This will initiate subscription changeover.
- After changeover to this new state, the IED will continue to subscribe to the simulated GOOSE 1 message (in red). Even if this simulated GOOSE 1 message disappears, the real GOOSE 1 message (in green) will still not be processed. This means all Virtual Inputs derived from the GOOSE 1 message will go to their default state.
- The only way to bring the IED out of this state is to set the ***Subscriber Sim*** setting back to False. The IED will then immediately stop processing the simulated messages and start processing real messages again.
- During above steps, IED1 will continuously process the real GOOSE 2 and GOOSE 3 messages as normal because it has not received any simulated messages for these that would initiate a changeover.

The process is represented in the following figure:

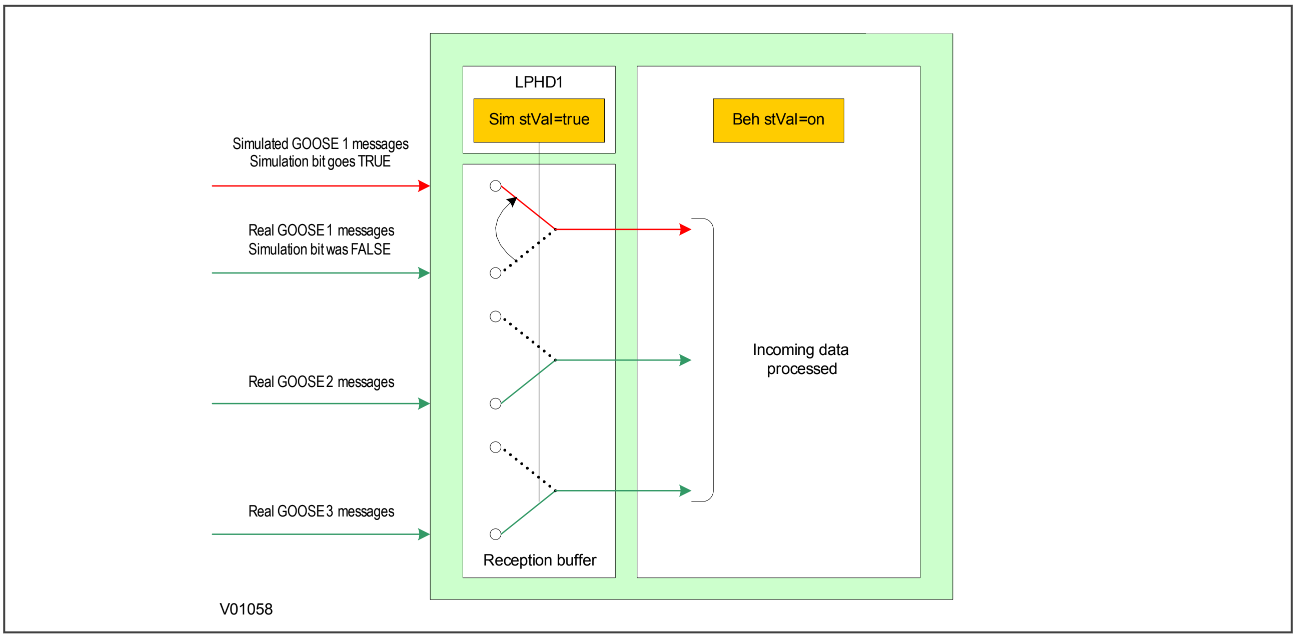


Figure 74: Simulated input behaviour

7.3 TESTING EXAMPLES

These examples show how you test the IED with and without simulated values. Depending on the IED Test Mode, it may respond by operating plant (for example by tripping the circuit breaker) or it may not operate plant.

7.3.1 TEST PROCEDURE FOR REAL VALUES

This procedure is for testing with real values without operating plant.

1. Set device into 'Contacts Blocked' Mode
   Select *COMMISSION TESTS* → ***IED Test Mode*** → `Contacts Blocked`
2. Confirm new behaviour has been enabled
   View *COMMISSION TESTS* → ***IED Mod/Beh***, and check that it shows `Test-blocked`
3. Set device into Simulation Listening Mode
   Select *COMMISSION TESTS* → ***Subscriber Sim*** = `Disabled`
4. If using sampled values set the sampled values test mode
   Select *IEC 61850-9.2LE* → ***SV Test Mode*** → `Disabled`
5. Inject real signals using a test device connected to the merging units. The device will continue to listen to 'real' GOOSE messages and ignore simulated messages received.
6. Verify function based on test signal outputs
   Binary outputs (e.g. CB trips) will not operate. All transmitted GOOSE and MMS data items will be tagged with the 'quality' parameter set to 'test', so that the receiver understands that they have been issued by a device under test and can respond accordingly. This is summarised in the following diagram

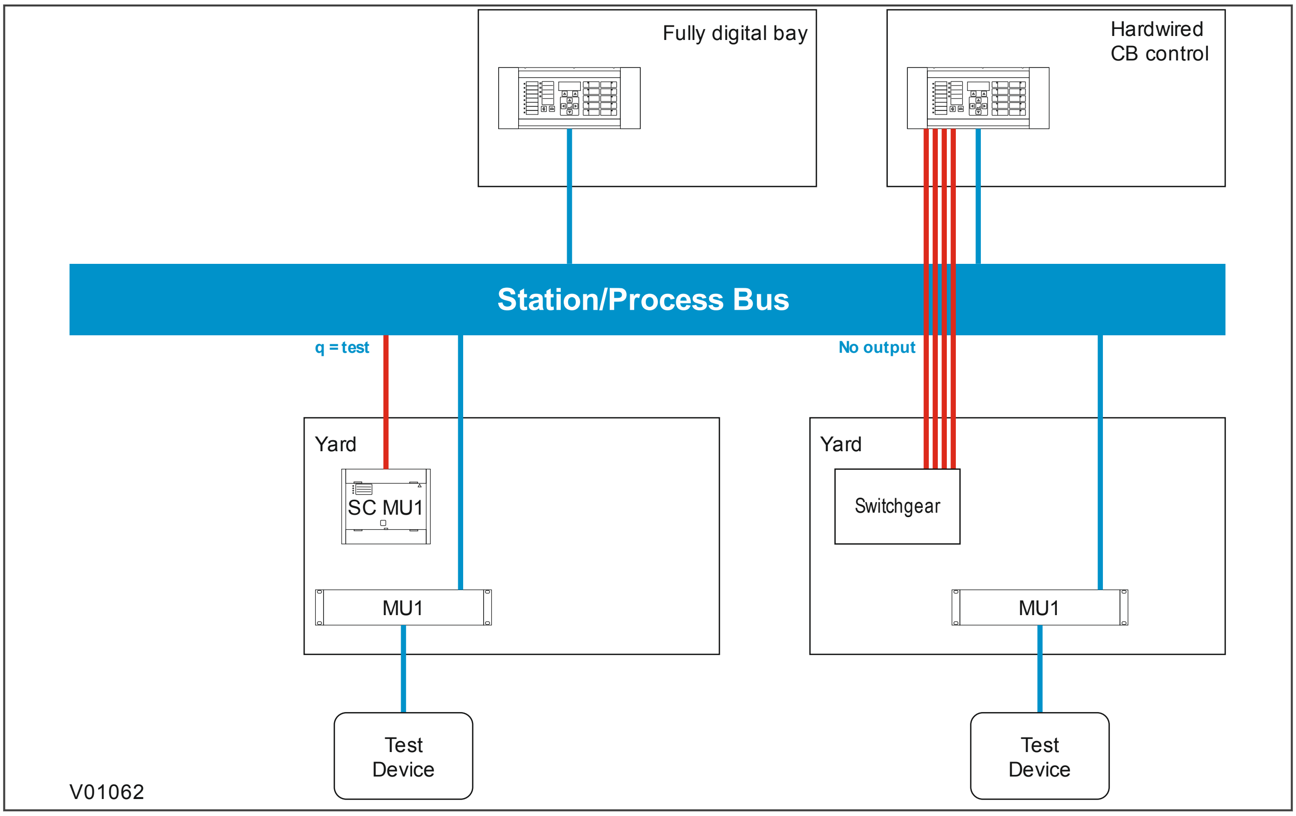


Figure 75: Test example 1

7.3.2 TEST PROCEDURE FOR SIMULATED VALUES - NO PLANT

This procedure is for testing with simulated values without operating plant.

1. Set device into 'Contacts Blocked' Mode
   Select *COMMISSION TESTS* → ***IED Test Mode*** → `Contacts Blocked`
2. Confirm new behaviour has been enabled
   View *COMMISSION TESTS* → ***IED Mod/Beh***, and check that it shows `test-blocked`

3. Set device into Simulation Listening Mode

   Select *COMMISSION TESTS* → ***Subscriber Sim*** = `Enabled`
4. If using sampled values set the sampled values test mode

   Select *IEC 61850-9.2LE* → ***SV Test Mode*** → `Enabled`
5. Inject simulated signals using a test device connected to the Ethernet network. The device will continue to listen to 'real' GOOSE messages until a simulated message is received. Once the simulated messages are received, the corresponding 'real' messages are ignored until the device is taken out of test mode. Each message is treated separately, but sampled values are considered as a single message.
6. Verify function based on test signal outputs

   Binary outputs (e.g. CB trips) will not operate. All transmitted GOOSE and MMS data items will be tagged with the 'quality' parameter set to 'test', so that the receiver understands that they have been issued by a device under test and can respond accordingly. This is summarised in the following diagram

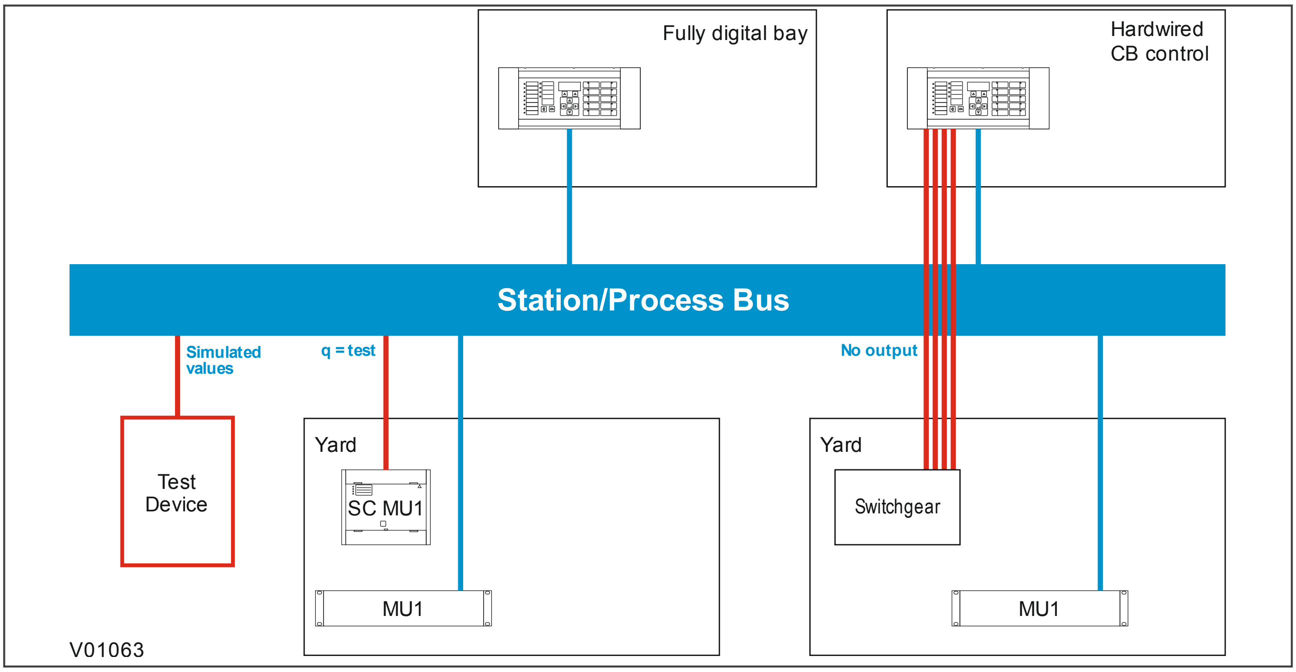


Figure 76: Test example 2

7.3.3 TEST PROCEDURE FOR SIMULATED VALUES - WITH PLANT

This procedure is for testing with simulated values with operating plant.

1. Set device into 'Contacts Blocked' Mode

   Select *COMMISSION TESTS* → ***IED Test Mode*** → `Test`
2. Confirm new behaviour has been enabled

   View *COMMISSION TESTS* → ***IED Mod/Beh***, and check that it shows `Test`
3. Set device into Simulation Listening Mode

   Select *COMMISSION TESTS* → ***Subscriber Sim*** = `Enabled`

4. If using sampled values set the sampled values test mode

   Select *IEC 61850-9.2LE* → ***SV Test Mode*** → `Enabled`

5. Inject simulated signals using a test device connected to the Ethernet network.

   The device will continue to listen to 'real' GOOSE messages until a simulated message is received. Once the simulated messages are received, the corresponding 'real' messages are ignored until the device is taken out of IED test mode. Each message is treated separately, but sampled values are considered as a single message.

6. Verify function based on test signal outputs.

   Binary outputs (e.g. CB trips) will operate as normal. All transmitted GOOSE and MMS data items will be tagged with the 'quality' parameter set to 'test', so that the receiver understands that they have been issued by a device under test and can respond accordingly. This is summarised in the following diagram:

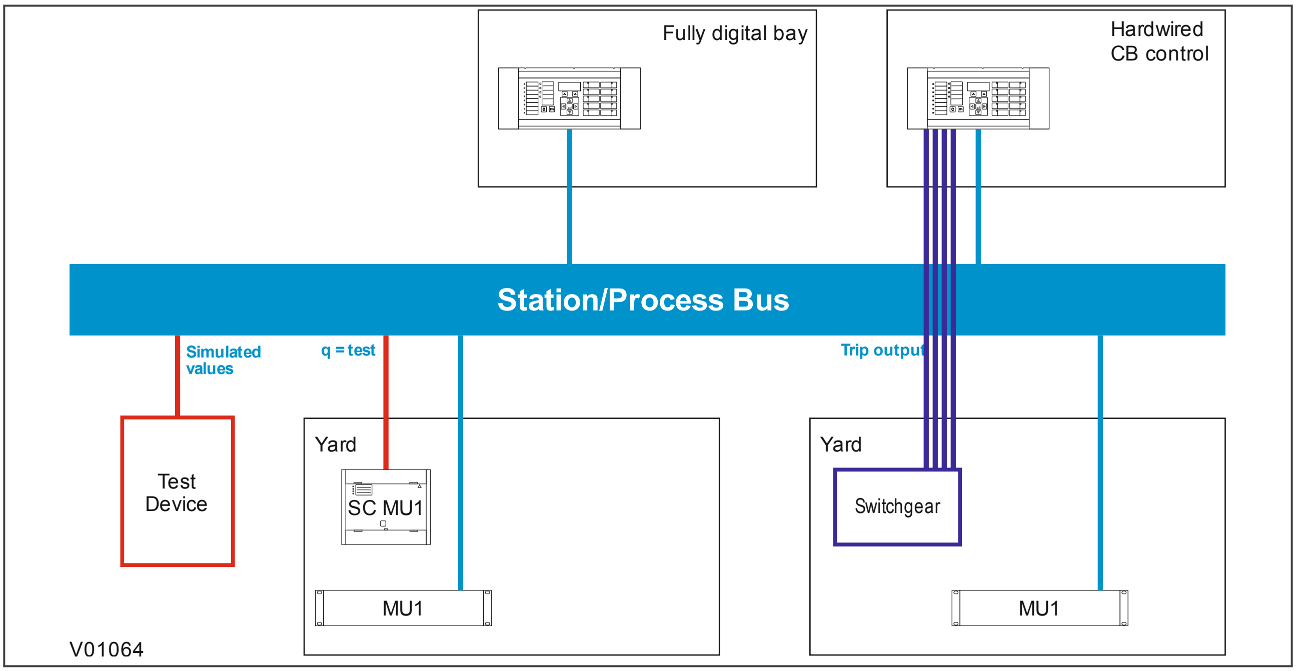


Figure 77: Test example 3

7.3.4 CONTACT TEST

The ***Apply Test*** command in this cell is used to change the state of the contacts set for operation.

If the device has been put into 'Contact Blocked' mode using an input signal (via the ***Block Contacts*** DDB signal) then the ***Apply Test*** command will not execute. This is to prevent a device that has been blocked by an external process having its contacts operated by a local operator using the HMI.

If the ***Block Contacts*** DDB is not set and the ***Apply Test*** command in this cell is issued, contacts change state and the command text on the LCD changes to `No Operation`. The contacts remain in the Test state until reset by issuing the ***Remove Test*** command. The command text on the LCD shows `No Operation` after the ***Remove Test*** command has been issued.

Note:
*When the **IED Test Mode** cell is set to Contacts Blocked, the **Relay O/P Status** cell does not show the current status of the output relays so cannot be used to confirm operation of the output relays. Therefore it is necessary to monitor the state of each contact in turn.*

8 ONLOAD CHECKS

Warning:
Onload checks are potentially very dangerous and may only be carried out by qualified and authorised personnel.

Onload checks can only be carried out if there are no restrictions preventing the energisation of the plant, and the other devices in the group have already been commissioned.

Remove all test leads and temporary shorting links, then replace any external wiring that has been removed to allow testing.

Warning:
If any external wiring has been disconnected for the commissioning process, replace it in accordance with the relevant external connection or scheme diagram.

8.1 CONFIRM CURRENT CONNECTIONS

1. Measure the current transformer secondary values for each input either by:
   a. reading from the device's HMI panel (providing it has first been verified by a secondary injection test)
   b. using a current clamp meter
2. Check that the current transformer polarities are correct by measuring the phase angle between the current and voltage, either against a phase meter already installed on site and known to be correct or by determining the direction of power flow by contacting the system control centre.
3. Ensure the current flowing in the neutral circuit of the current transformers is negligible.

If the ***Local Values*** cell is set to `Secondary`, the values displayed should be equal to the applied secondary voltage. The values should be within 1% of the applied secondary voltages. However, an additional allowance must be made for the accuracy of the test equipment being used.

If the ***Local Values*** cell is set to `Primary`, the values displayed should be equal to the applied secondary voltage multiplied the corresponding voltage transformer ratio set in the *CT & VT RATIOS* column. The values should be within 1% of the expected values, plus an additional allowance for the accuracy of the test equipment being used.

8.2 CONFIRM VOLTAGE CONNECTIONS

1. Using a multimeter, measure the voltage transformer secondary voltages to ensure they are correctly rated.
2. Check that the system phase rotation is correct using a phase rotation meter.
3. Compare the values of the secondary phase voltages with the measured voltage magnitude values, which can be found in the *MEASUREMENTS 1* menu column.

Cell in MEASUREMENTS 1 Column	Corresponding VT ratio in CT/VT RATIOS column
VAB MAGNITUDE *VBC MAGNITUDE* *VCA MAGNITUDE* *VAN MAGNITUDE* *VBN MAGNITUDE* *VCN MAGNITUDE*	Main VT Primary / Main VT Sec'y
C/S Voltage Mag	CS VT Primary / CS VT Secondary

If the ***Local Values*** cell is set to *`Secondary`*, the values displayed should be equal to the applied secondary voltage. The values should be within 1% of the applied secondary voltages. However, an additional allowance must be made for the accuracy of the test equipment being used.

If the ***Local Values*** cell is set to *`Primary`*, the values displayed should be equal to the applied secondary voltage multiplied the corresponding voltage transformer ratio set in the *CT & VT RATIOS* column. The values should be within 1% of the expected values, plus an additional allowance for the accuracy of the test equipment being used.

9 FINAL CHECKS

1. Remove all test leads and temporary shorting leads.
2. If you have had to disconnect any of the external wiring in order to perform the wiring verification tests, replace all wiring, fuses and links in accordance with the relevant external connection or scheme diagram.
3. The settings applied should be carefully checked against the required application-specific settings to ensure that they are correct, and have not been mistakenly altered during testing.
4. Ensure that all protection elements required have been set to `Enabled` in the *CONFIGURATION* column.
5. Ensure that the IED has been restored to service by checking that the ***Test Mode*** cell in the *COMMISSION TESTS* column is set to `Disabled`.
6. If the IED is in a new installation or the circuit breaker has just been maintained, the circuit breaker maintenance and current counters should be zero. These counters can be reset using the ***Reset All Values*** cell. If the required access level is not active, the device will prompt for a password to be entered so that the setting change can be made.
7. If the menu language has been changed to allow accurate testing it should be restored to the customer's preferred language.
8. If a P991/MMLG test block is installed, remove the P992/MMLB test plug and replace the cover so that the protection is put into service.
9. Ensure that all event records, fault records, disturbance records, alarms and LEDs and communications statistics have been reset.

Note:
Remember to restore the language setting to the customer's preferred language on completion.

CHAPTER 11

MAINTENANCE AND TROUBLESHOOTING

1 CHAPTER OVERVIEW

The Maintenance and Troubleshooting chapter provides details of how to maintain and troubleshoot products based on the Px4x and P40Agile platforms. Always follow the warning signs in this chapter. Failure to do so may result injury or defective equipment.

Caution:
Before carrying out any work on the equipment you should be familiar with the contents of the Safety Section or the Safety Guide SFTY/4LM and the ratings on the equipment's rating label.

The troubleshooting part of the chapter allows an error condition on the IED to be identified so that appropriate corrective action can be taken.

If the device develops a fault, it is usually possible to identify which module needs replacing. It is not possible to perform an on-site repair to a faulty module.

If you return a faulty unit or module to the manufacturer or one of their approved service centres, you should include a completed copy of the Repair or Modification Return Authorization (RMA) form.

This chapter contains the following sections:

2 MAINTENANCE

2.1 MAINTENANCE CHECKS

In view of the critical nature of the application, GE products should be checked at regular intervals to confirm they are operating correctly. GE products are designed for a life in excess of 20 years.

The devices are self-supervising and so require less maintenance than earlier designs of protection devices. Most problems will result in an alarm, indicating that remedial action should be taken. However, some periodic tests should be carried out to ensure that they are functioning correctly and that the external wiring is intact. It is the responsibility of the customer to define the interval between maintenance periods. If your organisation 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

Although some functionality checks can be performed from a remote location, these are predominantly restricted to checking that the unit is measuring the applied currents and voltages accurately, and checking the circuit breaker maintenance counters. For this reason, maintenance checks should also be performed locally at the substation.

Caution:
Before carrying out any work on the equipment you should be familiar with the contents of the Safety Section or the Safety Guide SFTY/4LM and the ratings on the equipment's rating label.

2.1.1 ALARMS

First check the alarm status LED to see if any alarm conditions exist. If so, press the Read key repeatedly to step through the alarms.

After dealing with any problems, clear the alarms. This will clear the relevant LEDs.

2.1.2 OPTO-ISOLATORS

Check the opto-inputs by repeating the commissioning test detailed in the Commissioning chapter.

2.1.3 OUTPUT RELAYS

Check the output relays by repeating the commissioning test detailed in the Commissioning chapter.

2.1.4 MEASUREMENT ACCURACY

If the power system is energised, the measured values can be compared with known system values to check that they are in the expected range. If they are within a set range, this indicates that the A/D conversion and the calculations are being performed correctly. Suitable test methods can be found in Commissioning chapter.

Alternatively, the measured values can be checked against known values injected into the device using the test block, (if fitted) or injected directly into the device's terminals. Suitable test methods can be found in the Commissioning chapter. These tests will prove the calibration accuracy is being maintained.

2.2 REPLACING THE DEVICE

If your product should develop a fault while in service, depending on the nature of the fault, the watchdog contacts will change state and an alarm condition will be flagged. In the case of a fault, you can replace either the complete device or just the faulty PCB, identified by the in-built diagnostic software.

If possible you should replace the complete device, as this reduces the chance of damage due to electrostatic discharge and also eliminates the risk of fitting an incompatible replacement PCB. However, we understand it may be difficult to remove an installed product and you may be forced to replace the faulty PCB on-site. The case and rear terminal blocks are designed to allow removal of the complete device, without disconnecting the scheme wiring.

Caution:
Replacing PCBs requires the correct on-site environment (clean and dry) as well as suitably trained personnel.

Caution:
If the repair is not performed by an approved service centre, the warranty will be invalidated.

Caution:
Before carrying out any work on the equipment, you should be familiar with the contents of the Safety Information section of this guide or the Safety Guide SFTY/4LM, as well as the ratings on the equipment's rating label. This should ensure that no damage is caused by incorrect handling of the electronic components.

Warning:
Before working at the rear of the device, isolate all voltage and current supplying it.

Note:
The current transformer inputs are equipped with integral shorting switches which will close for safety reasons, when the terminal block is removed.

To replace the complete device:

1. Carefully disconnect the cables not connected to the terminal blocks (e.g. IRIG-B, fibre optic cables, earth), as appropriate, from the rear of the device.
2. Remove the terminal block screws using a magnetic screwdriver to minimise the risk of losing the screws or leaving them in the terminal block.
3. Without exerting excessive force or damaging the scheme wiring, pull the terminal blocks away from their internal connectors.
4. Remove the terminal block screws that fasten the device to the panel and rack. These are the screws with the larger diameter heads that are accessible when the access covers are fitted and open.
5. Withdraw the device from the panel and rack. Take care, as the device will be heavy due to the internal transformers.
6. To reinstall the device, follow the above instructions in reverse, ensuring that each terminal block is relocated in the correct position and the chassis ground, IRIG-B and fibre optic connections are replaced. The terminal blocks are labelled alphabetically with 'A' on the left hand side when viewed from the rear.

Once the device has been reinstalled, it should be re-commissioned as set out in the Commissioning chapter.

Caution:
If the top and bottom access covers have been removed, some more screws with smaller diameter heads are made accessible. Do NOT remove these screws, as they secure the front panel to the device.

Note:
There are four possible types of terminal block: RTD/CLIO input, heavy duty, medium duty, and MiDOS. The terminal blocks are fastened to the rear panel with slotted or cross-head screws depending on the type of terminal block. Not all terminal block types are present on all products.

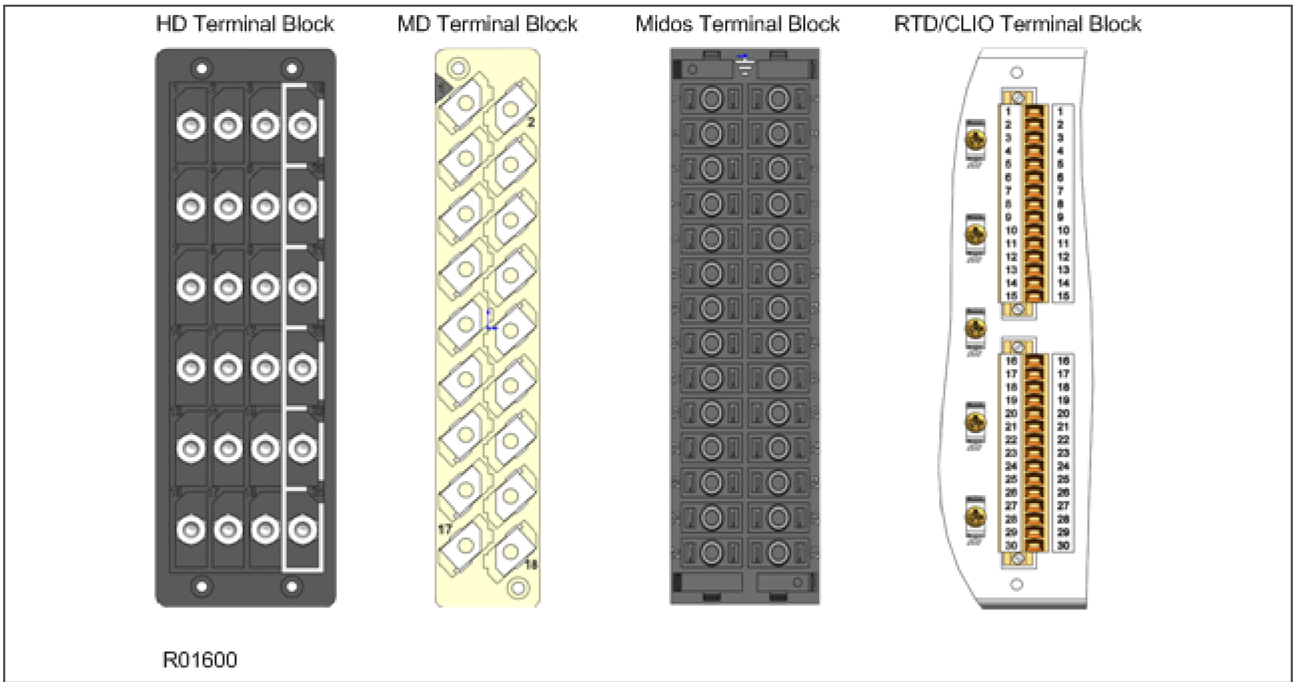


Figure 78: Possible terminal block types

2.3 REPAIRING THE DEVICE

If your product should develop a fault while in service, depending on the nature of the fault, the watchdog contacts will change state and an alarm condition will be flagged. In the case of a fault, either the complete unit or just the faulty PCB, identified by the in-built diagnostic software, should be replaced.

Replacement of printed circuit boards and other internal components must be undertaken by approved Service Centres. Failure to obtain the authorization of after-sales engineers prior to commencing work may invalidate the product warranty.

We recommend that you entrust any repairs to Automation Support teams, which are available world-wide.

2.4 REMOVING THE FRONT PANEL

Warning:
Before removing the front panel to replace a PCB, you must first remove the auxiliary power supply and wait 5 seconds for the internal capacitors to discharge. You should also isolate voltage and current transformer connections and trip circuit.

> **Caution:**
> **Before removing the front panel, you should be familiar with the contents of the Safety Information section of this guide or the Safety Guide SFTY/4LM, as well as the ratings on the equipment's rating label.**

To remove the front panel:

1. Open the top and bottom access covers. You must open the hinged access covers by more than 90° before they can be removed.
2. If fitted, remove the transparent secondary front cover.
3. Apply outward pressure to the middle of the access covers to bow them and disengage the hinge lug, so the access cover can be removed. The screws that fasten the front panel to the case are now accessible.
4. Undo and remove the screws. The 40TE case has four cross-head screws fastening the front panel to the case, one in each corner, in recessed holes. The 60TE/80TE cases have an additional two screws, one midway along each of the top and bottom edges of the front plate.
5. When the screws have been removed, pull the complete front panel forward to separate it from the metal case. The front panel is connected to the rest of the circuitry by a 64-way ribbon cable.
6. The ribbon cable is fastened to the front panel using an IDC connector; a socket on the cable and a plug with locking latches on the front panel. Gently push the two locking latches outwards which eject the connector socket slightly. Remove the socket from the plug to disconnect the front panel.

> **Caution:**
> **Do not remove the screws with the larger diameter heads which are accessible when the access covers are fitted and open. These screws hold the relay in its mounting (panel or cubicle).**

> **Caution:**
> **The internal circuitry is now exposed and is not protected against electrostatic discharge and dust ingress. Therefore ESD precautions and clean working conditions must be maintained at all times.**

2.5 REPLACING PCBS

1. To replace any of the PCBs, first remove the front panel.
2. Once the front panel has been removed, the PCBs are accessible. The numbers above the case outline identify the guide slot reference for each printed circuit board. Each printed circuit board has a label stating the corresponding guide slot number to ensure correct relocation after removal. To serve as a reminder of the slot numbering there is a label on the rear of the front panel metallic screen.
3. Remove the 64-way ribbon cable from the PCB that needs replacing
4. Remove the PCB in accordance with the board-specific instructions detailed later in this section.

> *Note:*
> *To ensure compatibility, always replace a faulty PCB with one of an identical part number.*

2.5.1 REPLACING THE MAIN PROCESSOR BOARD

The main processor board is situated in the front panel. This board contains application-specific settings in its non-volatile memory. You may wish to take a backup copy of these settings. This could save time in the re-commissioning process.

To replace the main processor board:

1. Remove front panel.
2. Place the front panel with the user interface face down and remove the six screws from the metallic screen, as shown in the figure below. Remove the metal plate.
3. Remove the screws that hold the main processor board in position.
4. Carefully disconnect the ribbon cable. Take care as this could easily be damaged by excessive twisting.
5. Replace the main processor board
6. Reassemble the front panel using the reverse procedure. Make sure the ribbon cable is reconnected to the main processor board and that all eight screws are refitted.
7. Refit the front panel.
8. Refit and close the access covers then press the hinge assistance T-pieces so they click back into the front panel moulding.
9. Once the unit has been reassembled, carry out the standard commissioning procedure as defined in the Commissioning chapter.

Note:
After replacing the main processor board, all the settings required for the application need to be re-entered. This may be done either manually or by downloading a settings file.

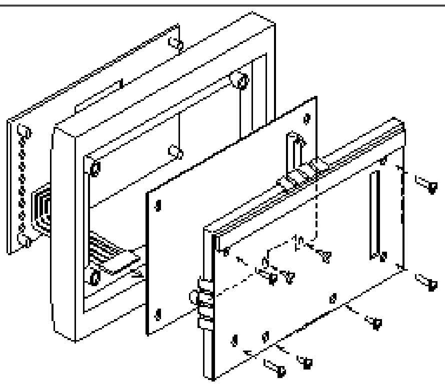


Figure 79: Front panel assembly

2.5.2 REPLACEMENT OF COMMUNICATIONS BOARDS

Most products will have at least one communications board of some sort fitted. There are several different boards available offering various functionality, depending on the application. Some products may even be fitted with two boards of different types.

To replace a faulty communications board:

1. Remove front panel.
2. Disconnect all connections at the rear.
3. The board is secured in the relay case by two screws, one at the top and another at the bottom. Remove these screws carefully as they are not captive in the rear panel.
4. Gently pull the communications board forward and out of the case.
5. Before fitting the replacement PCB check that the number on the round label next to the front edge of the PCB matches the slot number into which it will be fitted. If the slot number is missing or incorrect, write the correct slot number on the label.

6. Fit the replacement PCB carefully into the correct slot. Make sure it is pushed fully back and that the securing screws are refitted.
7. Reconnect all connections at the rear.
8. Refit the front panel.
9. Refit and close the access covers then press the hinge assistance T-pieces so they click back into the front panel moulding.
10. Once the unit has been reassembled, commission it according to the Commissioning chapter.

2.5.3 REPLACEMENT OF THE INPUT MODULE

Depending on the product, the input module consists of two or three boards fastened together and is contained within a metal housing. One board contains the transformers and one contains the analogue to digital conversion and processing electronics. Some devices have an additional auxiliary transformer contained on a third board.

To replace an input module:

1. Remove front panel.
2. The module is secured in the case by two screws on its right-hand side, accessible from the front, as shown below. Move these screws carefully as they are not captive in the front plate of the module.
3. On the right-hand side of the module there is a small metal tab which brings out a handle (on some modules there is also a tab on the left). Grasp the handle(s) and pull the module firmly forward, away from the rear terminal blocks. A reasonable amount of force is needed due to the friction between the contacts of the terminal blocks.
4. Remove the module from the case. The module may be heavy, because it contains the input voltage and current transformers.
5. Slot in the replacement module and push it fully back onto the rear terminal blocks. To check that the module is fully inserted, make sure the v-shaped cut-out in the bottom plate of the case is fully visible.
6. Refit the securing screws.
7. Refit the front panel.
8. Refit and close the access covers then press the hinge assistance T-pieces so they click back into the front panel moulding.
9. Once the unit has been reassembled, commission it according to the Commissioning chapter.

Caution:
With non-mounted IEDs, the case needs to be held firmly while the module is withdrawn. Withdraw the input module with care as it suddenly comes loose once the friction of the terminal blocks is overcome.

Note:
If individual boards within the input module are replaced, recalibration will be necessary. We therefore recommend replacement of the complete module to avoid on-site recalibration.

2.5.4 REPLACEMENT OF THE POWER SUPPLY BOARD

Caution:
Before removing the front panel, you should be familiar with the contents of the Safety Information section of this guide or the Safety Guide SFTY/4LM, as well as the ratings on the equipment's rating label.

The power supply board is fastened to an output relay board with push fit nylon pillars. This doubled-up board is secured on the extreme left hand side, looking from the front of the unit.

1. Remove front panel.
2. Pull the power supply module forward, away from the rear terminal blocks and out of the case. A reasonable amount of force is needed due to the friction between the contacts of the terminal blocks.
3. Separate the boards by pulling them apart carefully. The power supply board is the one with two large electrolytic capacitors.
4. Before reassembling the module, check that the number on the round label next to the front edge of the PCB matches the slot number into which it will be fitted. If the slot number is missing or incorrect, write the correct slot number on the label
5. Reassemble the module with a replacement PCB. Push the inter-board connectors firmly together. Fit the four push fit nylon pillars securely in their respective holes in each PCB.
6. Slot the power supply module back into the housing. Push it fully back onto the rear terminal blocks.
7. Refit the front panel.
8. Refit and close the access covers then press the hinge assistance T-pieces so they click back into the front panel moulding.
9. Once the unit has been reassembled, commission it according to the Commissioning chapter.

2.5.5 REPLACEMENT OF THE I/O BOARDS

There are several different types of I/O boards, which can be used, depending on the product and application. Some boards have opto-inputs, some have relay outputs and others have a mixture of both.

1. Remove front panel.
2. Gently pull the board forward and out of the case
3. If replacing the I/O board, make sure the setting of the link above IDC connector on the replacement board is the same as the one being replaced.
4. Before fitting the replacement board check the number on the round label next to the front edge of the board matches the slot number into which it will be fitted. If the slot number is missing or incorrect, write the correct slot number on the label.
5. Carefully slide the replacement board into the appropriate slot, ensuring that it is pushed fully back onto the rear terminal blocks.
6. Refit the front panel.
7. Refit and close the access covers then press at the hinge assistance T-pieces so they click back into the front panel moulding.
8. Once the unit has been reassembled, commission it according to the Commissioning chapter.

2.6 RECALIBRATION

Recalibration is not needed when a PCB is replaced, unless it is one of the boards in the input module. If any of the boards in the input module is replaced, the unit must be recalibrated.

Although recalibration is needed when a board inside the input module is replaced, it is not needed if the input module is replaced in its entirety.

Although it is possible to carry out recalibration on site, this requires special test equipment and software. We therefore recommend that the work be carried out by the manufacturer, or entrusted to an approved service centre.

2.7 SUPERCAPACITOR DISCHARGED

The supercapacitor maintains charge for two weeks with the IED de-energised. When first energising the IED after this time there may be a Battery Alarm due to the supercapacitor voltage dropping below a pre-defined threshold.

The battery alarm will clear after approximately 30 minutes of IED being energised, and once cleared there will be enough charge in the supercapacitor to backup status data.

Note:
Events, disturbance and maintenance records will be lost if the supercapacitor is fully discharged.

2.8 CLEANING

Warning:
Before cleaning the device, ensure that all AC and DC supplies and transformer connections are isolated, to prevent any chance of an electric shock while cleaning.

Only clean the equipment with a lint-free cloth dampened with clean water. Do not use detergents, solvents or abrasive cleaners as they may damage the product's surfaces and leave a conductive residue.

3 TROUBLESHOOTING

3.1 SELF-DIAGNOSTIC SOFTWARE

The device includes several self-monitoring functions to check the operation of its hardware and software while in service. If there is a problem with the hardware or software, it should be able to detect and report the problem, and attempt to resolve the problem by performing a reboot. In this case, the device would be out of service for a short time, during which the 'Healthy' LED on the front of the device is switched OFF and the watchdog contact at the rear is ON. If the restart fails to resolve the problem, the unit 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 device attempts to store a maintenance record to allow the nature of the problem to be communicated to the user.

The self-monitoring is implemented in two stages: firstly a thorough diagnostic check which is performed on boot-up, and secondly a continuous self-checking operation, which checks the operation of the critical functions whilst it is in service.

3.2 POWER-UP ERRORS

If the IED does not appear to power up, use the following to determine whether the fault is in the external wiring, auxiliary fuse, IED power supply module or IED front panel.

Test	Check	Action
1	Measure the auxiliary voltage on terminals 1 and 2. Verify the voltage level and polarity against the rating label on the front. Terminal 1 is –dc, 2 is +dc	If the auxiliary voltage is correct, go to test 2. Otherwise check the wiring and fuses in the auxiliary supply.
2	Check the LEDs and LCD backlight switch on at power-up. Also check the N/O (normally open) watchdog contact for closing.	If the LEDs and LCD backlight switch on, or the contact closes and no error code is displayed, the error is probably on the main processor board in the front panel. If the LEDs and LCD backlight do not switch on and the contact does not close, go to test 3.
3	Check the output (nominally 48 V DC)	If there is no field voltage, the fault is probably in the IED power supply module.

3.3 ERROR MESSAGE OR CODE ON POWER-UP

The IED performs a self-test during power-up. If it detects an error, a message appears on the LCD and the power-up sequence stops. If the error occurs when the IED application software is running, a maintenance record is created and the device reboots.

Test	Check	Action
1	Is an error message or code permanently displayed during power up?	If the IED locks up and displays an error code permanently, go to test 2. If the IED prompts for user input, go to test 4. If the IED reboots automatically, go to test 5.
2	Record displayed error, and then remove and re-apply IED auxiliary supply.	Record whether the same error code is displayed when the IED is rebooted. If no error code is displayed, contact the local service centre stating the error code and IED information. If the same code is displayed, go to test 3.

Test	Check	Action
3	Error Code Identification The following text messages (in English) are 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 The following hex error codes relate to errors detected in specific IED modules:	These messages indicate that a problem has been detected on the IED's main processor board in the front panel.
3.1	0c140005/0c0d0000	Input Module (including opto-isolated inputs)
3.2	0c140006/0c0e0000	Output IED Cards
3.3	The last four digits provide details on the actual error.	Other error codes relate to hardware or software problems on the main processor board. Contact General Electric with details of the problem for a full analysis.
4	The IED displays a message for corrupt settings and prompts for the default values to be restored for the affected settings.	The power-up tests have detected corrupted IED settings. Restore the default settings to allow the power-up to complete, and then reapply the application-specific settings.
5	The IED resets when the power-up is complete. A record error code is displayed	Error 0x0E080000, programmable scheme logic error due to excessive execution time. If the IED powers up successfully, check the programmable logic for feedback paths. Other error codes relate to software errors on the main processor board.

3.4 OUT OF SERVICE LED ON AT POWER-UP

Test	Check	Action	
1	Using the IED menu, confirm the Commission Test or Test Mode setting is Enabled. If it is not Enabled, go to test 2.	If the setting is Enabled, disable the test mode and make sure the Out of Service LED is OFF.	
2	Select the *VIEW RECORDS* column then view the last maintenance record from the menu.	Check for the H/W Verify Fail maintenance record. This indicates a discrepancy between the IED model number and the hardware. Examine the ***Maint Data***; cell. 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 (110 V VTs fitted)
		7	The VT type field in the model number is incorrect (440 V VTs fitted)

Test	Check	Action	
		8	The VT type field in the model number is incorrect (no VTs fitted)

3.5 ERROR CODE DURING OPERATION

The IED performs continuous self-checking. If the IED detects an error it displays an error message, logs a maintenance record and after a short delay resets itself. A permanent problem (for example due to a hardware fault) is usually detected in the power-up sequence. In this case the IED displays an error code and halts. If the problem was transient, the IED reboots correctly and continues operation. By examining the maintenance record logged, the nature of the detected fault can be determined.

3.6 MAL-OPERATION DURING TESTING

3.6.1 FAILURE OF OUTPUT CONTACTS

An apparent failure of the relay output contacts can be caused by the configuration. Perform the following tests to identify the real cause of the failure. The self-tests verify that the coils of the output relay contacts have been energized. An error is displayed if there is a fault in the output relay board.

Test	Check	Action
1	Is the Out of Service LED ON?	If this LED is ON, the relay may be in test mode or the protection has been disabled due to a hardware verify error.
2	Examine the Contact status in the Commissioning section of the menu.	If the relevant bits of the contact status are operated, go to test 4; if not, go to test 3.
3	Examine the fault record or use the test port to check the protection element is operating correctly.	If the protection element does not operate, check the test is correctly applied. If the protection element operates, check the programmable logic to make sure the protection element is correctly mapped to the contacts.
4	Using the Commissioning or Test mode function, apply a test pattern to the relevant relay output contacts. Consult the correct external connection diagram and use a continuity tester at the rear of the relay to check the relay output contacts operate.	If the output relay operates, the problem must be in the external wiring to the relay. If the output relay does not operate the output relay contacts may have failed (the self-tests verify that the relay coil is being energized). Ensure the closed resistance is not too high for the continuity tester to detect.

3.6.2 FAILURE OF OPTO-INPUTS

The opto-isolated inputs are mapped onto the IED's internal DDB signals using the programmable scheme logic. If an input is not recognised by the scheme logic, use the ***Opto I/P Status*** cell in the *COMMISSION TESTS* column to check whether the problem is in the opto-input itself, or the mapping of its signal to the scheme logic functions.

If the device does not correctly read the opto-input state, test the applied signal. Verify the connections to the opto-input using the wiring diagram and the nominal voltage settings in the *OPTO CONFIG* column. To do this:

1. Select the nominal voltage for all opto-inputs by selecting one of the five standard ratings in the ***Global Nominal V*** cell.
2. Select `Custom` to set each opto-input individually to a nominal voltage.
3. Using a voltmeter, check that the voltage on its input terminals is greater than the minimum pick-up level (See the Technical Specifications chapter for opto pick-up levels).

If the signal is correctly applied, this indicates failure of an opto-input, which may be situated on standalone opto-input board, or on an opto-input board that is part of the input module. Separate opto-input boards can simply be replaced. If, however, the faulty opto-input board is part of the input module, the complete input module should be replaced. This is because the analogue input module cannot be individually replaced without dismantling the module and recalibration of the IED.

3.6.3 INCORRECT ANALOGUE SIGNALS

If the measured analogue quantities do not seem correct, use the measurement function to determine the type of problem. The measurements can be configured in primary or secondary terms.

1. Compare the displayed measured values with the actual magnitudes at the terminals.
2. Check the correct terminals are used.
3. Check the CT and VT ratios set are correct.
4. Check the phase displacement to confirm the inputs are correctly connected.

3.7 PSL EDITOR TROUBLESHOOTING

A failure to open a connection could be due to one or more of the following:

- The IED address is not valid (this address is always 1 for the front port)
- Password in not valid
- Communication set-up (COM port, Baud rate, or Framing) is not correct
- Transaction values are not suitable for the IED or the type of connection
- The connection cable is not wired correctly or broken
- The option switches on any protocol converter used may be incorrectly set

3.7.1 DIAGRAM RECONSTRUCTION

Although a scheme can be extracted from an IED, a facility is provided to recover a scheme if the original file is unobtainable.

A recovered scheme is logically correct but much of the original graphical information is lost. Many signals are 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 such as titles and notes are lost.

Sometimes a gate type does not appear as expected. For example, a single-input AND gate in the original scheme appears as an OR gate when uploaded. Programmable gates with an inputs-to-trigger value of 1 also appear as OR gates

3.7.2 PSL VERSION CHECK

The PSL is saved with a version reference, time stamp and CRC check (Cyclic Redundancy Check). This gives a visual check whether the default PSL is in place or whether a new application has been downloaded.

4 REPAIR AND MODIFICATION PROCEDURE

Please follow these steps to return an Automation product to us:

1. Get the Repair and Modification Return Authorization (RMA) form
   An electronic version of the RMA form is available from the following:
   contact.centre@ge.com
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. Send the RMA form to your local contact
   For a list of local service contacts worldwide, email us at:
   contact.centre@ge.com
4. The local service contact provides the shipping information
   Your local service contact provides you with all the information needed to ship the product:
   - Pricing details
   - RMA number
   - Repair centre address

   If required, an acceptance of the quote must be delivered before going to the next stage.
5. Send the product to the repair centre
   - Address the shipment to the repair centre specified by your local contact
   - Make sure all items are packaged in an anti-static bag and foam protection
   - Make sure a copy of the import invoice is attached with the returned unit
   - Make sure a copy of the RMA form is attached with the returned unit
   - E-mail or fax a copy of the import invoice and airway bill document to your local contact.

CHAPTER 12

TECHNICAL SPECIFICATIONS

1 CHAPTER OVERVIEW

This chapter describes the technical specifications of the product.

This chapter contains the following sections:

2 INTERFACES

2.1 FRONT USB PORT

Front USB port	
Use	For local connection to laptop for configuration purposes and firmware downloads
Connector	USB type B
Isolation	Isolation to ELV level
Constraints	Maximum cable length 5 m

2.2 REAR SERIAL PORT 1

Rear serial port 1 (RP1)	
Use	For SCADA communications (multi-drop)
Standard	EIA(RS)485, K-bus
Connector	General purpose block, M4 screws (2 wire)
Cable	Screened twisted pair (STP)
Supported Protocols *	Courier, IEC-60870-5-103, DNP3.0, MODBUS
Isolation	Isolation to SELV level
Constraints	Maximum cable length 1000 m

* Not all models support all protocols - see ordering options

2.3 FIBRE REAR SERIAL PORT 1

Optional fibre rear serial port (RP1)	
Main Use	Serial SCADA communications over fibre
Connector	IEC 874-10 BFOC 2.5 –(ST®) (1 each for Tx and Rx)
Fibre type	Multimode 50/125 µm or 62.5/125 µm
Supported Protocols	Courier, IEC870-5-103, DNP 3.0, MODBUS
Wavelength	850 nm

2.4 REAR SERIAL PORT 2

Optional rear serial port (RP2)	
Use	For SCADA communications (multi-drop)
Standard	EIA(RS)485, K-bus, EIA(RS)232
Designation	SK4
Connector	9 pin D-type female connector
Cable	Screened twisted pair (STP)
Supported Protocols	Courier
Isolation	Isolation to SELV level
Constraints	Maximum cable length 1000 m for RS485 and K-bus, 15 m for RS232

2.5 IRIG-B (DEMODULATED)

IRIG-B Interface (Demodulated)	
Use	External clock synchronisation signal
Standard	IRIG 200-98 format B00X
Connector	BNC
Cable type	50 ohm coaxial
Isolation	Isolation to SELV level
Input signal	TTL level
Input impedance	10 k ohm at dc
Accuracy	+/- 1 ms

2.6 IRIG-B (MODULATED)

IRIG-B Interface (Modulated)	
Use	External clock synchronisation signal
Standard	IRIG 200-98 format B12X
Connector	BNC
Cable type	50 ohm coaxial
Isolation	Isolation to SELV level
Input signal	peak to peak, 200 mV to 20 mV
Input impedance	6 k ohm at 1000 Hz
Accuracy	+/- 1 ms

2.7 REAR ETHERNET PORT COPPER

Rear Ethernet port using CAT 5/6/7 wiring	
Main Use	Substation Ethernet communications
Standard	IEEE 802.3 10BaseT/100BaseTX
Connector	RJ45
Cable type	Screened twisted pair (STP)
Isolation	1.5 kV
Supported Protocols	IEC 61850
Constraints	Maximum cable length 100 m

2.8 REAR ETHERNET PORT FIBRE

Rear Ethernet port using fibre-optic cabling	
Main Use	Substation Ethernet communications
Connector	IEC 874-10 BFOC 2.5 –(ST®) (1 each for Tx and Rx)
Standard	IEEE 802.3 100 BaseFX
Fibre type	Multimode 50/125 µm or 62.5/125 µm
Supported Protocols	IEC 61850

Rear Ethernet port using fibre-optic cabling	
Optional Redundancy Protocols Supported	PRP (Parallel Redundancy Protocol) HSR (High-availability Seamless Redundancy) RSTP (Rapid Spanning Tree Protocol) Failover
Wavelength	1300 nm

2.8.1 100 BASE FX RECEIVER CHARACTERISTICS

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

Conditions: TA = 0°C to 70°C

2.8.2 100 BASE FX TRANSMITTER CHARACTERISTICS

Parameter	Sym	Min.	Typ.	Max.	Unit
Output Optical Power BOL 62.5/125 µm NA = 0.275 Fibre EOL	PO	-19 -20	-16.8	-14	dBm avg.
Output Optical Power BOL 50/125 µm NA = 0.20 Fibre EOL	PO	-22.5 -23.5	-20.3	-14	dBm avg.
Optical Extinction Ratio				10 -10	% dB
Output Optical Power at Logic "0" State	PO			-45	dBm avg.

Conditions: TA = 0°C to 70°C

3 PERFORMANCE OF GENERATOR DIFFERENTIAL PROTECTION AND MONITORING FUNCTIONS

3.1 GENERATOR DIFFERENTIAL PROTECTION

Accuracy	
Pick-up	Formula +/-5%
Drop-off	0.95 x setting +/-5%
Operating time	< 30 ms (currents applied at 4x pickup level or higher)
Repeatability	< 7.5%
Disengagement time	< 40 ms

3.2 TRANSFORMER DIFFERENTIAL PROTECTION

Accuracy	
Low set pick-up	Formula +/-5%
Low set drop-off	0.95 x formula +/- 5%
Low set pick-up and drop-off repeatability	< 1%
High set pick-up and drop-off repeatability	< 2%
Low set operate time	< 33 ms (currents applied at 3x pickup level or higher)
High set operate time	< 25 ms
Low set DT operate time	+/-2% or 33 ms, whichever is greater (currents applied at 3x pickup level or higher
Low set operate time repeatability	< 2 ms
High set operate time repeatability	< 2 ms
Low set disengagement time	< 40 ms
High set reset time	< 40 ms
2nd harmonic blocking pick-up	Setting +/-5%
2nd harmonic blocking drop-off	0.95 x setting +/-5%
2nd harmonic Pick-up and drop-off repeatability	< 2%
5th harmonic blocking pick-up	Setting +/-5%
5th harmonic blocking drop-off	0.95 x setting +/-5%
5th harmonic Pick-up and drop-off repeatability	< 2%

3.3 CIRCUITRY FAULT ALARM

Pick-up	Formula +/-5%
Drop-off	0.95 x formula +/-5%
Pick-up and drop-off repeatability	< 1%
Instantaneous operating time	< 33 ms (currents applied at 3x pickup level)
DT Operate	+/-2% or 33 ms, whichever is greater (currents applied at 3x pickup level or higher)

Operate time repeatability	< 3 ms
Disengagement time	< 40 ms

3.4 THROUGH FAULT MONITORING

Overcurrent pick-up	Setting +/-5%
Overcurrent drop-off	0.95 x setting +/-5%
Heating pickup (I2t)	Setting +/-2% or 5 A^2s, whichever greater
Pick-up repeatability	< 5%
Operating time repeatability	< 50 ms

3.5 THERMAL OVERLOAD

Accuracy	
Setting accuracy	+/-5%
Reset	95% of thermal setting +/-5%
Thermal alarm pick-up	+/-5% (calculated time)
Thermal overload pick-up	+/-5% (calculated time)
Cooling time accuracy	+/-5%
Repeatability	< 2.5%

3.6 TRANSFORMER THERMAL

Accuracy	
Hotspot> pick-up	+/-5% (Expected pick-up time is the time required to reach the temperature setting)
Hotspot> DT	+/-5% or 200 ms, whichever greater
Top Oil> pick-up	+/-5% (Expected pick-up time is the time required to reach the temperature setting)
Top Oil> DT	+/-5% or 200 ms, whichever greater
Pick-up repeatability	< 2.5%
Time repeatability	< 20 ms

3.7 LOSS OF LIFE

Accuracy	
FAA> pick-up	Formula +/-5%
Loss of Life> pick-up	Expected pick-up current +/-5%
Repeatability	< 2.5%
FAA> DT	+/-5% or 200 ms, whichever greater

3.8 FIELD FAILURE

Accuracy	
Mho characteristic pick-up	+/-5% or 0.5 Ω of Mho shape (Xb1<=10 & |Xa1|/Xb1<=16) or +/-5% or 0.5 Ω of Mho shape (Xb1>10 & |Xa1|/Xb1<=8)
Mho characteristic drop-off	105% x pick-up +/-5% or 0.5 Ω of Mho shape (Xb1 <=10 & |Xa1|/Xb1<=16) or 105% x pick-up +/-5% or 0.5 Ω of Mho shape (Xb1 >10 & |Xa1|/Xb1<=8)
Directional line pick-up	Setting angle +/-1°(offset = 0 Ω & VA>=20 V) or +/-5% x pick-up shape (offset =0 Ω)
Directional line drop-off	Setting angle +/-1°(offset = 0 Ω & VA>=20 V) or +/-5% x drop-off shape (offset =0 Ω)
Alarm linear characteristic line pick-up	+/-10%
Alarm linear characteristic drop-off	105% x setting +/-10%
Operating time	+/-2% or 50 ms, whichever is greater
Disengagement time	< 50 ms

3.9 NEGATIVE PHASE SEQUENCE THERMAL

Accuracy	
Pick-up	Formula +/-5%
Drop-off	0.95 x pick-up +/-5%
Operating time	+/-5% or 55 ms, whichever is greater
Disengagement time	< 30 ms
Repeatability	< 5%

3.10 VOLT/HZ

Accuracy	
Pick-up	Setting +/-2%
Drop-off	98% or pick up +/-2%
Repeatability (operating threshold)	< 1%
IDMT operating time	< +/-5% or 60 ms, whichever is greater
Definite time	+/-2% or 30 ms, whichever is greater
Disengagement time	< 50 ms
Repeatability (operating times)	< 10 ms
V/HZ measurement	+/-1%

3.11 UNINTENTIONAL ENERGIZATION AT STANDSTILL (DEAD MACHINE)

Accuracy	
I> pick-up	Setting +/-5%
V< pick-up	Setting +/-5%
I> drop-off	95% x setting +/-5%

Accuracy	
V< drop-off	105% x setting +/-5%
Operating time	+/-2% or 50 ms, whichever is greater
Repeatability	+/-2.5% or 10 ms, whichever is greater

3.12 RESISTIVE TEMPERATURE DETECTORS

Accuracy	
Pick-up	Setting +/-1°C
Drop-off	Setting -1°C
Operating time	+/-2% or < 3 s

3.13 POLE SIPPING

Lens characteristic pick-up	Setting +/-5%
Blinder pick-up	+/-1°
Reactance line pick-up	+/-5%
Lens DO characteristic lens angle	Adjusted by -5°, (ZA+ZB) +5%
Lens DO drop-off	+/-5%
Blinder DO characteristic	Blinder displaced by (ZA+ZB)/2 x tan 87.5°
Blinder DO drop-off	+/-1°
Repeatability	< 2.5%
T1, T2 and reset timer	+/-2% or 10 ms, whichever is greater

3.14 LOW IMPEDANCE RESTRICTED EARTH FAULT

Pick-up	Setting formula +/-5%
Drop-off	0.9 x formula +/-5%
Pick-up and drop-off repeatability	< 5%
Operate time	< 50 ms
Disengagement time	< 30 ms

3.15 HIGH IMPEDANCE RESTRICTED EARTH FAULT

Pick-up	Setting +/-5%
Operate time	< 30 ms

4 PERFORMANCE OF CURRENT PROTECTION FUNCTIONS

4.1 TRANSIENT OVERREACH AND OVERSHOOT

Accuracy	
Additional tolerance due to increasing X/R ratios	+/-5% over the X/R ratio of 1 to 90
Overshoot of overcurrent elements	< 40 ms
Disengagement time	< 30 ms (65 ms SEF)

4.2 VOLTAGE DEPENDENT OVERCURRENT PROTECTION

Accuracy	
VCO threshold pick-up	Setting +/-5%
Overcurrent pick-up	Formula +/-5%
VCO threshold drop-off	1.05 x setting +/-5%
Overcurrent drop-off	0.95 x formula +/-5%
Operating time	< 50 ms
Repeatability	< 2.5%
Operation (IDMT)	+/- 5% or 40 ms, whichever is greater
DT operate	+/- 5% or 50 ms, whichever is greater
tReset	+/- 5% or 50 ms, whichever is greater

4.3 NON DIRECTIONAL EARTH FAULT

2-Stage Accuracy	
Pick-up	Setting +/-5%
Drop-off	0.95 x setting +/-5%
IDMT trip level elements	1.05 x setting +/-5%
IDMT characteristic shape	+/-5% or 40 ms, whichever is greater
IEEE reset	+/-5% or 40 ms, whichever is greater
DT operation	+/-2% or 60 ms, whichever is greater
DT reset	+/-5%
Repeatability	2.5%

4.4 ROTOR EARTH FAULT

Accuracy	
Pick-up	Setting +/- 10% (1 k to 5 kΩ) Setting +/- 5% (5 k to 80 kΩ)
Drop-off	1.05 x setting formula +/-10% (1 k to 5 kΩ) 1.02 x setting formula +/-5% (5 k to 80 kΩ)
Repeatability	< 1%
DT operation for double-ended connection	+/-2% or 2.5/fs, whichever is greater

Accuracy	
Disengagement time	< 2.5/fs
DT operation for single ended connection	Field voltage 0 to 600 V DC +/-2% or 2.5/fs, whichever is greater
Disengagement time	< 2.5 f/s Field voltage 601 to 1200 V DC +/- 2% or 3.5/fs, whichever is greater
Disengagement time	< 3.5f/s

Note:
fs = injection frequency, 0.25/0.5/1 HZ

4.5 100% STATOR EARTH FAULT (3RD HARMONIC)

Accuracy	
VN3H</VN3H> pick-up	Setting +/-5%
V/P/Q/S<Inh	Setting +/-0.5%
VN3H< drop-off	105% x pick-up +/-5%
VN3H< drop-off	95% x pick-up +/-5%
V/P/Q/S<Inh drop-off	95% x pick-up +/-0.5%
Operating time	+/-0.5% or 50 ms, whichever is greater
Repeatability	< 0.5%
Disengagement/reset time	< 50 ms

4.6 100% STATOR EARTH FAULT (LOW FREQUENCY INJECTION)

Accuracy	
R<1/R<2 pick-up	Setting +/-5% (for R ≤ 300 Ω), ±7.5% (for R> 300 Ω) or 2 Ω whichever is greater
I>1/V<1/I<1 pick-up	Setting +/- 5%
R<1/R<2 drop-off	105% x setting +/- 5% (for R ≤ 300 Ω), ±7.5% (for R> 300 Ω)
V<1/I<1 drop-off	105% x setting +/-5%
I>1 drop-off	95% x setting +/-5%
Repeatability	< 1%
R<1/R<2/I>1/V<1/I<1 operating time without bandpass filter	+/-2% 220 ms, whichever is greater
R<1/R<2/I>1/V<1/I<1 disengagement time	< 120 ms
Repeatability	< 100 ms
R<1/R<2/I>1/V<1/I<1 operating time with bandpass filter	+/-2% or 1.3 s, whichever is greater
R<1/R<2/I>1/V<1/I<1 disengagement time	< 700 ms
Repeatability	< 100 ms

5 PERFORMANCE OF VOLTAGE PROTECTION FUNCTIONS

5.1 UNDERVOLTAGE PROTECTION

Pick-up (IDMT and DT)	Setting +/-5%
Drop-off (IDMT and DT)	1.02 x Setting +/-5%
Operate (IDMT and DT)	+/-2% or 50 ms, whichever is greater
Reset	< 75 ms
Repeatability	< 1%

5.2 OVERVOLTAGE PROTECTION

Pick-up (IDMT and DT)	Setting +/-5%
Drop-off (IDMT and DT)	0.98 x Setting +/-5%
Operate (IDMT and DT)	+/-2% or 50 ms, whichever is greater
Reset	< 75 ms
Repeatability	< 1%

5.3 RESIDUAL OVERVOLTAGE PROTECTION

Pick-up (IDMT and DT)	Setting +/-5%
Drop-off (IDMT and DT)	0.95 x Setting +/-5%
IDMT operate	+/-5%, 55 ms or 1 cycle, whichever is greater
DT operate	+/-2%, 55 ms or 1 cycle, whichever is greater
DT reset	+/-5% or 35 ms, whichever is greater

5.4 NEGATIVE PHASE SEQUENCE OVERVOLTAGE PROTECTION

Pick-up	Setting +/-5%
Drop-off	0.95 x Setting +/-5%
DT operate	+/-2% or 65 ms, whichever is greater
Disengagement time	< 35 ms
Operating time instant	< 60 ms
Operating time accelerated	< 45 ms
Operating time repeatability	< 10 ms
Operating threshold repeatability	< 1%

6 PERFORMANCE OF FREQUENCY PROTECTION FUNCTIONS

6.1 OVERFREQUENCY PROTECTION

Pick-up	Setting +/-10 mHz
Drop-off	Setting -25 mHz +/-10 mHz
DT operate	+/-2% or 50 ms, whichever is greater (excluding frequency tracking time delay)

6.2 UNDERFREQUENCY PROTECTION

Pick-up	Setting +/-10 mHz
Drop-off	Setting +25 mHz +/-10 mHz
DT Operate	+/- 2% or 50 ms, whichever is greater (excluding frequency tracking time delay)

6.3 RATE OF CHANGE OF FREQUENCY PROTECTION (DV/DT)

Accuracy	
Fixed window pick-up	Setting +/-5 mHz or +/-15%, whichever is greater (df/dt < 1.5 Hz/s)
Repeatability	< 5 %

Accuracy	
Rolling window pick-up	Setting +/-10 mHz or +/-10%, whichever is greater (df/dt < 1.5 Hz/s)
Repeatability	< 5 %

High and Low Freq	
Pick-up	Setting +/-2% or +/-80 mHz, whichever is greater

Delay Time	
Fixed window dead time	Setting +/-2% or +/- (100+20*X*Y) ms
Rolling window dead time	Setting +/-2% or +/- (150+20*X*Y) ms
Repeatability	< 30 ms

Note:
X = average cycles, Y = Iterations

6.4 GENERATOR ABNORMAL FREQUENCY

Accuracy	
Pick-up	Setting +/-10 mHz
Lower threshold drop-off	Setting -25 mHz +/-10 mHz
Upper threshold drop-off	Setting +25 mHz +/-10 mHz
Repeatability (operating threshold)	< 1%
Accumulation time	+/-2% or 50 ms, whichever is greater
Dead time	+/-2% or 50 ms, whichever is greater
Repeatability (operating times)	< 10 ms

7 POWER PROTECTION FUNCTIONS

7.1 THREE-PHASE POWER PROTECTION

Accuracy	
Over active pick-up	Setting +/-5% (Angle <=80° & Setting >=0.6 W)
Over active drop-off	95% x Setting +/-5% (Angle <=80° & Setting >=0.6W)

Accuracy	
Over reactive pick-up	Setting +/-5% (Angle >= 10°)
Over reactive drop-off	95% x Setting +/-5% (Angle >= 10°)

Accuracy	
Under active pick-up	Setting +/-10% (60°<Angle <=80°) or Setting +/-5% (Angle <=60°)
Under active drop-off	105% x Setting +/-10% (60°<Angle <=80°) or 105% x Setting +/-5% (Angle <=60°)

Accuracy	
Under reactive pick-up	Setting +/-10% (10°<Angle <=15°) or Setting +/-5% (Angle >=15°)
Under reactive drop-off	105% x Setting +/-10% (10°<Angle <=15°) or 105% x Setting +/-5% (Angle >=15°)
Operating time	+/-2% or 50 ms, whichever is greater
Disengagement time	< 50 ms
tReset	+/-5%
Instantaneous operating time	< 50 ms

7.2 NEGATIVE PHASE SEQUENCE OVERPOWER

Accuracy	
Pick-up	Setting +/-5%
Drop-off	0.95 x Setting +/-5%
Repeatability (operating threshold)	< 1%
Operating time	+/-2% or 70 ms, whichever is greater
Disengagement time	< 35 ms
Repeatability (operating times)	< 10 ms

7.3 SENSITIVE POWER

Accuracy (1 Phase)	
Over active pick-up	Setting +/-5% (Angle <=75°)
Over reactive pick-up	Setting +/-5% (Angle >=10°)
Under active pick-up	Setting +/-10% (Angle 75°, Setting < 10 W) or Setting +/-5% (Angle 75°, Setting < 10 W)

Accuracy (1 Phase)	
Under reactive pick-up	Setting +/-5% (Angle >=15°)
Over active drop-off	95% x Setting +/-5% (Angle <=75°)
Over reactive drop-off	95% x Setting +/-5% (Angle >=10°)
Under active drop-off	105% x Setting +/-10% (Angle <=75°, Setting < 10 W) or 105% x Setting +/-5% (Angle <=75°, Setting < 10 W)
Under reactive drop-off	105% x Setting +/-5% (Angle >=15°)

Accuracy (2 Phase)	
Over active pick-up	Setting +/-5% (Angle <=80°)
Over reactive pick-up	Setting +/-5% (Angle >=10°)
Under active pick-up	Setting +/-5% (Angle <= 80°)
Under reactive pick-up	Setting +/-5% (Angle >=10°)
Over active drop-off	95% x Setting +/-5% (Angle <=80°)
Over reactive drop-off	95% x Setting +/-5% (Angle >=10°)
Under active drop-off	105% x Setting +/-5% (Angle <=80°)
Under reactive drop-off	105% x Setting +/-5% (Angle >=10°)
Under reactive operating time	Setting +/-2% or 50 ms, whichever is greater
Under reactive disengagement time	< 50 ms
Under reactive tRESET	+/-5%
Under reactive instantaneous operating time	< 50 ms

8 PERFORMANCE OF MONITORING AND CONTROL FUNCTIONS

8.1 VOLTAGE TRANSFORMER SUPERVISION

Fast block operation	< 25 ms
Fast block reset	< 30 ms
Time delay	Setting +/-2% or 20 ms, whichever is greater

8.2 STANDARD CURRENT TRANSFORMER SUPERVISION

IN> Pick-up	Setting +/- 5%
VN< Pick-up	Setting +/- 5%
IN> Drop-off	0.9 x setting +/- 5%
VN< Drop-off	1.05 x setting +/-5% or 1 V, whichever is greater
Time delay operation	Setting +/-2% or 20 ms, whichever is greater
CTS block operation	< 1 cycle
CTS reset	< 35 ms

8.3 DIFFERENTIAL CURRENT TRANSFORMER SUPERVISION

CTS I1 pick-up ratio	Setting +/-5%
CTS I2/I1>1 pick-up ratio	0.95 x Setting +/-5%
CTS I2/I1>2 pick-up ratio	Setting +/-5%
CTS I1 drop-off ratio	0.95 x Setting +/-5%
CTS I2/I1>1 drop-off ratio	Setting +/-5%
CTS I2/I1>2 drop-off ratio	0.95 x Setting +/-5%
Pick-up and drop-off repeatability	< 1%
Time delay operation	Setting +/-2% or 33 ms, whichever is greater
CTS terminal block operation	< 33 ms
CTS differential block operation	< 33 ms
Operating time repeatability	< 2 ms
CTS disengagement time	< 40 ms

8.4 PSL TIMERS

Output conditioner timer	Setting +/- 2% or 50 ms, whichever is greater
Dwell conditioner timer	Setting +/- 2% or 50 ms, whichever is greater
Pulse conditioner timer	Setting +/- 2% or 50 ms, whichever is greater

9 MEASUREMENTS AND RECORDING

9.1 GENERAL

General Measurement Accuracy	
General measurement accuracy	Typically +/- 1%, but +/-0.5% between 0.2 - 2 In/Vn
Phase	0° to 360° +/- 5.0%
Current (0.05 to 3 In)	+/- 1.0% of reading, or 4mA (1A input), or 20mA (5A input)
Voltage (0.05 to 2 Vn)	+/- 5.0% of reading
Frequency (5 to 70 Hz)	+/- 0.025 Hz
Power (W) (0.2 to 2 Vn and 0.05 to 3 In)	+/- 5.0% of reading at unity power factor
Reactive power (Vars) (0.2 to 2 Vn and 0.05 to 3 In)	+/- 5.0% of reading at zero power factor
Apparent power (VA) (0.2 to 2 Vn and 0.05 to 3 In)	+/- 5.0% of reading
Energy (Wh) (0.2 to 2 Vn and 0.2 to 3 In)	+/- 5.0% of reading at zero power factor
Energy (Varh) (0.2 to 2 Vn and 0.2 to 3)	In +/- 5.0% of reading at zero power factor

9.2 DISTURBANCE RECORDS

Disturbance Records Measurement Accuracy	
Minimum record duration	0.1 s
Maximum record duration	10.5 s
Minimum number of records at 10.5 seconds	8
Magnitude and relative phases accuracy	+/- 5% of applied quantities
Duration accuracy	+/- 2%
Trigger position accuracy	+/- 2% (minimum Trigger 100 ms)

9.3 EVENT, FAULT AND MAINTENANCE RECORDS

Event, Fault & Maintenance Records	
Record location	Supercapacitor-backed memory
Viewing method	Front panel display or Settings Application Software
Extraction method	Extracted via the front USB port
Number of Event records	Up to 512 time tagged event records (newest overwrites oldest)
Number of Fault Records	Up to 20
Number of Maintenance Records	Up to 10
Event time stamp resolution	1 ms

9.4 CURRENT LOOP INPUTS/OUTPUTS

CLIO	
Current loop input accuracy	+/-1% of full scale
Current loop input drop-off under threshold	Setting +/-1% of full scale
Current loop input drop-off over threshold	Setting +/-1% of full scale
Current loop input sampling interval	50 ms

CLIO	
Current loop input DT operate time	+/-2% setting or 150 ms, whichever is greater
Current loop input instantaneous operate time	< 250 ms
Current loop output conversion interval	50 mS
Current loop output latency	< 1.07 s (1 s refresh rate) < 70 ms (0.5 cycle refresh rate)
Current loop output accuracy	+/-5% of full scale
Repeatability	< 5%
Current loop input load resistance	< 4 kohms (0-1 mA) < 300 ohms (0-10 mA / 0-20mA / 4-20mA)
Isolation between input channels and case/earth/other circuits	2 kV RMS for 1 minute
Current loop output compliance voltage	10 V (0-1 mA / 0-10 mA) 8.8V (0-20 mA / 4-20 mA)

10 REGULATORY COMPLIANCE

Compliance with the European Commission Directive on EMC and LVD is demonstrated using a technical file.

10.1 EMC COMPLIANCE: 2014/30/EU

The product specific Declaration of Conformity (DoC) lists the relevant harmonised standard(s) or conformity assessment used to demonstrate compliance with the EMC directive.

10.2 LVD COMPLIANCE: 2014/35/EU

The product specific Declaration of Conformity (DoC) lists the relevant harmonized standard(s) or conformity assessment used to demonstrate compliance with the LVD directive.

Safety related information, such as the installation I overvoltage category, pollution degree and operating temperature ranges are specified in the Technical Data section of the relevant product documentation and/or on the product labelling.

Unless otherwise stated in the Technical Data section of the relevant product documentation, the equipment is intended for indoor use only. Where the equipment is required for use in an outdoor location, it must be mounted in a specific cabinet or housing to provide the equipment with the appropriate level of protection from the expected outdoor environment.

10.3 R&TTE COMPLIANCE: 2014/53/EU

Radio and Telecommunications Terminal Equipment (R&TTE) directive 2014/53/EU.

Conformity is demonstrated by compliance to both the EMC directive and the Low Voltage directive, to zero volts.

10.4 UL/CUL COMPLIANCE

If marked with this logo, the product is compliant with the requirements of the Canadian and USA Underwriters Laboratories.

The relevant UL file number and ID is shown on the equipment.

11 MECHANICAL SPECIFICATIONS

11.1 PHYSICAL PARAMETERS

Case Types*	40TE 60TE 80TE
Weight (40TE case)	7 kg – 8 kg (depending on chosen options)
Weight (60TE case)	9 kg – 12 kg (depending on chosen options)
Weight (80TE case)	13 kg - 16 kg (depending on chosen options)
Dimensions in mm (w x h x l) (40TE case)	W: 206.0 mm H: 177.0 mm D: 243.1 mm
Dimensions in mm (w x h x l) (60TE case)	W: 309.6 mm H: 177.0 mm D: 243.1 mm
Dimensions in mm (w x h x l) (80TE case)	W 413.2 mm H 177.0 mm D 243.1 mm
Mounting	Panel, rack, or retrofit

Note:
**Case size is product dependent*.

11.2 ENCLOSURE PROTECTION

Against dust and dripping water (front face)	IP52 as per IEC 60529:1989/A2:2013
Protection against dust (whole case)	IP50 as per IEC 60529:1989/A2:2013
Protection for sides of the case (safety)	IP30 as per IEC 60529:1989/A2:2013
Protection for rear of the case (safety)	IP10 as per IEC 60529:1989/A2:2013

11.3 MECHANICAL ROBUSTNESS

Vibration test per EN 60255-21-1:1998	Response: class 2, Endurance: class 2
Shock and bump immunity per EN 60255-21-2:1988	Shock response: class 2, Shock withstand: class 1, Bump withstand: class 1
Seismic test per EN 60255-21-3: 1993	Class 2

11.4 TRANSIT PACKAGING PERFORMANCE

Primary packaging carton protection	ISTA 1C
Vibration tests	3 orientations, 7 Hz, amplitude 5.3 mm, acceleration 1.05g
Drop tests	10 drops from 610 mm height on multiple carton faces, edges and corners

12 RATINGS

12.1 AC MEASURING INPUTS

AC Measuring Inputs	
Nominal frequency	50 Hz or 60 Hz (settable)
Operating range	5 to 70 Hz
Phase rotation	ABC or ACB

12.2 CURRENT TRANSFORMER INPUTS

AC Current Inputs	
Nominal current (In)	1A or 5A dual rated*
Nominal burden per phase	< 0.04 VA at In, <40 MΩ (0-30 In)In = 1A < 0.01 VA at In, <8 MΩ (0-30 In)In = 5A
Thermal withstand	4In (continuous operation) 30In (for 10 s) 100In (for 1 s)
Linearity (standard CT)	Linear up to 16In (non-offset)
Linearity (sensitive CT)	Linear up to 2In (non-offset)

Note:
** A single input is used for both 1A and 5A applications. 1 A or 5 A operation is determined by means of software in the product's database.*

Note:
These specifications are applicable to all CTs.

12.3 VOLTAGE TRANSFORMER INPUTS

AC Voltage Inputs	
Nominal voltage	100 V to 120 V 380 V to 480 V
Nominal burden per phase	< 0.02 VA at Vn
Thermal withstand	2 x Vn (continuous operation) 2.6 x Vn (for 10 seconds)
Linearity	Linear up to 200 V (100/120 V supply) Linear up to 800 V (380/400 V supply)

13 POWER SUPPLY

13.1 AUXILIARY SUPPLY VOLTAGE

Nominal operating range	Cortec option (DC only) 24 to 48 V DC Cortec option (rated for AC or DC operation) 48 to 110 V DC 40 to 100 V AC rms Cortec option (rated for AC or DC operation) 110 to 250 V DC 100 to 240 V AC rms
Maximum operating range	Cortec option (DC only) 19 to 65 V DC Cortec option (rated for AC or DC operation) 37 to 150 V DC 32 to 110 V AC rms Cortec option (rated for AC or DC operation) 87 to 300 V DC 80 to 265 V AC rms
Frequency range for AC supply	45 to 65 Hz
Ripple	<15% for a DC supply (compliant with IEC 60255-26:2013)
Power up time	< 11 seconds

13.2 NOMINAL BURDEN

Quiescent burden	11 W or 22 VA
2nd rear communications port	1.25 W or 2.5 VA
Each relay output burden	0.13 W or 0.25 VA per output relay
Each opto-input burden (24 – 27 V)	0.065 W or 0.13 VA max
Each opto-input burden (30 – 34 V)	0.065 W or 0.13 VA max
Each opto-input burden (48 – 54 V)	0.125 W or 0.25 VA max
Each opto-input burden (110 – 125 V)	0.36 W or 0.72 VA max
Each opto-input burden (220 – 250 V)	0.9 W or 1.8 VA max

13.3 POWER SUPPLY INTERRUPTION

Standard	IEC 60255-26:2013 (DC and AC)
24-48V DC SUPPLY 100% interruption without de-energising	20 ms at 24 V (half and full load) 50 ms at 36 V (half and full load) 100 ms at 48 V (half and full load)

48-110V DC SUPPLY 100% interruption without de-energising	20 ms at 37V (half and full load) 50 ms at 60 V (half and full load) 100 ms at 72 V (half load) 100 ms at 85 V (full load) 200 ms at 110 V (half and full load)
110-250V DC SUPPLY 100% interruption without de-energising	20 ms at 87 V (half load) 50 ms at 110 V (half load) 50 ms at 98 V (full load) 100 ms at 160 V (half load) 100 ms at 135 V (full load) 200 ms at 210 V (half load) 200 ms at 174 V (full load)
40-100V AC SUPPLY 100% voltage dip without de-energising	50 ms at 32 V (half load) 10 ms at 32 V (full load)
100-240V AC SUPPLY 100% voltage dip without de-energising	50 ms at 80 V (full and half load)

Note:
Maximum loading = all inputs/outputs energised.

Note:
Quiescent or 1/2 loading = 1/2 of all inputs/outputs energised.

13.4 SUPERCAPACITOR

Discharge time	>14 days

14 INPUT / OUTPUT CONNECTIONS

14.1 ISOLATED DIGITAL INPUTS

Opto-isolated digital inputs (opto-inputs)	
Compliance	ESI 48-4
Rated nominal voltage	24 to 250 V dc
Operating range	19 to 265 V dc
Withstand	300 V dc
Recognition time with half-cycle ac immunity filter removed	< 2 ms
Recognition time with filter on	< 12 ms

14.1.1 NOMINAL PICKUP AND RESET THRESHOLDS

Nominal battery voltage	Logic levels: 60-80% DO/PU	Logic Levels: 50-70% DO/PU	Logic Levels: 58-75% DO/PU
24/27 V	Logic 0 < 16.2V, Logic 1 > 19.2V	Logic 0 <12V, Logic 1 > 16.8V	Logic 0 <15.7V, Logic 1 > 18V
30/34	Logic 0 < 20.4V, Logic 1 > 24V	Logic 0 < 15V, Logic 1 > 21V	Logic 0 < 19.7V, Logic 1 > 22.5V
48/54	Logic 0 < 32.4V, Logic 1 > 38.4V	Logic 0 < 24V, Logic 1 > 33.6V	Logic 0 < 31.3V, Logic 1 > 36V
110/125	Logic 0 < 75V, Logic 1 > 88V	Logic 0 < 55.V, Logic 1 > 77V	Logic 0 < 72.5V, Logic 1 > 82.5V
220/250	Logic 0 < 150V, Logic 1 > 176V	Logic 0 < 110V, Logic 1 > 154V	Logic 0 < 145V, Logic 1 > 165V

Note:
Filter is required to make the opto-inputs immune to induced AC voltages.

14.2 STANDARD OUTPUT CONTACTS

Compliance	In accordance with IEC 60255-1:2009
Use	General purpose relay outputs for signalling, tripping and alarming
Rated voltage	300 V
Maximum continuous current	10 A
Short duration withstand carry	30 A for 3 s 250 A for 30 ms
Make and break, dc resistive	50 W
Make and break, dc inductive	62.5 W (L/R = 50 ms)
Make and break, ac resistive	2500 VA resistive (cos phi = unity)
Make and break, ac inductive	2500 VA inductive (cos phi = 0.7)
Make and carry, dc resistive	30 A for 3 s, 10000 operations (subject to a maximum load of 7500W))
Make, carry and break, dc resistive	4 A for 1.5 s, 10000 operations (subject to the above limit for make and break, dc resistive load)
Make, carry and break, dc inductive	0.5 A for 1 s, 10000 operations (subject to the above limit for make and break, dc inductive load)
Make, carry and break ac resistive	30 A for 200 ms, 2000 operations (subject to the above limits)

Make, carry and break ac inductive	10 A for 1.5 s, 10000 operations (subject to the above limits)
Loaded contact	10000 operations min.
Unloaded contact	100000 operations min.
Operate time	< 5 ms
Reset time	< 10 ms

14.3 HIGH BREAK OUTPUT CONTACTS

Compliance	In accordance with IEC 60255-1:2009
Use	For applications requiring high rupture capacity
Rated voltage	300 V
Maximum continuous current	10 A DC
Short duration withstand carry	30 A DC for 3 s 250 A for 30 ms
Make and break, dc resistive	7500 W
Make and break, dc inductive	2500 W (L/R = 50 ms)
Make and carry, dc resistive	30 A for 3 s, 10000 operations (subject to the above limits)
Make, carry and break, dc resistive	30 A for 3 s, 5000 operations (subject to the above limit for make and break, dc resistive load) 30 A for 200 ms, 10000 operations (subject to the above limit for make and break, dc resistive load)
Make, carry and break, dc inductive	10 A for 40 ms, 10000 operations (subject to the above limit for make and break, dc inductive load) 10 A for 20 ms (250V, 4 shots per second, subject to the above limit for make and break, dc inductive load)
Loaded contact	10,000 operations minimum.
Unloaded contact	100,000 operations minimum.
Operate time	< 0.2 ms
Reset time	< 8 ms
MOV Protection	Maximum voltage 330 V DC

14.4 WATCHDOG CONTACTS

Use	Non-programmable contacts for relay healthy/relay fail indication
Breaking capacity, dc resistive	30 W
Breaking capacity, dc inductive	15 W (L/R = 40 ms)
Breaking capacity, ac inductive	375 VA inductive (cos phi = 0.7)

15 ENVIRONMENTAL CONDITIONS

15.1 AMBIENT TEMPERATURE RANGE

Compliance	IEC 60255-27: 2013
Test Method	IEC 60068-2-1:2007 and IEC 60068-2-2 2007
Operating temperature range	-25°C to +55°C (continuous)
Storage and transit temperature range	-25°C to +70°C (continuous)

15.2 TEMPERATURE ENDURANCE TEST

Temperature Endurance Test	
Test Method	IEC 60068-2-1: 2007 and 60068-2-2: 2007
Operating temperature range	-40°C (96 hours) +70°C (96 hours)
Storage and transit temperature range	-40°C (96 hours) +70°C (96 hours)

15.3 AMBIENT HUMIDITY RANGE

Compliance	IEC 60068-2-78: 2013 and IEC 60068-2-30: 2005
Durability	56 days at 93% relative humidity and +40°C
Damp heat cyclic	six (12 + 12) hour cycles, 93% RH, +25 to +55°C

15.4 CORROSIVE ENVIRONMENTS

Compliance	IEC 60068-2-42: 2003, IEC 60068-2-43: 2003
Industrial corrosive environment/poor environmental control, Sulphur Dioxide	21 days exposure to elevated concentrations (25ppm) of SO_2 at 75% relative humidity and +25°C
Industrial corrosive environment/poor environmental control, Hydrogen Sulphide	21 days exposure to elevated concentrations (10ppm) of H_2S at 75% relative humidity and +25°C
Salt mist	IEC 60068-2-52: 1996 KB severity 3

16 TYPE TESTS

16.1 INSULATION

Compliance	IEC 60255-27: 2013
Insulation resistance	> 100 M ohm at 500 V DC (Using only electronic/brushless insulation tester)

16.2 CREEPAGE DISTANCES AND CLEARANCES

Compliance	IEC 60255-27: 2013
Pollution degree	3
Overvoltage category	III
Impulse test voltage (not RJ45)	5 kV
Impulse test voltage (RJ45)	1 kV

16.3 HIGH VOLTAGE (DIELECTRIC) WITHSTAND

IEC Compliance	IEC 60255-27: 2013
Between all independent circuits	2 kV ac rms for 1 minute
Between independent circuits and protective earth conductor terminal	2 kV ac rms for 1 minute
Between all case terminals and the case earth	2 kV ac rms for 1 minute
Across open watchdog contacts	1 kV ac rms for 1 minute
Across open contacts of changeover output relays	1 kV ac rms for 1 minute
Between all RJ45 contacts and protective earth	1 kV ac rms for 1 minute
Between all screw-type EIA(RS)485 contacts and protective earth	1 kV ac rms for 1 minute
ANSI/IEEE Compliance	ANSI/IEEE C37.90-2005
Across open contacts of normally open output relays	1.5 kV ac rms for 1 minute
Across open contacts of normally open changeover output relays	1 kV ac rms for 1 minute
Across open watchdog contacts	1 kV ac rms for 1 minute

16.4 IMPULSE VOLTAGE WITHSTAND TEST

Compliance	IEC 60255-27: 2013
Between all independent circuits	Front time: 1.2 µs, Time to half-value: 50 µs, Peak value: 5 kV, 0.5 J
Between terminals of all independent circuits	Front time: 1.2 µs, Time to half-value: 50 µs, Peak value: 5 kV, 0.5 J
Between all independent circuits and protective earth conductor terminal	Front time: 1.2 µs, Time to half-value: 50 µs, Peak value: 5 kV, 0.5 J

Note:
Exceptions are communications ports and normally-open output contacts, where applicable.

17 ELECTROMAGNETIC COMPATIBILITY

17.1 1 MHZ BURST HIGH FREQUENCY DISTURBANCE TEST

Compliance	IEC 60255-22-1: 2008, Class III, IEC 60255-26:2013
Common-mode test voltage (level 3)	2.5 kV
Differential test voltage (level 3)	1.0 kV

17.2 DAMPED OSCILLATORY TEST

Compliance	EN61000-4-18: 2011: Level 3, 100 kHz and 1 MHz. Level 4: 3 MHz, 10 MHz and 30 MHz, IEC 60255-26:2013
Common-mode test voltage (level 3)	2.5 kV
Common-mode test voltage (level 4)	4.0 kV
Differential mode test voltage	1.0 kV

17.3 IMMUNITY TO ELECTROSTATIC DISCHARGE

Compliance	IEC 60255-26:2013, IEC 61000-4-2:2009
Class 4 Condition	15 kV discharge in air to user interface, display, and exposed metalwork
Class 3 Condition	8 kV discharge in air to all communication ports

17.4 ELECTRICAL FAST TRANSIENT OR BURST REQUIREMENTS

Compliance	IEC 60255-26:2013, IEC 61000-4-4:2012
Applied to communication inputs	Amplitude: 2 kV, burst frequency 5 kHz and 100 KHz (level 4)
Applied to power supply and all other inputs except for communication inputs	Amplitude: 4 kV, burst frequency 5 kHz and 100 KHz (level 4)

17.5 SURGE WITHSTAND CAPABILITY

Compliance	IEEE/ANSI C37.90.1: 2002
Condition 1	4 kV fast transient and 2.5 kV oscillatory applied common mode and differential mode to opto inputs, output relays, CTs, VTs, power supply
Condition 2	4 kV fast transient and 2.5 kV oscillatory applied common mode to communications, IRIG-B

17.6 SURGE IMMUNITY TEST

Compliance	IEC 60255-26:2013, IEC 61000-4-5:2014+AMD1:2017
Pulse duration	Time to half-value: 1.2/50 µs
Between all groups and protective earth conductor terminal	Amplitude 4 kV
Between terminals of each group (excluding communications ports, where applicable)	Amplitude 2 kV

17.7 IMMUNITY TO RADIATED ELECTROMAGNETIC ENERGY

Compliance	IEC 60255-26:2013, IEC 61000-4-3:2006 + A2:2010
Frequency band	80 MHz to 3.0 GHz
Spot tests at	80, 160, 380, 450, 900, 1850, 2150 MHz
Test field strength	10 V/m
Test using AM	1 kHz @ 80%
Compliance	IEEE/ANSI C37.90.2: 2004
Frequency band	80 MHz to 1 GHz
Spot tests at	80, 160, 380, 450 MHz
Waveform	1 kHz @ 80% am and pulse modulated
Field strength	35 V/m

17.8 RADIATED IMMUNITY FROM DIGITAL COMMUNICATIONS

Compliance	IEC 61000-4-3:2006 + A2:2010
Frequency bands	800 to 960 MHz, 1.4 to 2.0 GHz
Test field strength	30 V/m
Test using AM	1 kHz / 80%

17.9 RADIATED IMMUNITY FROM DIGITAL RADIO TELEPHONES

Compliance	IEC 60255-26:2013, IEC 61000-4-3:2006 + A2:2010
Frequency bands	900 MHz and 1.89 GHz
Test field strength	10 V/m

17.10 IMMUNITY TO CONDUCTED DISTURBANCES INDUCED BY RADIO FREQUENCY FIELDS

Compliance	IEC 60255-26:2013, IEC 61000-4-6:2013 Level 3
Frequency bands	150 kHz to 80 MHz

Test disturbance voltage	10 V rms
Test using AM	1 kHz @ 80%
Spot tests	27 MHz and 68 MHz

17.11 MAGNETIC FIELD IMMUNITY

Compliance	IEC 61000-4-8:2009 Level 5 IEC 61000-4-9:2016 Level 5 IEC 61000-4-10:2016 Level 5
IEC 61000-4-8 test	100 A/m applied continuously, 1000 A/m applied for 3 s
IEC 61000-4-9 test	1000 A/m applied in all planes
IEC 61000-4-10 test	100 A/m applied in all planes at 100 kHz/1 MHz with a burst duration of 2 seconds

17.12 CONDUCTED EMISSIONS

Compliance	IEC 60255-26:2013, EN 55016-2-1:2014
Power supply test 1	0.15 - 0.5 MHz, 79 dBμV (quasi peak) 66 dBμV (average)
Power supply test 2	0.5 – 30 MHz, 73 dBμV (quasi peak) 60 dBμV (average)
RJ45 test 1 (where applicable)	0.15 - 0.5 MHz, 97 dBμV (quasi peak) 84 dBμV (average)
RJ45 test 2 (where applicable)	0.5 – 30 MHz, 87 dBμV (quasi peak) 74 dBμV (average)

17.13 RADIATED EMISSIONS

Compliance	IEC 60255-26:2013
Test 1	30 – 230 MHz, 40 dBμV/m at 10 m measurement distance
Test 2	230 – 1 GHz, 47 dBμV/m at 10 m measurement distance
Test 3	1 – 2 GHz, 76 dBμV/m at 10 m measurement distance

17.14 POWER FREQUENCY

Compliance	IEC 60255-26:2013, IEC 61000-4-16:2015
Opto-inputs (Compliance is achieved using the opto-input filter)	300 V common-mode (Class A) 150 V differential mode (Class A)

> *Note:*
> *Compliance is achieved using the opto-input filter.*

APPENDIX A

ORDERING OPTIONS

Variants Order No.			Order No.
Generator Protection Relay			P345
Design Suffix			
As K plus increased main processor memory (XCPU3)			M
Extended Phase 2 CPU			K
Vx Auxiliary Rating			
24 - 54Vdc			7
48 - 125Vdc (40 - 100Vac)			8
110 - 250Vdc, 100 - 240Vac			9
In/Vn Rating			
In = 1/5A, Vn = 100 - 120Vac			1
In = 1/5A, Vn = 380 - 480Vac			2
Hardware Options	Protocol Compatibility	Design Suffix Compatibility	
Standard - None	1, 2, 3 & 4	K/M	1
IRIG-B Only (modulated)	1, 2, 3 & 4	K/M	2
Fibre Optic Converter Only (withdrawn)	1, 2, 3 & 4	K/M	~~3~~
IRIG-B (modulated) & Fibre Optic Converter	1, 2, 3 & 4	K/M	4
Ethernet (100Mbit/s)	6, 8	K/M	6
2nd Rear Comms	1, 2, 3 & 4	K/M	7
IRIG-B (modulated) & 2nd Rear Comms	1, 2, 3 & 4	K/M	8
Ethernet (100Mbit/s) plus IRIG-B (modulated)	6, 8	K/M	A
Ethernet (100Mbit/s) plus IRIG-B (un-modulated)	6, 8	K/M	B
IRIG-B (un-modulated)	1, 2, 3 & 4	K/M	C
Redundant Ethernet Self-Healing Ring, 2 multi-mode fibre ports + IRIG-B (modulated)	6, 8	K/M *	G
Redundant Ethernet Self-Healing Ring, 2 multi-mode fibre ports + IRIG-B (un-modulated)	6, 8	K/M *	H
Redundant Ethernet RSTP, 2 multi-mode fibre ports + IRIG-B (modulated)	6, 8	K/M *	J
Redundant Ethernet RSTP, 2 multi-mode fibre ports + IRIG-B (un-modulated)	6, 8	K/M *	K
Redundant Ethernet Dual Homing Star, 2 multi-mode fibre ports + IRIG-B (modulated)	6, 8	K/M *	L
Redundant Ethernet Dual-Homing Star, 2 multi-mode fibre ports + IRIG-B (un-modulated)	6, 8	K/M *	M
Redundant Ethernet PRP/HSR, 2 fibre ports + Modulated IRIG-B	6, 8	K/M **	N
Redundant Ethernet PRP/HSR, 2 fibre ports + Unmodulated IRIG-B	6, 8	K/M **	P
Redundant Ethernet PRP/HSR/RSTP/Failover, 2 multi-mode fibre ports + Modulated/Un-Modulated IRIG-B	6, 8	M	R
Redundant Ethernet PRP/HSR/RSTP/Failover, 2 copper ports RJ45 + Modulated/Un-Modulated IRIG-B	6, 8	M	S
Redundant Ethernet PRP/HSR/RSTP/Failover, 1 copper port RJ45 + 1 multi-mode fibre port + Modulated/Un-Modulated IRIG-B	6, 8	M	T
* Options are only available with software version 35 and later			
** Options are only available with software version 36 and later			
Product Specific Option			
Size 16 Case, No Option (24 Opto Inputs + 24 Relay Outputs)			A
Size 16 Case, 24 Opto Inputs + 24 Relay Outputs + RTD			B
Size 16 Case, 24 Opto Inputs + 24 Relay Outputs + CLIO			C
Size 16 Case, 32 Opto Inputs + 24 Relay Outputs			D
Size 16 Case, 24 Opto Inputs + 32 Relay Outputs			E
Size 16 Case, 24 Opto Inputs + 24 Relay Outputs + RTD + CLIO			F
Size 16 Case, 32 Opto Inputs + 24 Relay Outputs + RTD			G
Size 16 Case, 24 Opto Inputs + 32 Relay Outputs + RTD			H
Size 16 Case, 32 Opto Inputs + 16 Relay Outputs + RTD + CLIO			J
Size 16 Case, 16 Opto Inputs + 32 Relay Outputs + RTD + CLIO			K
Size 16 Case, 24 Opto Inputs + 16 Relay Outputs + 4 High Break Outputs			L
Size 16 Case, 24 Opto Inputs + 16 Relay Outputs + 4 High Break Outputs + RTD			M
Size 16 Case, 24 Opto Inputs + 16 Relay Outputs + 4 High Break Outputs + CLIO			N
Size 16 Case, 24 Opto Inputs + 16 Relay Outputs + 4 High Break Outputs + RTD + CLIO			P
Size 16 Case, 16 Opto Inputs + 16 Relay Outputs + 8 High Break Outputs			Q
Size 16 Case, 16 Opto Inputs + 16 Relay Outputs + 8 High Break Outputs + RTD			R
Size 16 Case, 16 Opto Inputs + 16 Relay Outputs + 8 High Break Outputs + CLIO			S
Size 16 Case, 16 Opto Inputs + 16 Relay Outputs + 8 High Break Outputs + RTD + CLIO			T
Protocol / Communications Options	Hardware Compatibility	Design Suffix Compatibility	
K-Bus	1, 2, 3, 4, 7, 8, C	K/M	1
Modbus	1, 2, 3, 4, 7, 8, C	K/M	2
IEC 60870-5-103 (VDEW)	1, 2, 3, 4, 7, 8, C	K/M	3
DNP3.0	1, 2, 3, 4, 7, 8, C	K/M	4
IEC61850 + Courier (via rear RS485 port)	6, A & B G, H, J, K, L, M * N, P **	K/M K/M K/M	6
DNP3.0 Over Ethernet with Courier rear port K-Bus/RS485 protocol	6, A, B, G, H, J, K, L, M, N, P ***	M only	8
* Options are only available with software version 35 and later			
** Options are only available with software version 36 and later			
*** Options are only available with software version 38 and later			
Mounting Option			
Flush/Panel Mounting with Harsh Env.Coating, White Front Panel			M
19" Rack Mounting with Harsh Env. Coating, White Front Panel			N
Panel Mounting, with harsh environment coating			P
Rack Mounting, with harsh environment coating			Q
Flush/Panel Mounting with Harsh Env. Coating, with USB Port, Black and Silver Front Panel			S
19" Rack Mounting with Harsh Env. Coating, with USB Port, Black and Silver Front Panel			T
Multilingual Language Option			
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 Issue			**
Customisation			
Default			0
Customer			A

Note: The following items are obsolete so they need to be ordered separately

Item	**PCS Material/Ordering code**
20 Hz Generator	P345:20HZ-GEN-*
Bandpass Filter	P345:BP-FILTER-*
400/5A Tripping CT	P345:CT
Generator and Filter mounting	Surface-mounting S Flush-mounting F Rail-mounting R

APPENDIX B

SETTINGS AND SIGNALS

.

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
SYSTEM DATA	00.00		
Language	00.01	English	From 0 to 3 in steps of 1 *[Indexed String]*
Password	00.02	AAAA	From 65 to 90 in steps of 1 *[ASCII Password(8 chars)]*
This setting defines the plain text password.			
Sys Fn Links	00.03		From 1 to 1 in steps of 1 *[Binary Flag (8 bits); Indexed Strings]*
This setting allows 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). Only bit 0 is used.			
Description	00.04	MiCOM P34*	From 32 to 163 in steps of 1 *[ASCII Text(16 chars)]*
* = 1 for Model 1, 2 for Model 2, 3 for Model 3, 4 for Model 4, 5 for Model 5, 6 for Model 6, 7 for Model 7, 8 for Model 8			
Plant Reference	00.05	MiCOM	From 32 to 163 in steps of 1 *[ASCII Text(16 chars)]*
In this cell, you can enter and edit a 16 character plant description.			
Model Number	00.06	Model Number	Model Number *[ASCII Text(32 chars)]*
This cell displays the IED model number. This cannot be edited.			
Serial Number	00.08	Serial Number	Serial Number *[ASCII Text(7 chars)]*
This cell displays the IED serial number. This cannot be edited			
Frequency	00.09	50	50 or 60 *[Unsigned Integer(8 bits)]*
This cell sets the mains frequency to either 50 Hz or 60 Hz			
Comms Level	00.0A	2	Comms Level *[Unsigned Integer(16 bits)]*
This cell displays the Courier communications conformance level			
Relay Address	00.0B	1	From 0 to 255 in steps of 1 *[Unsigned Integer(16 bits)]*
Plant Status	00.0C		Plant Status *[Binary Flag(16 bits)]*
This cell displays the circuit breaker plant status. The first two bits are used. One to indicate the 52A state and one to indicate the 52B state.			
Control Status	00.0D		Control Status *[Binary Flag(16 bits)]*
Active Group	00.0E		Active Group *[Unsigned Integer(16 bits)]*
CB Trip/Close	00.10	No Operation	
Visible to LCD+Front Port			
CB Trip/Close	00.10	No Operation	
Visible to Rear Port			
Software Ref. 1	00.11		Software Ref. 1 *[ASCII Text(16 chars)]*
Software Ref 2	00.12		Software Ref 2 *[ASCII Text(16 chars)]*
Ethernet Card Software Reference, if fitted.			
Opto I/P Status	00.20		Opto I/P Status *[Binary Flag; Indexed String]*
The original register 30007 is available for opto inputs #1 to #16			
Relay O/P Status	00.21		Relay O/P Status *[Binary Flag; Indexed String]*
Alarm Status 1	00.22		Alarm Status 1

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
			[Binary Flag; Indexed String]
Opto I/P Status	00.30		Opto I/P Status *[Binary Flag; Indexed String]*
The original register 30007 is available for opto inputs #1 to #16			
Relay O/P Status	00.40		Relay O/P Status *[Binary Flag; Indexed String]*
Alarm Status 1	00.50		Alarm Status 1 *[Binary Flag; Indexed String]*
Alarm Status 2	00.51		Alarm Status 2 *[Binary Flag; Indexed String]*
Alarm Status 3	00.52		Alarm Status 3 *[Binary Flag(32 bits); Indexed String]*
Access Level	00.D0		Access Level *[Unsigned Integer(16 bits)]*
Password Level 1	00.D2	AAAA	From 65 to 90 in steps of 1 *[ASCII Password(8 chars)]*
Password Level 2	00.D3	AAAA	From 65 to 90 in steps of 1 *[ASCII Password(8 chars)]*
Password Level 3	00.D4	AAAA	From 65 to 90 in steps of 1 *[ASCII Password(8 chars)]*
Security Feature	00.DF		Security Feature *[Unsigned Integer (16-bits)]*
This setting displays the level of cyber security implemented, 1 = phase 1.			
Username	00.E0		
There are three Authentication methods suppored by P40 Authentication framework. • Legacy Device Authentication • Device Authentication (RBAC) • Server Authentication (RBAC) Respectively, acceptable username are, • Empty • Enumaratrion including ADMINISTRATOR, ENGINEER, OPERATOR and VIEWER • Usernames are restricted to a maximum of 16 characters. Only uppercase A to Z and numbers 0 to 9 are permissible username characters.			
Password	00.E1		From 33 to 122 in steps of 1 *[Encrypted Password (8 chars)]*
This cell allows you to enter the encrypted password. It is not visible via the user interfaced.			
Password Level 1	00.E2	AAAA	From 33 to 122 in steps of 1 *[Encrypted Password (8 chars)]*
This setting allows you to change the encrypted password level 1. This is not visible via the user interface.			
Password Level 2	00.E3	AAAA	From 33 to 122 in steps of 1 *[Encrypted Password (8 chars)]*
This setting allows you to change the encrypted password level 2. This is not visible via the user interface.			
Password Level 3	00.E4	AAAA	From 33 to 122 in steps of 1 *[Encrypted Password (8 chars)]*
This setting allows you to change the encrypted password level 3. This is not visible via the user interface.			
VIEW RECORDS	01.00		
Previous Modbus addresses in the event and fault records are retained for backward compatibility.			
Menu Cell Ref	01.02	(From Record)	Menu Cell Ref *[Cell Reference]*
Indicates type of event. Previous Modbus address - 3x00107; See Event sheet			
Time & Date	01.03	(From Record)	Time & Date

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
			[IEC870 Time & Date]
Previous Modbus address - 3x00103 to 3x00106			
Event Text	01.04		Event Text *[Ascii String (32 chars)]*
See Event sheet			
Event Value	01.05		Event Value *[Unsigned Int / Binary Flag (32 bits)]*
Previous addresses - 3x00108 to 3x00109 binary flag for contact, opto, alarm & protection events. Unsigned integers for maintenance records. Details see Event sheet.			
Select Fault	01.06		From 0 to 20 in steps of 1 *[Unsigned Integer (16 bits)]*
Allows Fault Record to be selected			
Faulted Phase	01.40		Faulted Phase *[Binary Flag (8 Bits)]*
Previous Modbus address 3x00113. For fault record use only.			
Start Elements1	01.42		Start Elements1 *[Binary Flag (32 Bits)]*
Previous Modbus address 3x00114 to 3x00115. For fault record use only.			
Start Elements2	01.43		Start Elements2 *[Binary Flag (32 Bits)]*
Previous Modbus address 3x00116 to 3x00117. For fault record use only.			
Start Elements3	01.44		Start Elements3 *[Binary Flag (32 Bits)]*
For fault record use only.			
Start Elements4	01.45		Start Elements4 *[Binary Flag (32 Bits)]*
For fault record use only.			
Trip Elements1	01.49		Trip Elements1 *[Binary Flag (32 Bits)]*
Previous Modbus address 3x00118 to 3x00119. For fault record use only.			
Trip Elements2	01.4A		Trip Elements2 *[Binary Flag (32 Bits)]*
Previous Modbus address 3x00120 to 3x00121. For fault record use only.			
Trip Elements3	01.4B		Trip Elements3 *[Binary Flag (32 Bits)]*
For fault record use only.			
Trip Elements4	01.4C		Trip Elements4 *[Binary Flag (32 Bits)]*
Fault Alarms	01.50		Fault Alarms *[Binary Flag (32 Bits)]*
Previous Modbus address 3x00122 to 3x00123. For fault record use only.			
Fault Alarms 2	01.51		Fault Alarms 2 *[Binary Flag (32 Bits)]*
Fault Time	01.55	(From Record)	Fault Time *[IEC870 Time & Date]*
Previous Modbus address 3x00124 to 3x00127. For fault record use only.			
Active Group	01.57		Active Group *[Unsigned Integer]*
Previous Modbus address 3x00128. For fault record use only.			
System Frequency	01.59		System Frequency *[Courier Number (frequency)]*
Previous Modbus address 3x00129. For fault record use only.			
Fault Duration	01.5B		Fault Duration *[Courier Number (time)]*
Previous Modbus addresses 3x00130 to 3x00131. For fault record use only.			
CB Operate Time	01.5E		CB Operate Time *[Courier Number (time)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Previous Modbus address 3x00132. For fault record use only.			
Relay Trip Time	01.60		Relay Trip Time *[Courier Number (time)]*
Previous Modbus addresses 3x00133 to 3x00134. For fault record use only.			
IA IA-1 IA-1 RMS	01.62		IA IA-1 IA-1 RMS *[Courier Number (current)]*
Previous Modbus addresses 3x00135 to 3x00136. For fault record use only.			
IB IB-1 IB-1 RMS	01.63		IB IB-1 IB-1 RMS *[Courier Number (current)]*
Previous Modbus addresses 3x00137 to 3x00138. For fault record use only.			
IC IC-1 IC-1 RMS	01.64		IC IC-1 IC-1 RMS *[Courier Number (current)]*
Previous Modbus addresses 3x00139 to 3x00140. For fault record use only.			
VAB	01.65		VAB *[Courier Number (voltage)]*
Previous Modbus addresses 3x00141 to 3x00142. For fault record use only.			
VBC	01.66		VBC *[Courier Number (voltage)]*
Previous Modbus addresses 3x00143 to 3x00144. For fault record use only.			
VCA	01.67		VCA *[Courier Number (voltage)]*
Previous Modbus addresses 3x00145 to 3x00146. For fault record use only.			
VAN VA-1 RMS	01.68		VAN VA-1 RMS *[Courier Number (voltage)]*
Previous Modbus addresses 3x00147 to 3x00148. For fault record use only.			
VBN VB-1 RMS	01.69		VBN VB-1 RMS *[Courier Number (voltage)]*
Previous Modbus addresses 3x00149 to 3x00150. For fault record use only.			
VCN VC-1 RMS	01.6A		VCN VC-1 RMS *[Courier Number (voltage)]*
Previous Modbus addresses 3x00151 to 3x00152. For fault record use only.			
IA-2 IA-2 RMS	01.70		IA-2 IA-2 RMS *[Courier Number (current)]*
Previous Modbus addresses 3x00153 to 3x00154. For fault record use only.			
IB-2 IB-2 RMS	01.71		IB-2 IB-2 RMS *[Courier Number (current)]*
Previous Modbus addresses 3x00155 to 3x00156. For fault record use only.			
IC-2 IC-2 RMS	01.72		IC-2 IC-2 RMS *[Courier Number (current)]*
Previous Modbus addresses 3x00157 to 3x00158. For fault record use only.			
IA Differential	01.80		IA Differential *[Courier Number (current)]*
Previous Modbus addresses 3x00159 to 3x00160. For fault record use only.			
IB Differential	01.81		IB Differential *[Courier Number (current)]*
Previous Modbus addresses 3x00161 to 3x00162. For fault record use only.			
IC Differential	01.82		IC Differential *[Courier Number (current)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Previous Modbus addresses 3x00163 to 3x00164. For fault record use only.			
IA Diff PU	01.83		IA Diff PU *[Courier Number (current)]*
IB Diff PU	01.84		IB Diff PU *[Courier Number (current)]*
IC Diff PU	01.85		IC Diff PU *[Courier Number (current)]*
IA Diff 2H	01.86		IA Diff 2H *[Courier Number (current)]*
IB Diff 2H	01.87		IB Diff 2H *[Courier Number (current)]*
IC Diff 2H	01.88		IC Diff 2H *[Courier Number (current)]*
IA Diff 5H	01.89		IA Diff 5H *[Courier Number (current)]*
IB Diff 5H	01.8A		IB Diff 5H *[Courier Number (current)]*
IC Diff 5H	01.8B		IC Diff 5H *[Courier Number (current)]*
VN Measured VN1 Measured	01.90		VN Measured VN1 Measured *[Courier Number (voltage)]*
Previous Modbus addresses 3x00165 to 3x00166. For fault record use only.			
VN2 Measured	01.92		VN2 Measured *[Courier Number (voltage)]*
For fault record use only.			
VN Derived VN-1 Derived RMS	01.94		VN Derived VN-1 Derived RMS *[Courier Number (voltage)]*
Previous Modbus addresses 3x00167 to 3x00168. For fault record use only.			
IN Measured IN Derived	01.96		IN Measured IN Derived *[Courier Number (current)]*
Previous Modbus addresses 3x00169 to 3x00170. For fault record use only.			
I Sensitive1	01.99		I Sensitive1 *[Courier Number (current)]*
Previous Modbus addresses 3x00171 to 3x00172. For fault record use only.			
I Sensitive2	01.9A		I Sensitive2 *[Courier Number (current)]*
IREF Diff	01.9C		IREF Diff *[Courier Number (current)]*
Previous Modbus addresses 3x00173 to 3x00174. For fault record use only.			
IREF Bias	01.9D		IREF Bias *[Courier Number (current)]*
Previous Modbus addresses 3x00175 to 3x00176. For fault record use only.			
I2	01.A0		I2 *[Courier Number (current)]*
Previous Modbus addresses 3x00177 to 3x00178. For fault record use only.			
V2	01.A2		V2

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
			[Courier Number (voltage)]
For fault record use only.			
3 Phase Watts	01.A6		3 Phase Watts *[Courier Number (Power)]*
Previous Modbus addresses 3x00179 to 3x00180. For fault record use only.			
3 Phase VArs	01.A8		3 Phase VArs *[Courier Number (VAr)]*
Previous Modbus addresses 3x00181 to 3x00182. For fault record use only.			
3Ph Power Factor	01.AA		3Ph Power Factor *[Courier Number (Decimal)]*
Previous Modbus address 3x00183. For fault record use only.			
Sen Watts	01.AB		Sen Watts *[Courier Number (Power)]*
Single phase for non P345 and single phase or Wattmetric depending on Setting [4721] for P345			
Sen VArs	01.AC		Sen VArs *[Courier Number (VAr)]*
Single phase for non P345 and single phase or Wattmetric depending on Setting [4721] for P345			
Sen Power Factor	01.AD		Sen Power Factor *[Courier Number (Decimal)]*
Single phase for non P345 and single phase or Wattmetric depending on Setting [4721] for P345			
RTD 1	01.B0		RTD 1 *[Courier Number (Temperature)]*
Previous Modbus address 3x00184. For fault record use only. Courier text = RTD Label setting			
RTD 2	01.B1		RTD 2 *[Courier Number (Temperature)]*
Previous Modbus address 3x00185. For fault record use only. Courier text = RTD Label setting			
RTD 3	01.B2		RTD 3 *[Courier Number (Temperature)]*
Previous Modbus address 3x00186. For fault record use only. Courier text = RTD Label setting			
RTD 4	01.B3		RTD 4 *[Courier Number (Temperature)]*
Previous Modbus address 3x00187. For fault record use only. Courier text = RTD Label setting			
RTD 5	01.B4		RTD 5 *[Courier Number (Temperature)]*
Previous Modbus address 3x00188. For fault record use only. Courier text = RTD Label setting			
RTD 6	01.B5		RTD 6 *[Courier Number (Temperature)]*
Previous Modbus address 3x00189. For fault record use only. Courier text = RTD Label setting			
RTD 7	01.B6		RTD 7 *[Courier Number (Temperature)]*
Previous Modbus address 3x00190. For fault record use only. Courier text = RTD Label setting			
RTD 8	01.B7		RTD 8 *[Courier Number (Temperature)]*
Previous Modbus address 3x00191. For fault record use only. Courier text = RTD Label setting			
RTD 9	01.B8		RTD 9 *[Courier Number (Temperature)]*
Previous Modbus address 3x00192. For fault record use only. Courier text = RTD Label setting			
RTD 10	01.B9		RTD 10 *[Courier Number (Temperature)]*
Previous Modbus address 3x00193. For fault record use only. Courier text = RTD Label setting			
df/dt	01.C2		df/dt *[Courier Number (Hz/s)]*
Previous Modbus address 3x00194. For fault record use only.			
CLIO Input 1	01.C6		CLIO Input 1 *[Courier Number (Decimal)]*
Previous Modbus address 3x00490. For fault record use only. Courier text = RTD Label setting			
CLIO Input 2	01.C7		CLIO Input 2 *[Courier Number (Decimal)]*
Previous Modbus address 3x00492. For fault record use only. Courier text = RTD Label setting			

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
CLIO Input 3	01.C8		CLIO Input 3 *[Courier Number (Decimal)]*
Previous Modbus address 3x00494. For fault record use only. Courier text = RTD Label setting			
CLIO Input 4	01.C9		CLIO Input 4 *[Courier Number (Decimal)]*
Previous Modbus address 3x00496. For fault record use only. Courier text = RTD Label setting			
64S V Magnitude	01.CA		64S V Magnitude *[Courier Number (voltage)]*
For fault record use only.			
64S I Magnitude	01.CB		64S I Magnitude *[Courier Number (current)]*
For fault record use only.			
64S R primary	01.CC		64S R primary *[Courier Number (resistance)]*
For fault record use only.			
64R CL Input	01.CD		64R CL Input *[Courier Number (current)]*
For fault record use only.			
64R R Fault	01.CE		64R R Fault *[Courier Number (resistance)]*
For fault record use only.			
IA Peak Mag IA-1 Peak	01.E4		IA Peak Mag IA-1 Peak *[Courier Number (Current)]*
IA Peak Magnitude			
IB Peak Mag IB-1 Peak	01.E5		IB Peak Mag IB-1 Peak *[Courier Number (Current)]*
IB Peak Magnitude			
IC Peak Mag IC-1 Peak	01.E6		IC Peak Mag IC-1 Peak *[Courier Number (Current)]*
IC Peak Magnitude			
I2t Phase A-1	01.E7		I2t Phase A-1 *[Courier Number (I2t)]*
I2t Phase A			
I2t Phase B-1	01.E8		I2t Phase B-1 *[Courier Number (I2t)]*
I2t Phase B			
I2t Phase C-1	01.E9		I2t Phase C-1 *[Courier Number (I2t)]*
I2t Phase C			
IA-2 Peak Mag IA-2 Peak	01.EA		IA-2 Peak Mag IA-2 Peak *[Courier Number (Current)]*
IA Peak Magnitude			
IB-2 Peak Mag IB-2 Peak	01.EB		IB-2 Peak Mag IB-2 Peak *[Courier Number (Current)]*
IB Peak Magnitude			
IC-2 Peak Mag IC-2 Peak	01.EC		IC-2 Peak Mag IC-2 Peak *[Courier Number (Current)]*
IC Peak Magnitude			
I2t Phase A-2	01.ED		I2t Phase A-2 *[Courier Number (I2t)]*
I2t Phase A			
I2t Phase B-2	01.EE		I2t Phase B-2 *[Courier Number (I2t)]*
I2t Phase B			

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
I2t Phase C-2	01.EF		I2t Phase C-2 *[Courier Number (I2t)]*
I2t Phase C			
Select Maint	01.F0	Manual override to select a fault record.	From 0 to 9 in steps of 1 *[Unsigned Integer (16 bits)]*
Allows Self Test Report to be selected			
Maint Text	01.F1		Maint Text *[Ascii Text (32 chars)]*
Maint Type	01.F2		Maint Type *[Unsigned integer (32 bits)]*
Maint Data	01.F3		Maint Data *[Unsigned integer (32 bits)]*
Evt Iface Source	01.FA		Evt Iface Source *[Integer byte field]*
Cyber Security event states			
Evt Access Level	01.FB		Evt Access Level *[Integer byte field]*
Cyber Security event states			
Evt Extra Info	01.FC		Evt Extra Info *[Integer byte field]*
Cyber Security event states			
Evt Unique Id	01.FE		Evt Unique Id *[Unsigned integer]*
Cyber Security event states			
Reset Indication	01.FF	No	
MEASUREMENTS 1	02.00		
IA Magnitude IA-1 Magnitude	02.01		IA Magnitude IA-1 Magnitude *[Courier Number (current)]*
IA Phase Angle IA-1 Phase Angle	02.02		IA Phase Angle IA-1 Phase Angle *[Courier Number (angle)]*
IB Magnitude IB-1 Magnitude	02.03		IB Magnitude IB-1 Magnitude *[Courier Number (current)]*
IB Phase Angle IB-1 Phase Angle	02.04		IB Phase Angle IB-1 Phase Angle *[Courier Number (angle)]*
IC Magnitude IC-1 Magnitude	02.05		IC Magnitude IC-1 Magnitude *[Courier Number (current)]*
IC Phase Angle IC-1 Phase Angle	02.06		IC Phase Angle IC-1 Phase Angle *[Courier Number (angle)]*
IN Measured Mag	02.07		IN Measured Mag *[Courier Number (current)]*
IN Measured Ang	02.08		IN Measured Ang *[Courier Number (angle)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
IN Derived Mag IN-1 Derived Mag	02.09		IN Derived Mag IN-1 Derived Mag *[Courier Number (current)]*
Isen1 Magnitude	02.0B		Isen1 Magnitude *[Courier Number (current)]*
Isen1 Angle	02.0C		Isen1 Angle *[Courier Number (angle)]*
I1 Magnitude	02.0D		I1 Magnitude *[Courier Number (current)]*
I2 Magnitude	02.0E		I2 Magnitude *[Courier Number (current)]*
I0 Magnitude	02.0F		I0 Magnitude *[Courier Number (current)]*
IA RMS IA-1 RMS	02.10		IA RMS IA-1 RMS *[Courier Number (current)]*
IB RMS IB-1 RMS	02.11		IB RMS IB-1 RMS *[Courier Number (current)]*
IC RMS IC-1 RMS	02.12		IC RMS IC-1 RMS *[Courier Number (current)]*
IN-2 Derived Mag	02.13		IN-2 Derived Mag *[Courier Number (current)]*
VAB Magnitude	02.14		VAB Magnitude *[Courier Number (voltage)]*
VAB Phase Angle	02.15		VAB Phase Angle *[Courier Number (angle)]*
VBC Magnitude	02.16		VBC Magnitude *[Courier Number (voltage)]*
VBC Phase Angle	02.17		VBC Phase Angle *[Courier Number (angle)]*
VCA Magnitude	02.18		VCA Magnitude *[Courier Number (voltage)]*
VCA Phase Angle	02.19		VCA Phase Angle *[Courier Number (angle)]*
VAN Magnitude	02.1A		VAN Magnitude *[Courier Number (voltage)]*
VAN Phase Angle	02.1B		VAN Phase Angle *[Courier Number (angle)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
VBN Magnitude	02.1C		VBN Magnitude *[Courier Number (voltage)]*
VBN Phase Angle	02.1D		VBN Phase Angle *[Courier Number (angle)]*
VCN Magnitude	02.1E		VCN Magnitude *[Courier Number (voltage)]*
VCN Phase Angle	02.1F		VCN Phase Angle *[Courier Number (angle)]*
VN Measured Mag VN1 Measured Mag	02.20		VN Measured Mag VN1 Measured Mag *[Courier Number (voltage)]*
VN Measured Ang VN1 Measured Ang	02.21		VN Measured Ang VN1 Measured Ang *[Courier Number (angle)]*
VN Derived Mag	02.22		VN Derived Mag *[Courier Number (voltage)]*
VN Derived Ang	02.23		VN Derived Ang *[Courier Number (angle)]*
V1 Magnitude	02.24		V1 Magnitude *[Courier Number (voltage)]*
V2 Magnitude	02.25		V2 Magnitude *[Courier Number (voltage)]*
V0 Magnitude	02.26		V0 Magnitude *[Courier Number (voltage)]*
VAN RMS	02.27		VAN RMS *[Courier Number (voltage)]*
VBN RMS	02.28		VBN RMS *[Courier Number (voltage)]*
VCN RMS	02.29		VCN RMS *[Courier Number (voltage)]*
Isen2 Magnitude	02.2A		Isen2 Magnitude *[Courier Number (current)]*
Isen2 Angle	02.2B		Isen2 Angle *[Courier Number (angle)]*
Frequency	02.2D		Frequency *[Courier Number (frequency)]*
I1 Magnitude	02.40		I1 Magnitude *[Courier Number (current)]*
I1 Phase Angle	02.41		I1 Phase Angle *[Courier Number (angle)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
I2 Magnitude	02.42		I2 Magnitude *[Courier Number (current)]*
I2 Phase Angle	02.43		I2 Phase Angle *[Courier Number (angle)]*
I0 Magnitude	02.44		I0 Magnitude *[Courier Number (current)]*
I0 Phase Angle	02.45		I0 Phase Angle *[Courier Number (angle)]*
V1 Magnitude	02.46		V1 Magnitude *[Courier Number (voltage)]*
V1 Phase Angle	02.47		V1 Phase Angle *[Courier Number (angle)]*
V2 Magnitude	02.48		V2 Magnitude *[Courier Number (voltage)]*
V2 Phase Angle	02.49		V2 Phase Angle *[Courier Number (angle)]*
V0 Magnitude	02.4A		V0 Magnitude *[Courier Number (voltage)]*
V0 Phase Angle	02.4B		V0 Phase Angle *[Courier Number (angle)]*
VN2 Measured Mag	02.50		VN2 Measured Mag *[Courier Number (voltage)]*
VN2 Measured Ang	02.51		VN2 Measured Ang *[Courier Number (angle)]*
C/S Voltage Mag	02.70		C/S Voltage Mag *[Courier Number (voltage)]*
C/S Voltage Ang	02.71		C/S Voltage Ang *[Courier Number (angle)]*
CS Gen-Bus Mag	02.72		CS Gen-Bus Mag *[Courier Number (angle)]*
Visible if System Checks enabled			
CS Gen-Bus Angle	02.73		CS Gen-Bus Angle *[Courier Number (angle)]*
Visible if System Checks enabled			
Slip Frequency	02.74		Slip Frequency *[Courier Number (frequency)]*
Visible if System Checks enabled			
CS Frequency	02.75		CS Frequency *[Courier Number (frequency)]*
MEASUREMENTS 2	03.00		
A Phase Watts	03.01		A Phase Watts *[Courier Number (Power)]*
Alternative Modbus register pairs 30391 and 30392 available with improved G125 floating point data type			

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
B Phase Watts	03.02		B Phase Watts *[Courier Number (Power)]*
Alternative Modbus register pairs 30393 and 30394 available with improved G125 floating point data type			
C Phase Watts	03.03		C Phase Watts *[Courier Number (Power)]*
Alternative Modbus register pairs 30395 and 30396 available with improved G125 floating point data type			
A Phase VArs	03.04		A Phase VArs *[Courier Number (VAr)]*
Alternative Modbus register pairs 30397 and 30398 available with improved G125 floating point data type			
B Phase VArs	03.05		B Phase VArs *[Courier Number (VAr)]*
Alternative Modbus register pairs 30399 and 30400 available with improved G125 floating point data type			
C Phase VArs	03.06		C Phase VArs *[Courier Number (VAr)]*
Alternative Modbus register pairs 30401 and 30402 available with improved G125 floating point data type			
A Phase VA	03.07		A Phase VA *[Courier Number (VA)]*
Alternative Modbus register pairs 30403 and 30404 available with improved G125 floating point data type			
B Phase VA	03.08		B Phase VA *[Courier Number (VA)]*
Alternative Modbus register pairs 30405 and 30406 available with improved G125 floating point data type			
C Phase VA	03.09		C Phase VA *[Courier Number (VA)]*
Alternative Modbus register pairs 30407 and 30408 available with improved G125 floating point data type			
3 Phase Watts	03.0A		3 Phase Watts *[Courier Number (Power)]*
Alternative Modbus register pairs 30409 and 30410 available with improved G125 floating point data type			
3 Phase VArs	03.0B		3 Phase VArs *[Courier Number (VAr)]*
Alternative Modbus register pairs 30411 and 30412 available with improved G125 floating point data type			
3 Phase VA	03.0C		3 Phase VA *[Courier Number (VA)]*
Alternative Modbus register pairs 30413 and 30414 available with improved G125 floating point data type			
NPS Power S2	03.0D		NPS Power S2 *[Courier Number (VA)]*
Alternative Modbus register pairs 30500 and 30501 available with improved G125 floating point data type			
3Ph Power Factor	03.0E		3Ph Power Factor *[Courier Number (decimal)]*
APh Power Factor	03.0F		APh Power Factor *[Courier Number (decimal)]*
BPh Power Factor	03.10		BPh Power Factor *[Courier Number (decimal)]*
CPh Power Factor	03.11		CPh Power Factor *[Courier Number (decimal)]*
3Ph WHours Fwd	03.12		3Ph WHours Fwd *[Courier Number (Wh)]*
Alternative Modbus register pairs 30415 and 30416 available with improved G125 floating point data type			
3Ph WHours Rev	03.13		3Ph WHours Rev *[Courier Number (Wh)]*
Alternative Modbus register pairs 30417 and 30418 available with improved G125 floating point data type			
3Ph VArHours Fwd	03.14		3Ph VArHours Fwd *[Courier Number (VArh)]*
Alternative Modbus register pairs 30419 and 30420 available with improved G125 floating point data type			
3Ph VArHours Rev	03.15		3Ph VArHours Rev *[Courier Number (VArh)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Alternative Modbus register pairs 30421 and 30422 available with improved G125 floating point data type			
3Ph W Fix Demand	03.16		3Ph W Fix Demand *[Courier Number (Power)]*
Alternative Modbus register pairs 30423 and 30424 available with improved G125 floating point data type			
3Ph VArs Fix Dem	03.17		3Ph VArs Fix Dem *[Courier Number (Vars)]*
Alternative Modbus register pairs 30425 and 30426 available with improved G125 floating point data type			
IA Fixed Demand	03.18		IA Fixed Demand *[Courier Number (Current)]*
IB Fixed Demand	03.19		IB Fixed Demand *[Courier Number (Current)]*
IC Fixed Demand	03.1A		IC Fixed Demand *[Courier Number (Current)]*
3 Ph W Roll Dem	03.1B		3 Ph W Roll Dem *[Courier Number (Power)]*
Alternative Modbus register pairs 30427 and 30428 available with improved G125 floating point data type			
3Ph VArs RollDem	03.1C		3Ph VArs RollDem *[Courier Number (VAr)]*
Alternative Modbus register pairs 30429 and 30430 available with improved G125 floating point data type			
IA Roll Demand	03.1D		IA Roll Demand *[Courier Number (Current)]*
IB Roll Demand	03.1E		IB Roll Demand *[Courier Number (Current)]*
IC Roll Demand	03.1F		IC Roll Demand *[Courier Number (Current)]*
3Ph W Peak Dem	03.20		3Ph W Peak Dem *[Courier Number (Power)]*
Alternative Modbus register pairs 30431 and 30432 available with improved G125 floating point data type			
3Ph VAr Peak Dem	03.21		3Ph VAr Peak Dem *[Courier Number (VAr)]*
Alternative Modbus register pairs 30433 and 30434 available with improved G125 floating point data type			
IA Peak Demand	03.22		IA Peak Demand *[Courier Number (Current)]*
IB Peak Demand	03.23		IB Peak Demand *[Courier Number (Current)]*
IC Peak Demand	03.24		IC Peak Demand *[Courier Number (Current)]*
Reset Demand	03.25	No	
NPS Power S2 CT2	03.26		NPS Power S2 CT2 *[Courier Number (VA)]*
Alternative Modbus register pairs 30596 and 30597 available with improved G125 floating point data type			
MEASUREMENTS 3	04.00		
IA-2 Magnitude	04.01		IA-2 Magnitude *[Courier Number (Current)]*
IA-2 Phase Angle	04.02		IA-2 Phase Angle *[Courier Number (Angle)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
IB-2 Magnitude	04.03		IB-2 Magnitude *[Courier Number (Current)]*
IB-2 Phase Angle	04.04		IB-2 Phase Angle *[Courier Number (Angle)]*
IC-2 Magnitude	04.05		IC-2 Magnitude *[Courier Number (Current)]*
IC-2 Phase Angle	04.06		IC-2 Phase Angle *[Courier Number (Angle)]*
IA Differential	04.07		IA Differential *[Courier Number (Current)]*
IB Differential	04.08		IB Differential *[Courier Number (Current)]*
IC Differential	04.09		IC Differential *[Courier Number (Current)]*
IA Bias	04.0A		IA Bias *[Courier Number (Current)]*
IB Bias	04.0B		IB Bias *[Courier Number (Current)]*
IC Bias	04.0C		IC Bias *[Courier Number (Current)]*
IREF Diff	04.0D		IREF Diff *[Courier Number (Current)]*
IREF Bias	04.0E		IREF Bias *[Courier Number (Current)]*
VN 3rd Harmonic	04.0F		VN 3rd Harmonic *[Courier Number (Voltage)]*
NPS Thermal	04.10		NPS Thermal *[Courier Number (Percentage)]*
Reset NPSThermal	04.11	No	
RTD 1	04.12		RTD 1 *[Courier Number (Temperature)]*
Courier text = RTD label setting			
RTD 2	04.13		RTD 2 *[Courier Number (Temperature)]*
Courier text = RTD label setting			
RTD 3	04.14		RTD 3 *[Courier Number (Temperature)]*
Courier text = RTD label setting			
RTD 4	04.15		RTD 4 *[Courier Number (Temperature)]*
Courier text = RTD label setting			
RTD 5	04.16		RTD 5 *[Courier Number (Temperature)]*
Courier text = RTD label setting			

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
RTD 6	04.17		RTD 6 *[Courier Number (Temperature)]*
Courier text = RTD label setting			
RTD 7	04.18		RTD 7 *[Courier Number (Temperature)]*
Courier text = RTD label setting			
RTD 8	04.19		RTD 8 *[Courier Number (Temperature)]*
Courier text = RTD label setting			
RTD 9	04.1A		RTD 9 *[Courier Number (Temperature)]*
Courier text = RTD label setting			
RTD 10	04.1B		RTD 10 *[Courier Number (Temperature)]*
Courier text = RTD label setting			
RTD Open Cct	04.1C		RTD Open Cct *[Binary Flag (10 bits); Indexed String]*
RTD Short Cct	04.1D		RTD Short Cct *[Binary Flag (10 bits); Indexed String]*
RTD Data Error	04.1E		RTD Data Error *[Binary Flag (10 bits); Indexed String]*
Reset RTD Flags	04.1F	No	
Sen Watts	04.20		Sen Watts *[Courier Number (Power)]*
Single phase for non P345 and single phase or Wattmetric depending on Setting [4721] for P345			
Sen Vars	04.21		Sen Vars *[Courier Number (Var)]*
Single phase for non P345 and single phase or Wattmetric depending on Setting [4721] for P345			
Sen Power Factor	04.22		Sen Power Factor *[Courier Number (angle)]*
Single phase for non P345 and single phase or Wattmetric depending on Setting [4721] for P345			
Thermal Overload	04.23		Thermal Overload *[Courier Number (Percentage)]*
Reset ThermalO/L	04.24	No	
CLIO Input 1	04.25		CLIO Input 1 *[Courier Number (Decimal)]*
Courier Text = CLIO label setting			
CLIO Input 2	04.26		CLIO Input 2 *[Courier Number (Decimal)]*
Courier Text = CLIO label setting			
CLIO Input 3	04.27		CLIO Input 3 *[Courier Number (Decimal)]*
Courier Text = CLIO label setting			
CLIO Input 4	04.28		CLIO Input 4 *[Courier Number (Decimal)]*
Courier Text = CLIO label setting			
F Band1 Time (s)	04.30		F Band1 Time (s) *[Unsigned Integer (32 bits)]*
Turbine Abnormal Frequency (TAF). Band 1 Accumulated Time			
Reset Freq Band1	04.32	No	
Reset TAF Band 1 Time			
F Band2 Time (s)	04.34		F Band2 Time (s) *[Unsigned Integer (32 bits)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Turbine Abnormal Frequency (TAF). Band 2 Accumulated Time			
Reset Freq Band2	04.36	No	
Reset TAF Band 2 Time			
F Band3 Time (s)	04.38		F Band3 Time (s) *[Unsigned Integer (32 bits)]*
Turbine Abnormal Frequency (TAF). Band 3 Accumulated Time			
Reset Freq Band3	04.3A	No	
Reset TAF Band 3 Time			
F Band4 Time (s)	04.3C		F Band4 Time (s) *[Unsigned Integer (32 bits)]*
Turbine Abnormal Frequency (TAF). Band 4 Accumulated Time			
Reset Freq Band4	04.3E	No	
Reset TAF Band 4 Time			
F Band5 Time (s)	04.40		F Band5 Time (s) *[Unsigned Integer (32 bits)]*
Turbine Abnormal Frequency (TAF). Band 5 Accumulated Time			
Reset Freq Band5	04.42	No	
Reset TAF Band 5 Time			
F Band6 Time (s)	04.44		F Band6 Time (s) *[Unsigned Integer (32 bits)]*
Turbine Abnormal Frequency (TAF). Band 6 Accumulated Time			
Reset Freq Band6	04.46	No	
Reset TAF Band 6 Time			
df/dt	04.48		df/dt *[Courier Number (Hz/sec)]*
dep on df/dt setting in configuration collumn			
Volts/Hz	04.50		Volts/Hz *[Courier Number (Volts/Hz)]*
Vab/Frequency			
64S V Magnitude	04.52		64S V Magnitude *[Courier Number (voltage)]*
Low frequency injection St EF Voltage magnitude measured at the relay terminal			
64S I Magnitude	04.54		64S I Magnitude *[Courier Number (current)]*
Low frequency injection St EF Current magnitude measured at the relay terminal			
64S I Angle	04.55		64S I Angle *[Courier Number (angle)]*
St EF current angle measurement, affected by Comp Angle setting when St EF is enabled. I64S phase angle relative to V64S vector.			
64S R secondary	04.57		64S R secondary *[Courier Number (resistance)]*
St EF secondary resistance measurement at the relay terminal, affected by Series R and Parallel G settings			
64S R primary	04.58		64S R primary *[Courier Number (resistance)]*
St EF primary resistance, converted from secondary resistance using the R Factor setting			
64R CL Input	04.71		64R CL Input *[Courier Number (current)]*
64R R Fault	04.72		64R R Fault *[Courier Number (resistance)]*
IA Diff PU	04.91		IA Diff PU *[Courier Number (current)]*
IB Diff PU	04.92		IB Diff PU *[Courier Number (current)]*
IC Diff PU	04.93		IC Diff PU *[Courier Number (current)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
IA Bias PU	04.94		IA Bias PU *[Courier Number (current)]*
IB Bias PU	04.95		IB Bias PU *[Courier Number (current)]*
IC Bias PU	04.96		IC Bias PU *[Courier Number (current)]*
IA Diff 2H	04.97		IA Diff 2H *[Courier Number (current)]*
IB Diff 2H	04.98		IB Diff 2H *[Courier Number (current)]*
IC Diff 2H	04.99		IC Diff 2H *[Courier Number (current)]*
IA Diff 5H	04.9A		IA Diff 5H *[Courier Number (current)]*
IB Diff 5H	04.9B		IB Diff 5H *[Courier Number (current)]*
IC Diff 5H	04.9C		IC Diff 5H *[Courier Number (current)]*
CT2 I1 Mag	04.9D		CT2 I1 Mag *[Courier Number (current)]*
CT2 I1 Angle	04.9E		CT2 I1 Angle *[Courier Number (angle)]*
CT2 I2 Mag	04.9F		CT2 I2 Mag *[Courier Number (current)]*
CT2 I2 Angle	04.A0		CT2 I2 Angle *[Courier Number (angle)]*
CT2 I0 Mag	04.A1		CT2 I0 Mag *[Courier Number (current)]*
CT2 I0 Angle	04.A2		CT2 I0 Angle *[Courier Number (angle)]*
CT1 I2/I1	04.A3		CT1 I2/I1 *[Courier Number (Ratio)]*
CT2 I2/I1	04.A4		CT2 I2/I1 *[Courier Number (Ratio)]*
ZA Mag	04.A5		ZA Mag *[Courier Number (resistance)]*
ZA=VA/IA			
MEASUREMENTS 4	05.00		
Hot Spot T	05.01		Hot Spot T *[Courier Number (°C)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Top Oil T	05.02	No	Top Oil T *[Courier Number (°C)]*
Reset Xthermal	05.03	No	
Ambient T	05.04		Ambient T *[Courier Number (°C)]*
TOL Pretrip left	05.05		TOL Pretrip left *[Courier Number (decimal)]*
LOL status	05.06		LOL status *[Courier Number (decimal)]*
Reset LOL	05.07	No	
Rate of LOL	05.08	No	Rate of LOL *[Courier Number (decimal)]*
LOL Ageing Fact	05.09		LOL Ageing Fact *[Courier Number (decimal)]*
Lres at Design T	05.0A	No	Lres at Design T *[Courier Number (decimal)]*
FAA,m	05.0B		FAA,m *[Courier Number (decimal)]*
Lres at FAA,m	05.0C	No	Lres at FAA,m *[Courier Number (decimal)]*
Counter 1	05.60		Counter 1 *[Courier Number (decimal)]*
Counter 2	05.61		Counter 2 *[Courier Number (decimal)]*
Counter 3	05.62		Counter 3 *[Courier Number (decimal)]*
Counter 4	05.63		Counter 4 *[Courier Number (decimal)]*
Counter 5	05.64		Counter 5 *[Courier Number (decimal)]*
Counter 6	05.65		Counter 6 *[Courier Number (decimal)]*
Counter 7	05.66		Counter 7 *[Courier Number (decimal)]*
Counter 8	05.67		Counter 8 *[Courier Number (decimal)]*
Counter 9	05.68		Counter 9 *[Courier Number (decimal)]*
Counter 10	05.69		Counter 10

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
			[Courier Number (decimal)]
Counter 11	05.6A		Counter 11 *[Courier Number (decimal)]*
Counter 12	05.6B		Counter 12 *[Courier Number (decimal)]*
Counter 13	05.6C		Counter 13 *[Courier Number (decimal)]*
Counter 14	05.6D		Counter 14 *[Courier Number (decimal)]*
Counter 15	05.6E		Counter 15 *[Courier Number (decimal)]*
Counter 16	05.6F		Counter 16 *[Courier Number (decimal)]*
Reset Counter1	05.80		
Reset Counter2	05.81		
Reset Counter3	05.82		
Reset Counter4	05.83		
Reset Counter5	05.84		
Reset Counter6	05.85		
Reset Counter7	05.86		
Reset Counter8	05.87		
Reset Counter9	05.88		
Reset Counter10	05.89		
Reset Counter11	05.8A		
Reset Counter12	05.8B		
Reset Counter13	05.8C		
Reset Counter14	05.8D		
Reset Counter15	05.8E		
Reset Counter16	05.8F		
CB CONDITION	06.00		
CB Operations	06.01		CB Operations *[Unsigned Integer]*
Total IA Broken	06.02		Total IA Broken

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
			[Courier Number (current)]
Total IB Broken	06.03		Total IB Broken *[Courier Number (current)]*
Total IC Broken	06.04		Total IC Broken *[Courier Number (current)]*
CB Operate Time	06.05		CB Operate Time *[Courier Number (time)]*
CB Close Time	06.06		CB Close Time *[Courier Number (time)]*
Reset CB Data	06.07	No	
CB CONTROL	07.00		
CB Control by	07.01	Disabled	From 0 to 7 in steps of 1 *[Indexed String]*
Close Pulse Time	07.02	0.5	From 0.1 to 10 in steps of 0.01 *[Courier Number (time-seconds)]*
Trip Pulse Time	07.03	0.5	From 0.1 to 5 in steps of 0.01 *[Courier Number (time-seconds)]*
Man Close Delay	07.05	10	From 0.01 to 600 in steps of 0.01 *[Courier Number (time-seconds)]*
Manual Close Delay			
CB Healthy Time	07.06	5	From 0.01 to 9999 in steps of 0.01 *[Courier Number (time-seconds)]*
Sys Check Time	07.07	5	From 0.01 to 9999 in steps of 0.01 *[Courier Number (time-seconds)]*
Lockout Reset	07.08	No	
Reset Lockout by	07.09	CB Close	0 or 1 *[Indexed String]*
Man Close RstDly	07.0A	1	From 0.01 to 600 in steps of 0.01 *[Courier Number (time-seconds)]*
Manual Close Reset Delay			
CB Status Input	07.11	None	From 0 to 3 in steps of 1 *[Indexed String]*
DATE AND TIME	08.00		
Date/Time	08.01		
Battery Status	08.06		Battery Status *[Indexed String]*
Battery Alarm	08.07	Enabled	0 or 1 *[Indexed String]*
Primary Source	08.08	PTP	From 0 to 3 in steps of 1 *[Indexed String]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Sets the primary time synchronisation source			
Secondary Source	08.09	None	From 0 to 3 in steps of 1 *[Indexed String]*
Sets the secondary time synchronisation source			
Domain Number	08.0F	0	From 0 to 127 in steps of 1 *[Integers]*
Assigns the PTP domain number. A domain is grouping of PTP clocks that synchronise to each other on a network. This provides a way of implementing independent synchronisation of PTP clocks on a shared network			
Act. Time Source	08.10		Act. Time Source *[Indexed String]*
Displays the active time synchronisation source being used. 'Free Running' means the IED is not synchronised with any normal time-server, including IRIG-B, PTP or SNTP. The IED relies solely on its internal clock.			
IRIG-B Status	08.11		IRIG-B Status *[Indexed String]*
Displays the status of IRIG-B			
PTP Status	08.12		PTP Status *[Indexed String]*
IEC61850 or DNP3.0 over Ethernet versions only. Displays the status of PTP time synchronisation No Master Found = No PTP master can be found, the IED has not received a valid 'Announce' message. Illegal Master = Master clock is not valid, typically this will occur when the clock is not using the correct epoch Valid Master = At least valid one master clock is available			
SNTP Status	08.13		SNTP Status *[Indexed String]*
IRIG-B Type	08.1F	UTC	0 or 1 *[Indexed String]*
Determines if IRIG-B Type is UTC or Local.			
LocalTime Enable	08.20	Disabled	From 0 to 2 in steps of 1 *[Indexed String]*
LocalTime Offset	08.21	0	From -720 to 720 in steps of 15 *[Courier Number (Time Minutes)]*
DST Enable	08.22	Disabled	0 or 1 *[Indexed String]*
DST Offset	08.23	60	30 or 60 *[Courier Number (Time Minutes)]*
DST Start	08.24	Last	From 0 to 4 in steps of 1 *[Indexed String]*
DST Start Day	08.25	Sunday	From 0 to 6 in steps of 1 *[Indexed String]*
DST Start Month	08.26	March	From 0 to 11 in steps of 1 *[Indexed String]*
DST Start Mins	08.27	60	From 0 to 1425 in steps of 15 *[Courier Number (Time Minutes)]*
DST End	08.28	Last	From 0 to 4 in steps of 1 *[Indexed String]*
DST End Day	08.29	Sunday	From 0 to 6 in steps of 1 *[Indexed String]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
DST End Month	08.2A	October	From 0 to 11 in steps of 1 *[Indexed String]*
DST End Mins	08.2B	60	From 0 to 1425 in steps of 15 *[Courier Number (Time Minutes)]*
RP1 Time Zone	08.30	Local	0 or 1 *[Indexed String]*
RP2 Time Zone	08.31	Local	0 or 1 *[Indexed String]*
DNPOE Time Zone	08.32	Local	0 or 1 *[Indexed String]*
Tunnel Time Zone	08.33	Local	0 or 1 *[Indexed String]*
CONFIGURATION	09.00		
Restore Defaults	09.01	No Operation	
Setting Group	09.02	Select via Menu	0 or 1 *[Indexed String]*
Active Settings	09.03	Group 1	From 0 to 3 in steps of 1 *[Indexed String]*
Save Changes	09.04	No Operation	
Copy From	09.05	Group 1	From 0 to 3 in steps of 1 *[Indexed String]*
Copy To	09.06	No Operation	
Setting Group 1	09.07	Enabled	0 or 1 *[Indexed String]*
Setting Group 2	09.08	Disabled	0 or 1 *[Indexed String]*
Setting Group 3	09.09	Disabled	0 or 1 *[Indexed String]*
Setting Group 4	09.0A	Disabled	0 or 1 *[Indexed String]*
System Config	09.0B	Visible	0 or 1 *[Indexed String]*
Power	09.0C	Enabled	0 or 1 *[Indexed String]*
Field Failure	09.0D	Enabled	0 or 1 *[Indexed String]*
NPS Thermal	09.0E	Enabled	0 or 1 *[Indexed String]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
System Backup	09.0F	Enabled	0 or 1 *[Indexed String]*
Overcurrent	09.10	Enabled	0 or 1 *[Indexed String]*
Thermal Overload	09.11	Disabled	0 or 1 *[Indexed String]*
Differential	09.12	Enabled	0 or 1 *[Indexed String]*
Earth Fault	09.13	Enabled	0 or 1 *[Indexed String]*
Rotor EF	09.14	Enabled	0 or 1 *[Indexed String]*
SEF/REF/SPower	09.15	Disabled SEF/REF	From 0 to 2 in steps of 1 *[Indexed String]*
Residual O/V NVD	09.16	Enabled	0 or 1 *[Indexed String]*
Residual Overvoltage			
100% Stator EF	09.17	Disabled Enabled	0 or 1 *[Indexed String]*
V/Hz	09.18	Disabled	0 or 1 *[Indexed String]*
df/dt	09.19	Enabled	0 or 1 *[Indexed String]*
Dead Machine	09.1B	Disabled	0 or 1 *[Indexed String]*
Volt Protection	09.1D	Enabled	0 or 1 *[Indexed String]*
Freq Protection	09.1E	Enabled	0 or 1 *[Indexed String]*
RTD Inputs	09.1F	Enabled	0 or 1 *[Indexed String]*
CB Fail	09.20	Disabled	0 or 1 *[Indexed String]*
Supervision	09.21	Disabled	0 or 1 *[Indexed String]*
Pole Slipping	09.24	Enabled	0 or 1 *[Indexed String]*
Input Labels	09.25	Visible	0 or 1 *[Indexed String]*
Output Labels	09.26	Visible	0 or 1 *[Indexed String]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
RTD Labels	09.27	Visible	0 or 1 *[Indexed String]*
CT & VT Ratios	09.28	Visible	0 or 1 *[Indexed String]*
Record Control	09.29	Visible	0 or 1 *[Indexed String]*
Disturb Recorder	09.2A	Visible	0 or 1 *[Indexed String]*
Disturbance recorder			
Measure't Setup	09.2B	Visible	0 or 1 *[Indexed String]*
Comms Settings	09.2C	Visible	0 or 1 *[Indexed String]*
Commission Tests	09.2D	Visible	0 or 1 *[Indexed String]*
Setting Values	09.2E	Primary	0 or 1 *[Indexed String]*
Control Inputs	09.2F	Visible	0 or 1 *[Indexed String]*
CLIO inputs	09.30	Enabled	0 or 1 *[Indexed String]*
CLIO outputs	09.31	Enabled	0 or 1 *[Indexed String]*
System Checks	09.33	Disabled	0 or 1 *[Indexed String]*
Ctrl I/P Config	09.35	Visible	0 or 1 *[Indexed String]*
Ctrl I/P Labels	09.36	Visible	0 or 1 *[Indexed String]*
Direct Access	09.39	Enabled	From 0/0 to 3/1 in steps of 1/1 *[Indexed String]*
Function Key	09.50	Visible	0 or 1 *[Indexed String]*
RP1 Read Only	09.FB	Disabled	0 or 1 *[Indexed String]*
RP2 Read Only	09.FC	Disabled	0 or 1 *[Indexed String]*
NIC Read Only	09.FD	Disabled	0 or 1 *[Indexed String]*
LCD Contrast	09.FF	11	From 0 to 31 in steps of 1

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
			[Unsigned Integer (16 bits)]
CT AND VT RATIOS	0A.00		
Values for multipliers used else where			
Main VT Primary	0A.12	110	From 100 to 1000000 in steps of 1 [Courier Number (Voltage)]
Label V1=Main VT Rating/110			
Main VT Sec'y	0A.13	110	From 80*V1 to 140*V1 in steps of 1*V1 [Courier Number (Voltage)]
Label M1=[0A12]/[0A13]			
C/S VT Primary	0A.16	110	From 100 to 1000000 in steps of 1 [Courier Number (Voltage)]
Label Vcs=C/S VT Rating/110			
C/S VT Sec'y	0A.17	110	From 80 to 140 in steps of 1 [Courier Number (Voltage)]
Label Mcs=[0A16]/[0A17]			
VN VT Primary/VN1 VT Primary	0A.22	110	From 100 to 1000000 in steps of 1 [Courier Number (Voltage)]
Neutral Displacement VT Primary. Label V3=Neutral Disp VT Rating/110			
VN VT Secondary/VN1 VT Secondary	0A.23	110	From 80*V3 to 140*V3 in steps of 1*V3 [Courier Number (Voltage)]
Neutral Displacement VT Secondary. Label M3=[0A22]/[0A23]			
VN2 VT Primary	0A.27	110	From 100 to 1000000 in steps of 1 [Courier Number (Voltage)]
Second NVD VT. Label V2=VN2 VT Rating/110			
VN2 VT Secondary	0A.28	110	From 80*V2 to 140*V2 in steps of 1*V2 [Courier Number (Voltage)]
Second NVD VT. Label M2=[0A27]/[0A28]			
Ph CT Polarity\Ph CT1 Polarity	0A.31	Standard	0 or 1 [Indexed String]
Polarity of phase CT group (3 phase)			
Phase CT Primary\Phase CT1 Primary	0A.32	300	From 1 to 60000 in steps of 1 [Courier Number (Current)]
I1=Phase CT1 secondary rating			
Phase CT Sec'y\Phase CT1 Sec'y	0A.33	1	1 or 5 [Courier Number (Current)]
Label M4=[0A32]/[0A33]			
Ph CT2 Polarity	0A.36	Standard	0 or 1 [Indexed String]
Polarity of phase CT2 group (3 phase)			
Phase CT2 Prim'y	0A.37	300	From 1 to 60000 in steps of 1 [Courier Number (Current)]
I4=Phase CT2 secondary rating			
Phase CT2 Sec'y	0A.38	1	1 or 5 [Courier Number (Current)]
Label M7=[0A37]/[0A38]			
E/F CT Polarity	0A.51	Standard	0 or 1 [Indexed String]
Polarity of E/F (IN1) CT			
E/F CT Primary	0A.52	1	From 1 to 60000 in steps of 1 [Courier Number (Current)]
Label I2=E/F CT secondary rating			
E/F CT Secondary	0A.53	1	1 or 5 [Courier Number (Current)]
Label M5=[0A52]/[0A53]			
Isen CT Polarity	0A.61	Standard	0 or 1 [Indexed String]
Polarity of SEF (Isen) CT			

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Isen CT Primary	0A.62	1	From 1 to 60000 in steps of 1 *[Courier Number (Current)]*
Label I3=SEF CT secondary rating			
Isen CT Sec'y	0A.63	1	1 or 5 *[Courier Number (Current)]*
Label M6=[0A62]/[0A63]			
RECORD CONTROL	0B.00		
Alarm Event	0B.04	Enabled	0 or 1 *[Indexed String]*
Relay O/P Event	0B.05	Enabled	0 or 1 *[Indexed String]*
Opto Input Event	0B.06	Enabled	0 or 1 *[Indexed String]*
General Event	0B.07	Enabled	0 or 1 *[Indexed String]*
Fault Rec Event	0B.08	Enabled	0 or 1 *[Indexed String]*
Maint Rec Event	0B.09	Enabled	0 or 1 *[Indexed String]*
Protection Event	0B.0A	Enabled	0 or 1 *[Indexed String]*
DDB 31 - 0	0B.40	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 63 - 32	0B.41	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 95 - 64	0B.42	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 127 - 96	0B.43	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 159 - 128	0B.44	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 191 - 160	0B.45	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 223 - 192	0B.46	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 255 - 224	0B.47	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 287 - 256	0B.48	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 319 - 288	0B.49	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
DDB 351 - 320	0B.4A	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 383 - 352	0B.4B	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 415 - 384	0B.4C	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 447 - 416	0B.4D	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 479 - 448	0B.4E	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 511 - 480	0B.4F	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 543 - 512	0B.50	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 575 - 544	0B.51	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 607 - 576	0B.52	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 639 - 608	0B.53	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 671 - 640	0B.54	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 703 - 672	0B.55	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 735 - 704	0B.56	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 767 - 736	0B.57	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 799 - 768	0B.58	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 831 - 800	0B.59	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 863 - 832	0B.5A	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 895 - 864	0B.5B	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 927 - 896	0B.5C	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 959 - 928	0B.5D	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
DDB 991 - 960	0B.5E	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 1023 - 992	0B.5F	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 1055-1024	0B.60	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 1087-1056	0B.61	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 1119-1088	0B.62	0x7FFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 1151-1120	0B.63	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 1183-1152	0B.64	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 1215-1184	0B.65	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 1247-1216	0B.66	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 1279-1248	0B.67	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 1311-1280	0B.68	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 1343-1312	0B.69	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 1375-1344	0B.6A	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 1407-1376	0B.6B	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 1439-1408	0B.6C	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 1471-1440	0B.6D	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 1503-1472	0B.6E	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 1535-1504	0B.6F	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 1567-1536	0B.70	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 1599-1568	0B.71	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
			[Binary Flag (32 bits)]
DDB 1631-1600	0B.72	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 1663-1632	0B.73	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 1695-1664	0B.74	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 1727-1696	0B.75	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 1759-1728	0B.76	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 1791-1760	0B.77	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 1823-1792	0B.78	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 1855-1824	0B.79	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 1887-1856	0B.7A	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 1919-1888	0B.7B	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 1951-1920	0B.7C	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 1983-1952	0B.7D	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 2015-1984	0B.7E	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DDB 2047-2016	0B.7F	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
DISTURB RECORDER	0C.00		
DISTURBANCE RECORDER			
Duration	0C.52	1.5	From 0.1 to 10.5 in steps of 0.01 *[Courier Number (time-seconds)]*
Trigger Position	0C.54	33.3	From 0 to 100 in steps of 0.1 *[Courier Number (Percentage)]*
Trigger Mode	0C.56	Single	
Analog Channel 1	0C.58	VAN	From 0 to ** in steps of 1 *[Indexed String]*
** Max = 7 for P341, 8 for P342; 11 for P343, 12 for P344, 14 for P345			
Analog Channel 2	0C.59	VBN	From 0 to ** in steps of 1 *[Indexed String]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Analog Channel 3	0C.5A	VCN	From 0 to ** in steps of 1 *[Indexed String]*
Analog Channel 4	0C.5B	VN1	From 0 to ** in steps of 1 *[Indexed String]*
Analog Channel 5	0C.5C	IA (IA-1)	From 0 to ** in steps of 1 *[Indexed String]*
Analog Channel 6	0C.5D	IB (IB-1)	From 0 to ** in steps of 1 *[Indexed String]*
Analog Channel 7	0C.5E	IC (IC-1)	From 0 to ** in steps of 1 *[Indexed String]*
Analog Channel 8	0C.5F	I Sensitive	From 0 to ** in steps of 1 *[Indexed String]*
Analog Channel 9	0C.60	IN	From 0 to ** in steps of 1 *[Indexed String]*
AnalogChannel 10	0C.61	IA-2	From 0 to ** in steps of 1 *[Indexed String]*
AnalogChannel 11	0C.62	IB-2	From 0 to ** in steps of 1 *[Indexed String]*
AnalogChannel 12	0C.63	IC-2	From 0 to ** in steps of 1 *[Indexed String]*
AnalogChannel 13	0C.64	VN2	From 0 to ** in steps of 1 *[Indexed String]*
AnalogChannel 14	0C.65	V64S	From 0 to ** in steps of 1 *[Indexed String]*
AnalogChannel 15	0C.66	I64S	From 0 to ** in steps of 1 *[Indexed String]*
AnalogChannel 16	0C.67	Not used	From 0 to ** in steps of 1 *[Indexed String]*
AnalogChannel 17	0C.68	Not used	From 0 to ** in steps of 1 *[Indexed String]*
AnalogChannel 18	0C.69	Not used	From 0 to ** in steps of 1 *[Indexed String]*
AnalogChannel 19	0C.6A	Not used	From 0 to ** in steps of 1 *[Indexed String]*
AnalogChannel 20	0C.6B	Not used	From 0 to ** in steps of 1 *[Indexed String]*
Digital Input 1	0C.80	Output R1	From 0 to DDB Size in steps of 1 *[Indexed String]*
Input 1 Trigger	0C.81	No Trigger	From 0 to 2 in steps of 1

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
			[Indexed String]
Digital Input 2	0C.82	Output R2	From 0 to DDB Size in steps of 1 *[Indexed String]*
Input 2 Trigger	0C.83	No Trigger	From 0 to 2 in steps of 1 *[Indexed String]*
Digital Input 3	0C.84	Output R3	From 0 to DDB Size in steps of 1 *[Indexed String]*
Input 3 Trigger	0C.85	Trigger L/H	From 0 to 2 in steps of 1 *[Indexed String]*
Digital Input 4	0C.86	Output R4	From 0 to DDB Size in steps of 1 *[Indexed String]*
Input 4 Trigger	0C.87	No Trigger	From 0 to 2 in steps of 1 *[Indexed String]*
Digital Input 5	0C.88	Output R5	From 0 to DDB Size in steps of 1 *[Indexed String]*
Input 5 Trigger	0C.89	No Trigger	From 0 to 2 in steps of 1 *[Indexed String]*
Digital Input 6	0C.8A	Output R6	From 0 to DDB Size in steps of 1 *[Indexed String]*
Input 6 Trigger	0C.8B	No Trigger	From 0 to 2 in steps of 1 *[Indexed String]*
Digital Input 7	0C.8C	Output R7	From 0 to DDB Size in steps of 1 *[Indexed String]*
Input 7 Trigger	0C.8D	No Trigger	From 0 to 2 in steps of 1 *[Indexed String]*
Digital Input 8	0C.8E	Input L1 Output R8	From 0 to DDB Size in steps of 1 *[Indexed String]*
Input 8 Trigger	0C.8F	No Trigger	From 0 to 2 in steps of 1 *[Indexed String]*
Digital Input 9	0C.90	Input L2 Output R9	From 0 to DDB Size in steps of 1 *[Indexed String]*
Input 9 Trigger	0C.91	No Trigger	From 0 to 2 in steps of 1 *[Indexed String]*
Digital Input 10	0C.92	Input L3 Output R10	From 0 to DDB Size in steps of 1 *[Indexed String]*
Input 10 Trigger	0C.93	No Trigger	From 0 to 2 in steps of 1 *[Indexed String]*
Digital Input 11	0C.94	Input L4 Output R11	From 0 to DDB Size in steps of 1 *[Indexed String]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Input 11 Trigger	0C.95	No Trigger	From 0 to 2 in steps of 1 *[Indexed String]*
Digital Input 12	0C.96	Input L5 Output R12	From 0 to DDB Size in steps of 1 *[Indexed String]*
Input 12 Trigger	0C.97	No Trigger	From 0 to 2 in steps of 1 *[Indexed String]*
Digital Input 13	0C.98	Input L6 Output R13	From 0 to DDB Size in steps of 1 *[Indexed String]*
Input 13 Trigger	0C.99	No Trigger	From 0 to 2 in steps of 1 *[Indexed String]*
Digital Input 14	0C.9A	Input L7 Output R14	From 0 to DDB Size in steps of 1 *[Indexed String]*
Input 14 Trigger	0C.9B	No Trigger	From 0 to 2 in steps of 1 *[Indexed String]*
Digital Input 15	0C.9C	Input L8 Input L1	From 0 to DDB Size in steps of 1 *[Indexed String]*
Input 15 Trigger	0C.9D	No Trigger	From 0 to 2 in steps of 1 *[Indexed String]*
Digital Input 16	0C.9E	Unused Input L2	From 0 to DDB Size in steps of 1 *[Indexed String]*
Input 16 Trigger	0C.9F	No Trigger	From 0 to 2 in steps of 1 *[Indexed String]*
Digital Input 17	0C.A0	Unused Input L3	From 0 to DDB Size in steps of 1 *[Indexed String]*
Input 17 Trigger	0C.A1	No Trigger	From 0 to 2 in steps of 1 *[Indexed String]*
Digital Input 18	0C.A2	Unused Input L4	From 0 to DDB Size in steps of 1 *[Indexed String]*
Input 18 Trigger	0C.A3	No Trigger	From 0 to 2 in steps of 1 *[Indexed String]*
Digital Input 19	0C.A4	Unused Input L5	From 0 to DDB Size in steps of 1 *[Indexed String]*
Input 19 Trigger	0C.A5	No Trigger	From 0 to 2 in steps of 1 *[Indexed String]*
Digital Input 20	0C.A6	Unused Input L6	From 0 to DDB Size in steps of 1 *[Indexed String]*
Input 20 Trigger	0C.A7	No Trigger	From 0 to 2 in steps of 1 *[Indexed String]*
Digital Input 21	0C.A8	Unused Input L7	From 0 to DDB Size in steps of 1 *[Indexed String]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Input 21 Trigger	0C.A9	No Trigger	From 0 to 2 in steps of 1 *[Indexed String]*
Digital Input 22	0C.AA	Unused Input L8	From 0 to DDB Size in steps of 1 *[Indexed String]*
Input 22 Trigger	0C.AB	No Trigger	From 0 to 2 in steps of 1 *[Indexed String]*
Digital Input 23	0C.AC	Unused Input L9	From 0 to DDB Size in steps of 1 *[Indexed String]*
Input 23 Trigger	0C.AD	No Trigger	From 0 to 2 in steps of 1 *[Indexed String]*
Digital Input 24	0C.AE	Unused Input L10	From 0 to DDB Size in steps of 1 *[Indexed String]*
Input 24 Trigger	0C.AF	No Trigger	From 0 to 2 in steps of 1 *[Indexed String]*
Digital Input 25	0C.B0	Unused Input L11	From 0 to DDB Size in steps of 1 *[Indexed String]*
Input 25 Trigger	0C.B1	No Trigger	From 0 to 2 in steps of 1 *[Indexed String]*
Digital Input 26	0C.B2	Unused Input L12	From 0 to DDB Size in steps of 1 *[Indexed String]*
Input 26 Trigger	0C.B3	No Trigger	From 0 to 2 in steps of 1 *[Indexed String]*
Digital Input 27	0C.B4	Unused Input L13	From 0 to DDB Size in steps of 1 *[Indexed String]*
Input 27 Trigger	0C.B5	No Trigger	From 0 to 2 in steps of 1 *[Indexed String]*
Digital Input 28	0C.B6	Unused Input L14	From 0 to DDB Size in steps of 1 *[Indexed String]*
Input 28 Trigger	0C.B7	No Trigger	From 0 to 2 in steps of 1 *[Indexed String]*
Digital Input 29	0C.B8	Unused Input L15	From 0 to DDB Size in steps of 1 *[Indexed String]*
Input 29 Trigger	0C.B9	No Trigger	From 0 to 2 in steps of 1 *[Indexed String]*
Digital Input 30	0C.BA	Unused Input L16	From 0 to DDB Size in steps of 1 *[Indexed String]*
Input 30 Trigger	0C.BB	No Trigger	From 0 to 2 in steps of 1 *[Indexed String]*
Digital Input 31	0C.BC	Unused	From 0 to DDB Size in steps of 1

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
		Function Key 10	*[Indexed String]*
Input 31 Trigger	0C.BD	No Trigger Trigger L/H	From 0 to 2 in steps of 1 *[Indexed String]*
Digital Input 32	0C.BE	Unused	From 0 to DDB Size in steps of 1 *[Indexed String]*
Input 32 Trigger	0C.BF	No Trigger	From 0 to 2 in steps of 1 *[Indexed String]*
MEASURE'T SETUP	0D.00		
MEASUREMENT SETTINGS			
Default Display	0D.01	Description	Default Display *[Indexed String]*
This cell is used to show the default display option			
Local Values	0D.02	Primary	0 or 1 *[Indexed String]*
Local Measurement Values			
Remote Values	0D.03	Primary	0 or 1 *[Indexed String]*
Remote Measurement Values			
Measurement Ref	0D.04	VA	From 0 to 5 in steps of 1 *[Indexed String]*
Measurement Phase Reference			
Measurement Mode	0D.05	0	From 0 to 3 in steps of 1 *[Unsigned Integer]*
Fix Dem Period	0D.06	15	From 1 to 99 in steps of 1 *[Courier Number (Time Minutes)]*
Fixed Demand Interval			
Roll Sub Period	0D.07	1	From 1 to 99 in steps of 1 *[Courier Number (Time Minutes)]*
Rolling demand sub period			
Num Sub Periods	0D.08	15	From 1 to 15 in steps of 1 *[Unsigned Integer]*
Number of rolling sub-periods			
Remote 2 Values	0D.0B	Primary	0 or 1 *[Indexed String]*
Remote 2 Measurement Values. Visible when Model no. Hardware option (Field 7) = 7 or 8			
COMMUNICATIONS	0E.00		
RP1 Protocol	0E.01		RP1 Protocol *[Indexed String]*
RP1 Address	0E.02	1	From 0 to 255 in steps of 1 *[Unsigned integer (16 bits)]*
Rear Port 1 Courier Protocol device address			
RP1 Address	0E.02	1	From 1 to 247 in steps of 1 *[Unsigned integer (16 bits)]*
Rear Port 1 Modbus Protocol device address			
RP1 Address	0E.02	1	From 0 to 254 in steps of 1 *[Unsigned integer (16 bits)]*
Rear Port 1 IEC60870-5-103 Protocol device address			
RP1 Address	0E.02	1	From 0 to 65534 in steps of 1 *[Unsigned integer (16 bits)]*
Rear Port 1 DNP 3.0 Protocol device address			
RP1 InactivTimer	0E.03	15	From 1 to 30 in steps of 1 *[Courier Number (Time Minutes)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Rear Port 1 Courier Protocol inactivity timer			
RP1 InactivTimer	0E.03	15	From 1 to 30 in steps of 1 *[Courier Number (Time Minutes)]*
Rear Port 1 Modbus Protocol inactivity timer			
RP1 InactivTimer	0E.03	15	From 1 to 30 in steps of 1 *[Courier Number (Time Minutes)]*
Rear Port 1 IEC60870-5-103 Protocol inactivity timer			
RP1 Baud Rate	0E.04	19200 bits/s	From 0 to 2 in steps of 1 *[Indexed String]*
Rear Port 1 Modbus Protcol serial bit/baud rate			
RP1 Baud Rate	0E.04	19200 bits/s	0 or 1 *[Indexed String]*
Rear Port 1 IEC60870-5-103 Protcol serial bit/baud rate			
RP1 Baud Rate	0E.04	19200 bits/s	From 0 to 5 in steps of 1 *[Indexed String]*
Rear Port 1 DNP 3.0 Protcol serial bit/baud rate			
RP1 Parity	0E.05	None	From 0 to 2 in steps of 1 *[Indexed String]*
Rear Port 1 Modbus Protocol parity			
RP1 Parity	0E.05	None	From 0 to 2 in steps of 1 *[Indexed String]*
Rear Port 1 DNP 3.0 Protocol parity			
RP1 Meas Period	0E.06	15	From 1 to 60 in steps of 1 *[Courier Number (Time)]*
Rear Port 1 IEC60870-5-103 Protocol measurment period			
RP1 PhysicalLink	0E.07	Copper	0 or 1 *[Indexed String]*
Rear Port 1 Physical link selector. Available when Fibre Optic Comms card is specified by model number			
RP1 Time Sync	0E.08	Disabled	0 or 1 *[Indexed String]*
Rear Port 1 DNP 3.0 Protocol time sync configuration. NB Not available when IRIG-B option fitted and enabled.			
Modbus IEC Time	0E.09	Standard	0 or 1 *[Indexed String]*
Controls the format of the time-date G12 data type. Modbus Only.			
RP1 CS103Blcking	0E.0A	Disabled	From 0 to 2 in steps of 1 *[Indexed String]*
Rear Port 1 IEC60870-5-103 Protocol blocking configuration			
RP1 Card Status	0E.0B		RP1 Card Status *[Indexed String]*
Rear Port 1 Courier Protocol Status			
RP1 Port Config	0E.0C	K-Bus	0 or 1 *[Indexed String]*
Rear Port 1 Courier Protocol copper port configuration; K-Bus or EIA485			
RP1 Comms Mode	0E.0D	IEC60870 FT1.2	0 or 1 *[Indexed String]*
Rear Port 1 Courier Protocol EIA485 mode			
RP1 Baud Rate	0E.0E	19200 bits/s	From 0 to 2 in steps of 1 *[Indexed String]*
Rear Port 1 Courier Protocol EIA485 bit/baud rate			
DNP Need Time	0E.11	10	From 1 to 30 in steps of 1 *[Courier Number (Time)]*
DNP App Fragment	0E.12	2048	From 100 to 2048 in steps of 1 *[Unsigned Integer]*
DNP App Timeout	0E.13	2	From 1 to 120 in steps of 1 *[Courier Number (Time)]*
DNP SBO Timeout	0E.14	10	From 1 to 10 in steps of 1

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
			[Courier Number (Time)]
DNP Link Timeout	0E.15	0	From 0 to 120 in steps of 1 *[Courier Number (Time)]*
Class 0 Poll	0E.16	Running Counters	0 or 1 *[Indexed String]*
Used for DNP3 serial only. When set the cell to "Running Counters", the IED will only report the static counters (object 20) in class 0 responses. Otherwise if set to "Frozen Counters", the IED will only report the frozen counters (object 21) in class 0 responses.			
NIC Protocol	0E.1F	IEC61850	NIC Protocol *[Indexed String]*
NIC MAC Address	0E.22	Ethernet MAC Addr	NIC MAC Address *[ASCII Text (17 chars)]*
NIC Tunl Timeout	0E.64	5.00 min	From 1 to 30 in steps of 1 *[Courier Number (time-minutes)]*
NIC Link Report	0E.6A	Alarm	From 0 to 2 in steps of 1 *[Courier Number (Time Minutes)]*
REAR PORT2 (RP2)	0E.80		
Visible when Rear Port 2 fitted.			
RP2 Protocol	0E.81	Courier	RP2 Protocol *[ASCII Text(16 chars)]*
Rear Port 2 Protocol - "Courier"			
RP2 Card Status	0E.84		RP2 Card Status *[Indexed String]*
Rear Port 2 Courier Protocol Status			
RP2 Port Config	0E.88	EIA232 (RS232)	From 0 to 2 in steps of 1 *[Indexed String]*
Rear Port 2 Courier Protocol port configuration; K-Bus or EIA485			
RP2 Comms Mode	0E.8A	IEC60870 FT1.2	0 or 1 *[Indexed String]*
Rear Port 2 Courier Protocol EIA485 mode			
RP2 Address	0E.90	255	From 0 to 255 in steps of 1 *[Unsigned Integer (16 bits)]*
Rear Port 2 Courier Protocol device address			
RP2 InactivTimer	0E.92	15	From 1 to 30 in steps of 1 *[Courier Number (time-minutes)]*
Rear Port 2 Courier Protocol inactivity timer			
RP2 Baud Rate	0E.94	19200 bits/s	From 0 to 2 in steps of 1 *[Indexed String]*
Rear Port 2 Courier Protocol EIA485 bit/baud rate			
NIC Protocol	0E.A0	DNP3	NIC Protocol *[Indexed String]*
IP address	0E.A1	0.0.0.0	IP address *[ASCII Text(16 chars)]*
Subnet mask	0E.A2	0.0.0.0	Subnet mask *[ASCII Text(16 chars)]*
NIC MAC Address	0E.A3	Ethernet MAC Addr	NIC MAC Address *[ASCII Text (17 chars)]*
Gateway	0E.A4	0.0.0.0	Gateway *[ASCII Text]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
DNP Time Sync	0E.A5	Disabled	0 or 1 *[Indexed String]*
Meas Scaling	0E.A6	Normalised	From 0 to 2 in steps of 1 *[Indexed String]*
NIC Tunl Timeout	0E.A7	5 mins	From 1 to 30 in steps of 1 *[Courier Number (Time Minutes)]*
NIC Link Report	0E.A8	Alarm	From 0 to 2 in steps of 1 *[Indexed String]*
SNTP PARAMETERS	0E.AA		
SNTP Server 1	0E.AB	0.0.0.0	SNTP Server 1 *[Courier Number (Time Minutes)]*
SNTP Server 2	0E.AC	0.0.0.0	SNTP Server 2 *[Indexed String]*
SNTP Poll Rate	0E.AD	64 s	SNTP Poll Rate *[Courier Number (time)]*
DNP Need Time	0E.B1	10	From 1 to 30 in steps of 1 *[Courier Number (time)]*
The duration of time waited before requesting another time sync from the master			
DNP App Fragment	0E.B2	2048	From 100 to 2048 in steps of 1 *[Unsigned Integer]*
The maximum message length (application fragment size) transmitted by the relay			
DNP App Timeout	0E.B3	2	From 1 to 120 in steps of 1 *[Courier Number (time)]*
Duration of time waited, after sending a message fragment and awaiting a confirmation from the master			
DNP SBO Timeout	0E.B4	10	From 1 to 10 in steps of 1 *[Courier Number (time)]*
Duration of time waited, after receiving a select command and awaiting an operate confirmation from the master			
Class 0 Poll	0E.B5	Running Counters	0 or 1 *[Indexed String]*
Used for DNP3 over Ethernet only. When set the cell to “Running Counters”, the IED will only report the static counters (object 20) in class 0 responses. Otherwise if set to “Frozen Counters”, the IED will only report the frozen counters (object 21) in class 0 responses.			
SYSLOG	0E.BA		
SysLog Pri IP	0E.BB	0.0.0.0	From 0.0.0.0 to 223.255.255.255 in steps of 1 *[IP Parameters]*
External Security Log Server 1 configured to monitor security logging message on the network. Setting this cell to 0.0.0.0 disables sending security logging message to Security Log Server 1.			
SysLog Sec IP	0E.BC	0.0.0.0	From 0.0.0.0 to 223.255.255.255 in steps of 1 *[IP Parameters]*
External Security Log Server 2 configured to monitor security logging message on the network. Setting this cell to 0.0.0.0 disables sending security logging message to Security Log Server 2			
SysLog Port	0E.BD	514	From 1 to 65535 in steps of 1 *[Unsigned Integer (32 bits)]*
The destination UDP/IP port sent to both Primary and Secondary Syslog servers.			
SysLog Status	0E.BE	Disabled	SysLog Status *[Indexed String]*
SNMP PARAMETERS	0E.C0		
SNMP specific parameters heading.			

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
SNMP Version	0E.C1	V2C and V3	From 0 to 3 in steps of 1 *[Indexed String]*
Selection for the main processor SNMP version interface. Selecting 'None' disables this SNMP interface.			
Trap Dest. IP1	0E.C2	0.0.0.0	From 0.0.0.0 to 223.255.255.255 in steps of 1 *[Unsigned Integer (32 bits)]*
Trap destination 1 IP for the main processor SNMP version interface. This is set to the SNMP manager IP address. Setting this cell to 0.0.0.0 disables this Trap interface			
Trap Dest. IP2	0E.C3	0.0.0.0	From 0.0.0.0 to 223.255.255.255 in steps of 1 *[Unsigned Integer (32 bits)]*
Trap destination 2 IP for the main processor SNMP version interface. This is set to the SNMP manager IP address. Setting this cell to 0.0.0.0 disables this Trap interface			
SNMPv3 Security	0E.C4		
SNMP v3 specific parameters heading.			
User Name	0E.C5	ReadOnlyUserName	From 32 to 234 in steps of 1 *[ASCII Text]*
SNMP v3 user name. Can be edited to a custom value of up to 16 characters.			
Security Level	0E.C6	AuthNoPriv	From 0 to 2 in steps of 1 *[Indexed String]*
Sets the SNMP v3 security level. There levels of security are defined by the SNMP standard: 0 - Without authentication and without privacy (noAuthNoPriv) 1 - With authentication but without privacy (AuthNoPriv) 2 - With authentication and with privacy (AuthPriv) Authentication is used to check the identity of users, Privacy allows for encryption of SNMP messages. Both Authentication and Privacy are optional, however if Privacy is used, then the security model used by the IED MUST protect the SNMP message from disclosure, i.e., it MUST encrypt/decrypt the messages.			
Auth Protocol	0E.C7	HMAC-MD5-96	0 or 1 *[Indexed String]*
SNMP v3 Authentication Protocol. Sets the hash-based message authentication code function used for the authentication of messages. MD5 – Is a Message Digest implementation SHA – Is a Secure Hash Algorithm implementation SHA is considered cryptographically stronger that MD5, but takes a longer time to compute. Both implementations are considered secure. The SNMP Manager and the IED must use the same Authentication Protocol.			
Auth Password	0E.C8	AAAAAAAA	From 33 to 122 in steps of 1 *[ASCII Password (8)]*
SNMP v3 authentication password. Can be edited to a custom value with a fixed length of 8 characters.			
Encrypt Protocol	0E.C9	CBC-DES	From 0 to 0 in steps of 1 *[Indexed String]*
SNMP v3 encryption protocol. Cannot be changed.			
Encrypt Password	0E.CA	BBBBBBBB	From 33 to 122 in steps of 1 *[ASCII Password (8)]*
SNMP v3 encryption password used for privacy. Can be edited to a custom value with a fixed length of 8 characters.			
SNMPv2c Security	0E.D1		
SNMP v2c specific parameters heading.			
Community Name	0E.D2	CCCCCCCC	From 32 to 122 in steps of 1 *[ASCII Password (8)]*
SNMP v2c community name, used for authentication between the SNMP manager and the IED. Can be edited to a custom value of 1-8 characters. The community name setting must be the same in both the SNMP Manager and the IED.			
COMMISSION TESTS	0F.00		
Opto I/P Status	0F.01		Opto I/P Status *[Binary Flag (32 bits); Indexed String]*
The original register 30007 is available for Opto Inputs #1 to #16.			

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Relay O/P Status	0F.02		Relay O/P Status *[Binary Flag (32 bits); Indexed String]*
Test Port Status	0F.03		Test Port Status *[Binary Flag(8 bits); Indexed String]*
Monitor Bit 1	0F.05	64	From 0 to 2047 in steps of 1 *[Unsigned Integer]*
Monitor Bit 2	0F.06	65	From 0 to 2047 in steps of 1 *[Unsigned Integer]*
Monitor Bit 3	0F.07	66	From 0 to 2047 in steps of 1 *[Unsigned Integer]*
Monitor Bit 4	0F.08	67	From 0 to 2047 in steps of 1 *[Unsigned Integer]*
Monitor Bit 5	0F.09	68	From 0 to 2047 in steps of 1 *[Unsigned Integer]*
Monitor Bit 6	0F.0A	69	From 0 to 2047 in steps of 1 *[Unsigned Integer]*
Monitor Bit 7	0F.0B	70	From 0 to 2047 in steps of 1 *[Unsigned Integer]*
Monitor Bit 8	0F.0C	71	From 0 to 2047 in steps of 1 *[Unsigned Integer]*
IED Test Mode	0F.0D	Disabled	From 0 to 2 in steps of 1 *[Indexed String]*
The IED Test Mode menu cell is used to allow online 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. This setting influences the processing of GOOSE and control service frames with an IEC61850 Test mode flag. To select test mode the IED Test Mode menu cell should be set to 'Test', 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. In IEC 60870-5-103 builds changes the Cause of Transmission, COT, to Test Mode. In IED Test Mode, only GOOSE messages and control service commands with a quality flat set to "test" will be processed as valid . To enable testing of output contacts the IED 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. In Contacts Blocked Mode, only GOOSE messages and control service commands with a quality flat set to "test" will be processed as valid. Once testing is complete the cell must be set back to 'Disabled' to restore the IED back to service The following IEC 61850 Mode definitions apply for the different settings: 0 = Disabled Mod = 1 (On) 1 = Test Mod = 3 (Test) 2 = Contacts Blocked Mod = 4 (Test/blocked) Note: The cell 'Test Mode' used in software prior to IEC 61850 edition 2 has been renamed as 'IED Test Mode'			
Test Pattern	0F.0E	0	From 0 to 20 in steps of 1 *[Binary Flag (32bits)]*
This cell is used to select the output relay contacts that will be tested when the 'Contact Test' cell is set to 'Apply Test'.			
Contact Test	0F.0F	No Operation	
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			

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
issuing the 'Remove Test' command. The command text on the LCD will again revert to 'No Operation' after the 'Remove Test' command has been issued. Note: When the 'Test Mode' cell is set to 'Enabled' the 'Relay O/P Status' cell does not show the current status of the output relays and hence can not be used to confirm operation of the output relays. Therefore it will be necessary to monitor the state of each contact in turn.			
Test LEDs	0F.10	No Operation	
Red LED Status	0F.15		Red LED Status *[Binary Flag (32 bits); Indexed String]*
Green LED Status	0F.16		Green LED Status *[Binary Flag (32 bits); Indexed String]*
IED Mod/Beh	0F.1E		IED Mod/Beh *[Indexed String]*
Indicates the current Mod/Beh status of whole IED			
Subscriber Sim	0F.1F	Disabled	0 or 1 *[Indexed String]*
Used to enable/disable the 'subscriber simulation' feature, for Sampled Values and GOOSE subscriptions			
DDB 31 - 0	0F.20		DDB 31 - 0 *[Binary Flag(32)]*
See DDB definition table.			
DDB 63 - 32	0F.21		DDB 63 - 32 *[Binary Flag(32)]*
DDB 95 - 64	0F.22		DDB 95 - 64 *[Binary Flag(32)]*
DDB 127 - 96	0F.23		DDB 127 - 96 *[Binary Flag(32)]*
DDB 159 - 128	0F.24		DDB 159 - 128 *[Binary Flag(32)]*
DDB 191 - 160	0F.25		DDB 191 - 160 *[Binary Flag(32)]*
DDB 223 - 192	0F.26		DDB 223 - 192 *[Binary Flag(32)]*
DDB 255 - 224	0F.27		DDB 255 - 224 *[Binary Flag(32)]*
DDB 287 - 256	0F.28		DDB 287 - 256 *[Binary Flag(32)]*
DDB 319 - 288	0F.29		DDB 319 - 288 *[Binary Flag(32)]*
DDB 351 - 320	0F.2A		DDB 351 - 320 *[Binary Flag(32)]*
DDB 383 - 352	0F.2B		DDB 383 - 352 *[Binary Flag(32)]*
DDB 415 - 384	0F.2C		DDB 415 - 384 *[Binary Flag(32)]*
DDB 447 - 416	0F.2D		DDB 447 - 416 *[Binary Flag(32)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
DDB 479 - 448	0F.2E		DDB 479 - 448 *[Binary Flag(32)]*
DDB 511 - 480	0F.2F		DDB 511 - 480 *[Binary Flag(32)]*
DDB 543 - 512	0F.30		DDB 543 - 512 *[Binary Flag(32)]*
DDB 575 - 544	0F.31		DDB 575 - 544 *[Binary Flag(32)]*
DDB 607 - 576	0F.32		DDB 607 - 576 *[Binary Flag(32)]*
DDB 639 - 608	0F.33		DDB 639 - 608 *[Binary Flag(32)]*
DDB 671 - 640	0F.34		DDB 671 - 640 *[Binary Flag(32)]*
DDB 703 - 672	0F.35		DDB 703 - 672 *[Binary Flag(32)]*
DDB 735 - 704	0F.36		DDB 735 - 704 *[Binary Flag(32)]*
DDB 767 - 736	0F.37		DDB 767 - 736 *[Binary Flag(32)]*
DDB 799 - 768	0F.38		DDB 799 - 768 *[Binary Flag(32)]*
DDB 831 - 800	0F.39		DDB 831 - 800 *[Binary Flag(32)]*
DDB 863 - 832	0F.3A		DDB 863 - 832 *[Binary Flag(32)]*
DDB 895 - 864	0F.3B		DDB 895 - 864 *[Binary Flag(32)]*
DDB 927 - 896	0F.3C		DDB 927 - 896 *[Binary Flag(32)]*
DDB 959 - 928	0F.3D		DDB 959 - 928 *[Binary Flag(32)]*
DDB 991 - 960	0F.3E		DDB 991 - 960 *[Binary Flag(32)]*
DDB 1023 - 992	0F.3F		DDB 1023 - 992 *[Binary Flag(32)]*
DDB 1055-1024	0F.40		DDB 1055-1024 *[Binary Flag(32)]*
DDB 1087-1056	0F.41		DDB 1087-1056

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
			[Binary Flag(32)]
DDB 1119-1088	0F.42		DDB 1119-1088 *[Binary Flag(32)]*
DDB 1151-1120	0F.43		DDB 1151-1120 *[Binary Flag(32)]*
DDB 1183-1152	0F.44		DDB 1183-1152 *[Binary Flag(32)]*
DDB 1215-1184	0F.45		DDB 1215-1184 *[Binary Flag(32)]*
DDB 1247-1216	0F.46		DDB 1247-1216 *[Binary Flag(32)]*
DDB 1279-1248	0F.47		DDB 1279-1248 *[Binary Flag(32)]*
DDB 1311-1280	0F.48		DDB 1311-1280 *[Binary Flag(32)]*
DDB 1343-1312	0F.49		DDB 1343-1312 *[Binary Flag(32)]*
DDB 1375-1344	0F.4A		DDB 1375-1344 *[Binary Flag(32)]*
DDB 1407-1376	0F.4B		DDB 1407-1376 *[Binary Flag(32)]*
DDB 1439-1408	0F.4C		DDB 1439-1408 *[Binary Flag(32)]*
DDB 1471-1440	0F.4D		DDB 1471-1440 *[Binary Flag(32)]*
DDB 1503-1472	0F.4E		DDB 1503-1472 *[Binary Flag(32)]*
DDB 1535-1504	0F.4F		DDB 1535-1504 *[Binary Flag(32)]*
DDB 1567-1536	0F.50		DDB 1567-1536 *[Binary Flag(32)]*
DDB 1599-1568	0F.51		DDB 1599-1568 *[Binary Flag(32)]*
DDB 1631-1600	0F.52		DDB 1631-1600 *[Binary Flag(32)]*
DDB 1663-1632	0F.53		DDB 1663-1632 *[Binary Flag(32)]*
DDB 1695-1664	0F.54		DDB 1695-1664 *[Binary Flag(32)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
DDB 1727-1696	0F.55		DDB 1727-1696 *[Binary Flag(32)]*
DDB 1759-1728	0F.56		DDB 1759-1728 *[Binary Flag(32)]*
DDB 1791-1760	0F.57		DDB 1791-1760 *[Binary Flag(32)]*
DDB 1823-1792	0F.58		DDB 1823-1792 *[Binary Flag(32)]*
DDB 1855-1824	0F.59		DDB 1855-1824 *[Binary Flag(32)]*
DDB 1887-1856	0F.5A		DDB 1887-1856 *[Binary Flag(32)]*
DDB 1919-1888	0F.5B		DDB 1919-1888 *[Binary Flag(32)]*
DDB 1951-1920	0F.5C		DDB 1951-1920 *[Binary Flag(32)]*
DDB 1983-1952	0F.5D		DDB 1983-1952 *[Binary Flag(32)]*
DDB 2015-1984	0F.5E		DDB 2015-1984 *[Binary Flag(32)]*
DDB 2047-2016	0F.5F		DDB 2047-2016 *[Binary Flag(32)]*
CB MONITOR SETUP	10.00		
Broken I^	10.01	2	From 1 to 2 in steps of 0.1 *[Courier Number (Decimal)]*
Broken Current Index (CT1 I-RMS for P348 only and it will use IA-1, IB-1, IC-1 for P341-P346)			
I^ Maintenance	10.02	Alarm Disabled	0 or 1 *[Indexed String]*
Broken Current to cause maintenance alarm (CT1 I-RMS for P348 only and it will use IA-1, IB-1, IC-1 for P341-P346)			
I^ Maintenance	10.03	1000	From 1 to 25000 in steps of 1 *[Courier Number (Current)]*
IX Maintenance Alarm (CT1 I-RMS for P348 only and it will use IA-1, IB-1, IC-1 for P341-P346)			
I^ Lockout	10.04	Alarm Disabled	0 or 1 *[Indexed String]*
Broken Current to cause lockout alarm (CT1 I-RMS for P348 only and it will use IA-1, IB-1, IC-1 for P341-P346)			
I^ Lockout	10.05	2000	From 1 to 25000 in steps of 1 *[Courier Number (Current)]*
IX Maintenance Lockout (CT1 I-RMS for P348 only and it will use IA-1, IB-1, IC-1 for P341-P346)			
No. CB Ops Maint	10.06	Alarm Disabled	0 or 1 *[Indexed String]*
Circuit Breaker Trips to cause maintenance alarm			
No. CB Ops Maint	10.07	10	From 1 to 10000 in steps of 1 *[Unsigned Integer]*
Number of Circuit Breaker Trips for maintenance alarm			
No. CB Ops Lock	10.08	Alarm Disabled	0 or 1 *[Indexed String]*
Circuit Breaker Trips to cause lockout alarm			

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
No. CB Ops Lock	10.09	20	From 1 to 10000 in steps of 1 *[Unsigned Integer]*
Number of Circuit Breaker Trips for lockout alarm			
CB Time Maint	10.0A	Alarm Disabled	0 or 1 *[Indexed String]*
Circuit Breaker Operating Time to cause maintenance alarm			
CB Time Maint	10.0B	0.1	From 0.005 to 0.5 in steps of 0.001 *[Courier Number (time-seconds)]*
Circuit Breaker Operating time for maintenance alarm			
CB Time Lockout	10.0C	Alarm Disabled	0 or 1 *[Indexed String]*
Circuit Breaker Operating Time to cause lockout alarm			
CB Time Lockout	10.0D	0.2	From 0.005 to 0.5 in steps of 0.001 *[Courier Number (time-seconds)]*
Circuit Breaker Operating time for lockout alarm			
Fault Freq Lock	10.0E	Alarm Disabled	0 or 1 *[Indexed String]*
Excessive fault frequency			
Fault Freq Count	10.0F	10	From 1 to 9999 in steps of 1 *[Unsigned Integer]*
Excessive Fault Frequency Counter			
Fault Freq Time	10.10	3600	From 0 to 9999 in steps of 1 *[Courier Number (time-seconds)]*
Excessive Fault Frequency Time			
OPTO CONFIG	11.00		
Visible for Model Number design suffix 'B' and beyond			
Global Nominal V	11.01	48/54V	From 0 to 5 in steps of 1 *[Indexed String]*
Select Custom to select individual Opto . Threshold Voltages			
Opto Input 1	11.02	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*
Opto Input 2	11.03	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*
Opto Input 3	11.04	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*
Opto Input 4	11.05	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*
Opto Input 5	11.06	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*
Opto Input 6	11.07	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*
Opto Input 7	11.08	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*
Opto Input 8	11.09	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*
Opto Input 9	11.0A	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*
Opto Input 10	11.0B	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Opto Input 11	11.0C	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*
Opto Input 12	11.0D	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*
Opto Input 13	11.0E	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*
Opto Input 14	11.0F	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*
Opto Input 15	11.10	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*
Opto Input 16	11.11	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*
Opto Input 17	11.12	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*
Opto Input 18	11.13	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*
Opto Input 19	11.14	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*
Opto Input 20	11.15	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*
Opto Input 21	11.16	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*
Opto Input 22	11.17	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*
Opto Input 23	11.18	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*
Opto Input 24	11.19	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*
Opto Input 25	11.1A	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*
Opto Input 26	11.1B	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*
Opto Input 27	11.1C	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*
Opto Input 28	11.1D	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*
Opto Input 29	11.1E	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*
Opto Input 30	11.1F	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Opto Input 31	11.20	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*
Opto Input 32	11.21	48/54V	From 0 to 4 in steps of 1 *[Indexed String]*
Opto Filter Ctrl	11.50	0xFFFFFFFF	From 0x00000000 to 0xFFFFFFFF in steps of 1 *[Binary Flag (32 bits)]*
Opto filter configuration			
Characteristic	11.80	Standard 60%-80%	0 or 1 *[Indexed String]*
Opto input pickup & drop-off threshold. Applicable to design suffix "J" or better.			
CONTROL INPUTS	12.00		
Ctrl I/P Status	12.01		
Control Input 1	12.02	No Operation	
Control Input 2	12.03	No Operation	
Control Input 3	12.04	No Operation	
Control Input 4	12.05	No Operation	
Control Input 5	12.06	No Operation	
Control Input 6	12.07	No Operation	
Control Input 7	12.08	No Operation	
Control Input 8	12.09	No Operation	
Control Input 9	12.0A	No Operation	
Control Input 10	12.0B	No Operation	
Control Input 11	12.0C	No Operation	
Control Input 12	12.0D	No Operation	
Control Input 13	12.0E	No Operation	
Control Input 14	12.0F	No Operation	
Control Input 15	12.10	No Operation	
Control Input 16	12.11	No Operation	
Control Input 17	12.12	No Operation	
Control Input 18	12.13	No Operation	
Control Input 19	12.14	No Operation	
Control Input 20	12.15	No Operation	
Control Input 21	12.16	No Operation	

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Control Input 22	12.17	No Operation	
Control Input 23	12.18	No Operation	
Control Input 24	12.19	No Operation	
Control Input 25	12.1A	No Operation	
Control Input 26	12.1B	No Operation	
Control Input 27	12.1C	No Operation	
Control Input 28	12.1D	No Operation	
Control Input 29	12.1E	No Operation	
Control Input 30	12.1F	No Operation	
Control Input 31	12.20	No Operation	
Control Input 32	12.21	No Operation	
CTRL I/P CONFIG	13.00		
Hotkey Enabled	13.01	0xFFFFFFFF	From 0xFFFFFFFF to 32 in steps of 1 *[Binary Flag (32 bits); Indexed String]*
Hotkey Menu - Control Input availability			
Control Input 1	13.10	Latched	0 or 1 *[Indexed String]*
Individual Control Input Type			
Ctrl Command 1	13.11	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*
Individual Control Input Command Text			
Control Input 2	13.14	Latched	0 or 1 *[Indexed String]*
Individual Control Input Type			
Ctrl Command 2	13.15	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*
Individual Control Input Command Text			
Control Input 3	13.18	Latched	0 or 1 *[Indexed String]*
Individual Control Input Type			
Ctrl Command 3	13.19	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*
Individual Control Input Command Text			
Control Input 4	13.1C	Latched	0 or 1 *[Indexed String]*
Individual Control Input Type			
Ctrl Command 4	13.1D	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*
Individual Control Input Command Text			
Control Input 5	13.20	Latched	0 or 1 *[Indexed String]*
Individual Control Input Type			
Ctrl Command 5	13.21	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*
Individual Control Input Command Text			
Control Input 6	13.24	Latched	0 or 1

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
			[Indexed String]
Individual Control Input Type			
Ctrl Command 6	13.25	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*
Individual Control Input Command Text			
Control Input 7	13.28	Latched	0 or 1 *[Indexed String]*
Individual Control Input Type			
Ctrl Command 7	13.29	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*
Individual Control Input Command Text			
Control Input 8	13.2C	Latched	0 or 1 *[Indexed String]*
Individual Control Input Type			
Ctrl Command 8	13.2D	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*
Individual Control Input Command Text			
Control Input 9	13.30	Latched	0 or 1 *[Indexed String]*
Individual Control Input Type			
Ctrl Command 9	13.31	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*
Individual Control Input Command Text			
Control Input 10	13.34	Latched	0 or 1 *[Indexed String]*
Individual Control Input Type			
Ctrl Command 10	13.35	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*
Individual Control Input Command Text			
Control Input 11	13.38	Latched	0 or 1 *[Indexed String]*
Individual Control Input Type			
Ctrl Command 11	13.39	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*
Individual Control Input Command Text			
Control Input 12	13.3C	Latched	0 or 1 *[Indexed String]*
Individual Control Input Type			
Ctrl Command 12	13.3D	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*
Individual Control Input Command Text			
Control Input 13	13.40	Latched	0 or 1 *[Indexed String]*
Individual Control Input Type			
Ctrl Command 13	13.41	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*
Individual Control Input Command Text			
Control Input 14	13.44	Latched	0 or 1 *[Indexed String]*
Individual Control Input Type			
Ctrl Command 14	13.45	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*
Individual Control Input Command Text			
Control Input 15	13.48	Latched	0 or 1 *[Indexed String]*
Individual Control Input Type			
Ctrl Command 15	13.49	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*
Individual Control Input Command Text			

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Control Input 16	13.4C	Latched	0 or 1 *[Indexed String]*
Individual Control Input Type			
Ctrl Command 16	13.4D	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*
Individual Control Input Command Text			
Control Input 17	13.50	Latched	0 or 1 *[Indexed String]*
Individual Control Input Type			
Ctrl Command 17	13.51	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*
Individual Control Input Command Text			
Control Input 18	13.54	Latched	0 or 1 *[Indexed String]*
Individual Control Input Type			
Ctrl Command 18	13.55	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*
Individual Control Input Command Text			
Control Input 19	13.58	Latched	0 or 1 *[Indexed String]*
Individual Control Input Type			
Ctrl Command 19	13.59	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*
Individual Control Input Command Text			
Control Input 20	13.5C	Latched	0 or 1 *[Indexed String]*
Individual Control Input Type			
Ctrl Command 20	13.5D	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*
Individual Control Input Command Text			
Control Input 21	13.60	Latched	0 or 1 *[Indexed String]*
Individual Control Input Type			
Ctrl Command 21	13.61	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*
Individual Control Input Command Text			
Control Input 22	13.64	Latched	0 or 1 *[Indexed String]*
Individual Control Input Type			
Ctrl Command 22	13.65	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*
Individual Control Input Command Text			
Control Input 23	13.68	Latched	0 or 1 *[Indexed String]*
Individual Control Input Type			
Ctrl Command 23	13.69	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*
Individual Control Input Command Text			
Control Input 24	13.6C	Latched	0 or 1 *[Indexed String]*
Individual Control Input Type			
Ctrl Command 24	13.6D	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*
Individual Control Input Command Text			
Control Input 25	13.70	Latched	0 or 1 *[Indexed String]*
Individual Control Input Type			
Ctrl Command 25	13.71	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Individual Control Input Command Text			
Control Input 26	13.74	Latched	0 or 1 *[Indexed String]*
Individual Control Input Type			
Ctrl Command 26	13.75	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*
Individual Control Input Command Text			
Control Input 27	13.78	Latched	0 or 1 *[Indexed String]*
Individual Control Input Type			
Ctrl Command 27	13.79	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*
Individual Control Input Command Text			
Control Input 28	13.7C	Latched	0 or 1 *[Indexed String]*
Individual Control Input Type			
Ctrl Command 28	13.7D	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*
Individual Control Input Command Text			
Control Input 29	13.80	Latched	0 or 1 *[Indexed String]*
Individual Control Input Type			
Ctrl Command 29	13.81	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*
Individual Control Input Command Text			
Control Input 30	13.84	Latched	0 or 1 *[Indexed String]*
Individual Control Input Type			
Ctrl Command 30	13.85	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*
Individual Control Input Command Text			
Control Input 31	13.88	Latched	0 or 1 *[Indexed String]*
Individual Control Input Type			
Ctrl Command 31	13.89	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*
Individual Control Input Command Text			
Control Input 32	13.8C	Latched	0 or 1 *[Indexed String]*
Individual Control Input Type			
Ctrl Command 32	13.8D	SET/RESET	From 0 to 3 in steps of 1 *[Indexed String]*
Individual Control Input Command Text			
FUNCTION KEYS	17.00		
Fn Key Status	17.01	0	Fn Key Status *[Binary Flag (10 bits); Indexed String]*
Fn Key 1	17.02	Unlocked	From 0 to 2 in steps of 1 *[Indexed String]*
Fn Key 1 Mode	17.03	Toggled	0 or 1 *[Indexed String]*
Fn Key 1 Label	17.04	Function Key 1	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Fn Key 2	17.05	Unlocked	From 0 to 2 in steps of 1 *[Indexed String]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Fn Key 2 Mode	17.06	Normal	0 or 1 *[Indexed String]*
Fn Key 2 Label	17.07	Function Key 2	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Fn Key 3	17.08	Unlocked	From 0 to 2 in steps of 1 *[Indexed String]*
Fn Key 3 Mode	17.09	Normal	0 or 1 *[Indexed String]*
Fn Key 3 Label	17.0A	Function Key 3	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Fn Key 4	17.0B	Unlocked	From 0 to 2 in steps of 1 *[Indexed String]*
Fn Key 4 Mode	17.0C	Toggled	0 or 1 *[Indexed String]*
Fn Key 4 Label	17.0D	Function Key 4	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Fn Key 5	17.0E	Unlocked	From 0 to 2 in steps of 1 *[Indexed String]*
Fn Key 5 Mode	17.0F	Toggled	0 or 1 *[Indexed String]*
Fn Key 5 Label	17.10	Function Key 5	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Fn Key 6	17.11	Unlocked	From 0 to 2 in steps of 1 *[Indexed String]*
Fn Key 6 Mode	17.12	Toggled	0 or 1 *[Indexed String]*
Fn Key 6 Label	17.13	Function Key 6	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Fn Key 7	17.14	Unlocked	From 0 to 2 in steps of 1 *[Indexed String]*
Fn Key 7 Mode	17.15	Normal	0 or 1 *[Indexed String]*
Fn Key 7 Label	17.16	Function Key 7	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Fn Key 8	17.17	Unlocked	From 0 to 2 in steps of 1 *[Indexed String]*
Fn Key 8 Mode	17.18	Normal	0 or 1 *[Indexed String]*
Fn Key 8 Label	17.19	Function Key 8	From 32 to 163 in steps of 1

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
			[ASCII Text (16 chars)]
Fn Key 9	17.1A	Unlocked	From 0 to 2 in steps of 1 [Indexed String]
Fn Key 9 Mode	17.1B	Normal	0 or 1 [Indexed String]
Fn Key 9 Label	17.1C	Function Key 9	From 32 to 163 in steps of 1 [ASCII Text (16 chars)]
Fn Key 10	17.1D	Unlocked	From 0 to 2 in steps of 1 [Indexed String]
Fn Key 10 Mode	17.1E	Normal	0 or 1 [Indexed String]
Fn Key 10 Label	17.1F	Function Key 10	From 32 to 163 in steps of 1 [ASCII Text (16 chars)]
IEC61850 CONFIG	19.00		
Switch Conf.Bank	19.05	No Action	
Restore MCL	19.0A	No Action	
Active Conf.Name	19.10	Not Available	Active Conf.Name [Courier Number]
Active Conf.Rev	19.11	Not Available	Active Conf.Rev [ASCII Text]
Active Conf.Ed	19.12	Not Available	Active Conf.Ed [ASCII Text]
IEC61850 Active Configuration Edition			
Inact.Conf.Name	19.20	Not Available	Inact.Conf.Name [ASCII Text]
Inact.Conf.Rev	19.21	Not Available	Inact.Conf.Rev [ASCII Text]
Inact.Conf.Ed	19.22	Not Available	Inact.Conf.Ed [ASCII Text]
IEC61850 Inactive Configuration Edition			
IP From HMI	19.2F	Disabled	0 or 1 [Indexed String]
When set to Enabled the IP Address, Subnet Mask & Gateway may be configured via the HMI. When set to Disabled these parameters may only be set using the .MCL file. This setting allows for an Ethernet connection to be established with the relay without needing to first send a .MCL file via the serial port. Once a connection has been established the correct .MCL can be sent via Ethernet and this setting can be changed back to “Disabled”. Note: You can enable this feature when you use the IED for the first time. However, the IED will at this point not have an active MCL file and any data model extracted from IEC 61850 may not be correct. Therefore, to prevent any issues you should send a correct MCL file to the IED after a connection is first established.			
IP PARAMETERS	19.30		
IEC61850 versions only.			
IP Address	19.31	0.0.0.0	IP Address [ASCII Text]

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
IEC61850 versions only. Displays the unique network IP address that identifies the IED.			
Subnet Address	19.32	0.0.0.0	Subnet Address *[ASCII Text]*
IEC61850 versions only. Displays the sub-network the IED is connected to.			
Gateway	19.33	0.0.0.0	Gateway *[ASCII Text]*
IEC61850 versions only. Displays the IP address of the gateway (proxy) that the IED is connected to, if any.			
Media	19.34	1xFibre Optic	0 or 1 *[Indexed String]*
IEC 61850 versions only. Displays the communication media of the Ethernet port that is currently in use.			
IP address	19.38	0.0.0.0	IP address *[ASCII text]*
IEC 61850 versions only. When IP From HMI is enabled this is used to set the unique network IP address that identifies the unit.			
Subnet mask	19.39	0.0.0.0	Subnet mask *[ASCII text]*
IEC 61850 versions only. When IP From HMI is enabled this is used to set the sub-network mask.			
Gateway	19.3A	0.0.0.0	Gateway *[ASCII text]*
IEC61850 versions only. Set the IP address of the gateway (proxy) the relay is connected to via HMI if any.			
Media	19.3B	1xFibre Optic	0 or 1 *[Indexed String]*
IEC 61850 versions only. Sets the communication media of the Ethernet port. For products with dual redundant fibre select the 1xCopper/2xFibre setting			
SNTP PARAMETERS	19.40		
SNTP Server 1	19.41	0.0.0.0	SNTP Server 1 *[ASCII Text]*
SNTP Server 2	19.42	0.0.0.0	SNTP Server 2 *[ASCII Text]*
IEC 61850 SCL	19.50		
IED Name	19.51	Not Available	IED Name *[ASCII Text]*
IEC 61850 GOOSE	19.60		
GoEna	19.70	0x00	From 0xFF to 32 in steps of 1 *[Binary Flag (32 bits)]*
Test Mode	19.71	0x00	From 0xFF to 32 in steps of 1 *[Indexed String]*
Ignore Test Flag	19.73	No	0 or 1 *[Indexed String]*
SECURITY CONFIG	25.00		
This Column contains settings for Cyber Security configuration			
User Banner	25.01	ACCESS ONLY FOR AUTHORISED USERS	From 32 to 234 in steps of 1 *[ASCII Text]*
With this setting, you can enter text for the NERC compliant banner.			
Attempts Limit	25.02	3	From 0 to 3 in steps of 1 *[Unsigned Integer (16 bits)]*
This setting defines the maximum number of failed password attempts before action is taken.			
Blocking Timer	25.04	60	From 1 to 5940 in steps of 1 *[Unsigned Integer (16 bits)]*
This setting defines the time duration for which the user is blocked, after exceeding the maximum attempts limit.			
Front Port	25.05	Enabled	0 or 1

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
			[Indexed String]
This setting enables or disables the physical Front Port.			
Rear Port 1	25.06	Enabled	0 or 1 *[Indexed String]*
This setting enables or disables the primary physical rear port (RP1).			
Rear Port 2	25.07	Enabled	0 or 1 *[Indexed String]*
This setting enables or disables the secondary physical rear port (RP2).			
Ethernet Port	25.08	Enabled	0 or 1 *[Indexed String]*
This setting enables or disables the physical Ethernet Port			
Courier Tunnel	25.09	Enabled	0 or 1 *[Indexed String]*
This setting enables or disables the logical tunnelled Courier port			
IEC61850	25.0A	Enabled	0 or 1 *[Indexed String]*
This setting enables or disables the logical IEC61850 port.			
DNP3 OE	25.0B	Enabled	0 or 1 *[Indexed String]*
This setting enables or disables the logical DNP3 over Ethernet port.			
Force Logout	25.0C	No Operation	
The user in role of ADMINISTRATOR can force logout all the active sessions or on dedicated interface.			
Attempts Remain	25.11		Attempts Remain *[Unsigned Integer (16 bits)]*
This cell displays the number of password attempts remaining			
Blk Time Remain	25.12		Blk Time Remain *[Unsigned Integer (16 bits)]*
This cell displays the remaining blocking time.			
LOCAL SESSIONS	25.1A		
FP InactivTimer	25.1B	10	From 0 to 30 in steps of 1 *[Courier Number (time-minutes)]*
A configurable period of time when a user is automatically logged out on Front Port if they remain inactive for. Once log out, resetting of the entered access-level back to 0. Setting the inactivity timer settings to 0 disables session management and the automatic-logout feature is disabled (i.e. a logged in user remains logged in forever; or until the user manually logs out)			
UI InactivTimer	25.1C	10	From 0 to 30 in steps of 1 *[Courier Number (time-minutes)]*
A configurable period of time when a user is automatically logged out on UI if they remain inactive for. Once log out, resetting of the entered access-level back to 0. Setting the inactivity timer settings to 0 disables session management and the automatic-logout feature is disabled (i.e. a logged in user remains logged in forever; or until the user manually logs out)			
RBAC	25.30		
Auth. Method	25.31	Server + Device	From 0 to 2 in steps of 1 *[Indexed string]*
Configure the active Authentication method			
RADIUS Pri IP	25.32	0.0.0.0	From 0.0.0.0 to 223.255.255.255 in steps of 1 *[IP Parameters]*
RADIUS Server 1 configured to provide Server Authentication service. Setting this cell to 0.0.0.0 disables RADUIS Server 1			
RADIUS Sec IP	25.33	0.0.0.0	From 0.0.0.0 to 223.255.255.255 in steps of 1 *[IP Parameters]*
RADIUS Server 2 configured to provide Server Authentication service. Setting this cell to 0.0.0.0 disables RADUIS Server 2			
RADIUS Auth Port	25.34	1812	From 1 to 65535 in steps of 1 *[Unsigned Integer (32 bits)]*
The destination TCP/IP port sent to both Primary and Secondary RADUIS servers.			
RADIUS Security	25.35	PAP EAP-TTLS-PAP	From 0 to 3 in steps of 1 *[Indexed string]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Option for choosing authentication scheme used by RADIUS server. EAP-TTLS-MSCHAP2 - EAP Transport Layer Security (EAP-TLS) is an IETF open standard that uses the TLS protocol. Using TLS, a secure channel is then established between Relay and Radius server. The Microsoft version of Challenge-Handshake Authentication Protocol Version 2 (MS-CHAPv2) is a password based authentication method that utilises the user account credentials (username and password) stored in Active Directory Domain Services to authenticate. EAP-TTLS-MSCHAP2 represents the MSCHAPv2 method transferred over EAP-TTLS channel. PAP - Password Authentication Protocol (PAP) is a password-based authentication protocol. PAP is considered a weak authentication scheme. Protected Extensible Authentication Protocol (PEAP) is a protocol that encapsulates the Extensible Authentication Protocol (EAP) within an encrypted and authenticated TLS tunnel. EAP-PEAP-MSCHAP2 - represents the EAP-MSCHAPv2 method encapsulated by PEAP. PAP EAP-TTLS-PAP - represents the PAP protocol transferred over EAP-TTLS channel.			
RADIUS Timeout	25.36	2	From 1 to 900 in steps of 1 *[Courier Number (time-seconds)]*
RADIUS Retries	25.37	10	From 1 to 99 in steps of 1 *[Unsigned Integer (8 bits)]*
Define the times Relay will retry to request authentication from Radius server if no response.			
RADIUS Secret	25.38	ChangeMe1#	From 33 to 122 in steps of 1 *[ASCII Password (16)]*
The shared secret is used by Radius server to verify the identity of IED.			
Bypass Auth.	25.40	Disabled	From 0 to 4 in steps of 1 *[Indexed string]*
Allow a user, when logged in as an administrator, to bypass the authentication requirements for specific interfaces.			
RADIUS Status	25.FE	Disabled	RADIUS Status *[Indexed string]*
Reporting the status of Radius server.			
Security Code	25.FF		Security Code *[ASCII Text]*
This cell displays the 16-character security code required when requesting a recovery password. UI only cell.			
CTRL I/P LABELS	29.00		
Control Input 1	29.01	Control Input 1	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Text description for the Control Input.			
Control Input 2	29.02	Control Input 2	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Text description for the Control Input.			
Control Input 3	29.03	Control Input 3	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Text description for the Control Input.			
Control Input 4	29.04	Control Input 4	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Text description for the Control Input.			
Control Input 5	29.05	Control Input 5	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Text description for the Control Input.			
Control Input 6	29.06	Control Input 6	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Text description for the Control Input.			
Control Input 7	29.07	Control Input 7	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Text description for the Control Input.			
Control Input 8	29.08	Control Input 8	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Text description for the Control Input.			

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Control Input 9	29.09	Control Input 9	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Text description for the Control Input.			
Control Input 10	29.0A	Control Input 10	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Text description for the Control Input.			
Control Input 11	29.0B	Control Input 11	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Text description for the Control Input.			
Control Input 12	29.0C	Control Input 12	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Text description for the Control Input.			
Control Input 13	29.0D	Control Input 13	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Text description for the Control Input.			
Control Input 14	29.0E	Control Input 14	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Text description for the Control Input.			
Control Input 15	29.0F	Control Input 15	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Text description for the Control Input.			
Control Input 16	29.10	Control Input 16	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Text description for the Control Input.			
Control Input 17	29.11	Control Input 17	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Text description for the Control Input.			
Control Input 18	29.12	Control Input 18	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Text description for the Control Input.			
Control Input 19	29.13	Control Input 19	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Text description for the Control Input.			
Control Input 20	29.14	Control Input 20	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Text description for the Control Input.			
Control Input 21	29.15	Control Input 21	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Text description for the Control Input.			
Control Input 22	29.16	Control Input 22	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Text description for the Control Input.			
Control Input 23	29.17	Control Input 23	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Text description for the Control Input.			
Control Input 24	29.18	Control Input 24	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Text description for the Control Input.			
Control Input 25	29.19	Control Input 25	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Text description for the Control Input.			
Control Input 26	29.1A	Control Input 26	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Text description for the Control Input.			
Control Input 27	29.1B	Control Input 27	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Text description for the Control Input.			
Control Input 28	29.1C	Control Input 28	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Text description for the Control Input.			
Control Input 29	29.1D	Control Input 29	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Text description for the Control Input.			
Control Input 30	29.1E	Control Input 30	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Text description for the Control Input.			
Control Input 31	29.1F	Control Input 31	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Text description for the Control Input.			
Control Input 32	29.20	Control Input 32	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Text description for the Control Input.			
GROUP 1: SYSTEM CONFIG	30.00		
Winding Config	30.01	Generator	0 or 1 *[Indexed String]*
Ref Power S	30.02	100000000	From 100000 to 5000000000 in steps of 100000 *[Courier Number (VA)]*
HV Connection	30.11	Y-Wye	From 0 to 2 in steps of 1 *[Indexed String]*
HV Grounding	30.12	Grounded	0 or 1 *[Indexed String]*
HV Nominal	30.13	220000	From 100 to 1000000 in steps of 1 *[Courier Number (Voltage)]*
% Reactance	30.20	0.1	From 1 to 100 in steps of 0.1 *[Courier Number (Percentage)]*
LV Vector Group	30.31	0	From 0 to 11 in steps of 1 *[Unsigned Integer]*
LV Connection	30.32	Y-Wye	From 0 to 2 in steps of 1 *[Indexed String]*
LV Grounding	30.33	Grounded	0 or 1 *[Indexed String]*
LV Nominal	30.34	11000	From 100 to 1000000 in steps of 1 *[Courier Number (Voltage)]*
Match Factor HV	30.40		Match Factor HV *[Courier Number (Decimal)]*
Match Factor LV	30.41		Match Factor LV *[Courier Number (Decimal)]*
Phase Sequence	30.42	Standard ABC	0 or 1 *[Indexed String]*
VT Reversal	30.43	No Swap	From 0 to 3 in steps of 1 *[Indexed String]*
CT Reversal\CT1	30.44	No Swap	From 0 to 3 in steps of 1

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Reversal			[Indexed String]
CT2 Reversal	30.45	No Swap	From 0 to 3 in steps of 1 [Indexed String]
C/S Input	30.50	A-N	From 0 to 5 in steps of 1 [Indexed String]
I*=Phase CT secondary rating			
C/S V Ratio Corr	30.51	1	From 0.1 to 5 in steps of 0.001 [Courier Number (Decimal)]
C/S VT Vect Grp	30.52	0	From 0 to 11 in steps of 1 [Courier Number (Decimal)]
Main VT Location	30.53	Gen	0 or 1 [Indexed String]
Neutral Displacement VT Primary			
CounterSourcePSL	30.9F	0xFFFF	From 0x0000 to 0xFFFF in steps of 1 [Binary Flag (16 bits)]
Counter 1	30.A0	65535	From 1 to 65535 in steps of 1 [Courier Number (Decimal)]
Counter 1 Setting			
Counter 2	30.A1	65535	From 1 to 65535 in steps of 1 [Courier Number (Decimal)]
Counter 2 Setting			
Counter 3	30.A2	65535	From 1 to 65535 in steps of 1 [Courier Number (Decimal)]
Counter 3 Setting			
Counter 4	30.A3	65535	From 1 to 65535 in steps of 1 [Courier Number (Decimal)]
Counter 4 Setting			
Counter 5	30.A4	65535	From 1 to 65535 in steps of 1 [Courier Number (Decimal)]
Counter 5 Setting			
Counter 6	30.A5	65535	From 1 to 65535 in steps of 1 [Courier Number (Decimal)]
Counter 6 Setting			
Counter 7	30.A6	65535	From 1 to 65535 in steps of 1 [Courier Number (Decimal)]
Counter 7 Setting			
Counter 8	30.A7	65535	From 1 to 65535 in steps of 1 [Courier Number (Decimal)]
Counter 8 Setting			
Counter 9	30.A8	65535	From 1 to 65535 in steps of 1 [Courier Number (Decimal)]
Counter 9 Setting			
Counter 10	30.A9	65535	From 1 to 65535 in steps of 1 [Courier Number (Decimal)]
Counter 10 Setting			
Counter 11	30.AA	65535	From 1 to 65535 in steps of 1 [Courier Number (Decimal)]
Counter 11 Setting			
Counter 12	30.AB	65535	From 1 to 65535 in steps of 1 [Courier Number (Decimal)]
Counter 12 Setting			
Counter 13	30.AC	65535	From 1 to 65535 in steps of 1 [Courier Number (Decimal)]
Counter 13 Setting			

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Counter 14	30.AD	65535	From 1 to 65535 in steps of 1 *[Courier Number (Decimal)]*
Counter 14 Setting			
Counter 15	30.AE	65535	From 1 to 65535 in steps of 1 *[Courier Number (Decimal)]*
Counter 15 Setting			
Counter 16	30.AF	65535	From 1 to 65535 in steps of 1 *[Courier Number (Decimal)]*
Counter 16 Setting			
Counter 1 Label	30.C0	Counter 1	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Counter 2 Label	30.C1	Counter 2	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Counter 3 Label	30.C2	Counter 3	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Counter 4 Label	30.C3	Counter 4	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Counter 5 Label	30.C4	Counter 5	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Counter 6 Label	30.C5	Counter 6	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Counter 7 Label	30.C6	Counter 7	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Counter 8 Label	30.C7	Counter 8	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Counter 9 Label	30.C8	Counter 9	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Counter 10 Label	30.C9	Counter 10	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Counter 11 Label	30.CA	Counter 11	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Counter 12 Label	30.CB	Counter 12	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Counter 13 Label	30.CC	Counter 13	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Counter 14 Label	30.CD	Counter 14	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Counter 15 Label	30.CE	Counter 15	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Counter 16 Label	30.CF	Counter 16	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Timer 1	30.E0	0	From 0 to 14400 in steps of 0.001 *[Courier Number (Time)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Timer1 Setting			
Timer 2	30.E1	0	From 0 to 14400 in steps of 0.001 *[Courier Number (Time)]*
Timer2 Setting			
Timer 3	30.E2	0	From 0 to 14400 in steps of 0.001 *[Courier Number (Time)]*
Timer3 Setting			
Timer 4	30.E3	0	From 0 to 14400 in steps of 0.001 *[Courier Number (Time)]*
Timer4 Setting			
Timer 5	30.E4	0	From 0 to 14400 in steps of 0.001 *[Courier Number (Time)]*
Timer5 Setting			
Timer 6	30.E5	0	From 0 to 14400 in steps of 0.001 *[Courier Number (Time)]*
Timer6 Setting			
Timer 7	30.E6	0	From 0 to 14400 in steps of 0.001 *[Courier Number (Time)]*
Timer7 Setting			
Timer 8	30.E7	0	From 0 to 14400 in steps of 0.001 *[Courier Number (Time)]*
Timer8 Setting			
Timer 9	30.E8	0	From 0 to 14400 in steps of 0.001 *[Courier Number (Time)]*
Timer9 Setting			
Timer 10	30.E9	0	From 0 to 14400 in steps of 0.001 *[Courier Number (Time)]*
Timer10 Setting			
Timer 11	30.EA	0	From 0 to 14400 in steps of 0.001 *[Courier Number (Time)]*
Timer11 Setting			
Timer 12	30.EB	0	From 0 to 14400 in steps of 0.001 *[Courier Number (Time)]*
Timer12 Setting			
Timer 13	30.EC	0	From 0 to 14400 in steps of 0.001 *[Courier Number (Time)]*
Timer13 Setting			
Timer 14	30.ED	0	From 0 to 14400 in steps of 0.001 *[Courier Number (Time)]*
Timer14 Setting			
Timer 15	30.EE	0	From 0 to 14400 in steps of 0.001 *[Courier Number (Time)]*
Timer15 Setting			
Timer 16	30.EF	0	From 0 to 14400 in steps of 0.001 *[Courier Number (Time)]*
Timer16 Setting			
GROUP 1: POWER	31.00		
Comp Angle	31.01	0	From -5 to 5 in steps of 0.1 *[Courier Number (Angle)]*
Power1 Function	31.04	Over	From 0 to 2 in steps of 1 *[Indexed String]*
Power1 Dirn	31.05	Forward	0 or 1 *[Indexed String]*
Power1 Mode	31.06	Active	0 or 1 *[Indexed String]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Power1 3Ph Watts	31.08	0.5	From 0.4*V1*I1 to 300*V1*I1 in steps of 0.1*V1*I1 *[Courier Number (Power)]*
Power1 3Ph VArs	31.0A	0.5	From 0.4*V1*I1 to 300*V1*I1 in steps of 0.1*V1*I1 *[Courier Number (Var)]*
Power1 TimeDelay	31.0B	5	From 0 to 100 in steps of 0.01 *[Courier Number (Time)]*
Power1 DO Timer	31.0C	0	From 0 to 100 in steps of 0.01 *[Courier Number (Time)]*
P1 Poledead Inh	31.0D	Enabled	0 or 1 *[Indexed String]*
Power2 Function	31.14	Over	From 0 to 2 in steps of 1 *[Indexed String]*
Power2 Dirn	31.15	Forward	0 or 1 *[Indexed String]*
Power2 Mode	31.16	Active	0 or 1 *[Indexed String]*
Power2 3Ph Watts	31.18	0.5	From 0.4*V1*I1 to 300*V1*I1 in steps of 0.1*V1*I1 *[Courier Number (Power)]*
Power2 3Ph VArs	31.1A	0.5	From 0.4*V1*I1 to 300*V1*I1 in steps of 0.1*V1*I1 *[Courier Number (Var)]*
Power2 TimeDelay	31.1B	5	From 0 to 100 in steps of 0.01 *[Courier Number (Time)]*
Power2 DO Timer	31.1C	0	From 0 to 100 in steps of 0.01 *[Courier Number (Time)]*
P2 Poledead Inh	31.1D	Enabled	0 or 1 *[Indexed String]*
Power3 Function	31.24	Disabled	From 0 to 2 in steps of 1 *[Indexed String]*
Power3 Dirn	31.25	Forward	0 or 1 *[Indexed String]*
Power3 Mode	31.26	Active	0 or 1 *[Indexed String]*
Power3 3Ph Watts	31.28	0.5	From 0.4*V1*I1 to 300*V1*I1 in steps of 0.1*V1*I1 *[Courier Number (Power)]*
Power3 3Ph VArs	31.2A	0.5	From 0.4*V1*I1 to 300*V1*I1 in steps of 0.1*V1*I1 *[Courier Number (Var)]*
Power3 TimeDelay	31.2B	5	From 0 to 100 in steps of 0.01 *[Courier Number (Time)]*
Power3 DO Timer	31.2C	0	From 0 to 100 in steps of 0.01

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
			[Courier Number (Time)]
P3 Poledead Inh	31.2D	Enabled	0 or 1 [Indexed String]
Power4 Function	31.34	Disabled	From 0 to 2 in steps of 1 [Indexed String]
Power4 Dirn	31.35	Forward	0 or 1 [Indexed String]
Power4 Mode	31.36	Active	0 or 1 [Indexed String]
Power4 3Ph Watts	31.38	0.5	From 0.4*V1*I1 to 300*V1*I1 in steps of 0.1*V1*I1 [Courier Number (Power)]
Power4 3Ph VArs	31.3A	0.5	From 0.4*V1*I1 to 300*V1*I1 in steps of 0.1*V1*I1 [Courier Number (Var)]
Power4 TimeDelay	31.3B	5	From 0 to 100 in steps of 0.01 [Courier Number (Time)]
Power4 DO Timer	31.3C	0	From 0 to 100 in steps of 0.01 [Courier Number (Time)]
P4 Poledead Inh	31.3D	Enabled	0 or 1 [Indexed String]
NPS OVERPOWER	31.60		
S2> CT Source	31.61	IA-1 IB-1 IC-1	0 or 1 [Indexed String]
S2>1 Status	31.62	Disabled	0 or 1 [Indexed String]
S2>1 Setting	31.64	0.5	From 0.1*V1*I1/0.1*V1*I4 to 30*V1*I1/30*V1*I4 in steps of 0.01*V1*I1/0.01*V1*I4 [Courier Number (VA)]
S2>1 Time Delay	31.68	0.1	From 0 to 100 in steps of 0.01 [Courier Number (Time)]
GROUP 1: FIELD FAILURE	32.00		
FFail Alm Status	32.01	Disabled	0 or 1 [Indexed String]
FFail Alm Angle	32.02	15	From 15 to 75 in steps of 1 [Courier Number (Angle)]
FFail Alm Delay	32.03	5	From 0 to 100 in steps of 0.01 [Courier Number (Time)]
FFail1 Status	32.04	Enabled	0 or 1 [Indexed String]

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
FFail1 Xa1	32.05	20	From -250*V1/I1 to 250*V1/I1 in steps of 0.5*V1/I1 *[Courier Number (Impedance)]*
FFail1 Xb1	32.06	220	From 0.5*V1/I1 to 500*V1/I1 in steps of 0.5*V1/I1 *[Courier Number (Impedance)]*
FFail1 TimeDelay	32.07	5	From 0 to 100 in steps of 0.01 *[Courier Number (Time)]*
FFail1 DO Timer	32.08	0	From 0 to 100 in steps of 0.01 *[Courier Number (Time)]*
FFail2 Status	32.09	Disabled	0 or 1 *[Indexed String]*
FFail2 Xa2	32.0A	20	From -250 to 250*V1/I1 in steps of 0.5*V1/I1 *[Courier Number (Impedance)]*
FFail2 Xb2	32.0B	110	From 0.5*V1/I1 to 500*V1/I1 in steps of 0.5*V1/I1 *[Courier Number (Impedance)]*
FFail2 TimeDelay	32.0C	0	From 0 to 100 in steps of 0.01 *[Courier Number (Time)]*
FFail2 DO Timer	32.0D	0	From 0 to 100 in steps of 0.01 *[Courier Number (Time)]*
FFail Dirn Line	32.20	Disabled	0 or 1 *[Indexed String]*
Line Offset	32.21	0	From -250*V1/I1 to 250*V1/I1 in steps of 0.5/I1 *[Courier Number (Impedance)]*
Line Angle	32.22	0	From -180 to 180 in steps of 0.1 *[Courier Number (Angle)]*
GROUP 1: NPS THERMAL	33.00		
I2therm>1 Alarm	33.01	Enabled	0 or 1 *[Indexed String]*
I2therm>1 Set	33.02	0.05	From 0.03*I1 to 0.5*I1 in steps of 0.01*I1 *[Courier Number (Current)]*
I2therm>1 Delay	33.03	20	From 0 to 100 in steps of 0.01 *[Courier Number (Time)]*
I2therm>2 Trip	33.04	Enabled	0 or 1 *[Indexed String]*
I2therm>2 Set	33.05	0.1	From 0.05*I1 to 0.5*I1 in steps of 0.01*I1 *[Courier Number (Current)]*
I2therm>2 kSet	33.06	15	From 2 to 40 in steps of 0.1 *[Courier Number (Time)]*
I2therm>2 kRESET	33.07	15	From 2 to 40 in steps of 0.1 *[Courier Number (Time)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
I2therm>2 tMAX	33.08	1000	From 500 to 2000 in steps of 1 *[Courier Number (Time)]*
I2therm>2 tMIN	33.09	0.25	From 0 to 100 in steps of 0.01 *[Courier Number (Time)]*
GROUP 1: SYSTEM BACKUP	34.00		
V Dep OC Func	34.01	Volt controlled	From 0 to 2 in steps of 1 *[Indexed String]*
Vector Rotation	34.02	None	0 or 1 *[Indexed String]*
V Dep OC Char	34.20	IEC S Inverse	From 0 to 15 in steps of 1 *[Indexed String]*
V Dep OC I> Set	34.23	1	From 0.8*I1 to 4*I1 in steps of 0.01*I1 *[Courier Number (Current)]*
V Dep OC T Dial	34.25	1	From 0.01 to 100 in steps of 0.01 *[Courier Number (Decimal)]*
V Dep OC Reset	34.26	DT	0 or 1 *[Indexed String]*
V Dep OC Delay	34.27	1	From 0 to 100 in steps of 0.01 *[Courier Number (Time)]*
V Dep OC TMS	34.28	1	From 0.025 to 1.2 in steps of 0.025 *[Courier Number (Decimal)]*
V Dep OC K (RI)	34.29	1	From 0.1 to 10 in steps of 0.05 *[Courier Number (Decimal)]*
V Dep OC Usr Rst	34.2A	DT	From 0 to 4 in steps of 1 *[Indexed String]*
Visible if the Default curves are selected			
V Dep OC tRESET	34.2B	0	From 0 to 100 in steps of 0.01 *[Courier Number (Time)]*
Visible if operating characteritic is selected as DT or IEC/Uk curves or reset characteritic is selected as DT			
V Dep OC V<1 Set	34.2D	80	From 5*V1 to 120*V1 in steps of 1*V1 *[Courier Number (Voltage)]*
V Dep OC V<2 Set	34.2E	60	From 5*V1 to 120*V1 in steps of 1*V1 *[Courier Number (Voltage)]*
V Dep OC k Set	34.2F	0.25	From 0.1 to 1 in steps of 0.05 *[Courier Number (Decimal)]*
Z< Function	34.30	Enabled	0 or 1 *[Indexed String]*
Vector Rotation	34.31	None	0 or 1 *[Indexed String]*
Z<1 Status	34.34	Enabled	0 or 1

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
			[Indexed String]
Z<1 Setting	34.36	70	From 2*V1/I1 to 500*V1/I1 in steps of 0.5*V1/I1 *[Courier Number (Impedance)]*
Z<1 Time Delay	34.38	5	From 0 to 100 in steps of 0.01 *[Courier Number (Time)]*
Z<1 tRESET	34.3A	0	From 0 to 100 in steps of 0.01 *[Courier Number (Time)]*
Z<2 Status	34.44	Disabled	0 or 1 *[Indexed String]*
Z<2 Setting	34.46	70	From 2*V1/I1 to 500*V1/I1 in steps of 0.5*V1/I1 *[Courier Number (Impedance)]*
Z<2 Time Delay	34.48	5	From 0 to 100 in steps of 0.01 *[Courier Number (Time)]*
Z<2 tRESET	34.4A	0	From 0 to 100 in steps of 0.01 *[Courier Number (Time)]*
GROUP 1: OVERCURRENT	35.00		
PHASE O/C PHASE O/C PEAK	35.20		
I> CT Source	35.21	IA-1 IB-1 IC-1	0 or 1 *[Indexed String]*
I>1 Function\I>1 Status	35.23	IEC S Inverse Enabled	From 0////0 to 16////1 in steps of 1////1 *[Indexed String]*
I>1 Direction	35.24	Non-Directional	From 0 to 2 in steps of 1 *[Indexed String]*
I>1 Current Set	35.27	1	From 0.08*I1 to 4.0*I1 in steps of 0.01*I1 *[Courier Number (Current)]*
I>1 Time Delay	35.29	1	From 0 to 200 in steps of 0.01 *[Courier Number (time-seconds)]*
I>1 TMS	35.2A	1	From 0.025 to 1.2 in steps of 0.025 *[Courier Number (Decimal)]*
I>1 Time Dial	35.2B	1	From 0.01 to 100 in steps of 0.01 *[Courier Number (Decimal)]*
I>1 k (RI)	35.2C	1	From 0.1 to 10 in steps of 0.05 *[Courier Number (Decimal)]*
I>1 Reset Char	35.2E	DT	0 or 1 *[Indexed String]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
I>1 Usr Rst Char	35.2F	DT	From 0 to 4 in steps of 1 *[Indexed String]*
Visible if the Default curves are selected			
I>1 tRESET	35.30	0	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
Visible if operating charactertitic is selected as DT or IEC/Uk curves or reset charactertitic is selected as DT			
I>2 Function\I>2 Status	35.32	Disabled	From 0 to 16///1 in steps of 1 *[Indexed String]*
I>2 Direction	35.33	Non-Directional	From 0 to 2 in steps of 1 *[Indexed String]*
I>2 Current Set	35.36	1	From 0.08*I1 to 4.0*I1 in steps of 0.01*I1 *[Courier Number (Current)]*
I>2 Time Delay	35.38	1	From 0 to 200 in steps of 0.01 *[Courier Number (time-seconds)]*
I>2 TMS	35.39	1	From 0.025 to 1.2 in steps of 0.025 *[Courier Number (Decimal)]*
I>2 Time Dial	35.3A	1	From 0.01 to 100 in steps of 0.01 *[Courier Number (Decimal)]*
I>2 k (RI)	35.3B	1	From 0.1 to 10 in steps of 0.05 *[Courier Number (Decimal)]*
I>2 Reset Char	35.3C	DT	0 or 1 *[Indexed String]*
I>2 Usr Rst Char	35.3D	DT	From 0 to 4 in steps of 1 *[Indexed String]*
Visible if the Default curves are selected			
I>2 tRESET	35.3E	0	From 0 to 100 in steps of 0.01 *[Courier Number (Time)]*
Visible if operating charactertitic is selected as DT or IEC/Uk curves or reset charactertitic is selected as DT			
I>3 Status	35.40	Disabled	0 or 1 *[Indexed String]*
I>3 Direction	35.41	Non-Directional	From 0 to 2 in steps of 1 *[Indexed String]*
I>3 Current Set	35.43	10	From 0.08*I1 to 32*I1/10*I1/32*I1 in steps of 0.01*I1 *[Courier Number (Current)]*
I>3 Time Delay	35.44	0	From 0 to 200/100 in steps of 0.01 *[Courier Number (time-seconds)]*
I>4 Status	35.47	Disabled	0 or 1 *[Indexed String]*
I>4 Direction	35.48	Non-Directional	From 0 to 2 in steps of 1 *[Indexed String]*
I>4 Current Set	35.4A	10	From 0.08*I1 to 32*I1/10*I1/32*I1 in steps of 0.01*I1 *[Courier Number (Current)]*
I>4 Time Delay	35.4B	0	From 0 to 200/100 in steps of 0.01 *[Courier Number (time-seconds)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
I> Char Angle	35.4E	30	From -95 to 95 in steps of 1 *[Courier Number (Angle)]*
I> Function Link	35.4F	15	From 0 to 15 in steps of 1 *[Binary Flag]*
NPS OVERCURRENT	35.50		
I2> CT Source	35.51	IA-1 IB-1 IC-1	0 or 1 *[Indexed String]*
I2>1 Status	35.52	Disabled	0 or 1 *[Indexed String]*
I2>1 Direction	35.54	Non-Directional	From 0 to 2 in steps of 1 *[Indexed String]*
I2>1 Current Set	35.56	0.2	From 0.08*I1 to 4*I1 in steps of 0.01*I1 *[Courier Number (Current)]*
I2>1 Time Delay	35.58	10	From 0 to 100 in steps of 0.01 *[Courier Number (Time)]*
I2>2 Status	35.62	Disabled	0 or 1 *[Indexed String]*
I2>2 Direction	35.64	Non-Directional	From 0 to 2 in steps of 1 *[Indexed String]*
I2>2 Current Set	35.66	0.2	From 0.08*I1 to 4*I1 in steps of 0.01*I1 *[Courier Number (Current)]*
I2>2 Time Delay	35.68	10	From 0 to 100 in steps of 0.01 *[Courier Number (Time)]*
I2>3 Status	35.72	Disabled	0 or 1 *[Indexed String]*
I2>3 Direction	35.74	Non-Directional	From 0 to 2 in steps of 1 *[Indexed String]*
I2>3 Current Set	35.76	0.2	From 0.08*I1 to 4*I1 in steps of 0.01*I1 *[Courier Number (Current)]*
I2>3 Time Delay	35.78	10	From 0 to 100 in steps of 0.01 *[Courier Number (Time)]*
I2>4 Status	35.82	Disabled	0 or 1 *[Indexed String]*
I2>4 Direction	35.84	Non-Directional	From 0 to 2 in steps of 1 *[Indexed String]*
I2>4 Current Set	35.86	0.2	From 0.08*I1 to 4*I1 in steps of 0.01*I1 *[Courier Number (Current)]*
I2>4 Time Delay	35.88	10	From 0 to 100 in steps of 0.01 *[Courier Number (Time)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
I2> VTS Block	35.90	15	From 0 to 15 in steps of 1 *[Binary Flag]*
I2> Char Angle	35.94	-60	From -95 to 95 in steps of 1 *[Courier Number (Angle)]*
I2> V2pol Set	35.98	5	From 0.5*V1 to 25*V1 in steps of 0.5*V1 *[Courier Number (Voltage)]*
GROUP 1: THERMAL OVERLOAD	36.00		
GEN THERMAL	36.40		
Thermal	36.50	Enabled	0 or 1 *[Indexed String]*
Thermal I>	36.55	1.2	From 0.5*I1 to 2.5*I1 in steps of 0.01*I1 *[Courier Number (Current)]*
Thermal Alarm	36.5A	90	From 20 to 100 in steps of 1 *[Courier Number (Percentage)]*
T-heating	36.5F	1	From 1 to 200 in steps of 1 *[Courier Number (Time Minutes)]*
T-cooling	36.64	1	From 1 to 200 in steps of 1 *[Courier Number (Time Minutes)]*
M Factor	36.69	0	From 0 to 10 in steps of 1 *[Courier Number (Decimal)]*
XFORMER THERMAL	36.70		
Thermal	36.71	Enabled	0 or 1 *[Indexed String]*
Mn't Winding	36.72	HV Current	From 0 to 2 in steps of 1 *[Indexed String]*
Ambient T	36.73	AVERAGE	From 0 to 14 in steps of 1 *[Indexed String]*
Amb CLI Type	36.74	4-20mA	From 0 to 3 in steps of 1 *[Indexed String]*
Amb CLI Min	36.75	0	From -9999 to 9999 in steps of 0.1 *[Courier Number (Decimal)]*
Amb CLI Max	36.76	100	From -9999 to 9999 in steps of 0.1 *[Courier Number (Decimal)]*
Average Amb T	36.77	25	From -25 to 75 in steps of 0.1 *[Courier Number (Decimal)]*
Top Oil T	36.78	CALCULATED	From 0 to 14 in steps of 1 *[Indexed String]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Top Oil CLI Typ	36.79	4-20mA	From 0 to 3 in steps of 1 *[Indexed String]*
Top Oil CLI Min	36.7A	0	From -9999 to 9999 in steps of 0.1 *[Courier Number (Decimal)]*
Top Oil CLI Max	36.7B	100	From -9999 to 9999 in steps of 0.1 *[Courier Number (Decimal)]*
IB	36.7C	1	From 0.1 to 4 in steps of 0.01 *[Courier Number (Per Unit)]*
Rated NoLoadLoss	36.7D	3	From 0.1 to 100 in steps of 0.1 *[Courier Number (Decimal)]*
Hot Spot overtop	36.7E	25	From 0.1 to 200 in steps of 0.1 *[Courier Number (Decimal)]*
Top Oil overamb	36.7F	55	From 0.1 to 200 in steps of 0.1 *[Courier Number (Decimal)]*
Cooling Mode	36.80	Natural	From 0 to 4 in steps of 1 *[Indexed String]*
Cooling Status	36.81	Natural	
NATURAL COOL	36.82		
Winding exp m	36.83	0.8	From 0.01 to 2 in steps of 0.01 *[Courier Number (Decimal)]*
Oil exp n	36.84	0.8	From 0.01 to 2 in steps of 0.01 *[Courier Number (Decimal)]*
FORCED AIR COOL	36.85		
Winding exp m	36.86	0.8	From 0.01 to 2 in steps of 0.01 *[Courier Number (Decimal)]*
Oil exp n	36.87	0.8	From 0.01 to 2 in steps of 0.01 *[Courier Number (Decimal)]*
FORCED OIL COOL	36.88		
Winding exp m	36.89	0.8	From 0.01 to 2 in steps of 0.01 *[Courier Number (Decimal)]*
Oil exp n	36.8A	0.8	From 0.01 to 2 in steps of 0.01 *[Courier Number (Decimal)]*
FORCED AIR & OIL	36.8B		
Winding exp m	36.8C	0.8	From 0.01 to 2 in steps of 0.01 *[Courier Number (Decimal)]*
Oil exp n	36.8D	0.8	From 0.01 to 2 in steps of 0.01 *[Courier Number (Decimal)]*
Hot spot rise co	36.8E	1	From 0.01 to 20 in steps of 0.01

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
			[Courier Number (Time Minutes)]
Top oil rise co	36.8F	120	From 1 to 1000 in steps of 1 [Courier Number (Time Minutes)]
TOL Status	36.90	Enabled	0 or 1 [Indexed String]
Hot Spot>1 Set	36.91	110	From 1 to 300 in steps of 0.1 [Courier Number (Decimal)]
tHot Spot>1 Set	36.92	10	From 0 to 60000 in steps of 1 [Courier Number (Time Minutes)]
Hot Spot>2 Set	36.93	130	From 1 to 300 in steps of 0.1 [Courier Number (Decimal)]
tHot Spot>2 Set	36.94	10	From 0 to 60000 in steps of 1 [Courier Number (Time Minutes)]
Hot Spot>3 Set	36.95	150	From 1 to 300 in steps of 0.1 [Courier Number (Decimal)]
tHot Spot>3 Set	36.96	10	From 0 to 60000 in steps of 1 [Courier Number (Time Minutes)]
Top Oil>1 Set	36.97	70	From 1 to 300 in steps of 0.1 [Courier Number (Decimal)]
tTop Oil>1 Set	36.98	10	From 0 to 60000 in steps of 1 [Courier Number (Time Minutes)]
Top Oil>2 Set	36.99	80	From 1 to 300 in steps of 0.1 [Courier Number (Decimal)]
tTop Oil>2 Set	36.9A	10	From 0 to 60000 in steps of 1 [Courier Number (Time Minutes)]
Top Oil>3 Set	36.9B	90	From 1 to 300 in steps of 0.1 [Courier Number (Decimal)]
tTop Oil>3 Set	36.9C	10	From 0 to 60000 in steps of 1 [Courier Number (Time Minutes)]
tPre-trip Set	36.9D	5	From 0 to 60000 in steps of 1 [Courier Number (Time Minutes)]
LOL Status	36.A0	Enabled	0 or 1 [Indexed String]
Life Hours at HS	36.A1	180000	From 1 to 300000 in steps of 1 [Courier Number (Decimal)]
Design HS temp	36.A2	110	From 1 to 200 in steps of 0.1 [Courier Number (Decimal)]
Constant B Set	36.A3	15000	From 1 to 100000 in steps of 1 [Courier Number (Decimal)]

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
FAA> Set	36.A4	2	From 0.1 to 30 in steps of 0.01 *[Courier Number (Decimal)]*
tFAA> Set	36.A5	10	From 0 to 60000 in steps of 1 *[Courier Number (Decimal)]*
LOL>1 Set	36.A6	160000	From 1 to 300000 in steps of 1 *[Courier Number (Decimal)]*
tLOL> Set	36.A7	10	From 0 to 60000 in steps of 1 *[Courier Number (Decimal)]*
Reset Life Hours	36.B0	0	From 0 to 300000 in steps of 1 *[Courier Number (Decimal)]*
GROUP 1: DIFFERENTIAL	37.00		
Was in database column 30, moved in version 32 s/w			
GEN DIFF	37.01		
Gen Diff Func	37.02	Percentage Bias	From 0 to 3 in steps of 1 *[Indexed String]*
Gen Diff Is1	37.03	0.1	From 0.05*I1/0.05*I4 to 0.5*I1/0.5*I4 in steps of 0.01*I1/0.01*I4 *[Courier Number (Current)]*
Gen Diff k1	37.04	0	From 0 to 20 in steps of 5 *[Courier Number (Percentage)]*
Gen Diff Is2	37.05	1.2	From 1*I1 to 5*I1 in steps of 0.1*I1 *[Courier Number (Current)]*
Gen Diff k2	37.06	150	From 20 to 150 in steps of 10 *[Courier Number (Percentage)]*
Interturn Is_A	37.10	0.1	From 0.05*I1 to 2*I1 in steps of 0.01*I1 *[Courier Number (Current)]*
Interturn Is_B	37.14	0.1	From 0.05*I1 to 2*I1 in steps of 0.01*I1 *[Courier Number (Current)]*
Interturn Is_C	37.18	0.1	From 0.05*I1 to 2*I1 in steps of 0.01*I1 *[Courier Number (Current)]*
Interturn Delay	37.1C	0.1	From 0 to 100 in steps of 0.01 *[Courier Number (Time)]*
XFORMER DIFF	37.30		
Xform Diff Func	37.31	Enabled	0 or 1 *[Indexed String]*
Set Mode	37.32	Simple	0 or 1 *[Indexed String]*
Xform Is1	37.33	0.2	From 0.05*PU to 2.5*PU in steps of 0.01*PU *[Courier Number (Per Unit)]*
Xform K1	37.34	30	From 0 to 150 in steps of 1

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
			[Courier Number (Percentage)]
Xform Is2	37.35	1	From 0.1*PU to 10*PU in steps of 0.1*I1 [Courier Number (Per Unit)]
Xform K2	37.36	80	From 15 to 150 in steps of 1 [Courier Number (Percentage)]
Xform tDIFF	37.37	0	From 0 to 10 in steps of 0.01 [Courier Number (time-seconds)]
Xform Is-CTS	37.40	1.5	From 0.1*PU to 2.5*PU in steps of 0.01*PU [Courier Number (Per Unit)]
Xform HS1 Status	37.41	Enabled	0 or 1 [Indexed String]
Xform Is-HS1	37.42	10	From 2.5*PU to 16*PU in steps of 0.1*PU [Courier Number (Per Unit)]
Xform HS2 Status	37.43	Enabled	0 or 1 [Indexed String]
Xform Is-HS2	37.44	16	From 2.5*PU to 16*PU in steps of 0.1*PU [Courier Number (Per Unit)]
Zero seq filt HV	37.50	Enabled	0 or 1 [Indexed String]
Zero seq filt LV	37.51	Enabled	0 or 1 [Indexed String]
2nd harm blocked	37.52	Enabled	0 or 1 [Indexed String]
Xform Ih(2)%>	37.53	20	From 5 to 50 in steps of 1 [Courier Number (Percentage)]
Cross blocking	37.54	Disabled	0 or 1 [Indexed String]
5th harm blocked	37.55	Disabled	0 or 1 [Indexed String]
Xform Ih(5)%>	37.56	35	From 0 to 100 in steps of 1 [Courier Number (Percentage)]
Circuitry Fail	37.60	Enabled	0 or 1 [Indexed String]
Is-cctfail	37.61	0.1	From 0.03*PU to 1*PU in steps of 0.01*PU [Courier Number (Per Unit)]
K-cctfail	37.62	0.1	From 0 to 0.5 in steps of 0.01 [Courier Number (Percentage)]
CctFail Delay	37.63	5	From 0 to 10 in steps of 0.1 [Courier Number (time-seconds)]

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
GROUP 1: EARTH FAULT	38.00		
IN Input	38.01	Derived Measured	IN Input *[Indexed String]*
IN>1 Function	38.25	IEC S Inverse	From 0 to 16 in steps of 1 *[Indexed String]*
IN>1 Current	38.29	0.2 0.1	From 0.08*I1/0.02*I2 to 4.0*I1/4.0*I2 in steps of 0.01*I1/0.01*I2 *[Courier Number (Current)]*
IN>1 IDG Is	38.2A	1.5	From 1 to 4 in steps of 0.1 *[Courier Number (Decimal)]*
IN>1 Time Delay	38.2C	1	From 0 to 200 in steps of 0.01 *[Courier Number (time-seconds)]*
IN>1 TMS	38.2D	1	From 0.025 to 1.2 in steps of 0.025 *[Courier Number (Decimal)]*
IN>1 Time Dial	38.2E	1	From 0.01 to 100 in steps of 0.01 *[Courier Number (Decimal)]*
IN>1 k (RI)	38.2F	1	From 0.1 to 10 in steps of 0.05 *[Courier Number (Decimal)]*
IN>1 IDG Time	38.30	1.2	From 1 to 2 in steps of 0.01 *[Courier Number (time-seconds)]*
IN>1 Reset Char	38.32	DT	0 or 1 *[Indexed String]*
IN>1 Usr RstChr	38.33	DT	From 0 to 4 in steps of 1 *[Indexed String]*
Visible if the Default curves are selected			
IN>1 tRESET	38.34	0	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
Visible if operating characteritic is selected as DT or IEC/Uk curves or reset characteritic is selected as DT			
IN>2 Function	38.36	Disabled Disabled	From 0/0 to 16/////1 in steps of 1/1 *[Indexed String]*
IN>2 Current	38.3A	0.2 0.45	From 0.08*I1/0.02*I2 to 4.0*I1/10.0*I2 in steps of 0.01*I1/0.01*I2 *[Courier Number (Current)]*
IN>2 Time Delay	38.3D	1 0	From 0 to 200 in steps of 0.01 *[Courier Number (time-seconds)]*
GROUP 1: ROTOR EF	39.00		
Injection Freq	39.02	0.25 Hz	From 0 to 2 in steps of 1 *[Indexed String]*
CL I/P Select	39.04	CL1	From 0 to 3 in steps of 1 *[Indexed String]*
64R R<1 Alarm	39.08	Enabled	0 or 1 *[Indexed String]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
64R R<1 Alm Set	39.0C	40000	From 1000 to 80000 in steps of 1 *[Courier Number (Resistance)]*
64R R<1 Alm Dly	39.10	10	From 0 to 600 in steps of 0.1 *[Courier Number (time-seconds)]*
64R R<2 Trip	39.14	Enabled	0 or 1 *[Indexed String]*
64R R<2 Trip Set	39.18	5000	From 1000 to 80000 in steps of 1 *[Courier Number (Resistance)]*
64R R<2 Trip Dly	39.1C	1	From 0 to 600 in steps of 0.1 *[Courier Number (time-seconds)]*
R Compensation	39.20	0	From -1000 to 1000 in steps of 1 *[Courier Number (Resistance)]*
GROUP 1: SEF/REF PROT'N	3A.00		
SEF/REF Options	3A.01	SEF	From 0/0 to 4/7 in steps of 1/1 *[Indexed String]*
ISEF>1 Function	3A.2A	DT	From 0/0 to 15////1 in steps of 1/1 *[Indexed String]*
ISEF>1 Direction	3A.2B	Non-Directional	From 0 to 2 in steps of 1 *[Indexed String]*
ISEF>1 Current	3A.2E	0.05	From 0.005*I3 to 0.1*I3 in steps of 0.00025*I3 *[Courier Number (Current)]*
ISEF>1 Delay	3A.31	1	From 0 to 200 in steps of 0.01 *[Courier Number (time-seconds)]*
ISEF> Func Link	3A.57	15	From 15/1 to 4/1 in steps of 1/1 *[Binary Flags]*
ISEF DIRECTIONAL	3A.58		
ISEF> Char Angle	3A.59	90	From -95 to 95 in steps of 1 *[Courier Number(Angle)]*
ISEF>VNpol Input	3A.5A	Measured	0 or 1 *[Indexed String]*
ISEF> VNpol Set	3A.5B	5	From 0.5*V1 to 80*V1 in steps of 0.5*V1 *[Courier Number (Voltage)]*
WATTMETRIC SEF	3A.5D		
PN> Setting	3A.5E	9	From 0.0*V1*I3/0.0*V3*I3 to 20*V1*I3/20*V3*I3 in steps of 0.05*V1*I3/0.05*V3*I3 *[Courier Number (Power)]*
RESTRICTED E/F	3A.60		
IREF> CT Source	3A.61	IA-1 IB-1 IC-1	0 or 1

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
			[Indexed String]
IREF> k1	3A.62	0	From 0 to 20 in steps of 1 *[Courier Number (Percentage)]*
IREF> k2	3A.63	150	From 0 to 150 in steps of 1 *[Courier Number (Percentage)]*
IREF> Is1	3A.64	0.2	From 0.05*I1 to 1.0*I1 in steps of 0.01*I1 *[Courier Number (Current)]*
IREF> Is2	3A.65	1	From 0.1*I1 to 1.5*I1 in steps of 0.01*I1 *[Courier Number (Current)]*
IREF> Is	3A.66	0.2	From 0.05*I3 to 1.0*I3 in steps of 0.01*I3 *[Courier Number (Current)]*
VN>1 Status	3B.10	Enabled	0 or 1 *[Indexed String]*
VN>1 Input	3B.12	Derived VN1	VN>1 Input *[Indexed String]*
VN>1 Input is always the derived VN			
VN>1 Function	3B.14	DT	From 0 to 5 in steps of 1 *[Indexed String]*
VN>1 Voltage Set	3B.16	5	From 1*V1/1*V3 to 80*V1/80*V3 in steps of 1*V1/1*V3 *[Courier Number (Voltage)]*
VN>1 Time Delay	3B.18	5	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
VN>1 TMS	3B.1A	1	From 0.5 to 100 in steps of 0.5 *[Courier Number (Decimal)]*
VN>1 tReset	3B.1C	0	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
VN>2 Status	3B.20	Disabled	0 or 1 *[Indexed String]*
VN>2 Input	3B.22	Derived VN1	VN>2 Input *[Indexed String]*
VN>2 Input is always the derived VN			
VN>2 Function	3B.24	DT	From 0 to 5 in steps of 1 *[Indexed String]*
VN>2 Voltage Set	3B.26	10	From 1*V1/1*V3 to 80*V1/80*V3 in steps of 1*V1/1*V3 *[Courier Number (Voltage)]*
VN>2 Time Delay	3B.28	10	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
VN>2 TMS	3B.2A	1	From 0.5 to 100 in steps of 0.5 *[Courier Number (Decimal)]*
VN>2 tReset	3B.2C	0	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
VN>3 Status	3B.30	Enabled	0 or 1 *[Indexed String]*
VN>3 Input	3B.32	VN1	VN>3 Input *[Indexed String]*
VN>3 Input is always the measured VN1			
VN>3 Function	3B.34	DT	From 0 to 5 in steps of 1 *[Indexed String]*
VN>3 Voltage Set	3B.36	5	From 1*V3 to 80*V3 in steps of 1*V3 *[Courier Number (Voltage)]*
VN>3 Time Delay	3B.38	5	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
VN>3 TMS	3B.3A	1	From 0.5 to 100 in steps of 0.5 *[Courier Number (Decimal)]*
VN>3 tReset	3B.3C	0	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
VN>4 Status	3B.40	Disabled	0 or 1 *[Indexed String]*
VN>4 Input	3B.42	VN1	VN>4 Input *[Indexed String]*
VN>4 Input is always the measured VN1			
VN>4 Function	3B.44	DT	From 0 to 5 in steps of 1 *[Indexed String]*
VN>4 Voltage Set	3B.46	10	From 1*V3 to 80*V3 in steps of 1*V3 *[Courier Number (Voltage)]*
VN>4 Time Delay	3B.48	10	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
VN>4 TMS	3B.4A	1	From 0.5 to 100 in steps of 0.5 *[Courier Number (Decimal)]*
VN>4 tReset	3B.4C	0	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
VN>5 Status	3B.50	Enabled	0 or 1 *[Indexed String]*
VN>5 Input	3B.52	VN2	VN>5 Input *[Indexed String]*
VN>5 Input is always the measured VN2			
VN>5 Function	3B.54	DT	From 0 to 5 in steps of 1 *[Indexed String]*
VN>5 Voltage Set	3B.56	5	From 1*V2 to 80*V2 in steps of 1*V2 *[Courier Number (Voltage)]*
VN>5 Time Delay	3B.58	5	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
VN>5 TMS	3B.5A	1	From 0.5 to 100 in steps of 0.5 *[Courier Number (Decimal)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
VN>5 tReset	3B.5C	0	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
VN>6 Status	3B.60	Disabled	0 or 1 *[Indexed String]*
VN>6 Input	3B.62	VN2	VN>6 Input *[Indexed String]*
VN>6 Input is always the measured VN2			
VN>6 Function	3B.64	DT	From 0 to 5 in steps of 1 *[Indexed String]*
VN>6 Voltage Set	3B.66	10	From 1*V2 to 80*V2 in steps of 1*V2 *[Courier Number (Voltage)]*
VN>6 Time Delay	3B.68	10	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
VN>6 TMS	3B.6A	1	From 0.5 to 100 in steps of 0.5 *[Courier Number (Decimal)]*
VN>6 tReset	3B.6C	0	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
GROUP 1: 100% STATOR EF	3C.00		
VN 3rd Harmonic\100%St EF Status	3C.01	VN3H< Enabled	From 0 to 2 in steps of 1 *[Indexed String]*
100% St EF VN3H<	3C.02	1	From 0.1*V3 to 20*V3 in steps of 0.1*V3 *[Courier Number (Voltage)]*
VN3H< Delay	3C.03	5	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
V< Inhibit set	3C.04	80	From 30*V1 to 120*V1 in steps of 1*V1 *[Courier Number (Voltage)]*
P< Inhibit	3C.05	Disabled	0 or 1 *[Indexed String]*
P< Inhibit set	3C.06	4	From 4*V1*I1 to 200*V1*I1 in steps of 0.5*V1*I1 *[Courier Number (Power)]*
Q< Inhibit	3C.07	Disabled	0 or 1 *[Indexed String]*
Q< Inhibit set	3C.08	4	From 4*V1*I1 to 200*V1*I1 in steps of 0.5*V1*I1 *[Courier Number (Var)]*
S< Inhibit	3C.09	Disabled	0 or 1 *[Indexed String]*
S< Inhibit set	3C.0A	4	From 4*V1*I1 to 200*V1*I1 in steps of 0.5*V1*I1 *[Courier Number (VA)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
100% St EF VN3H>	3C.0B	20	From 0.1*V3 to 20*V3 in steps of 0.1*V3 *[Courier Number (Voltage)]*
VN3H> Delay	3C.0C	5	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
64S LF Injection	3C.10	Enabled	0 or 1 *[Indexed String]*
Available to P345 only			
64S R Factor	3C.14	10	From 0.01 to 200 in steps of 0.01 *[Courier Number (Decimal)]*
Scaling factor for primary resistance across earthing transformer. Affects the stator resistance settings and measurements only.			
64S R<1 Alarm	3C.1C	Enabled	0 or 1 *[Indexed String]*
64S R<1 Alm Set	3C.20	100	From 10 to 700 in steps of 0.1 *[Courier Number (Resistance)]*
64S R<1 Alm Dly	3C.24	1	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
64S R<2 Trip	3C.28	Enabled	0 or 1 *[Indexed String]*
64S R<2 Trip Set	3C.2C	20	From 10 to 700 in steps of 0.1 *[Courier Number (Resistance)]*
64S R<2 Trip Dly	3C.30	1	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
64S Angle Comp	3C.34	0	From -60 to 60 in steps of 0.1 *[Courier Number (Angle)]*
64S Series R	3C.38	0	From 0 to 700 in steps of 0.1 *[Courier Number (Resistance)]*
64S Parallel G	3C.3C	0	From 0 to 0.1 in steps of 0.0000001 *[Courie Number (Conductance)]*
64S Overcurrent	3C.40	Enabled	0 or 1 *[Indexed String]*
64S I>1 Trip Set	3C.44	0.5	From 0.02 to 1.5 in steps of 0.01 *[Courier Number (Current)]*
64S I>1 Trip Dly	3C.48	1	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
64S Supervision	3C.4C	Disabled	0 or 1 *[Indexed String]*
64S V< Set	3C.50	1	From 0.3 to 25 in steps of 0.1 *[Courier Number (Voltage)]*
64S I< Set	3C.54	0.01	From 0.005 to 0.04 in steps of 0.001 *[Courier Number (Current)]*
64S Superv'n Dly	3C.58	1	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
GROUP 1: VOLTS/HZ	3D.00		
V/Hz Alm Status	3D.01	Enabled	0 or 1 *[Indexed String]*
V/Hz Alarm Set	3D.02	2.31	From 1.5*V1 to 3.5*V1 in steps of 0.01*V1 *[Courier Number (Volts/Hz)]*
V/Hz Alarm Delay	3D.03	10	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
V/Hz>1 Status	3D.10	Enabled	0 or 1 *[Indexed String]*
V/Hz>1 Trip Func	3D.13	DT	From 0 to 5 in steps of 1 *[Indexed String]*
V/Hz>1 Trip Set	3D.16	2.42	From 1.5*V1 to 3.5*V1 in steps of 0.01*V1 *[Courier Number (Volts/Hz)]*
V/Hz>1 Trip TMS	3D.19	1	From 0.01 to 12 in steps of 0.01 *[Courier Number (Decimal)]*
V/Hz>1 Delay	3D.1A	60	From 0 to 600 in steps of 0.01 *[Courier Number (time-seconds)]*
V/Hz>1 Reset Chr	3D.1B	DT	From 0 to 4 in steps of 1 *[Indexed String]*
V/Hz>1 tRESET	3D.1C	0	From 0 to 600 in steps of 0.01 *[Courier Number (time-seconds)]*
V/Hz>2 Status	3D.20	Enabled	0 or 1 *[Indexed String]*
V/Hz>2 Trip Set	3D.25	2.64	From 1.5*V1 to 3.5*V1 in steps of 0.01*V1 *[Courier Number (Volts/Hz)]*
V/Hz>2 Delay	3D.2A	3	From 0 to 600 in steps of 0.01 *[Courier Number (time-seconds)]*
V/Hz>3 Status	3D.30	Enabled	0 or 1 *[Indexed String]*
V/Hz>3 Trip Set	3D.35	2.86	From 1.5*V1 to 3.5*V1 in steps of 0.01*V1 *[Courier Number (Volts/Hz)]*
V/Hz>3 Delay	3D.3A	2	From 0 to 600 in steps of 0.01 *[Courier Number (time-seconds)]*
V/Hz>4 Status	3D.40	Enabled	0 or 1 *[Indexed String]*
V/Hz>4 Trip Set	3D.45	3.08	From 1.5*V1 to 3.5*V1 in steps of 0.01*V1 *[Courier Number (Volts/Hz)]*
V/Hz>4 Delay	3D.4A	1	From 0 to 600 in steps of 0.01 *[Courier Number (time-seconds)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Operating Mode	3E.10	Rolling Window Fixed Window	0 or 1 *[Indexed String]*
df/dt Avg Cycles	3E.11	3	From 2 to 12 in steps of 1 *[Courier Number(Decimal)]*
df/dt Iterations	3E.12	2	From 1 to 4 in steps of 1 *[Courier Number(Decimal)]*
df/dt>1 Status	3E.20	Enabled	0 or 1 *[Indexed String]*
df/dt>1 Setting	3E.21	0.2	From 0.1 to 10 in steps of 0.01 *[Courier Number (Hz/s)]*
df/dt>1 Dir'n	3E.22	Both	From 0 to 2 in steps of 1 *[Indexed String]*
df/dt>1 Time	3E.23	0.5	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
df/dt>1 f L/H	3E.24	Enabled	0 or 1 *[Indexed String]*
df/dt>1 f Low	3E.25	49.5	From 45 to 65 in steps of 0.01 *[Courier Number (Frequency)]*
df/dt>1 f High	3E.26	50.5	From 45 to 65 in steps of 0.01 *[Courier Number (Frequency)]*
df/dt>2 Status	3E.30	Enabled	0 or 1 *[Indexed String]*
df/dt>2 Setting	3E.31	0.2	From 0.1 to 10 in steps of 0.01 *[Courier Number (Hz/s)]*
df/dt>2 Dir'n	3E.32	Positive	From 0 to 2 in steps of 1 *[Indexed String]*
df/dt>2 Time	3E.33	0.5	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
df/dt>3 Status	3E.40	Enabled	0 or 1 *[Indexed String]*
df/dt>3 Setting	3E.41	0.2	From 0.1 to 10 in steps of 0.01 *[Courier Number (Hz/s)]*
df/dt>3 Dir'n	3E.42	Positive	From 0 to 2 in steps of 1 *[Indexed String]*
df/dt>3 Time	3E.43	0.5	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
df/dt>4 Status	3E.50	Enabled	0 or 1 *[Indexed String]*
df/dt>4 Setting	3E.51	0.2	From 0.1 to 10 in steps of 0.01

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
			[Courier Number (Hz/s)]
df/dt>4 Dir'n	3E.52	Positive	From 0 to 2 in steps of 1 [Indexed String]
df/dt>4 Time	3E.53	0.5	From 0 to 100 in steps of 0.01 [Courier Number (time-seconds)]
GROUP 1: DEAD MACHINE	40.00		
Dead Mach Status	40.01	Enabled	0 or 1 [Indexed String]
DM CT Source	40.02	IA-1 IB-1 IC-1	0 or 1 [Indexed String]
Dead Mach I>	40.03	0.1	From 0.08*I1/0.08*I4 to 4*I1/4*I4 in steps of 0.01*I1/0.01*I4 [Courier Number (Current)]
Dead Mach V<	40.04	80	From 10*V1 to 120*V1 in steps of 1*V1 [Courier Number (Voltage)]
Dead Mach tPU	40.05	5	From 0 to 10 in steps of 0.1 [Courier Number (time-seconds)]
Dead Mach tDO	40.06	0.5	From 0 to 10 in steps of 0.1 [Courier Number (time-seconds)]
GROUP 1: VOLT PROTECTION	42.00		
UNDER VOLTAGE	42.01		
V< Measur't Mode	42.02	Phase-Neutral	0 or 1 [Indexed String]
V< Operate Mode	42.03	Any Phase	0 or 1 [Indexed String]
V<1 Function	42.04	DT	From 0 to 6 in steps of 1 [Indexed String]
V<1 Voltage Set	42.05	50	From 10*V1 to 120*V1 in steps of 1*V1 [Courier Number (Voltage)]
V<1 Time Delay	42.06	10	From 0 to 100 in steps of 0.01 [Courier Number (time-seconds)]
V<1 TMS	42.07	1	From 0.05 to 100 in steps of 0.05 [Courier Number (Decimal)]
V<1 Poledead Inh	42.08	Enabled	0 or 1 [Indexed String]
V<2 Status	42.09	Disabled	0 or 1 [Indexed String]
V<2 Voltage Set	42.0A	38	From 10*V1 to 120*V1 in steps of 1*V1

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
			[Courier Number (Voltage)]
V<2 Time Delay	42.0B	5	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
V<2 Poledead Inh	42.0C	Enabled	0 or 1 *[Indexed String]*
V<3 Status	42.10	Disabled	0 or 1 *[Indexed String]*
V<3 Voltage Set	42.12	38	From 10*V1 to 120*V1 in steps of 1*V1 *[Courier Number (Voltage)]*
V<3 Time Delay	42.14	5	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
V<3 Poledead Inh	42.16	Enabled	0 or 1 *[Indexed String]*
OVERVOLTAGE	42.20		
V> Measur't Mode	42.21	Phase-Phase	0 or 1 *[Indexed String]*
V> Operate Mode	42.22	Any Phase	0 or 1 *[Indexed String]*
V>1 Function\V>1 Status	42.24	DT Enabled	From 0 to 6/1 in steps of 1 *[Indexed String]*
V>1 Voltage Set	42.25	130 110	From 60*V1/10*V1 to 185*V1 in steps of 1*V1 *[Courier Number (Voltage)]*
V>1 Time Delay	42.26	10 1	From 0 to 100 in steps of 0.01 *[Courier Number (Time)]*
V>1 TMS	42.27	1	From 0.05 to 100 in steps of 0.05 *[Courier Number (Decimal)]*
V>2 Status	42.30	Disabled	0 or 1 *[Indexed String]*
V>2 Voltage Set	42.31	150 110	From 60*V1/10*V1 to 185*V1 in steps of 1*V1 *[Courier Number (Voltage)]*
V>2 Time Delay	42.32	0.5 1	From 0 to 100 in steps of 0.01 *[Courier Number (Time)]*
NPS OVERVOLTAGE	42.60		
V2>1 Status	42.61	Disabled	0 or 1 *[Indexed String]*
V2>1 Voltage Set	42.62	15	From 1*V1 to 150*V1 in steps of 1*V1 *[Courier Number (Voltage)]*
V2>1 Time Delay	42.63	1	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
GROUP 1: FREQ PROTECTION	43.00		
UNDER FREQUENCY	43.01		
F<1 Status	43.02	Enabled	0 or 1 *[Indexed String]*
F<1 Setting	43.03	49.5	From 45 to 65 in steps of 0.01 *[Courier Number (Frequency)]*
F<1 Time Delay	43.04	4	From 0 to 20000 in steps of 0.01 *[Courier Number (time-seconds)]*
F<2 Status	43.05	Disabled	0 or 1 *[Indexed String]*
F<2 Setting	43.06	49	From 45 to 65 in steps of 0.01 *[Courier Number (Frequency)]*
F<2 Time Delay	43.07	3	From 0 to 20000 in steps of 0.01 *[Courier Number (time-seconds)]*
F<3 Status	43.08	Disabled	0 or 1 *[Indexed String]*
F<3 Setting	43.09	48.5	From 45 to 65 in steps of 0.01 *[Courier Number (Frequency)]*
F<3 Time Delay	43.0A	2	From 0 to 20000 in steps of 0.01 *[Courier Number (time-seconds)]*
F<4 Status	43.0B	Disabled	0 or 1 *[Indexed String]*
F<4 Setting	43.0C	48	From 45 to 65 in steps of 0.01 *[Courier Number (Frequency)]*
F<4 Time Delay	43.0D	1	From 0 to 20000 in steps of 0.01 *[Courier Number (time-seconds)]*
F< Function Link	43.0E	0	From 0 to 15 in steps of 1 *[Binary Flag (4 bits)]*
OVER FREQUENCY	43.0F		
F>1 Status	43.10	Enabled	0 or 1 *[Indexed String]*
F>1 Setting	43.11	50.5 5	From 45/0.1 to 68/70 in steps of 0.01/0.1 *[Courier Number (Frequency)]*
F>1 Time Delay	43.12	2	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
F>2 Status	43.13	Disabled	0 or 1 *[Indexed String]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
F>2 Setting	43.14	51 5	From 45/0.1 to 68/70 in steps of 0.01/0.1 *[Courier Number (Frequency)]*
F>2 Time Delay	43.15	1	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
TURBINE F PROT	43.20		
Turbine Abnormal Frequency Protection			
Turbine F Status	43.22	Disabled	0 or 1 *[Indexed String]*
Band 1 Status	43.24	Enabled	0 or 1 *[Indexed String]*
Band 1 Freq Low	43.26	46.5	From 20 to 70 in steps of 0.01 *[Courier Number (Frequency)]*
Band 1 Freq High	43.28	47	From 20 to 70 in steps of 0.01 *[Courier Number (Frequency)]*
Band 1 Duration	43.2A	1	From 0 to 3600000 in steps of 0.01 *[Courier Number (time-seconds)]*
Band 1 Accumulated Time Threshold			
Band 1 Dead Time	43.2C	0.2	From 0 to 200 in steps of 0.01 *[Courier Number (time-seconds)]*
Band 2 Status	43.34	Enabled	0 or 1 *[Indexed String]*
Band 2 Freq Low	43.36	47	From 20 to 70 in steps of 0.01 *[Courier Number (Frequency)]*
Band 2 Freq High	43.38	47.5	From 20 to 70 in steps of 0.01 *[Courier Number (Frequency)]*
Band 2 Duration	43.3A	2.5	From 0 to 3600000 in steps of 0.01 *[Courier Number (time-seconds)]*
Band 2 Accumulated Time Threshold			
Band 2 Dead Time	43.3C	0.2	From 0 to 200 in steps of 0.01 *[Courier Number (time-seconds)]*
Band 3 Status	43.44	Enabled	0 or 1 *[Indexed String]*
Band 3 Freq Low	43.46	47.5	From 20 to 70 in steps of 0.01 *[Courier Number (Frequency)]*
Band 3 Freq High	43.48	48	From 20 to 70 in steps of 0.01 *[Courier Number (Frequency)]*
Band 3 Duration	43.4A	14	From 0 to 3600000 in steps of 0.01 *[Courier Number (time-seconds)]*
Band 3 Accumulated Time Threshold			
Band 3 Dead Time	43.4C	0.2	From 0 to 200 in steps of 0.01 *[Courier Number (time-seconds)]*
Band 4 Status	43.54	Enabled	0 or 1 *[Indexed String]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Band 4 Freq Low	43.56	48	From 20 to 70 in steps of 0.01 *[Courier Number (Frequency)]*
Band 4 Freq High	43.58	48.5	From 20 to 70 in steps of 0.01 *[Courier Number (Frequency)]*
Band 4 Duration	43.5A	100	From 0 to 3600000 in steps of 0.01 *[Courier Number (time-seconds)]*
Band 4 Accumulated Time Threshold			
Band 4 Dead Time	43.5C	0.2	From 0 to 200 in steps of 0.01 *[Courier Number (time-seconds)]*
Band 5 Status	43.64	Enabled	0 or 1 *[Indexed String]*
Band 5 Freq Low	43.66	48.5	From 20 to 70 in steps of 0.01 *[Courier Number (Frequency)]*
Band 5 Freq High	43.68	49	From 20 to 70 in steps of 0.01 *[Courier Number (Frequency)]*
Band 5 Duration	43.6A	540	From 0 to 3600000 in steps of 0.01 *[Courier Number (time-seconds)]*
Band 5 Accumulated Time Threshold			
Band 5 Dead Time	43.6C	0.2	From 0 to 200 in steps of 0.01 *[Courier Number (time-seconds)]*
Band 6 Status	43.74	Enabled	0 or 1 *[Indexed String]*
Band 6 Freq Low	43.76	49	From 20 to 70 in steps of 0.01 *[Courier Number (Frequency)]*
Band 6 Freq High	43.78	49.5	From 20 to 70 in steps of 0.01 *[Courier Number (Frequency)]*
Band 6 Duration	43.7A	3000	From 0 to 3600000 in steps of 0.01 *[Courier Number (time-seconds)]*
Band 6 Accumulated Time Threshold			
Band 6 Dead Time	43.7C	0.2	From 0 to 200 in steps of 0.01 *[Courier Number (time-seconds)]*
GROUP 1: RTD PROTECTION	44.00		
Select RTD	44.01	0	From 1023 to 10 in steps of 1 *[Binary Flags(10 bits)Indexed String]*
RTD 1 Alarm Set	44.02	80	From 0 to 200 in steps of 1 *[Courier Number (Temperature)]*
RTD 1 Alarm Dly	44.03	10	From 0 to 100 in steps of 1 *[Courier Number (time-seconds)]*
RTD 1 Trip Set	44.04	85	From 0 to 200 in steps of 1 *[Courier Number (Temperature)]*
RTD 1 Trip Dly	44.05	1	From 0 to 100 in steps of 1 *[Courier Number (time-seconds)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
RTD 2 Alarm Set	44.06	80	From 0 to 200 in steps of 1 *[Courier Number (Temperature)]*
RTD 2 Alarm Dly	44.07	10	From 0 to 100 in steps of 1 *[Courier Number (time-seconds)]*
RTD 2 Trip Set	44.08	85	From 0 to 200 in steps of 1 *[Courier Number (Temperature)]*
RTD 2 Trip Dly	44.09	1	From 0 to 100 in steps of 1 *[Courier Number (time-seconds)]*
RTD 3 Alarm Set	44.0A	80	From 0 to 200 in steps of 1 *[Courier Number (Temperature)]*
RTD 3 Alarm Dly	44.0B	10	From 0 to 100 in steps of 1 *[Courier Number (time-seconds)]*
RTD 3 Trip Set	44.0C	85	From 0 to 200 in steps of 1 *[Courier Number (Temperature)]*
RTD 3 Trip Dly	44.0D	1	From 0 to 100 in steps of 1 *[Courier Number (time-seconds)]*
RTD 4 Alarm Set	44.0E	80	From 0 to 200 in steps of 1 *[Courier Number (Temperature)]*
RTD 4 Alarm Dly	44.0F	10	From 0 to 100 in steps of 1 *[Courier Number (time-seconds)]*
RTD 4 Trip Set	44.10	85	From 0 to 200 in steps of 1 *[Courier Number (Temperature)]*
RTD 4 Trip Dly	44.11	1	From 0 to 100 in steps of 1 *[Courier Number (time-seconds)]*
RTD 5 Alarm Set	44.12	80	From 0 to 200 in steps of 1 *[Courier Number (Temperature)]*
RTD 5 Alarm Dly	44.13	10	From 0 to 100 in steps of 1 *[Courier Number (time-seconds)]*
RTD 5 Trip Set	44.14	85	From 0 to 200 in steps of 1 *[Courier Number (Temperature)]*
RTD 5 Trip Dly	44.15	1	From 0 to 100 in steps of 1 *[Courier Number (time-seconds)]*
RTD 6 Alarm Set	44.16	80	From 0 to 200 in steps of 1 *[Courier Number (Temperature)]*
RTD 6 Alarm Dly	44.17	10	From 0 to 100 in steps of 1 *[Courier Number (time-seconds)]*
RTD 6 Trip Set	44.18	85	From 0 to 200 in steps of 1 *[Courier Number (Temperature)]*
RTD 6 Trip Dly	44.19	1	From 0 to 100 in steps of 1

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
			[Courier Number (time-seconds)]
RTD 7 Alarm Set	44.1A	80	From 0 to 200 in steps of 1 [Courier Number (Temperature)]
RTD 7 Alarm Dly	44.1B	10	From 0 to 100 in steps of 1 [Courier Number (time-seconds)]
RTD 7 Trip Set	44.1C	85	From 0 to 200 in steps of 1 [Courier Number (Temperature)]
RTD 7 Trip Dly	44.1D	1	From 0 to 100 in steps of 1 [Courier Number (time-seconds)]
RTD 8 Alarm Set	44.1E	80	From 0 to 200 in steps of 1 [Courier Number (Temperature)]
RTD 8 Alarm Dly	44.1F	10	From 0 to 100 in steps of 1 [Courier Number (time-seconds)]
RTD 8 Trip Set	44.20	85	From 0 to 200 in steps of 1 [Courier Number (Temperature)]
RTD 8 Trip Dly	44.21	1	From 0 to 100 in steps of 1 [Courier Number (time-seconds)]
RTD 9 Alarm Set	44.22	80	From 0 to 200 in steps of 1 [Courier Number (Temperature)]
RTD 9 Alarm Dly	44.23	10	From 0 to 100 in steps of 1 [Courier Number (time-seconds)]
RTD 9 Trip Set	44.24	85	From 0 to 200 in steps of 1 [Courier Number (Temperature)]
RTD 9 Trip Dly	44.25	1	From 0 to 100 in steps of 1 [Courier Number (time-seconds)]
RTD 10 Alarm Set	44.26	80	From 0 to 200 in steps of 1 [Courier Number (Temperature)]
RTD 10 Alarm Dly	44.27	10	From 0 to 100 in steps of 1 [Courier Number (time-seconds)]
RTD 10 Trip Set	44.28	85	From 0 to 200 in steps of 1 [Courier Number (Temperature)]
RTD 10 Trip Dly	44.29	1	From 0 to 100 in steps of 1 [Courier Number (time-seconds)]
GROUP 1: CB FAIL & I<	45.00		
BREAKER FAIL	45.01		
CB Fail 1 Status	45.02	Enabled	0 or 1 [Indexed String]
CB Fail 1 Timer	45.03	0.2	From 0 to 10 in steps of 0.01 [Courier Number (time-seconds)]

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
CB Fail 2 Status	45.04	Disabled	0 or 1 *[Indexed String]*
CB Fail 2 Timer	45.05	0.4	From 0 to 10 in steps of 0.01 *[Courier Number (time-seconds)]*
CBF Non I Reset	45.06	CB Open & I<	From 0 to 2 in steps of 1 *[Indexed String]*
CBF Ext Reset	45.07	CB Open & I<	From 0 to 2 in steps of 1 *[Indexed String]*
UNDER CURRENT	45.08		
I< Current Set	45.09	0.1	From 0.02*I1/0.02*I4 to 3.2*I1/3.2*I4 in steps of 0.01*I1/0.01*I4 *[Courier Number (Current)]*
IN< Current Set	45.0A	0.1	From 0.02*I2 to 3.2*I2 in steps of 0.01*I2 *[Courier Number (Current)]*
ISEF< Current	45.0B	0.02	From 0.001*I3 to 0.8*I3 in steps of 0.0005*I3 *[Courier Number (Current)]*
I< CT Source	45.15	IA-1 IB-1 IC-1	0 or 1 *[Indexed String]*
GROUP 1: SUPERVISION	46.00		
VT SUPERVISION	46.01		
VTS Status	46.02	Blocking	0 or 1 *[Indexed String]*
VTS Reset Mode	46.03	Manual	0 or 1 *[Indexed String]*
VTS Time Delay	46.04	5	From 1 to 10 in steps of 0.1 *[Courier Number (time-seconds)]*
VTS I> Inhibit	46.05	10	From 0.08*I1 to 32*I1 in steps of 0.01*I1 *[Courier Number (Current)]*
VTS I2> Inhibit	46.06	0.05	From 0.05*I1 to 0.5*I1 in steps of 0.01*I1 *[Courier Number (Current)]*
CT SUPERVISION	46.07		
CTS1 Status	46.08	Disabled	0 or 1 *[Indexed String]*
CTS1 VN Input	46.09	Derived	0 or 1 *[Indexed String]*
CTS1 VN< Inhibit	46.0A	5	From 0.5*V1/0.5*V3 to 22*V1/22*V3 in steps of 0.5*V1/0.5*V3 *[Courier Number (Voltage)]*
CTS1 IN> Set	46.0B	0.2	From 0.08*I1 to 4*I1 in steps of 0.01*I1 *[Courier Number (Current)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
CTS1 Time Delay	46.0C	5	From 0 to 10 in steps of 1 *[Courier Number (time-seconds)]*
CTS2 Status	46.20	Disabled	0 or 1 *[Indexed String]*
CTS2 VN Input	46.24	Derived	0 or 1 *[Indexed String]*
CTS2 VN< Inhibit	46.28	5	From 0.5*V1/0.5*V3 to 22*V1/22*V3 in steps of 0.5*V1/0.5*V3 *[Courier Number (Voltage)]*
CTS2 IN> Set	46.2C	0.2	From 0.08*I1 to 4*I1 in steps of 0.01*I1 *[Courier Number (Current)]*
CTS2 Time Delay	46.30	5 2	From 0 to 10 in steps of 1 *[Courier Number (time-seconds)]*
Diff CTS Status	46.31	Enabled	0 or 1 *[Indexed String]*
Diff CTS Mode	46.32	Restrain	0 or 1 *[Indexed String]*
CTS Time Delay	46.33	2	From 0 to 10 in steps of 0.1 *[Courier Number (time-seconds)]*
CTS I1	46.34	10	From 5 to 100 in steps of 1 *[Courier Number (Percentage)]*
CTS I2/I1>1	46.35	5	From 5 to 100 in steps of 1 *[Courier Number (Percentage)]*
CTS I2/I1>2	46.36	30	From 5 to 100 in steps of 1 *[Courier Number (Percentage)]*
THROUGH FAULT	46.50		
Through Fault	46.51	Enabled	0 or 1 *[Indexed String]*
Monitored Input	46.52	HV	0 or 1 *[Indexed String]*
TF I> Trigger	46.53	1	From 0.08*In to 16*In in steps of 0.01 *[Courier Number (Current)]*
TF I2t> Alarm	46.54	800(In * In *t)	From 0 to 50000 in steps of 1 *[Courier Number (I2t)]*
GROUP 1: SENSITIVE POWER	47.00		
Comp Angle	47.20	0	From -5 to 5 in steps of 0.1 *[Courier Number (Angle)]*
P> CT Source	47.21	Single	

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
P> Phase Select	47.22	A	From 0 to 2 in steps of 1 *[Indexed String]*
Sen Power1 Func	47.24	Over	From 0 to 2 in steps of 1 *[Indexed String]*
Sen Power1 Dirn	47.26	Forward	0 or 1 *[Indexed String]*
Sen Power1 Mode	47.28	Active	0 or 1 *[Indexed String]*
SPower1 1Ph Watt	47.2C	0.5*V1*I3	From 0.2*V1*I3 to 100*V1*I3 in steps of 0.1*V1*I3 *[Courier Number (Power)]*
SPower1 1Ph VArs	47.2D	0.5*V1*I3	From 0.2*V1*I3 to 100*V1*I3 in steps of 0.1*V1*I3 *[Courier Number (Var)]*
SPower1 3Ph Watt	47.2E	0.5*V1*I3	From 0.4*V1*I3 to 300*V1*I3 in steps of 0.1*V1*I3 *[Courier Number (Power)]*
SPower1 3Ph Vars	47.2F	0.5*V1*I3	From 0.4*V1*I3 to 300*V1*I3 in steps of 0.1*V1*I3 *[Courier Number (Var)]*
Sen Power1 Delay	47.34	5	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
Power1 DO Timer	47.38	0	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
P1 Poledead Inh	47.3C	Enabled	0 or 1 *[Indexed String]*
Sen Power2 Func	47.44	Over	From 0 to 2 in steps of 1 *[Indexed String]*
Sen Power2 Dirn	47.46	Forward	0 or 1 *[Indexed String]*
Sen Power2 Mode	47.48	Active	0 or 1 *[Indexed String]*
SPower2 1Ph Watt	47.4C	0.5*V1*I3	From 0.2*V1*I3 to 100*V1*I3 in steps of 0.1*V1*I3 *[Courier Number (Power)]*
SPower2 1Ph VArs	47.4D	0.5*V1*I3	From 0.2*V1*I3 to 100*V1*I3 in steps of 0.1*V1*I3 *[Courier Number (Var)]*
SPower2 3Ph Watt	47.4E	0.5*V1*I3	From 0.4*V1*I3 to 300*V1*I3 in steps of 0.1*V1*I3 *[Courier Number (Power)]*
SPower2 3Ph VArs	47.4F	0.5*V1*I3	From 0.4*V1*I3 to 300*V1*I3 in steps of 0.1*V1*I3 *[Courier Number (Var)]*
Sen Power2 Delay	47.54	2	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
Power2 DO Timer	47.58	0	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
P2 Poledead Inh	47.5C	Enabled	0 or 1 *[Indexed String]*
Sen Power3 Func	47.64	Over	From 0 to 2 in steps of 1 *[Indexed String]*
Sen Power3 Dirn	47.66	Forward	0 or 1 *[Indexed String]*
Sen Power3 Mode	47.68	Active	0 or 1 *[Indexed String]*
SPower3 1Ph Watt	47.6C	0.5*V1*I3	From 0.2*V1*I3 to 100*V1*I3 in steps of 0.1*V1*I3 *[Courier Number (Power)]*
SPower3 1Ph VArs	47.6D	0.5*V1*I3	From 0.2*V1*I3 to 100*V1*I3 in steps of 0.1*V1*I3 *[Courier Number (Var)]*
SPower3 3Ph Watt	47.6E	0.5*V1*I3	From 0.4*V1*I3 to 300*V1*I3 in steps of 0.1*V1*I3 *[Courier Number (Power)]*
SPower3 3Ph VArs	47.6F	0.5*V1*I3	From 0.4*V1*I3 to 300*V1*I3 in steps of 0.1*V1*I3 *[Courier Number (Var)]*
Sen Power3 Delay	47.74	5	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
Power3 DO Timer	47.78	0	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
P3 Poledead Inh	47.7C	Enabled	0 or 1 *[Indexed String]*
Sen Power4 Func	47.84	Over	From 0 to 2 in steps of 1 *[Indexed String]*
Sen Power4 Dirn	47.86	Forward	0 or 1 *[Indexed String]*
Sen Power4 Mode	47.88	Active	0 or 1 *[Indexed String]*
SPower4 1Ph Watt	47.8C	0.5*V1*I3	From 0.2*V1*I3 to 100*V1*I3 in steps of 0.1*V1*I3 *[Courier Number (Power)]*
SPower4 1Ph VArs	47.8D	0.5*V1*I3	From 0.2*V1*I3 to 100*V1*I3 in steps of 0.1*V1*I3 *[Courier Number (Var)]*
SPower4 3Ph Watt	47.8E	0.5*V1*I3	From 0.4*V1*I3 to 300*V1*I3 in steps of 0.1*V1*I3 *[Courier Number (Power)]*
SPower4 3Ph VArs	47.8F	0.5*V1*I3	From 0.4*V1*I3 to 300*V1*I3 in steps of 0.1*V1*I3 *[Courier Number (Var)]*
Sen Power4 Delay	47.94	5	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
Power4 DO Timer	47.98	0	From 0 to 100 in steps of 0.01

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
			[Courier Number (time-seconds)]
P4 Poledead Inh	47.9C	Enabled	0 or 1 *[Indexed String]*
GROUP 1: POLE SLIPPING	49.00		
PSlip Function	49.01	Enabled	0 or 1 *[Indexed String]*
Z Based PoleSlip	49.02		
Pole Slip Mode	49.03	Generating	From 0 to 2 in steps of 1 *[Indexed String]*
PSlip Za Forward	49.04	100*V1/I1	From 0.5*V1/I1 to 350*V1/I1 in steps of 0.5*V1/I1 *[Courier Number (Impedance)]*
PSlip Zb Reverse	49.05	150*V1/I1	From 0.5*V1/I1 to 350*V1/I1 in steps of 0.5*V1/I1 *[Courier Number (Impedance)]*
Lens Angle	49.06	120	From 90 to 150 in steps of 1 *[Courier Number (Angle)]*
PSlip Timer T1	49.07	0.015	From 0 to 1 in steps of 0.005 *[Courier Number (time-seconds)]*
PSlip Timer T2	49.08	0.015	From 0 to 1 in steps of 0.005 *[Courier Number (time-seconds)]*
Blinder Angle	49.09	75	From 20 to 90 in steps of 1 *[Courier Number (Angle)]*
PSlip Zc	49.0A	50*V1/I1	From 0.5*V1/I1 to 350*V1/I1 in steps of 0.5*V1/I1 *[Courier Number (Impedance)]*
Zone1 Slip Count	49.0B	1	From 1 to 20 in steps of 1 *[Unsigned Integer]*
Zone2 Slip Count	49.0C	2	From 1 to 20 in steps of 1 *[Unsigned Integer]*
PSlip Reset Time	49.0D	30	From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]*
GROUP 1: INPUT LABELS	4A.00		
Opto Input 1	4A.01	L1 Setting Group	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Opto Input 2	4A.02	L2 Setting Group	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Opto Input 3	4A.03	L3 Block IN>3&4 L3 Block IN>2	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Opto Input 4	4A.04	L4 Block I>3&4	From 32 to 163 in steps of 1

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
		L4 Block I>2	*[ASCII Text (16 chars)]*
Opto Input 5	4A.05	L5 Reset	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Opto Input 6	4A.06	L6 Ext Prot Trip	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Opto Input 7	4A.07	L7 52a	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Opto Input 8	4A.08	L8 52b	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Opto Input 9	4A.09	L9 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Opto Input 10	4A.0A	L10 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Opto Input 11	4A.0B	L11 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Opto Input 12	4A.0C	L12 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Opto Input 13	4A.0D	L13 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Opto Input 14	4A.0E	L14 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Opto Input 15	4A.0F	L15 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Opto Input 16	4A.10	L16 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Opto Input 17	4A.11	L17 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Opto Input 18	4A.12	L18 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Opto Input 19	4A.13	L19 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Opto Input 20	4A.14	L20 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Opto Input 21	4A.15	L21 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Opto Input 22	4A.16	L22 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Opto Input 23	4A.17	L23 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Opto Input 24	4A.18	L24 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Opto Input 25	4A.19	L25 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Opto Input 26	4A.1A	L26 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Opto Input 27	4A.1B	L27 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Opto Input 28	4A.1C	L28 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Opto Input 29	4A.1D	L29 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Opto Input 30	4A.1E	L30 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Opto Input 31	4A.1F	L31 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Opto Input 32	4A.20	L32 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
GROUP 1: OUTPUT LABELS	4B.00		
Relay 1	4B.01	R1 IN>1 Start R1 Trip CB	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Relay 2	4B.02	R2 I>1 Start R2 Trip PrimeMov	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Relay 3	4B.03	R3 Any Trip	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Relay 4	4B.04	R4 General Alarm	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Relay 5	4B.05	R5 CB Fail	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Relay 6	4B.06	R6 Control Close R6 E/F Trip	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Relay 7	4B.07	R7 Control Trip R7 V or F Trip R7 Volt Trip	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Relay 8	4B.08	R8 Not Used R8 Freq Trip	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Relay 9	4B.09	R9 Not Used R9 Diff Trip	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Relay 10	4B.0A	R10 Not Used	From 32 to 163 in steps of 1

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
		R10 SysBack Trip	*[ASCII Text (16 chars)]*
Relay 11	4B.0B	R11 Not Used R11 NPS Trip	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Relay 12	4B.0C	R12 Not Used R12 Ffail Trip	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Relay 13	4B.0D	R13 Not Used R13 Power Trip	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Relay 14	4B.0E	R14 Not Used R14 V/Hz Trip	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Relay 15	4B.0F	R15 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Relay 16	4B.10	R16 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Relay 17	4B.11	R17 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Relay 18	4B.12	R18 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Relay 19	4B.13	R19 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Relay 20	4B.14	R20 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Relay 21	4B.15	R21 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Relay 22	4B.16	R22 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Relay 23	4B.17	R23 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Relay 24	4B.18	R24 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Relay 25	4B.19	R25 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Relay 26	4B.1A	R26 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Relay 27	4B.1B	R27 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Relay 28	4B.1C	R28 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Relay 29	4B.1D	R29 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Relay 30	4B.1E	R30 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Relay 31	4B.1F	R31 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
Relay 32	4B.20	R32 Not Used	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
GROUP 1: RTD LABELS	4C.00		
RTD 1	4C.01	RTD 1	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
RTD 2	4C.02	RTD 2	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
RTD 3	4C.03	RTD 3	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
RTD 4	4C.04	RTD 4	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
RTD 5	4C.05	RTD 5	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
RTD 6	4C.06	RTD 6	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
RTD 7	4C.07	RTD 7	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
RTD 8	4C.08	RTD 8	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
RTD 9	4C.09	RTD 9	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
RTD 10	4C.0A	RTD 10	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
GROUP 1: CLIO PROTECTION	4D.00		
CLIO Input 1	4D.02	Enabled	0 or 1 *[Indexed String]*
CLI1 Input Type	4D.04	4-20mA	From 0 to 3 in steps of 1 *[Indexed String]*
CLI1 Input Label	4D.06	CLIO Input 1	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
CLI1 Minimum	4D.08	0	From -9999 to 9999 in steps of 0.1 *[Courier Number (Decimal)]*
CLI1 Maximum	4D.0A	100	From -9999 to 9999 in steps of 0.1 *[Courier Number (Decimal)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
CLI1 Alarm	4D.0C	Disabled	0 or 1 *[Indexed String]*
CLI1 Alarm Fn	4D.0E	Over	0 or 1 *[Indexed String]*
CLI1 Alarm Set	4D.10	50	From CLI1 Minimum to CLI1 Maximum in steps of 0.1 *[Courier Number (Decimal)]*
CLI1 Alarm Delay	4D.12	1	From 0 to 100 in steps of 0.1 *[Courier Number (time-seconds)]*
CLI1 Trip	4D.14	Disabled	0 or 1 *[Indexed String]*
CLI1 Trip Fn	4D.16	Over	0 or 1 *[Indexed String]*
CLI1 Trip Set	4D.18	60	From CLI1 Minimum to CLI1 Maximum in steps of 0.1 *[Courier Number (Decimal)]*
CLI1 Trip Delay	4D.1A	0	From 0 to 100 in steps of 0.1 *[Courier Number (time-seconds)]*
CLI1 I< Alarm	4D.1C	Disabled	0 or 1 *[Indexed String]*
CLI1 I< Alm Set	4D.1E	0.0035	From 0 to 0.004 in steps of 0.0001 *[Courier Number (Current)]*
CLIO Input 2	4D.22	Enabled	0 or 1 *[Indexed String]*
CLI2 Input Type	4D.24	4-20mA	From 0 to 3 in steps of 1 *[Indexed String]*
CLI2 Input Label	4D.26	CLIO Input 2	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
CLI2 Minimum	4D.28	0	From -9999 to 9999 in steps of 0.1 *[Courier Number (Decimal)]*
CLI2 Maximum	4D.2A	100	From -9999 to 9999 in steps of 0.1 *[Courier Number (Decimal)]*
CLI2 Alarm	4D.2C	Disabled	0 or 1 *[Indexed String]*
CLI2 Alarm Fn	4D.2E	Over	0 or 1 *[Indexed String]*
CLI2 Alarm Set	4D.30	50	From CLI2 Minimum to CLI2 Maximum in steps of 0.1 *[Courier Number (Decimal)]*
CLI2 Alarm Delay	4D.32	1	From 0 to 100 in steps of 0.1 *[Courier Number (time-seconds)]*
CLI2 Trip	4D.34	Disabled	0 or 1 *[Indexed String]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
CLI2 Trip Fn	4D.36	Over	0 or 1 *[Indexed String]*
CLI2 Trip Set	4D.38	60	From CLI2 Minimum to CLI2 Maximum in steps of 0.1 *[Courier Number (Decimal)]*
CLI2 Trip Delay	4D.3A	0	From 0 to 100 in steps of 0.1 *[Courier Number (time-seconds)]*
CLI2 I< Alarm	4D.3C	Disabled	0 or 1 *[Indexed String]*
CLI2 I< Alm Set	4D.3E	0.0035	From 0 to 0.004 in steps of 0.0001 *[Courier Number (Current)]*
CLIO Input 3	4D.42	Enabled	0 or 1 *[Indexed String]*
CLI3 Input Type	4D.44	4-20mA	From 0 to 3 in steps of 1 *[Indexed String]*
CLI3 Input Label	4D.46	CLIO Input 3	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
CLI3 Minimum	4D.48	0	From -9999 to 9999 in steps of 0.1 *[Courier Number (Decimal)]*
CLI3 Maximum	4D.4A	100	From -9999 to 9999 in steps of 0.1 *[Courier Number (Decimal)]*
CLI3 Alarm	4D.4C	Disabled	0 or 1 *[Indexed String]*
CLI3 Alarm Fn	4D.4E	Over	0 or 1 *[Indexed String]*
CLI3 Alarm Set	4D.50	50	From CLI3 Minimum to CLI3 Maximum in steps of 0.1 *[Courier Number (Decimal)]*
CLI3 Alarm Delay	4D.52	1	From 0 to 100 in steps of 0.1 *[Courier Number (time-seconds)]*
CLI3 Trip	4D.54	Disabled	0 or 1 *[Indexed String]*
CLI3 Trip Fn	4D.56	Over	0 or 1 *[Indexed String]*
CLI3 Trip Set	4D.58	60	From CLI3 Minimum to CLI3 Maximum in steps of 0.1 *[Courier Number (Decimal)]*
CLI3 Trip Delay	4D.5A	0	From 0 to 100 in steps of 0.1 *[Courier Number (time-seconds)]*
CLI3 I< Alarm	4D.5C	Disabled	0 or 1 *[Indexed String]*
CLI3 I< Alm Set	4D.5E	0.0035	From 0 to 0.004 in steps of 0.0001

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
			[Courier Number (Current)]
CLIO Input 4	4D.62	Enabled	0 or 1 *[Indexed String]*
CLI4 Input Type	4D.64	4-20mA	From 0 to 3 in steps of 1 *[Indexed String]*
CLI4 Input Label	4D.66	CLIO Input 4	From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]*
CLI4 Minimum	4D.68	0	From -9999 to 9999 in steps of 0.1 *[Courier Number (Decimal)]*
CLI4 Maximum	4D.6A	100	From -9999 to 9999 in steps of 0.1 *[Courier Number (Decimal)]*
CLI4 Alarm	4D.6C	Disabled	0 or 1 *[Indexed String]*
CLI4 Alarm Fn	4D.6E	Over	0 or 1 *[Indexed String]*
CLI4 Alarm Set	4D.70	50	From CLI4 Minimum to CLI4 Maximum in steps of 0.1 *[Courier Number (Decimal)]*
CLI4 Alarm Delay	4D.72	1	From 0 to 100 in steps of 0.1 *[Courier Number (time-seconds)]*
CLI4 Trip	4D.74	Disabled	0 or 1 *[Indexed String]*
CLI4 Trip Fn	4D.76	Over	0 or 1 *[Indexed String]*
CLI4 Trip Set	4D.78	60	From CLI4 Minimum to CLI4 Maximum in steps of 0.1 *[Courier Number (Decimal)]*
CLI4 Trip Delay	4D.7A	0	From 0 to 100 in steps of 0.1 *[Courier Number (time-seconds)]*
CLI4 I< Alarm	4D.7C	Disabled	0 or 1 *[Indexed String]*
CLI4 I< Alm Set	4D.7E	0.0035	From 0 to 0.004 in steps of 0.0004 *[Courier Number (Current)]*
CLIO Output 1	4D.A0	Disabled	0 or 1 *[Indexed String]*
CLO1 Output Type	4D.A2	4-20mA	From 0 to 2 in steps of 1 *[Indexed String]*
CLO1 Set Values	4D.A4	Primary	0 or 1 *[Indexed String]*
CLO1 Parameter	4D.A6	IA Magnitude IA-1 RMS	From 0 to See G155 in steps of 1 *[Indexed String]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
CLO1 Minimum	4D.A8	See G155 table	
CLO1 Maximum	4D.AA	See G155 table	
CLIO Output 2	4D.B0	Disabled	0 or 1 *[Indexed String]*
CLO2 Output Type	4D.B2	4-20mA	From 0 to 2 in steps of 1 *[Indexed String]*
CLO2 Set Values	4D.B4	Primary	0 or 1 *[Indexed String]*
CLO2 Parameter	4D.B6	IB Magnitude IB-1 RMS	From 0 to See G155 in steps of 1 *[Indexed String]*
CLO2 Minimum	4D.B8	See G155 table	
CLO2 Maximum	4D.BA	See G155 table	
CLIO Output 3	4D.C0	Disabled	0 or 1 *[Indexed String]*
CLO3 Output Type	4D.C2	4-20mA	From 0 to 2 in steps of 1 *[Indexed String]*
CLO3 Set Values	4D.C4	Primary	0 or 1 *[Indexed String]*
CLO3 Parameter	4D.C6	IC Magnitude IC-1 RMS	From 0 to See G155 in steps of 1 *[Indexed String]*
CLO3 Minimum	4D.C8	See G155 table	
CLO3 Maximum	4D.CA	See G155 table	
CLIO Output 4	4D.D0	Disabled	0 or 1 *[Indexed String]*
CLO4 Output Type	4D.D2	4-20mA	From 0 to 2 in steps of 1 *[Indexed String]*
CLO4 Set Values	4D.D4	Primary	0 or 1 *[Indexed String]*
CLO4 Parameter	4D.D6	IN Measured Mag IN Derived Mag VA-1 RMS	From 0 to See G155 in steps of 1 *[Indexed String]*
CLO4 Minimum	4D.D8	See G155 table	
CLO4 Maximum	4D.DA	See G155 table	
VOLTAGE MONITORS	4E.01		
Live Voltage	4E.02	32	From 1*V1 to 132*V1 in steps of 0.5*V1 *[Courier Number (Voltage)]*
Dead Voltage	4E.03	13	From 1*V1 to 132*V1 in steps of 0.5*V1

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
			[Courier Number (Voltage)]
Gen UnderVoltage	4E.04	54	From 1*V1 to 132*V1 in steps of 0.5*V1 *[Courier Number (Voltage)]*
Gen Over Voltage	4E.05	130	From 1*V1 to 185*V1 in steps of 0.5*V1 *[Courier Number (Voltage)]*
Bus UnderVoltage	4E.06	54	From 10*V1 to 132*V1 in steps of 0.5*V1 *[Courier Number (Voltage)]*
Bus Over Voltage	4E.07	130	From 60*V1 to 185*V1 in steps of 0.5*V1 *[Courier Number (Voltage)]*
CS Diff Voltage	4E.08	6.5	From 1 to 132 in steps of 0.5 *[Courier Number (Voltage)]*
CS Voltage Block	4E.09	V<	From 0 to 7 in steps of 1 *[Indexed String]*
Gen Under Freq	4E.0A	49.5	From 45 to 65 in steps of 0.01 *[Courier Number (Frequency)]*
Gen Over Freq	4E.0B	50.5	From 45 to 65 in steps of 0.01 *[Courier Number (Frequency)]*
CHECK SYNC	4E.10		
CS1 Status	4E.11	Enabled	0 or 1 *[Indexed String]*
CS1 Phase Angle	4E.12	20	From 5 to 175 in steps of 0.01 *[Courier Number (Angle)]*
CS1 Slip Control	4E.13	Frequency only	From 0 to 3 in steps of 1 *[Indexed String]*
CS1 Slip Freq	4E.14	0.05	From 0.01 to 1 in steps of 0.01 *[Courier Number (Frequency)]*
CS1 Slip Timer	4E.15	1	From 0 to 99 in steps of 0.01 *[Courier Number (time-seconds)]*
CS2 Status	4E.16	Disabled	0 or 1 *[Indexed String]*
CS2 Phase Angle	4E.17	20	From 5 to 90 in steps of 0.01 *[Courier Number (Angle)]*
CS2 Slip Control	4E.18	Frequency only	From 0 to 4 in steps of 1 *[Indexed String]*
CS2 Slip Freq	4E.19	0.05	From 0.01 to 1 in steps of 0.01 *[Courier Number (Frequency)]*
CS2 Slip Timer	4E.1A	1	From 0 to 99 in steps of 0.01 *[Courier Number (time-seconds)]*
SYSTEM SPLIT	4E.20		

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
SS Status	4E.21	Enabled	0 or 1 *[Indexed String]*
SS Phase Angle	4E.22	120	From 90 to 175 in steps of 0.01 *[Courier Number (Angle)]*
SS Under V Block	4E.23	Enabled	0 or 1 *[Indexed String]*
SS UnderVoltage	4E.24	54	From 10 to 132 in steps of 0.5 *[Courier Number (Voltage)]*
SS Timer	4E.25	1	From 0 to 99 in steps of 0.01 *[Courier Number (time-seconds)]*
CB Close Time	4E.30	0.05	From 0 to 0.5 in steps of 0.001 *[Courier Number (time-seconds)]*
Select Record	B0.01		From 0 to 65535 in steps of 1 *[Unsigned Integer(2)]*
Faulted Phase	B0.40		Faulted Phase *[Binary Flag (8 Bits)]*
Start Elements1	B0.42		Start Elements1 *[Binary Flag (32 Bits) Indexed String]*
Start Elements2	B0.43		Start Elements2 *[Binary Flag (32 Bits) Indexed String]*
Start Elements3	B0.44		Start Elements3 *[Binary Flag (32 Bits) Indexed String]*
Start Elements4	B0.45		Start Elements4 *[Binary Flag (32 Bits)]*
For fault record use only.			
Trip Elements1	B0.49		Trip Elements1 *[Binary Flag (32 Bits) Indexed String]*
Trip Elements2	B0.4A		Trip Elements2 *[Binary Flag (32 Bits) Indexed String]*
Trip Elements3	B0.4B		Trip Elements3 *[Binary Flag (32 Bits) Indexed String]*
Trip Elements4	B0.4C		Trip Elements4 *[Binary Flag (32 Bits)]*
Fault Alarms	B0.50		Fault Alarms *[Binary Flag (32 Bits) Indexed String]*
Fault Alarms 2	B0.51		Fault Alarms 2 *[Binary Flag (32 Bits)]*
Fault Time	B0.55		Fault Time *[IEC870 Time & Date]*
Active Group	B0.57		Active Group

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
			[Unsigned Integer]
System Frequency	B0.59		System Frequency *[Courier Number (frequency)]*
Fault Duration	B0.5B		Fault Duration *[Courier Number (time)]*
CB Operate Time	B0.5E		CB Operate Time *[Courier Number (time)]*
Relay Trip Time	B0.60		Relay Trip Time *[Courier Number (time)]*
IA-1 IA-1 RMS	B0.62		IA-1 IA-1 RMS *[Courier Number (current)]*
IB-1 IB-1 RMS	B0.63		IB-1 IB-1 RMS *[Courier Number (current)]*
IC-1 IC-1 RMS	B0.64		IC-1 IC-1 RMS *[Courier Number (current)]*
VAB	B0.65		VAB *[Courier Number (voltage)]*
VBC	B0.66		VBC *[Courier Number (voltage)]*
VCA	B0.67		VCA *[Courier Number (voltage)]*
VAN VA-1 RMS	B0.68		VAN VA-1 RMS *[Courier Number (voltage)]*
VBN VB-1 RMS	B0.69		VBN VB-1 RMS *[Courier Number (voltage)]*
VCN VC-1 RMS	B0.6A		VCN VC-1 RMS *[Courier Number (voltage)]*
IA-2 IA-2 RMS	B0.70		IA-2 IA-2 RMS *[Courier Number (current)]*
IB-2 IB-2 RMS	B0.71		IB-2 IB-2 RMS *[Courier Number (current)]*
IC-2 IC-2 RMS	B0.72		IC-2 IC-2 RMS *[Courier Number (current)]*
IA Differential	B0.80		IA Differential

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
			[Courier Number (current)]
IB Differential	B0.81		IB Differential *[Courier Number (current)]*
IC Differential	B0.82		IC Differential *[Courier Number (current)]*
IA Diff PU	B0.83		IA Diff PU *[Courier Number (current)]*
IB Diff PU	B0.84		IB Diff PU *[Courier Number (current)]*
IC Diff PU	B0.85		IC Diff PU *[Courier Number (current)]*
IA Diff 2H	B0.86		IA Diff 2H *[Courier Number (current)]*
IB Diff 2H	B0.87		IB Diff 2H *[Courier Number (current)]*
IC Diff 2H	B0.88		IC Diff 2H *[Courier Number (current)]*
IA Diff 5H	B0.89		IA Diff 5H *[Courier Number (current)]*
IB Diff 5H	B0.8A		IB Diff 5H *[Courier Number (current)]*
IC Diff 5H	B0.8B		IC Diff 5H *[Courier Number (current)]*
VN1 Measured	B0.90		VN1 Measured *[Courier Number (voltage)]*
VN2 Measured	B0.92		VN2 Measured *[Courier Number (voltage)]*
VN Derived VN-1 Derived RMS	B0.94		VN Derived VN-1 Derived RMS *[Courier Number (voltage)]*
IN Measured	B0.96		IN Measured *[Courier Number (current)]*
I Sensitive1	B0.99		I Sensitive1 *[Courier Number (current)]*
I Sensitive2	B0.9A		I Sensitive2 *[Courier Number (current)]*
IREF Diff	B0.9C		IREF Diff *[Courier Number (current)]*
IREF Bias	B0.9D		IREF Bias *[Courier Number (current)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
I2	B0.A0		I2 *[Courier Number (current)]*
V2	B0.A2		V2 *[Courier Number (voltage)]*
3 Phase Watts	B0.A6		3 Phase Watts *[Courier Number (Power)]*
3 Phase VArs	B0.A8		3 Phase VArs *[Courier Number (VAr)]*
3Ph Power Factor	B0.AA		3Ph Power Factor *[Courier Number (Decimal)]*
Sen Watts	B0.AB		Sen Watts *[Courier Number (Power)]*
Sen VArs	B0.AC		Sen VArs *[Courier Number (VAr)]*
Sen Power Factor	B0.AD		Sen Power Factor *[Courier Number (Decimal)]*
RTD 1	B0.B0		RTD 1 *[Courier Number (Temperature)]*
RTD 2	B0.B1		RTD 2 *[Courier Number (Temperature)]*
RTD 3	B0.B2		RTD 3 *[Courier Number (Temperature)]*
RTD 4	B0.B3		RTD 4 *[Courier Number (Temperature)]*
RTD 5	B0.B4		RTD 5 *[Courier Number (Temperature)]*
RTD 6	B0.B5		RTD 6 *[Courier Number (Temperature)]*
RTD 7	B0.B6		RTD 7 *[Courier Number (Temperature)]*
RTD 8	B0.B7		RTD 8 *[Courier Number (Temperature)]*
RTD 9	B0.B8		RTD 9 *[Courier Number (Temperature)]*
RTD 10	B0.B9		RTD 10 *[Courier Number (Temperature)]*
CLIO Input 1	B0.C6		CLIO Input 1 *[Courier Number (Decimal)]*
CLIO Input 2	B0.C7		CLIO Input 2

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
			[Courier Number (Decimal)]
CLIO Input 3	B0.C8		CLIO Input 3 *[Courier Number (Decimal)]*
CLIO Input 4	B0.C9		CLIO Input 4 *[Courier Number (Decimal)]*
64S V Magnitude	B0.CA		64S V Magnitude *[Courier Number (voltage)]*
64S I Magnitude	B0.CB		64S I Magnitude *[Courier Number (current)]*
64S R primary	B0.CC		64S R primary *[Courier Number (resistance)]*
64R CL Input	B0.CD		64R CL Input *[Courier Number (current)]*
64R R Fault	B0.CE		64R R Fault *[Courier Number (resistance)]*
IA Peak Mag IA-1 Peak	B0.E4		IA Peak Mag IA-1 Peak *[Courier Number (Current)]*
IA(CT1) Peak Magnitude			
IB Peak Mag IB-1 Peak	B0.E5		IB Peak Mag IB-1 Peak *[Courier Number (Current)]*
IB(CT1) Peak Magnitude			
IC Peak Mag IC-1 Peak	B0.E6		IC Peak Mag IC-1 Peak *[Courier Number (Current)]*
IC(CT1) Peak Magnitude			
I2t Phase A	B0.E7		I2t Phase A *[Courier Number (I2t)]*
I2t(CT1) Phase A			
I2t Phase B	B0.E8		I2t Phase B *[Courier Number (I2t)]*
I2t(CT1) Phase B			
I2t Phase C	B0.E9		I2t Phase C *[Courier Number (I2t)]*
I2t(CT1) Phase C			
IA-2 Peak Mag IA-2 Peak	B0.EA		IA-2 Peak Mag IA-2 Peak *[Courier Number (Current)]*
IA(CT2) Peak Magnitude			
IB-2 Peak Mag IB-2 Peak	B0.EB		IB-2 Peak Mag IB-2 Peak *[Courier Number (Current)]*
IB(CT2) Peak Magnitude			
IC-2 Peak Mag IC-2 Peak	B0.EC		IC-2 Peak Mag IC-2 Peak *[Courier Number (Current)]*
IC(CT2) Peak Magnitude			
I2t Phase A-2	B0.ED		I2t Phase A-2 *[Courier Number (I2t)]*
I2t(CT2) Phase A			
I2t Phase B-2	B0.EE		I2t Phase B-2

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
			[Courier Number (I2t)]
I2t(CT2) Phase B			
I2t Phase C-2	B0.EF		I2t Phase C-2 *[Courier Number (I2t)]*
I2t(CT2) Phase C			
Select Record	B1.01		From 0 to 65535 in steps of 1 *[UINT16]*
Time and Date	B1.02		Time and Date *[IEC Date and Time]*
Maint Text	B1.03		Maint Text *[ASCII Text]*
Maint Type	B1.04		Maint Type *[UINT32]*
Maint Data	B1.05		Maint Data *[UINT32]*
Domain	B2.04	PSL Settings	0 or 1 *[Indexed String]*
Sub-Domain	B2.08	Group 1	From 0 to 3 in steps of 1 *[Indexed String]*
Version	B2.0C	256	From 0 to 65535 in steps of 1 *[Unsigned Integer (2 Bytes)]*
Start	B2.10		
Length	B2.14		
Data Transfer Reference	B2.18		
Transfer Mode	B2.1C	6	From 0 to 7 in steps of 1 *[Unsigned Integer Indexed Strings]*
Data Transfer	B2.20		
Recorder Source	B3.02	Samples	Recorder Source *[Indexed String]*
Reserved for future use	B3.03-1F		
Select Record	B4.01	0	From -199 to 199 in steps of 1 *[Unsigned Integer]*
Trigger Time	B4.02		Trigger Time *[IEC870 Time & Date]*
Active Channels	B4.03		Active Channels *[Binary Flag]*
Channel Types	B4.04		Channel Types *[Binary Flag]*
Channel Offsets	B4.05		Channel Offsets

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
			[Courier Number (decimal)]
Channel Scaling	B4.06		Channel Scaling *[Courier Number (decimal)]*
Channel SkewVal	B4.07		Channel SkewVal *[Integer]*
Channel MinVal	B4.08		Channel MinVal *[Integer]*
Channel MaxVal	B4.09		Channel MaxVal *[Integer]*
Format	B4.0A		Format *[Unsigned Integer]*
Record format: 0 = uncompressed, 1 = compressed			
Upload	B4.0B		Upload *[Unsigned Integer]*
Channel P Ratio	B4.0C		Channel P Ratio *[Courier Number (decimal)]*
Channel S Ratio	B4.0D		Channel S Ratio *[Courier Number (decimal)]*
Channel P or S	B4.0E		Channel P or S *[Unsigned Integer]*
No. Of Samples	B4.10		No. Of Samples *[Unsigned Integer]*
Trig Position	B4.11		Trig Position *[Unsigned Integer]*
Time Base	B4.12		Time Base *[Courier Number (time)]*
Sample Timer	B4.14		Sample Timer *[Unsigned Integer]*
Dist. Channel 1	B4.20		Dist. Channel 1 *[Integer]*
Dist. Channel 2	B4.21		Dist. Channel 2 *[Integer]*
Dist. Channel 3	B4.22		Dist. Channel 3 *[Integer]*
Dist. Channel 4	B4.23		Dist. Channel 4 *[Integer]*
Dist. Channel 5	B4.24		Dist. Channel 5 *[Integer]*
Dist. Channel 6	B4.25		Dist. Channel 6 *[Integer]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Dist. Channel 7	B4.26		Dist. Channel 7 *[Integer]*
Dist. Channel 8	B4.27		Dist. Channel 8 *[Integer]*
Dist. Channel 9	B4.28		Dist. Channel 9 *[Integer]*
Dist. Channel 10	B4.29		Dist. Channel 10 *[Integer]*
Dist. Channel 11	B4.2A		Dist. Channel 11 *[Integer]*
Dist. Channel 12	B4.2B		Dist. Channel 12 *[Integer]*
Dist. Channel 13	B4.2C		Dist. Channel 13 *[Integer]*
Dist. Channel 14	B4.2D		Dist. Channel 14 *[Integer]*
Dist. Channel 15	B4.2E		Dist. Channel 15 *[Integer]*
Dist. Channel 16	B4.2F		Dist. Channel 16 *[Integer]*
Dist. Channel 17	B4.30		Dist. Channel 17 *[Integer]*
Dist. Channel 18	B4.31		Dist. Channel 18 *[Integer]*
Dist. Channel 19	B4.32		Dist. Channel 19 *[Integer]*
Dist. Channel 20	B4.33		Dist. Channel 20 *[Integer]*
Dist. Channel 31	B4.3E		Dist. Channel 31 *[Binary Flag]*
Dist. Channel 32	B4.3F		Dist. Channel 32 *[Binary Flag]*
Calibration Coefficients (Hidden) (Note No Text)	B5.		
Cal Soft Version	B5.01		
Cal Date and Time	B5.02		
Channel Types	B5.03		
Cal Coeffs	B5.04		

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Comms Diagnostics (Hidden)	B6.00		
Bus Comms Err Count Front	B6.01		
Bus Message Count Front	B6.02		
Protocol Err Count Front	B6.03		
Reset front count	B6.05		
Bus Comms Err Count Rear	B6.06		
Protocol Err Count Rear	B6.07		
Busy Count Rear	B6.09		
Reset Rear Count	B6.0A		
Grp 1 PSL Ref	B7.01		Grp 1 PSL Ref *[ASCII Text (32 Chars)]*
Date/Time	B7.02		Date/Time *[IEC 870 Date & Time]*
Grp 1 PSL ID	B7.03		Grp 1 PSL ID *[Unsigned Integer (32 bits)]*
Grp 2 PSL Ref	B7.11		Grp 2 PSL Ref *[ASCII Text (32 Chars)]*
Date/Time	B7.12		Date/Time *[IEC 870 Date & Time]*
Grp 2 PSL ID	B7.13		Grp 2 PSL ID *[Unsigned Integer (32 bits)]*
Grp 3 PSL Ref	B7.21		Grp 3 PSL Ref *[ASCII Text (32 Chars)]*
Date/Time	B7.22		Date/Time *[IEC 870 Date & Time]*
Grp 3 PSL ID	B7.23		Grp 3 PSL ID *[Unsigned Integer (32 bits)]*
Grp 4 PSL Ref	B7.31		Grp 4 PSL Ref *[ASCII Text (32 Chars)]*
Date/Time	B7.32		Date/Time *[IEC 870 Date & Time]*
Grp 4 PSL ID	B7.33		Grp 4 PSL ID *[Unsigned Integer (32 bits)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Curve 1 Name	B8.01		Curve 1 Name *[ASCII Text (32 Chars)]*
Date & Time	B8.02		Date & Time *[IEC 870 Date & Time]*
Curve 1 ID	B8.03		Curve 1 ID *[Unsigned Integer (16 bits)]*
UserCurve 1 Type	B8.04	Operate 1.0	0 or 1 *[Indexed String]*
Curve 2 Name	B8.11		Curve 2 Name *[ASCII Text (32 Chars)]*
Date & Time	B8.12		Date & Time *[IEC 870 Date & Time]*
Curve 2 ID	B8.13		Curve 2 ID *[Unsigned Integer (16 bits)]*
UserCurve 2 Type	B8.14	Operate 1.0	0 or 1 *[Indexed String]*
Curve 3 Name	B8.21		Curve 3 Name *[ASCII Text (32 Chars)]*
Date & Time	B8.22		Date & Time *[IEC 870 Date & Time]*
Curve 3 ID	B8.23		Curve 3 ID *[Unsigned Integer (16 bits)]*
UserCurve 3 Type	B8.24	Reset 1.1	0 or 1 *[Indexed String]*
Curve 4 Name	B8.31		Curve 4 Name *[ASCII Text (32 Chars)]*
Date & Time	B8.32		Date & Time *[IEC 870 Date & Time]*
Curve 4 ID	B8.33		Curve 4 ID *[Unsigned Integer (16 bits)]*
UserCurve 4 Type	B8.34	Reset 1.1	0 or 1 *[Indexed String]*
COMMS SYS DATA	BF.00		
Dist Record Cntrl Ref	BF.01	B300	Dist Record Cntrl Ref *[Menu Cell(2)]*
Dist Record Extract Ref	BF.02	B400	Dist Record Extract Ref *[Menu Cell(2)]*
Setting Transfer	BF.03		
Reset Demand	BF.04		

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
Block Xfer Ref	BF.06	B200	Block Xfer Ref *[Menu Cell(2)]*
Encryption Key	BF.10		Encryption Key *[ASCII Text (16 Chars)]*
Connected i/face	BF.11		Connected i/face *[Unsigned Integer]*
DIAGNOSTICS (hidden)	E0.00		
Enable Column	E0.01	0 (No)	0 or 1 *[Indexed String]*
CPU Load-Instant	E0.11		CPU Load-Instant *[Unsigned Integer (32 bits)]*
CPU Load-Average	E0.12		CPU Load-Average *[Unsigned Integer (32 bits)]*
CPU Load-Min	E0.13		CPU Load-Min *[Unsigned Integer (32 bits)]*
CPU Load-Max	E0.14		CPU Load-Max *[Unsigned Integer (32 bits)]*
CPU Load Reset	E0.1F	0 (No)	0 or 1 *[Indexed String]*
DDB to set:	E0.21		From 0 to 1022 in steps of 1 *[Unsigned Integer (32 bits)]*
DDB to reset:	E0.22		From 0 to 1022 in steps of 1 *[Unsigned Integer (32 bits)]*
DDB to pulse:	E0.23		From 0 to 1022 in steps of 1 *[Unsigned Integer (32 bits)]*
Name Unfitted IO	E0.26	0 (No)	0 or 1 *[Indexed String]*
UINT32 - 1	E0.31		From 0 to 2^32-1 in steps of 1 *[Unsigned Integer (32 bits)]*
UINT32 - 2	E0.32		From 0 to 2^32-1 in steps of 1 *[Unsigned Integer (32 bits)]*
UINT32 - 3	E0.33		From 0 to 2^32-1 in steps of 1 *[Unsigned Integer (32 bits)]*
UINT32 - 4	E0.34		From 0 to 2^32-1 in steps of 1 *[Unsigned Integer (32 bits)]*
UINT32 - 5	E0.35		From 0 to 2^32-1 in steps of 1 *[Unsigned Integer (32 bits)]*
INT32 - 1	E0.41		INT32 - 1 *[Signed Integer (32 bits)]*

MENU TEXT	COL.ROW	DEFAULT SETTING	AVAILABLE OPTIONS
DESCRIPTION			
INT32 - 2	E0.42		INT32 - 2 *[Signed Integer (32 bits)]*
INT32 - 3	E0.43		INT32 - 3 *[Signed Integer (32 bits)]*
INT32 - 4	E0.44		INT32 - 4 *[Signed Integer (32 bits)]*
INT32 - 5	E0.45		INT32 - 5 *[Signed Integer (32 bits)]*
BIN32 - 1	E0.51		BIN32 - 1 *[Binary Flag (32 bits)]*
BIN32 - 2	E0.52		BIN32 - 2 *[Binary Flag (32 bits)]*
BIN32 - 3	E0.53		BIN32 - 3 *[Binary Flag (32 bits)]*
BIN32 - 4	E0.54		BIN32 - 4 *[Binary Flag (32 bits)]*
BIN32 - 5	E0.55		BIN32 - 5 *[Binary Flag (32 bits)]*
FLT32 - 1	E0.61		FLT32 - 1 *[Courier Number (meters)]*
FLT32 - 2	E0.62		FLT32 - 2 *[Courier Number (meters)]*
FLT32 - 3	E0.63		FLT32 - 3 *[Courier Number (meters)]*
FLT32 - 4	E0.64		FLT32 - 4 *[Courier Number (meters)]*
FLT32 - 5	E0.65		FLT32 - 5 *[Courier Number (meters)]*
ETHERNET STATUS	F0.00		
Ethernet Status Selector	F0.01		From 0 to 239 in steps of 1 *[Unsigned Integer]*
Ethernet Status Number	F0.03		Ethernet Status Number *[Unsigned Integer]*
Ethernet Fatal Error	F0.04		Ethernet Fatal Error *[Unsigned Integer]*

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
0	Relay 1	DDB_OUTPUT_RELAY_1
Output Relay 1		
1	Relay 2	DDB_OUTPUT_RELAY_2
Output Relay 2		
2	Relay 3	DDB_OUTPUT_RELAY_3
Output Relay 3		
3	Relay 4	DDB_OUTPUT_RELAY_4
Output Relay 4		
4	Relay 5	DDB_OUTPUT_RELAY_5
Output Relay 5		
5	Relay 6	DDB_OUTPUT_RELAY_6
Output Relay 6		
6	Relay 7	DDB_OUTPUT_RELAY_7
Output Relay 7		
7	Relay 8	DDB_OUTPUT_RELAY_8
Output Relay 8		
8	Relay 9	DDB_OUTPUT_RELAY_9
Output Relay 9		
9	Relay 10	DDB_OUTPUT_RELAY_10
Output Relay 10		
10	Relay 11	DDB_OUTPUT_RELAY_11
Output Relay 11		
11	Relay 12	DDB_OUTPUT_RELAY_12
Output Relay 12		
12	Relay 13	DDB_OUTPUT_RELAY_13
Output Relay 13		
13	Relay 14	DDB_OUTPUT_RELAY_14
Output Relay 14		
14	Relay 15	DDB_OUTPUT_RELAY_15
Output Relay 15		
15	Relay 16	DDB_OUTPUT_RELAY_16
Output Relay 16		
16	Relay 17	DDB_OUTPUT_RELAY_17
Output Relay 17		
17	Relay 18	DDB_OUTPUT_RELAY_18
Output Relay 18		
18	Relay 19	DDB_OUTPUT_RELAY_19
Output Relay 19		
19	Relay 20	DDB_OUTPUT_RELAY_20
Output Relay 20		
20	Relay 21	DDB_OUTPUT_RELAY_21
Output Relay 21		
21	Relay 22	DDB_OUTPUT_RELAY_22
Output Relay 22		
22	Relay 23	DDB_OUTPUT_RELAY_23
Output Relay 23		
23	Relay 24	DDB_OUTPUT_RELAY_24
Output Relay 24		
24	Relay 25	DDB_OUTPUT_RELAY_25
Output Relay 25		
25	Relay 26	DDB_OUTPUT_RELAY_26
Output Relay 26		
26	Relay 27	DDB_OUTPUT_RELAY_27
Output Relay 27		
27	Relay 28	DDB_OUTPUT_RELAY_28
Output Relay 28		
28	Relay 29	DDB_OUTPUT_RELAY_29
Output Relay 29		

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
29	Relay 30	DDB_OUTPUT_RELAY_30
Output Relay 30		
30	Relay 31	DDB_OUTPUT_RELAY_31
Output Relay 31		
31	Relay 32	DDB_OUTPUT_RELAY_32
Output Relay 32		
32	Opto 1	DDB_OPTO_ISOLATOR_1
Opto Isolator Input 1		
33	Opto 2	DDB_OPTO_ISOLATOR_2
Opto Isolator Input 2		
34	Opto 3	DDB_OPTO_ISOLATOR_3
Opto Isolator Input 3		
35	Opto 4	DDB_OPTO_ISOLATOR_4
Opto Isolator Input 4		
36	Opto 5	DDB_OPTO_ISOLATOR_5
Opto Isolator Input 5		
37	Opto 6	DDB_OPTO_ISOLATOR_6
Opto Isolator Input 6		
38	Opto 7	DDB_OPTO_ISOLATOR_7
Opto Isolator Input 7		
39	Opto 8	DDB_OPTO_ISOLATOR_8
Opto Isolator Input 8		
40	Opto 9	DDB_OPTO_ISOLATOR_9
Opto Isolator Input 9		
41	Opto 10	DDB_OPTO_ISOLATOR_10
Opto Isolator Input 10		
42	Opto 11	DDB_OPTO_ISOLATOR_11
Opto Isolator Input 11		
43	Opto 12	DDB_OPTO_ISOLATOR_12
Opto Isolator Input 12		
44	Opto 13	DDB_OPTO_ISOLATOR_13
Opto Isolator Input 13		
45	Opto 14	DDB_OPTO_ISOLATOR_14
Opto Isolator Input 14		
46	Opto 15	DDB_OPTO_ISOLATOR_15
Opto Isolator Input 15		
47	Opto 16	DDB_OPTO_ISOLATOR_16
Opto Isolator Input 16		
48	Opto 17	DDB_OPTO_ISOLATOR_17
Opto Isolator Input 17		
49	Opto 18	DDB_OPTO_ISOLATOR_18
Opto Isolator Input 18		
50	Opto 19	DDB_OPTO_ISOLATOR_19
Opto Isolator Input 19		
51	Opto 20	DDB_OPTO_ISOLATOR_20
Opto Isolator Input 20		
52	Opto 21	DDB_OPTO_ISOLATOR_21
Opto Isolator Input 21		
53	Opto 22	DDB_OPTO_ISOLATOR_22
Opto Isolator Input 22		
54	Opto 23	DDB_OPTO_ISOLATOR_23
Opto Isolator Input 23		
55	Opto 24	DDB_OPTO_ISOLATOR_24
Opto Isolator Input 24		
56	Opto 25	DDB_OPTO_ISOLATOR_25
Opto Isolator Input 25		
57	Opto 26	DDB_OPTO_ISOLATOR_26
Opto Isolator Input 26		

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
58	Opto 27	DDB_OPTO_ISOLATOR_27
Opto Isolator Input 27		
59	Opto 28	DDB_OPTO_ISOLATOR_28
Opto Isolator Input 28		
60	Opto 29	DDB_OPTO_ISOLATOR_29
Opto Isolator Input 29		
61	Opto 30	DDB_OPTO_ISOLATOR_30
Opto Isolator Input 30		
62	Opto 31	DDB_OPTO_ISOLATOR_31
Opto Isolator Input 31		
63	Opto 32	DDB_OPTO_ISOLATOR_32
Opto Isolator Input 32		
64	Relay Cond 1	DDB_OUTPUT_CON_1
Relay Conditioner 1		
65	Relay Cond 2	DDB_OUTPUT_CON_2
Relay Conditioner 2		
66	Relay Cond 3	DDB_OUTPUT_CON_3
Relay Conditioner 3		
67	Relay Cond 4	DDB_OUTPUT_CON_4
Relay Conditioner 4		
68	Relay Cond 5	DDB_OUTPUT_CON_5
Relay Conditioner 5		
69	Relay Cond 6	DDB_OUTPUT_CON_6
Relay Conditioner 6		
70	Relay Cond 7	DDB_OUTPUT_CON_7
Relay Conditioner 7		
71	Relay Cond 8	DDB_OUTPUT_CON_8
Relay Conditioner 8		
72	Relay Cond 9	DDB_OUTPUT_CON_9
Relay Conditioner 9		
73	Relay Cond 10	DDB_OUTPUT_CON_10
Relay Conditioner 10		
74	Relay Cond 11	DDB_OUTPUT_CON_11
Relay Conditioner 11		
75	Relay Cond 12	DDB_OUTPUT_CON_12
Relay Conditioner 12		
76	Relay Cond 13	DDB_OUTPUT_CON_13
Relay Conditioner 13		
77	Relay Cond 14	DDB_OUTPUT_CON_14
Relay Conditioner 14		
78	Relay Cond 15	DDB_OUTPUT_CON_15
Relay Conditioner 15		
79	Relay Cond 16	DDB_OUTPUT_CON_16
Relay Conditioner 16		
80	Relay Cond 17	DDB_OUTPUT_CON_17
Relay Conditioner 17		
81	Relay Cond 18	DDB_OUTPUT_CON_18
Relay Conditioner 18		
82	Relay Cond 19	DDB_OUTPUT_CON_19
Relay Conditioner 19		
83	Relay Cond 20	DDB_OUTPUT_CON_20
Relay Conditioner 20		
84	Relay Cond 21	DDB_OUTPUT_CON_21
Relay Conditioner 21		
85	Relay Cond 22	DDB_OUTPUT_CON_22
Relay Conditioner 22		
86	Relay Cond 23	DDB_OUTPUT_CON_23
Relay Conditioner 23		

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
87	Relay Cond 24	DDB_OUTPUT_CON_24
Relay Conditioner 24		
88	Relay Cond 25	DDB_OUTPUT_CON_25
Relay Conditioner 25		
89	Relay Cond 26	DDB_OUTPUT_CON_26
Relay Conditioner 26		
90	Relay Cond 27	DDB_OUTPUT_CON_27
Relay Conditioner 27		
91	Relay Cond 28	DDB_OUTPUT_CON_28
Relay Conditioner 28		
92	Relay Cond 29	DDB_OUTPUT_CON_29
Relay Conditioner 29		
93	Relay Cond 30	DDB_OUTPUT_CON_30
Relay Conditioner 30		
94	Relay Cond 31	DDB_OUTPUT_CON_31
Relay Conditioner 31		
95	Relay Cond 32	DDB_OUTPUT_CON_32
Relay Conditioner 32		
96	LED1 Red	DDB_OUTPUT_TRI_LED_1_RED
Tri-LED - 1 - Red		
97	LED1 Grn	DDB_OUTPUT_TRI_LED_1_GRN
Tri-LED - 1 - Green		
98	LED2 Red	DDB_OUTPUT_TRI_LED_2_RED
Tri-LED - 2 - Red		
99	LED2 Grn	DDB_OUTPUT_TRI_LED_2_GRN
Tri-LED - 2 - Green		
100	LED3 Red	DDB_OUTPUT_TRI_LED_3_RED
Tri-LED - 3 - Red		
101	LED3 Grn	DDB_OUTPUT_TRI_LED_3_GRN
Tri-LED - 3 - Green		
102	LED4 Red	DDB_OUTPUT_TRI_LED_4_RED
Tri-LED - 4 - Red		
103	LED4 Grn	DDB_OUTPUT_TRI_LED_4_GRN
Tri-LED - 4 - Green		
104	LED5 Red	DDB_OUTPUT_TRI_LED_5_RED
Tri-LED - 5 - Red		
105	LED5 Grn	DDB_OUTPUT_TRI_LED_5_GRN
Tri-LED - 5 - Green		
106	LED6 Red	DDB_OUTPUT_TRI_LED_6_RED
Tri-LED - 6 - Red		
107	LED6 Grn	DDB_OUTPUT_TRI_LED_6_GRN
Tri-LED - 6 - Green		
108	LED7 Red	DDB_OUTPUT_TRI_LED_7_RED
Tri-LED - 7 - Red		
109	LED7 Grn	DDB_OUTPUT_TRI_LED_7_GRN
Tri-LED - 7 - Green		
110	LED8 Red	DDB_OUTPUT_TRI_LED_8_RED
Tri-LED - 8 - Red		
111	LED8 Grn	DDB_OUTPUT_TRI_LED_8_GRN
Tri-LED - 8 - Green		
112	FnKey LED1 Red	DDB_OUTPUT_TRI_LED_9_RED
Tri-LED - 9 - Red		
113	FnKey LED1 Grn	DDB_OUTPUT_TRI_LED_9_GRN
Tri-LED - 9 - Green		
114	FnKey LED2 Red	DDB_OUTPUT_TRI_LED_10_RED
Tri-LED - 10 - Red		
115	FnKey LED2 Grn	DDB_OUTPUT_TRI_LED_10_GRN
Tri-LED - 10 - Green		

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
116	FnKey LED3 Red	DDB_OUTPUT_TRI_LED_11_RED
Tri-LED - 11 - Red		
117	FnKey LED3 Grn	DDB_OUTPUT_TRI_LED_11_GRN
Tri-LED - 11 - Green		
118	FnKey LED4 Red	DDB_OUTPUT_TRI_LED_12_RED
Tri-LED - 12 - Red		
119	FnKey LED4 Grn	DDB_OUTPUT_TRI_LED_12_GRN
Tri-LED - 12 - Green		
120	FnKey LED5 Red	DDB_OUTPUT_TRI_LED_13_RED
Tri-LED - 13 - Red		
121	FnKey LED5 Grn	DDB_OUTPUT_TRI_LED_13_GRN
Tri-LED - 13 - Green		
122	FnKey LED6 Red	DDB_OUTPUT_TRI_LED_14_RED
Tri-LED - 14 - Red		
123	FnKey LED6 Grn	DDB_OUTPUT_TRI_LED_14_GRN
Tri-LED - 14 - Green		
124	FnKey LED7 Red	DDB_OUTPUT_TRI_LED_15_RED
Tri-LED - 15 - Red		
125	FnKey LED7 Grn	DDB_OUTPUT_TRI_LED_15_GRN
Tri-LED - 15 - Green		
126	FnKey LED8 Red	DDB_OUTPUT_TRI_LED_16_RED
Tri-LED - 16 - Red		
127	FnKey LED8 Grn	DDB_OUTPUT_TRI_LED_16_GRN
Tri-LED - 16 - Green		
128	FnKey LED9 Red	DDB_OUTPUT_TRI_LED_17_RED
Tri-LED - 17 - Red		
129	FnKey LED9 Grn	DDB_OUTPUT_TRI_LED_17_GRN
Tri-LED - 17 - Green		
130	FnKey LED10 Red	DDB_OUTPUT_TRI_LED_18_RED
Tri-LED - 18 - Red		
131	FnKey LED10 Grn	DDB_OUTPUT_TRI_LED_18_GRN
Tri-LED - 18 - Green		
160	LED1 Con R	DDB_TRI_LED_RED_CON_1
Tri-LED Conditioner - 1 - Red		
161	LED1 Con G	DDB_TRI_LED_GRN_CON_1
Tri-LED Conditioner- 1 - Green		
162	LED2 Con R	DDB_TRI_LED_RED_CON_2
Tri-LED Conditioner - 2 - Red		
163	LED2 Con G	DDB_TRI_LED_GRN_CON_2
Tri-LED Conditioner - 2 - Green		
164	LED3 Con R	DDB_TRI_LED_RED_CON_3
Tri-LED Conditioner - 3 - Red		
165	LED3 Con G	DDB_TRI_LED_GRN_CON_3
Tri-LED Conditioner - 3 - Green		
166	LED4 Con R	DDB_TRI_LED_RED_CON_4
Tri-LED Conditioner - 4 - Red		
167	LED4 Con G	DDB_TRI_LED_GRN_CON_4
Tri-LED Conditioner - 4 - Green		
168	LED5 Con R	DDB_TRI_LED_RED_CON_5
Tri-LED Conditioner - 5 - Red		
169	LED5 Con G	DDB_TRI_LED_GRN_CON_5
Tri-LED Conditioner - 5 - Green		
170	LED6 Con R	DDB_TRI_LED_RED_CON_6
Tri-LED Conditioner - 6 - Red		
171	LED6 Con G	DDB_TRI_LED_GRN_CON_6
Tri-LED Conditioner - 6 - Green		
172	LED7 Con R	DDB_TRI_LED_RED_CON_7
Tri-LED Conditioner - 7 - Red		

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
173	LED7 Con G	DDB_TRI_LED_GRN_CON_7
Tri-LED Conditioner - 7 - Green		
174	LED8 Con R	DDB_TRI_LED_RED_CON_8
Tri-LED Conditioner - 8 - Red		
175	LED8 Con G	DDB_TRI_LED_GRN_CON_8
Tri-LED Conditioner - 8 - Green		
176	FnKey LED1 ConR	DDB_TRI_LED_RED_CON_9
Tri-LED Conditioner - 9 - Red		
177	FnKey LED1 ConG	DDB_TRI_LED_GRN_CON_9
Tri-LED Conditioner - 9 - Green		
178	FnKey LED2 ConR	DDB_TRI_LED_RED_CON_10
Tri-LED Conditioner - 10 - Red		
179	FnKey LED2 ConG	DDB_TRI_LED_GRN_CON_10
Tri-LED Conditioner - 10 - Green		
180	FnKey LED3 ConR	DDB_TRI_LED_RED_CON_11
Tri-LED Conditioner - 11 - Red		
181	FnKey LED3 ConG	DDB_TRI_LED_GRN_CON_11
Tri-LED Conditioner - 11 - Green		
182	FnKey LED4 ConR	DDB_TRI_LED_RED_CON_12
Tri-LED Conditioner - 12 - Red		
183	FnKey LED4 ConG	DDB_TRI_LED_GRN_CON_12
Tri-LED Conditioner - 12 - Green		
184	FnKey LED5 ConR	DDB_TRI_LED_RED_CON_13
Tri-LED Conditioner - 13 - Red		
185	FnKey LED5 ConG	DDB_TRI_LED_GRN_CON_13
Tri-LED Conditioner - 13 - Green		
186	FnKey LED6 ConR	DDB_TRI_LED_RED_CON_14
Tri-LED Conditioner - 14 - Red		
187	FnKey LED6 ConG	DDB_TRI_LED_GRN_CON_14
Tri-LED Conditioner - 14 - Green		
188	FnKey LED7 ConR	DDB_TRI_LED_RED_CON_15
Tri-LED Conditioner - 15 - Red		
189	FnKey LED7 ConG	DDB_TRI_LED_GRN_CON_15
Tri-LED Conditioner - 15 - Green		
190	FnKey LED8 ConR	DDB_TRI_LED_RED_CON_16
Tri-LED Conditioner - 16 - Red		
191	FnKey LED8 ConG	DDB_TRI_LED_GRN_CON_16
Tri-LED Conditioner - 16 - Green		
192	FnKey LED9 ConR	DDB_TRI_LED_RED_CON_17
Tri-LED Conditioner - 17 - Red		
193	FnKey LED9 ConG	DDB_TRI_LED_GRN_CON_17
Tri-LED Conditioner - 17 - Green		
194	FnKey LED10 ConR	DDB_TRI_LED_RED_CON_18
Tri-LED Conditioner - 18 - Red		
195	FnKey LED10 ConG	DDB_TRI_LED_GRN_CON_18
Tri-LED Conditioner - 18 - Green		
240	InterMiCOM in 1	DDB_INTERIN_1
InterMiCOM Input bit 1		
241	InterMiCOM in 2	DDB_INTERIN_2
InterMiCOM Input bit 2		
242	InterMiCOM in 3	DDB_INTERIN_3
InterMiCOM Input bit 3		
243	InterMiCOM in 4	DDB_INTERIN_4
InterMiCOM Input bit 4		
244	InterMiCOM in 5	DDB_INTERIN_5
InterMiCOM Input bit 5		
245	InterMiCOM in 6	DDB_INTERIN_6
InterMiCOM Input bit 6		

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
246	InterMiCOM in 7	DDB_INTERIN_7
InterMiCOM Input bit 7		
247	InterMiCOM in 8	DDB_INTERIN_8
InterMiCOM Input bit 8		
248	InterMiCOM out 1	DDB_INTEROUT_1
InterMiCOM Output bit 1		
249	InterMiCOM out 2	DDB_INTEROUT_2
InterMiCOM Output bit 2		
250	InterMiCOM out 3	DDB_INTEROUT_3
InterMiCOM Output bit 3		
251	InterMiCOM out 4	DDB_INTEROUT_4
InterMiCOM Output bit 4		
252	InterMiCOM out 5	DDB_INTEROUT_5
InterMiCOM Output bit 5		
253	InterMiCOM out 6	DDB_INTEROUT_6
InterMiCOM Output bit 6		
254	InterMiCOM out 7	DDB_INTEROUT_7
InterMiCOM Output bit 7		
255	InterMiCOM out 8	DDB_INTEROUT_8
InterMiCOM Output bit 8		
256	Function Key 1	DDB_FN_KEY_1
Function Key 1		
257	Function Key 2	DDB_FN_KEY_2
Function Key 2		
258	Function Key 3	DDB_FN_KEY_3
Function Key 3		
259	Function Key 4	DDB_FN_KEY_4
Function Key 4		
260	Function Key 5	DDB_FN_KEY_5
Function Key 5		
261	Function Key 6	DDB_FN_KEY_6
Function Key 6		
262	Function Key 7	DDB_FN_KEY_7
Function Key 7		
263	Function Key 8	DDB_FN_KEY_8
Function Key 8		
264	Function Key 9	DDB_FN_KEY_9
Function Key 9		
265	Function Key 10	DDB_FN_KEY_10
Function Key 10		
288	Timer out 1	DDB_TIMEROUT_1
Auxiliary Timer out 1		
289	Timer out 2	DDB_TIMEROUT_2
Auxiliary Timer out 2		
290	Timer out 3	DDB_TIMEROUT_3
Auxiliary Timer out 3		
291	Timer out 4	DDB_TIMEROUT_4
Auxiliary Timer out 4		
292	Timer out 5	DDB_TIMEROUT_5
Auxiliary Timer out 5		
293	Timer out 6	DDB_TIMEROUT_6
Auxiliary Timer out 6		
294	Timer out 7	DDB_TIMEROUT_7
Auxiliary Timer out 7		
295	Timer out 8	DDB_TIMEROUT_8
Auxiliary Timer out 8		
296	Timer out 9	DDB_TIMEROUT_9
Auxiliary Timer out 9		

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
297	Timer out 10	DDB_TIMEROUT_10
Auxiliary Timer out 10		
298	Timer out 11	DDB_TIMEROUT_11
Auxiliary Timer out 11		
299	Timer out 12	DDB_TIMEROUT_12
Auxiliary Timer out 12		
300	Timer out 13	DDB_TIMEROUT_13
Auxiliary Timer out 13		
301	Timer out 14	DDB_TIMEROUT_14
Auxiliary Timer out 14		
302	Timer out 15	DDB_TIMEROUT_15
Auxiliary Timer out 15		
303	Timer out 16	DDB_TIMEROUT_16
Auxiliary Timer out 16		
320	Timer in 1	DDB_TIMERIN_1
Auxiliary Timer in 1		
321	Timer in 2	DDB_TIMERIN_2
Auxiliary Timer in 2		
322	Timer in 3	DDB_TIMERIN_3
Auxiliary Timer in 3		
323	Timer in 4	DDB_TIMERIN_4
Auxiliary Timer in 4		
324	Timer in 5	DDB_TIMERIN_5
Auxiliary Timer in 5		
325	Timer in 6	DDB_TIMERIN_6
Auxiliary Timer in 6		
326	Timer in 7	DDB_TIMERIN_7
Auxiliary Timer in 7		
327	Timer in 8	DDB_TIMERIN_8
Auxiliary Timer in 8		
328	Timer in 9	DDB_TIMERIN_9
Auxiliary Timer in 9		
329	Timer in 10	DDB_TIMERIN_10
Auxiliary Timer in 10		
330	Timer in 11	DDB_TIMERIN_11
Auxiliary Timer in 11		
331	Timer in 12	DDB_TIMERIN_12
Auxiliary Timer in 12		
332	Timer in 13	DDB_TIMERIN_13
Auxiliary Timer in 13		
333	Timer in 14	DDB_TIMERIN_14
Auxiliary Timer in 14		
334	Timer in 15	DDB_TIMERIN_15
Auxiliary Timer in 15		
335	Timer in 16	DDB_TIMERIN_16
Auxiliary Timer in 16		
352	Prot'n Disabled	DDB_PROTECTION_DISABLED
Protection disabled - typically out of service due to test mode		
353	F out of Range	DDB_FREQ_ALARM
Frequency Out of Range		
354	SG-DDB Invalid	DDB_ILLEGAL_OPTO_SETTINGS_GROUP
Setting Group selection by DDB inputs invalid		
355	Prot'n Disabled	DDB_OOS_ALARM
Test Mode Enabled		
356	VT Fail Alarm	DDB_VTS_INDICATION
VTS VT Fail Alarm		
357	CT-1 Fail Alarm	DDB_CTS_INDICATION
CTS-1 CT-1 Fail Alarm		

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
358	CB Fail Alarm	DDB_BREAKER_FAIL_ALARM
Breaker Fail Any Trip		
359	I^ Maint Alarm	DDB_BROKEN_CURRENT_ALARM
Broken Current Maintenance Alarm		
360	I^ Lockout Alarm	DDB_BROKEN_CURRENT_LOCKOUT
Broken Current Lockout Alarm		
361	CB Ops Maint	DDB_MAINTENANCE_ALARM
Number of CB Operations Maintenance Alarm		
362	CB Ops Lockout	DDB_MAINTENANCE_LOCKOUT
Number of CB Operations Maintenance Lockout		
363	CB Op Time Maint	DDB_EXCESSIVE_OP_TIME_ALARM
Excessive CB Operation Time Maintenance Alarm		
364	CB Op Time Lock	DDB_EXCESSIVE_OP_TIME_LOCKOUT
Excessive CB Operation Time Lockout Alarm		
365	Fault Freq Lock	DDB_EFF_LOCKOUT
Excessive Fault Frequency Lockout Alarm		
366	CB Status Alarm	DDB_CB_STATUS_ALARM
CB Status Alarm		
367	Man CB Trip Fail	DDB_CB_FAILED_TO_TRIP
CB Failed to Trip		
368	Man CB Cls Fail	DDB_CB_FAILED_TO_CLOSE
CB Failed to Close		
369	Man CB Unhealthy	DDB_CONTROL_CB_UNHEALTHY
Control CB Unhealthy		
370	NPS Thermal Alm	DDB_NPS_ALARM
Negative Phase Sequence thermal Alarm		
371	Gen Thermal Alm	DDB_GEN_THERMAL_ALARM
Thermal Overload Alarm		
372	V/Hz Alarm	DDB_VPERHZ_ALARM
Volts Per Hz Alarm		
373	Field Fail Alarm	DDB_FIELDF_ALARM
Field Failure Alarm		
374	RTD Thermal Alm	DDB_RTD_ALARM
RTD Thermal Alarm		
375	RTD Open Cct	DDB_RTD_OPEN_CCT
RTD Open Circuit Failure		
376	RTD short Cct	DDB_RTD_SHORT_CCT
RTD Short Circuit Failure		
377	RTD Data Error	DDB_RTD_DATA_ERROR
RTD Data Inconsistency Error		
378	RTD Board Fail	DDB_RTD_BOARD_FAILURE
RTD Board Failure		
379	Freq Prot Alm	DDB_FREQ_PROT_ALM
Frequency Protection Alarm		
380	Voltage Prot Alm	DDB_VOLTAGE_PROT_ALM
Voltage Protection Alarm		
381	CT-2 Fail Alarm	DDB_CTS_2_INDICATION
CTS-2 CT-2 Fail Alarm		
382	64S R<1 Alarm	DDB_STEFI_UR_1_TRIP
64S 100% St EF Under Resistance Stage 1 Alarm		
383	64S Fail Alarm	DDB_STEFI_FAIL_ALARM
64S Injection Fail Alarm		
384	CL Card I/P Fail	DDB_CLIO_CARD_INPUT_FAIL
CLIO Input Board Failure		
385	CL Card O/P Fail	DDB_CLIO_CARD_OUTPUT_FAIL
CLIO Output Board Failure		
386	CL Input 1 Alarm	DDB_CL_INPUT_1_ALARM
Current Loop Input 1 Alarm		

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
387	CL Input 2 Alarm	DDB_CL_INPUT_2_ALARM
Current Loop Input 2 Alarm		
388	CL Input 3 Alarm	DDB_CL_INPUT_3_ALARM
Current Loop Input 3 Alarm		
389	CL Input 4 Alarm	DDB_CL_INPUT_4_ALARM
Current Loop Input 4 Alarm		
390	CLI1 I< Fail Alm	DDB_CLI_1_UNDERCURRENT_ALARM
Current Loop Input 1 Undercurrent Fail Alarm		
391	CLI2 I< Fail Alm	DDB_CLI_2_UNDERCURRENT_ALARM
Current Loop Input 2 Undercurrent Fail Alarm		
392	CLI3 I< Fail Alm	DDB_CLI_3_UNDERCURRENT_ALARM
Current Loop Input 3 Undercurrent Fail Alarm		
393	CLI4 I< Fail Alm	DDB_CLI_4_UNDERCURRENT_ALARM
Current Loop Input 4 Undercurrent Fail Alarm		
394	64R R<1 Alarm	DDB_64R_UR_1_TRIP
64R Rotor EF Under Resistance Stage 1 Alarm		
395	64R CL I/P Fail	DDB_64R_CLIO_INPUT_FAIL
64R Rotor EF Current Loop Input Fail		
396	CT Mismatch Alm	DDB_CT_PARA_MISMATCH_ALARM
CT parameter mismatch alarm		
397	Loss of Life Alm	DDB_LOL_ALARM
Loss of Life Alarm		
398	FAA Alarm	DDB_FAA_ALARM
Aging Acceleration Factor Alarm		
399	Thru Fault Alm	DDB_THROUGH_FAULT_ALARM
Through Fault Alarm		
400	Circuit Flt Alm	DDB_CIRCUITRY_FLT_ALM
Circuitry Fault Alarm		
401	XThermPretrp Alm	DDB_TOL_PRETRIP_ALARM
Tol Pretrip Alm		
402	Diff CTS Alarm	DDB_DIFF_CTS_INDICATION
Differential CTS Alarm		
403	Man No Checksync	DDB_CONTROL_NO_CHECK_SYNC
Manual close CB but do not satisfy CS condition		
404	System Split Alm	DDB_SYSTEM_SPLIT_ALARM
System Split Alarm		
405	Pslip Angle Alm	DDB_PSLIP_ANG_ALARM
Pole Slipping Alarm(internal phase angle)		
406	Pslip Power Alm	DDB_PSLIP_POW_ALARM
Pole Slipping Alarm(Sensitive Power)		
407	MR User Alarm 9	DDB_USER_ALARM_9
User Definable Alarm 9 (Manual Reset)		
408	MR User Alarm 8	DDB_USER_ALARM_8
User Definable Alarm 8 (Manual Reset)		
409	MR User Alarm 7	DDB_USER_ALARM_7
User Definable Alarm 7 (Manual Reset)		
410	MR User Alarm 6	DDB_USER_ALARM_6
User Definable Alarm 6 (Manual Reset)		
411	MR User Alarm 5	DDB_USER_ALARM_5
User Definable Alarm 5 (Manual Reset)		
412	SR User Alarm 4	DDB_USER_ALARM_4
User Definable Alarm 4 (Self Reset)		
413	SR User Alarm 3	DDB_USER_ALARM_3
User Definable Alarm 3 (Self Reset)		
414	SR User Alarm 2	DDB_USER_ALARM_2
User Definable Alarm 2 (Self Reset)		
415	SR User Alarm 1	DDB_USER_ALARM_1
User Definable Alarm 1 (Self Reset)		

ORDINAL	SIGNAL NAME	ELEMENT NAME	DESCRIPTION
416	Battery Fail	DDB_BATTERY_FAIL_ALARM	Battery Fail alarm indication
418	Rear Comm 2 Fail	DDB_INTERMICOM_FAIL_ALARM	InterMiCOM Second rear comm card failure indication
419	GOOSE IED Absent	DDB_GOOSE_MISSING_IED_ALARM	Enrolled GOOSE IED absent alarm indication
420	NIC Not Fitted	DDB_ECARD_NOT_FITTED_ALARM	Network Interface Card not fitted/failed alarm
421	NIC No Response	DDB_NIC_NOT_RESPONDING_ALARM	Network Interface Card not responding alarm
422	NIC Fatal Error	DDB_NIC_FATAL_ERROR_ALARM	Network Interface Card fatal error alarm indication
423	NIC Soft. Reload	DDB_NIC_SOFTWARE_RELOAD_ALARM	Network Interface Card software reload alarm
424	Bad TCP/IP Cfg.	DDB_INVALID_TCP_IP_CONFIG_ALARM	Bad TCP/IP Configuration Alarm
425	Bad OSI Config.	DDB_INVALID_OSI_CONFIG_ALARM	Bad OSI Configuration Alarm
426	NIC Link Fail	DDB_NIC_LINK_FAIL_ALARM	Network Interface Card link fail alarm indication
427	NIC SW Mis-Match	DDB_SW_MISMATCH_ALARM	Main card/NIC software mismatch alarm indication
428	IP Addr Conflict	DDB_IP_ADDRESS_CONFLICT_ALARM	IP address conflict alarm indication
429	IM Loopback	DDB_INTERIN_LOOPBACK_ALARM	InterMiCOM Loop-back alarm indication
430	IM Message Fail	DDB_INTERIN_MSG_FAIL_ALARM	InterMiCOM Message Fail alarm indication
431	IM Data CD Fail	DDB_INTERIN_DCD_FAIL_ALARM	InterMiCOM DCD Fail alarm indication
432	IM Channel Fail	DDB_INTERIN_CHAN_FAIL_ALARM	InterMiCOM Channel Fail alarm indication
433	Backup Setting	DDB_BACKUP_DATA_IN_USE	Setting Fail Indication during the setting changing process.
434	Reserved	DDB_DNPEV_BAD_SETTINGS_ALARM	Bad DNP Settings
435	Backup Usr Curve	DDB_BACKUP_USR_CRV_ALARM	Backup Curve
436	SNTP Failure	DDB_SNTP_FAIL_ALARM	SNTP sync fail alarm
437	NIC MemAllocFail	DDB_NIC_MEM_ALLOC_FAIL_ALARM	MMS libraries memory allocation fails
438	PTP Sync Fail	DDB_PTP_FAIL_ALARM	Indicates PTP sync failed
512	Gen Diff Block	DDB_GENDIFF_BLOCK	Block Generator Differential protection
513	Xform Diff Block	DDB_BLK_XFORMER_DIFF	Block Xformer Differential protection
514	Inhibit Diff CTS	DDB_DIFF_INHIBIT_CTS	differential CTS
515	Intlock CB OPN	DDB_INTERLOCK_CB1_OPN_ENABLED	CB open enabled (interlock)
516	Intlock CB CLS	DDB_INTERLOCK_CB1_CLS_ENABLED	CB close enabled (interlock)
517	P/Word Block UI	DDB_PASSWORD_BLK_UI	This DDB indicates the Pass Word is blocked on the UI
518	P/Word Block FP	DDB_PASSWORD_BLK_FP	This DDB indicates the Pass Word is blocked on the Front Port

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
519	P/Word Block RP1	DDB_PASSWORD_BLK_RP1
This DDB indicates the Pass Word is blocked on the first rear port		
520	P/Word Block RP2	DDB_PASSWORD_BLK_RP2
This DDB indicates the Pass Word is blocked on the second rear port		
521	Security Bypass	DDB_PASSWORD_BYPASS
Cyber Security Bypass is Enabled		
544	IN>1 Timer Blk	DDB_EF1_1_TIMER_BLOCK
Block Earth Fault Stage 1 time delay		
545	IN>2 Timer Blk	DDB_EF1_2_TIMER_BLOCK
Block Earth Fault Stage 2 time delay		
548	ISEF>1 Timer Blk	DDB_SEF_1_TIMER_BLOCK
Block SEF Stage 1 time delay		
552	64S I>1 Inhibit	DDB_STEFI_OC_1_INHIBIT
Inhibit 64S Overcurrent Protection		
553	64S R<1 Inhibit	DDB_STEFI_UR_1_INHIBIT
Inhibit 64S Under Impedance Stage 1		
554	64S R<2 Inhibit	DDB_STEFI_UR_2_INHIBIT
Inhibit 64S Under Impedance Stage 2		
555	64S Filter On	DDB_STEFI_FILTER_ON
Enable the 64S band pass filter permanently		
556	64R R<1 Inhibit	DDB_64R_UR_1_INHIBIT
Inhibit 64R Under Impedance Stage 1		
557	64R R<2 Inhibit	DDB_64R_UR_2_INHIBIT
Inhibit 64R Under Impedance Stage 2		
576	I>1 Timer Block	DDB_POC_1_TIMER_BLOCK
Block Phase Overcurrent Stage 1 time delay		
577	I>2 Timer Block	DDB_POC_2_TIMER_BLOCK
Block Phase Overcurrent Stage 2 time delay		
578	I>3 Timer Block	DDB_POC_3_TIMER_BLOCK
Block Phase Overcurrent Stage 3 time delay		
579	I>4 Timer Block	DDB_POC_4_TIMER_BLOCK
Block Phase Overcurrent Stage 4 time delay		
582	I2> Inhibit	DDB_NPSOC_INHIBIT
Inhibit NPS Overcurrent protection		
583	I2>1 Timer Block	DDB_NPSOC_1_TIMER_BLOCK
Block NPS Overcurrent Stage 1 Timer		
584	I2>2 Timer Block	DDB_NPSOC_2_TIMER_BLOCK
Block NPS Overcurrent Stage 2 Timer		
585	I2>3 Timer Block	DDB_NPSOC_3_TIMER_BLOCK
Block NPS Overcurrent Stage 3 Timer		
586	I2>4 Timer Block	DDB_NPSOC_4_TIMER_BLOCK
Block NPS Overcurrent Stage 4 Timer		
591	V<3 Timer Block	DDB_PUV_3_TIMER_BLOCK
Block Phase Under Voltage Stage 3 time delay		
592	VN>1 Timer Blk	DDB_RESOV_1_TIMER_BLOCK
Block Residual Over Voltage Stage 1 time delay		
593	VN>2 Timer Blk	DDB_RESOV_2_TIMER_BLOCK
Block Residual Over Voltage Stage 2 time delay		
594	VN>3 Timer Block	DDB_RESOV_3_TIMER_BLOCK
Block Residual Over Voltage Stage 3 Timer		
595	VN>4 Timer Block	DDB_RESOV_4_TIMER_BLOCK
Block Residual Over Voltage Stage 4 Timer		
596	VN>5 Timer Block	DDB_RESOV_5_TIMER_BLOCK
Block Residual Over Voltage Stage 5 Timer		
597	VN>6 Timer Block	DDB_RESOV_6_TIMER_BLOCK
Block Residual Over Voltage Stage 6 Timer		
598	V>1 Timer Block	DDB_POV_1_TIMER_BLOCK
Block Phase Over Voltage Stage 1 time delay		

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
599	V>2 Timer Block	DDB_POV_2_TIMER_BLOCK
Block Phase Over Voltage Stage 2 time delay		
600	V2>1 Accelerate	DDB_NPSOV_1_ACCELERATE
Accelerate NPS Over Voltage Stage 1 Start		
601	V<1 Timer Block	DDB_PUV_1_TIMER_BLOCK
Block Phase Under Voltage Stage 1 time delay		
602	V<2 Timer Block	DDB_PUV_2_TIMER_BLOCK
Block Phase Under Voltage Stage 2 time delay		
608	VDepOC Timer Blk	DDB_VOLT_DEP_OC_TIMER_BLOCK
Voltage Dependant Overcurrent time delay		
609	UnderZ Timer Blk	DDB_UNDERZ_TIMER_BLOCK
Under Impedance time delay		
624	Stop Freq Track	DDB_FREQ_STOP_TRACK
Stop / Halt Frequency Tracking		
625	V/Hz>1 Inhibit	DDB_VPERHZ_TRIP1_INH
Inhibit Volts per Hz Stage 1		
626	F<1 Timer Block	DDB_UFREQ_1_TIMER_BLOCK
Block Under Frequency Stage 1 Timer		
627	F<2 Timer Block	DDB_UFREQ_2_TIMER_BLOCK
Block Under Frequency Stage 2 Timer		
628	F<3 Timer Block	DDB_UFREQ_3_TIMER_BLOCK
Block Under Frequency Stage 3 Timer		
629	F<4 Timer Block	DDB_UFREQ_4_TIMER_BLOCK
Block Under Frequency Stage 4 Timer		
630	F>1 Timer Block	DDB_OFREQ_1_TIMER_BLOCK
Block Over Frequency Stage 1 Timer		
631	F>2 Timer Block	DDB_OFREQ_2_TIMER_BLOCK
Block Over Frequency Stage 2 Timer		
632	Turbine F Inh	DDB_TAF1_INHIBIT
Inhibit Turbine Abnormal Frequency Protection		
633	df/dt> Inhibit	DDB_DFDT_INHIBIT
df/dt> Inhibit		
634	df/dt>1 Tmr Blk	DDB_DFDT_1_TIMER_BLOCK
df/dt>1 Tmr Blk		
635	df/dt>2 Tmr Blk	DDB_DFDT_2_TIMER_BLOCK
df/dt>2 Tmr Blk		
636	df/dt>3 Tmr Blk	DDB_DFDT_3_TIMER_BLOCK
df/dt>3 Tmr Blk		
637	df/dt>4 Tmr Blk	DDB_DFDT_4_TIMER_BLOCK
df/dt>4 Tmr Blk		
640	Reset I2 Thermal	DDB_RESET_NPS_THERMAL
Reset NPS Thermal State		
641	Reset GenThermal	DDB_RESET_GEN_THERMAL
Reset Thermal Overload State		
649	Reset XThermal	DDB_RESET_XTHERMAL
Reset Xformer Thermal Overload State		
650	Forced Air Cool	DDB_XTHERMAL_AIRCOOL
Select forced air cooling		
651	Forced Oil Cool	DDB_XTHERMAL_OILCOOL
Select forced oil cooling		
652	TFR De-energised	DDB_TFR_DE_ENERGISED
Xformer De-energised Status		
653	Field Fail1 Inh	DDB_FIELDF_1_INHIBIT
Inhibit FIELDF Stage 1		
654	Field Fail2 Inh	DDB_FIELDF_2_INHIBIT
Inhibit FIELDF Stage 2		
655	FFail Alarm Inh	DDB_FIELDF_ALARM_INHIBIT
Inhibit FIELDF Alarm		

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
656	CL Input 1 Blk	DDB_CL_INPUT_1_BLOCK
Block Current Loop Input 1 protection		
657	CL Input 2 Blk	DDB_CL_INPUT_2_BLOCK
Block Current Loop Input 2 protection		
658	CL Input 3 Blk	DDB_CL_INPUT_3_BLOCK
Block Current Loop Input 3 protection		
659	CL Input 4 Blk	DDB_CL_INPUT_4_BLOCK
Block Current Loop Input 4 protection		
660	SPower1 Inhibit	DDB_SPOWER_1_INHIBIT
Block Sensitive Power 1 protection		
661	SPower2 Inhibit	DDB_SPOWER_2_INHIBIT
Block Sensitive Power 2 protection		
662	SPower3 Inhibit	DDB_SPOWER_3_INHIBIT
Block Sensitive Power 3 protection		
663	SPower4 Inhibit	DDB_SPOWER_4_INHIBIT
Block Sensitive Power 4 protection		
664	V<1 Inhibit	DDB_PUV_1_INHIBIT
Block Phase UnderVoltage 1 protection		
665	V<2 Inhibit	DDB_PUV_2_INHIBIT
Block Phase UnderVoltage 2 protection		
666	V<3 Inhibit	DDB_PUV_3_INHIBIT
Block Phase UnderVoltage 3 protection		
667	Power1 Inhibit	DDB_POWER_1_INHIBIT
Block Power 1 protection		
668	Power2 Inhibit	DDB_POWER_2_INHIBIT
Block Power 2 protection		
669	Power3 Inhibit	DDB_POWER_3_INHIBIT
Block Power 3 protection		
670	Power4 Inhibit	DDB_POWER_4_INHIBIT
Block Power 4 protection		
672	Fault REC TRIG	DDB_FAULT_RECORDER_START
Fault Record Trigger Input		
674	Any Trip	DDB_ANY_TRIP
Any Trip		
675	SG Select x1	DDB_SG_SELECTOR_X1
Setting Group Selector x1 (bit 0)		
676	SG Select 1x	DDB_SG_SELECTOR_1X
Setting Group Selector 1x (bit 1)		
677	Test Mode	DDB_TEST_MODE
Initiate Test Mode		
678	Init Trip CB	DDB_LOGIC_INPUT_TRIP
Logic Input Trip CB		
679	Init Close CB	DDB_LOGIC_INPUT_CLOSE
Logic Input Close CB		
680	Ext. Trip 3ph	DDB_EXTERNAL_TRIP_3PH
External Trip 3ph		
681	CB Aux 3ph(52-A)	DDB_CB_THREE_PHASE_52A
52-A (3 phase)		
682	CB Aux 3ph(52-B)	DDB_CB_THREE_PHASE_52B
52-B (3 phase)		
683	CB Healthy	DDB_CB_HEALTHY
CB Healthy		
684	MCB/VTS	DDB_VTS_MCB_OPTO
MCB/VTS opto		
685	Monitor Blocked	DDB_CS103_BLOCK
IEC60870-5-103 Monitor Blocking		
686	Command Blocked	DDB_CS103_CMD_BLOCK
IEC60870-5-103 Command Blocking		

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
687	Time Synch	DDB_TIME_SYNCH
Time synchronise to nearest minute on 0-1 change		
688	Reset Close Dly	DDB_RESET_CB_CLOSE_DELAY
Reset Manual CB Close Time Delay		
689	Reset Relays/LED	DDB_RESET_RELAYS_LEDS
Reset Latched Relays & LED's		
690	Reset Lockout	DDB_RESET_LOCKOUT
Reset Lockout Opto Input		
691	Reset All Values	DDB_RESET_ALL_VALUES
Reset CB Maintenance Values		
692	RP1 Read Only	DDB_RP1_READ_ONLY
Remote Read Only 1 DDB		
693	RP2 Read Only	DDB_RP2_READ_ONLY
Remote Read Only 2 DDB		
694	NIC Read Only	DDB_NIC_READ_ONLY
Remote Read Only NIC DDB		
695	103 MonitorBlock	DDB_MONITOR_BLOCKING
Monitor Block		
696	103 CommandBlock	DDB_COMMAND_BLOCKING
Command Block		
697	Not Used 1	DDB_USER_ALARM_16
In the previous version, these DDBs are exist and have related DNP3 address number.However in 36 version these DDBs are not used. If these DDBs are removed in 36 version, then most of the address numbers in 'DNP3 Object01' will be changed.		
698	Not Used 2	DDB_USER_ALARM_15
699	Not Used 3	DDB_USER_ALARM_14
700	Not Used 4	DDB_USER_ALARM_13
701	Not Used 5	DDB_USER_ALARM_12
So in order to keep the communication application of version 36 compatible with the previous version,		
702	Not Used 6	DDB_DFDT_TRIP
703	Not Used 7	DDB_DFDT_START
726	Block Contacts	DDB_CONTACTS_BLOCKED_IP
DDB to block output contacts, same as setting Commissioning Column -> Test Mode -> Contacts Blocked		
727	Contacts Blocked	DDB_CONTACTS_BLOCKED_OP
Indicates contacts blocked mode enabled. Can be mapped in PSL and sent via InterMiCOM/IM64 to block contacts at the remote end.		
728	Monitor Bit 1	DDB_MONITOR_PORT_1
Monitor Port 1		
729	Monitor Bit 2	DDB_MONITOR_PORT_2
Monitor Port 2		
730	Monitor Bit 3	DDB_MONITOR_PORT_3
Monitor Port 3		
731	Monitor Bit 4	DDB_MONITOR_PORT_4
Monitor Port 4		
732	Monitor Bit 5	DDB_MONITOR_PORT_5
Monitor Port 5		
733	Monitor Bit 6	DDB_MONITOR_PORT_6
Monitor Port 6		
734	Monitor Bit 7	DDB_MONITOR_PORT_7
Monitor Port 7		
735	Monitor Bit 8	DDB_MONITOR_PORT_8
Monitor Port 8		
736	Gen Diff Trip	DDB_GENDIFF_3PH_TRIP
Generator Differential Trip 3ph		
737	Gen Diff Trip A	DDB_GENDIFF_PH_A_TRIP

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
Generator Differential Trip A		
738	Gen Diff Trip B	DDB_GENDIFF_PH_B_TRIP
Generator Differential Trip B		
739	Gen Diff Trip C	DDB_GENDIFF_PH_C_TRIP
Generator Differential Trip C		
740	Xform Dif Trp	DDB_XFORMER_DIFF_3PH_TRIP
Xformer Differential Trip 3ph		
741	Xform Dif Trip A	DDB_XFORMER_DIFF_PH_A_TRIP
Xformer Differential Trip A		
742	Xform Dif Trip B	DDB_XFORMER_DIFF_PH_B_TRIP
Xformer Differential Trip B		
743	Xform Dif Trip C	DDB_XFORMER_DIFF_PH_C_TRIP
Xformer Differential Trip C		
744	Xform Bias Trp A	DDB_XFORMER_DIFF_BIAS_TRIP_A
Xformer Differential Low Set Trip A		
745	Xform Bias Trp B	DDB_XFORMER_DIFF_BIAS_TRIP_B
Xformer Differential Low Set Trip B		
746	Xform Bias Trp C	DDB_XFORMER_DIFF_BIAS_TRIP_C
Xformer Differential Low Set Trip C		
747	Xform HS1 Trip A	DDB_XFORMER_DIFF_HS1_TRIP_A
Xformer Differential HS1 Trip A		
748	Xform HS1 Trip B	DDB_XFORMER_DIFF_HS1_TRIP_B
Xformer Differential HS1Trip B		
749	Xform HS1 Trip C	DDB_XFORMER_DIFF_HS1_TRIP_C
Xformer Differential HS1Trip C		
750	Xform HS2 Trip A	DDB_XFORMER_DIFF_HS2_TRIP_A
Xformer Differential HS2 Trip A		
751	Xform HS2 Trip B	DDB_XFORMER_DIFF_HS2_TRIP_B
Xformer Differential HS2Trip B		
752	Xform HS2 Trip C	DDB_XFORMER_DIFF_HS2_TRIP_C
Xformer Differential HS2Trip C		
753	PSlip Angle Trip	DDB_PSLIP_ANG_TRIP
Pole Slipping Trip(internal phase angle)		
754	PSlip Power Trip	DDB_PSLIP_POW_TRIP
Pole Slipping Trip(Sensitive Power)		
755	FFail1 Cnt Trip	DDB_CNT_FFAIL_1_TRIP
Counter Based Filed Failure1 Trip		
756	FFail2 Cnt Trip	DDB_CNT_FFAIL_2_TRIP
Counter Based Filed Failure2 Trip		
757	PSlip Angle In	DDB_PSLIP_ANG_TRIP_INPUT
Pole Slipping Trip(internal phase angle)		
758	PSlip Power In	DDB_PSLIP_POW_TRIP_INPUT
Pole Slipping Trip(Sensitive Power)		
759	FFail1 Cnt In	DDB_CNT_FFAIL_1_TRIP_INPUT
Counter Based Filed Failure1 Trip		
760	FFail2 Cnt In	DDB_CNT_FFAIL_2_TRIP_INPUT
Counter Based Filed Failure2 Trip		
761	PSlip Ang Alm In	DDB_PSLIP_ANG_ALARM_INPUT
Pole Slipping Alarm(internal phase angle)		
762	PSlip Pow Alm In	DDB_PSLIP_POW_ALARM_INPUT
Pole Slipping Alarm(Sensitive Power)		
768	IN>1 Trip	DDB_EF1_1_TRIP
1st Stage EF Trip		
769	IN>2 Trip	DDB_EF1_2_TRIP
2nd Stage EF Trip		
772	IREF> Trip	DDB_REF_TRIP
REF Trip		
773	ISEF>1 Trip	DDB_SEF_1_TRIP

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
1st Stage SEF Trip		
777	100%StEF3H Trip	DDB_V3H_TRIP
100% Stator Earth Fault (3rd harmonic) Trip		
778	64S I>1 Trip	DDB_STEFI_OC_1_TRIP
64S 100% Stator Earth Fault Overcurrent Trip		
779	64S R<2 Trip	DDB_STEFI_UR_2_TRIP
64S 100% St EF Under Resistance Stage 2 Trip		
780	64R R<2 Trip	DDB_64R_UR_2_TRIP
64R Rotor Earth Fault Under Resistance Stage 2 Trip		
800	I>1 Trip	DDB_POC_1_3PH_TRIP
1st Stage O/C Trip 3ph		
801	I>1 Trip A	DDB_POC_1_PH_A_TRIP
1st Stage O/C Trip A		
802	I>1 Trip B	DDB_POC_1_PH_B_TRIP
1st Stage O/C Trip B		
803	I>1 Trip C	DDB_POC_1_PH_C_TRIP
1st Stage O/C Trip C		
804	I>2 Trip	DDB_POC_2_3PH_TRIP
2nd Stage O/C Trip 3ph		
805	I>2 Trip A	DDB_POC_2_PH_A_TRIP
2nd Stage O/C Trip A		
806	I>2 Trip B	DDB_POC_2_PH_B_TRIP
2nd Stage O/C Trip B		
807	I>2 Trip C	DDB_POC_2_PH_C_TRIP
2nd Stage O/C Trip C		
808	I>3 Trip	DDB_POC_3_3PH_TRIP
3rd Stage O/C Trip 3ph		
809	I>3 Trip A	DDB_POC_3_PH_A_TRIP
3rd Stage O/C Trip A		
810	I>3 Trip B	DDB_POC_3_PH_B_TRIP
3rd Stage O/C Trip B		
811	I>3 Trip C	DDB_POC_3_PH_C_TRIP
3rd Stage O/C Trip C		
812	I>4 Trip	DDB_POC_4_3PH_TRIP
4th Stage O/C Trip 3ph		
813	I>4 Trip A	DDB_POC_4_PH_A_TRIP
4th Stage O/C Trip A		
814	I>4 Trip B	DDB_POC_4_PH_B_TRIP
4th Stage O/C Trip B		
815	I>4 Trip C	DDB_POC_4_PH_C_TRIP
4th Stage O/C Trip C		
824	I2>1 Trip	DDB_NPSOC_1_TRIP
NPS Overcurrent Stage 1 Trip		
825	I2>2 Trip	DDB_NPSOC_2_TRIP
NPS Overcurrent Stage 2 Trip		
826	I2>3 Trip	DDB_NPSOC_3_TRIP
NPS Overcurrent Stage 3 Trip		
827	I2>4 Trip	DDB_NPSOC_4_TRIP
NPS Overcurrent Stage 4 Trip		
828	Bfail1 Trip 3ph	DDB_CBF1_TRIP_3PH
tBF1 Trip 3ph		
829	Bfail2 Trip 3ph	DDB_CBF2_TRIP_3PH
tBF2 Trip 3ph		
832	VN>1 Trip	DDB_RESOV_1_TRIP
1st Stage Residual O/V Trip		
833	VN>2 Trip	DDB_RESOV_2_TRIP
2nd Stage Residual O/V Trip		
834	VN>3 Trip	DDB_RESOV_3_TRIP

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
Residual O/V Stage 3 Trip		
835	VN>4 Trip	DDB_RESOV_4_TRIP
Residual O/V Stage 4 Trip		
836	VN>5 Trip	DDB_RESOV_5_TRIP
Residual O/V Stage 5 Trip		
837	VN>6 Trip	DDB_RESOV_6_TRIP
Residual O/V Stage 6 Trip		
838	V>1 Trip	DDB_POV_1_3PH_TRIP
1st Stage Phase O/V Trip 3ph		
839	V>1 Trip A/AB	DDB_POV_1_PH_A_TRIP
1st Stage Phase O/V Trip A/AB		
840	V>1 Trip B/BC	DDB_POV_1_PH_B_TRIP
1st Stage Phase O/V Trip B/BC		
841	V>1 Trip C/CA	DDB_POV_1_PH_C_TRIP
1st Stage Phase O/V Trip C/CA		
842	V>2 Trip	DDB_POV_2_3PH_TRIP
2nd Stage Phase O/V Trip 3ph		
843	V>2 Trip A/AB	DDB_POV_2_PH_A_TRIP
2nd Stage Phase O/V Trip A/AB		
844	V>2 Trip B/BC	DDB_POV_2_PH_B_TRIP
2nd Stage Phase O/V Trip B/BC		
845	V>2 Trip C/CA	DDB_POV_2_PH_C_TRIP
2nd Stage Phase O/V Trip C/CA		
846	V2>1 Trip	DDB_NPSOV_1_TRIP
NPS Over Voltage Stage 1 Trip		
847	V<1 Trip	DDB_PUV_1_3PH_TRIP
1st Stage Phase U/V Trip 3ph		
848	V<1 Trip A/AB	DDB_PUV_1_PH_A_TRIP
1st Stage Phase U/V Trip A/AB		
849	V<1 Trip B/BC	DDB_PUV_1_PH_B_TRIP
1st Stage Phase U/V Trip B/BC		
850	V<1 Trip C/CA	DDB_PUV_1_PH_C_TRIP
1st Stage Phase U/V Trip C/CA		
851	V<2 Trip	DDB_PUV_2_3PH_TRIP
2nd Stage Phase U/V Trip 3ph		
852	V<2 Trip A/AB	DDB_PUV_2_PH_A_TRIP
2nd Stage Phase U/V Trip A/AB		
853	V<2 Trip B/BC	DDB_PUV_2_PH_B_TRIP
2nd Stage Phase U/V Trip B/BC		
854	V<2 Trip C/CA	DDB_PUV_2_PH_C_TRIP
2nd Stage Phase U/V Trip C/CA		
864	Field Fail1 Trip	DDB_FIELDF_1_TRIP
Field Failure Stage 1 Trip		
865	Field Fail2 Trip	DDB_FIELDF_2_TRIP
Field Failure Stage 2 Trip		
866	PSlipz Z1 Trip	DDB_POLESLZ_ZONE1_TRIP
Pole Slip (Impedance) Zone1 Trip		
867	PSlipz Z2 Trip	DDB_POLESLZ_ZONE2_TRIP
Pole Slip (Impedance) Zone2 Trip		
868	V Dep OC Trip	DDB_VOLT_DEP_OC_3PH_TRIP
Voltage Dependant Overcurrent Trip 3ph		
869	V Dep OC Trip A	DDB_VOLT_DEP_OC_PH_A_TRIP
Voltage Dependant Overcurrent Trip A		
870	V Dep OC Trip B	DDB_VOLT_DEP_OC_PH_B_TRIP
Voltage Dependant Overcurrent Trip B		
871	V Dep OC Trip C	DDB_VOLT_DEP_OC_PH_C_TRIP
Voltage Dependant Overcurrent Trip C		
872	Z<1 Trip	DDB_UNDERZ_1_3PH_TRIP

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
Under Impedance 3Phase Stage 1 Trip		
873	Z<1 Trip A	DDB_UNDERZ_1_PH_A_TRIP
Under Impedance Phase A Stage 1 Trip		
874	Z<1 Trip B	DDB_UNDERZ_1_PH_B_TRIP
Under Impedance Phase B Stage 1 Trip		
875	Z<1 Trip C	DDB_UNDERZ_1_PH_C_TRIP
Under Impedance Phase C Stage 1 Trip		
876	Z<2 Trip	DDB_UNDERZ_2_3PH_TRIP
Under Impedance 3Phase Stage 2 Trip		
877	Z<2 Trip A	DDB_UNDERZ_2_PH_A_TRIP
Under Impedance Phase A Stage 2 Trip		
878	Z<2 Trip B	DDB_UNDERZ_2_PH_B_TRIP
Under Impedance Phase B Stage 2 Trip		
879	Z<2 Trip C	DDB_UNDERZ_2_PH_C_TRIP
Under Impedance Phase C Stage 2 Trip		
880	DeadMachine Trip	DDB_DEADMACH_TRIP
Dead Machine Protection Trip		
881	S2>1 Trip	DDB_PWRNPS_1_TRIP
NPS Overpower Stage 1 trip		
882	Power1 Trip	DDB_POWER_1_TRIP
Power Stage 1 Trip		
883	Power2 Trip	DDB_POWER_2_TRIP
Power Stage 2 Trip		
884	SPower1 Trip	DDB_SPOWER_1_TRIP
Sensitive Power Stage 1 Trip		
885	SPower2 Trip	DDB_SPOWER_2_TRIP
Sensitive Power Stage 2 Trip		
886	Power3 Trip	DDB_POWER_3_TRIP
Power Stage 3 Trip		
887	Power4 Trip	DDB_POWER_4_TRIP
Power Stage 4 Trip		
888	SPower3 Trip	DDB_SPOWER_3_TRIP
Sensitive Power Stage 3 Trip		
889	SPower4 Trip	DDB_SPOWER_4_TRIP
Sensitive Power Stage 4 Trip		
908	V<3 Trip	DDB_PUV_3_3PH_TRIP
3rd Stage Phase U/V Trip 3ph		
909	V<3 Trip A/AB	DDB_PUV_3_PH_A_TRIP
3rd Stage Phase U/V Trip A/AB		
910	V<3 Trip B/BC	DDB_PUV_3_PH_B_TRIP
3rd Stage Phase U/V Trip B/BC		
911	V<3 Trip C/CA	DDB_PUV_3_PH_C_TRIP
3rd Stage Phase U/V Trip C/CA		
912	V/Hz>1 Trip	DDB_VPERHZ_TRIP
1st Stage Volts per Hz Trip		
913	V/Hz>2 Trip	DDB_VPERHZ_TRIP2
Volts per Hz Stage 2 Trip		
914	V/Hz>3 Trip	DDB_VPERHZ_TRIP3
Volts per Hz Stage 3 Trip		
915	V/Hz>4 Trip	DDB_VPERHZ_TRIP4
Volts per Hz Stage 4 Trip		
916	F<1 Trip	DDB_UFREQ_1_TRIP
Under Frequency Stage 1 Trip		
917	F<2 Trip	DDB_UFREQ_2_TRIP
Under Frequency Stage 2 Trip		
918	F<3 Trip	DDB_UFREQ_3_TRIP
Under Frequency Stage 3 Trip		
919	F<4 Trip	DDB_UFREQ_4_TRIP

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
Under Frequency Stage 4 Trip		
920	F>1 Trip	DDB_OFREQ_1_TRIP
Over Frequency Stage 1 Trip		
921	F>2 Trip	DDB_OFREQ_2_TRIP
Over Frequency Stage 2 Trip		
922	Freq Band1 Trip	DDB_TAF1_TRIP1
Turbine Abnormal Frequency Band 1 Trip		
923	Freq Band2 Trip	DDB_TAF1_TRIP2
Turbine Abnormal Frequency Band 2 Trip		
924	Freq Band3 Trip	DDB_TAF1_TRIP3
Turbine Abnormal Frequency Band 3 Trip		
925	Freq Band4 Trip	DDB_TAF1_TRIP4
Turbine Abnormal Frequency Band 4 Trip		
926	Freq Band5 Trip	DDB_TAF1_TRIP5
Turbine Abnormal Frequency Band 5 Trip		
927	Freq Band6 Trip	DDB_TAF1_TRIP6
Turbine Abnormal Frequency Band 6 Trip		
928	df/dt>1 Trip	DDB_DFDT_1_TRIP
df/dt>1 Trip		
929	df/dt>2 Trip	DDB_DFDT_2_TRIP
df/dt>2 Trip		
930	df/dt>3 Trip	DDB_DFDT_3_TRIP
df/dt>3 Trip		
931	df/dt>4 Trip	DDB_DFDT_4_TRIP
df/dt>4 Trip		
936	df/dt>1 Under F	DDB_DFDT_1_UF
Rate Of Change Of Frequency Stage 1 Under Frequency		
937	df/dt>1 Over F	DDB_DFDT_1_OF
Rate Of Change Of Frequency Stage 1 Over Frequency		
944	NPS Thermal Trip	DDB_NPS_TRIP
Negative Phase Sequence Thermal Trip		
945	Gen Thermal Trip	DDB_GEN_THERMAL_TRIP
Thermal Overload Trip		
946	Hot Spot>1 Trip	DDB_XFORMER_HOT_SPOT_1_TRIP
Hot Spot>1 Trip		
947	Hot Spot>2 Trip	DDB_XFORMER_HOT_SPOT_2_TRIP
Hot Spot>2 Trip		
948	Hot Spot>3 Trip	DDB_XFORMER_HOT_SPOT_3_TRIP
Hot Spot>3 Trip		
949	Top Oil>1 Trip	DDB_XFORMER_TOP_OIL_1_TRIP
Top Oil>1 Trip		
950	Top Oil>2 Trip	DDB_XFORMER_TOP_OIL_2_TRIP
Top Oil>2 Trip		
951	Top Oil>3 Trip	DDB_XFORMER_TOP_OIL_3_TRIP
Top Oil>3 Trip		
976	RTD 1 Trip	DDB_RTD_1_TRIP
RTD 1 Trip		
977	RTD 2 Trip	DDB_RTD_2_TRIP
RTD 2 Trip		
978	RTD 3 Trip	DDB_RTD_3_TRIP
RTD 3 Trip		
979	RTD 4 Trip	DDB_RTD_4_TRIP
RTD 4 Trip		
980	RTD 5 Trip	DDB_RTD_5_TRIP
RTD 5 Trip		
981	RTD 6 Trip	DDB_RTD_6_TRIP
RTD 6 Trip		
982	RTD 7 Trip	DDB_RTD_7_TRIP

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
RTD 7 Trip		
983	RTD 8 Trip	DDB_RTD_8_TRIP
RTD 8 Trip		
984	RTD 9 Trip	DDB_RTD_9_TRIP
RTD 9 Trip		
985	RTD 10 Trip	DDB_RTD_10_TRIP
RTD 10 Trip		
986	Any RTD Trip	DDB_ANY_RTD_TRIP
Any RTD Trip		
987	CL Input 1 Trip	DDB_CL_INPUT_1_TRIP
Current Loop Input 1 Trip		
988	CL Input 2 Trip	DDB_CL_INPUT_2_TRIP
Current Loop Input 2 Trip		
989	CL Input 3 Trip	DDB_CL_INPUT_3_TRIP
Current Loop Input 3 Trip		
990	CL Input 4 Trip	DDB_CL_INPUT_4_TRIP
Current Loop Input 4 Trip		
992	Any Start	DDB_ANY_START
Any Start		
993	Xform Bias StrtA	DDB_XFORMER_DIFF_BIAS_STARTA
Xformer Differential Start A		
994	Xform Bias StrtB	DDB_XFORMER_DIFF_BIAS_STARTB
Xformer Differential Start B		
995	Xform Bias StrtC	DDB_XFORMER_DIFF_BIAS_STARTC
Xformer Differential Start C		
1008	IN>1 Start	DDB_EF1_1_START
1st Stage EF Start		
1009	IN>2 Start	DDB_EF1_2_START
2nd Stage EF Start		
1012	ISEF>1 Start	DDB_SEF_1_START
1st Stage SEF Start		
1016	100%StEF3H Start	DDB_V3H_START
100% Stator Earth Fault (3rd harmonic) Start		
1017	64S I< Start	DDB_STEFI_FAIL_I_START
64S 100% Stator Earth Fault Undercurrent Start		
1018	64S V< Start	DDB_STEFI_FAIL_V_START
64S 100% Stator Earth Fault Undervoltage Start		
1019	64S I>1 Start	DDB_STEFI_OC_1_START
64S 100% Stator Earth Fault Overcurrent Start		
1020	64S Start R<1Alm	DDB_STEFI_UR_1_START
64S 100% St EF Under Resistance Stg 1 Alm Start		
1021	64S R<2 Start	DDB_STEFI_UR_2_START
64S 100% St EF Under Resistance Stg 2 Trip Start		
1022	64R Start R<1Alm	DDB_64R_UR_1_START
64R Rotor EF Under Resistance Stg 1 Alm Start		
1023	64R R<2 Start	DDB_64R_UR_2_START
64R Rotor EF Under Resistance Stg 2 Trip Start		
1040	I>1 Start	DDB_POC_1_3PH_START
1st Stage O/C Start 3ph		
1041	I>1 Start A	DDB_POC_1_PH_A_START
1st Stage O/C Start A		
1042	I>1 Start B	DDB_POC_1_PH_B_START
1st Stage O/C Start B		
1043	I>1 Start C	DDB_POC_1_PH_C_START
1st Stage O/C Start C		
1044	I>2 Start	DDB_POC_2_3PH_START
2nd Stage O/C Start 3ph		
1045	I>2 Start A	DDB_POC_2_PH_A_START

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
2nd Stage O/C Start A		
1046	I>2 Start B	DDB_POC_2_PH_B_START
2nd Stage O/C Start B		
1047	I>2 Start C	DDB_POC_2_PH_C_START
2nd Stage O/C Start C		
1048	I>3 Start	DDB_POC_3_3PH_START
3rd Stage O/C Start 3ph		
1049	I>3 Start A	DDB_POC_3_PH_A_START
3rd Stage O/C Start A		
1050	I>3 Start B	DDB_POC_3_PH_B_START
3rd Stage O/C Start B		
1051	I>3 Start C	DDB_POC_3_PH_C_START
3rd Stage O/C Start C		
1052	I>4 Start	DDB_POC_4_3PH_START
4th Stage O/C Start 3ph		
1053	I>4 Start A	DDB_POC_4_PH_A_START
4th Stage O/C Start A		
1054	I>4 Start B	DDB_POC_4_PH_B_START
4th Stage O/C Start B		
1055	I>4 Start C	DDB_POC_4_PH_C_START
4th Stage O/C Start C		
1064	I2>1 Start	DDB_NPSOC_1_START
NPS Overcurrent Stage 1 Start		
1065	I2>2 Start	DDB_NPSOC_2_START
NPS Overcurrent Stage 2 Start		
1066	I2>3 Start	DDB_NPSOC_3_START
NPS Overcurrent Stage 3 Start		
1067	I2>4 Start	DDB_NPSOC_4_START
NPS Overcurrent Stage 4 Start		
1068	IA< Start	DDB_PHASE_A_UNDERCURRENT
Fast under current: Phase A		
1069	IB< Start	DDB_PHASE_B_UNDERCURRENT
Fast under current: Phase B		
1070	IC< Start	DDB_PHASE_C_UNDERCURRENT
Fast under current: Phase C		
1071	ISEF< Start	DDB_SEF_UNDERCURRENT
ISEF< Operate		
1072	IN< Start	DDB_EF_UNDERCURRENT
IN< Operate		
1075	TF OC Start	DDB_THROUGH_FAULT_OC_START
Through fault START		
1077	TF Recorder trig	DDB_THROUGH_FAULT_RECORDER
Through fault TRIGGER		
1088	VN>1 Start	DDB_RESOV_1_START
1st Stage Residual O/V Start		
1089	VN>2 Start	DDB_RESOV_2_START
2nd Stage Residual O/V Start		
1090	VN>3 Start	DDB_RESOV_3_START
Residual O/V Stage 3 Start		
1091	VN>4 Start	DDB_RESOV_4_START
Residual O/V Stage 4 Start		
1092	VN>5 Start	DDB_RESOV_5_START
Residual O/V Stage 5 Start		
1093	VN>6 Start	DDB_RESOV_6_START
Residual O/V Stage 6 Start		
1094	V>1 Start	DDB_POV_1_3PH_START
1st Stage Phase O/V Start 3ph		
1095	V>1 Start A/AB	DDB_POV_1_PH_A_START

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
1st Stage Phase O/V Start A/AB		
1096	V>1 Start B/BC	DDB_POV_1_PH_B_START
1st Stage Phase O/V Start B/BC		
1097	V>1 Start C/CA	DDB_POV_1_PH_C_START
1st Stage Phase O/V Start C/CA		
1098	V>2 Start	DDB_POV_2_3PH_START
2nd Stage Phase O/V Start 3ph		
1099	V>2 Start A/AB	DDB_POV_2_PH_A_START
2nd Stage Phase O/V Start A/AB		
1100	V>2 Start B/BC	DDB_POV_2_PH_B_START
2nd Stage Phase O/V Start B/BC		
1101	V>2 Start C/CA	DDB_POV_2_PH_C_START
2nd Stage Phase O/V Start C/CA		
1102	V2>1 Start	DDB_NPSOV_1_START
NPS Over Voltage Stage 1 Start		
1103	V<1 Start	DDB_PUV_1_3PH_START
1st Stage Phase U/V Start 3ph		
1104	V<1 Start A/AB	DDB_PUV_1_PH_A_START
1st Stage Phase U/V Start A/AB		
1105	V<1 Start B/BC	DDB_PUV_1_PH_B_START
1st Stage Phase U/V Start B/BC		
1106	V<1 Start C/CA	DDB_PUV_1_PH_C_START
1st Stage Phase U/V Start C/CA		
1107	V<2 Start	DDB_PUV_2_3PH_START
2nd Stage Phase U/V Start 3ph		
1108	V<2 Start A/AB	DDB_PUV_2_PH_A_START
2nd Stage Phase U/V Start A/AB		
1109	V<2 Start B/BC	DDB_PUV_2_PH_B_START
2nd Stage Phase U/V Start B/BC		
1110	V<2 Start C/CA	DDB_PUV_2_PH_C_START
2nd Stage Phase U/V Start C/CA		
1119	FFail Line Start	DDB_FIELDF_LINE_START
Field Failure Line Start		
1120	FFail1 Start	DDB_FIELDF_1_START
Field Failure Stage 1 Start		
1121	FFail2 Start	DDB_FIELDF_2_START
Field Failure Stage 2 Start		
1122	PSlipz Z1 Start	DDB_POLESLZ_ZONE1_START
Pole Slip (Impedance) Zone1 Start		
1123	PSlipz Z2 Start	DDB_POLESLZ_ZONE2_START
Pole Slip (Impedance) Zone2 Start		
1124	PSlipz LensStart	DDB_POLESLZ_LENS_START
Pole Slip (impedance) Lens Start		
1125	PSlipz BlindStrt	DDB_POLESLZ_BLINDER_START
Pole Slip (impedance) Blinder Start		
1126	PSlipz ReactStrt	DDB_POLESLZ_REACT_START
Pole Slip (impedance) Reactance Line Start		
1127	V Dep OC Start	DDB_VOLT_DEP_OC_3PH_START
Voltage Dependant Overcurrent Start 3Ph		
1128	V Dep OC Start A	DDB_VOLT_DEP_OC_PH_A_START
Voltage Dependant Overcurrent Start A		
1129	V Dep OC Start B	DDB_VOLT_DEP_OC_PH_B_START
Voltage Dependant Overcurrent Start B		
1130	V Dep OC Start C	DDB_VOLT_DEP_OC_PH_C_START
Voltage Dependant Overcurrent Start C		
1131	Z<1 Start	DDB_UNDERZ_1_3PH_START
Under Impedance 3Phase Stage 1 Start		
1132	Z<1 Start A	DDB_UNDERZ_1_PH_A_START

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
Under Impedance Phase A Stage 1 Start		
1133	Z<1 Start B	DDB_UNDERZ_1_PH_B_START
Under Impedance Phase B Stage 1 Start		
1134	Z<1 Start C	DDB_UNDERZ_1_PH_C_START
Under Impedance Phase C Stage 1 Start		
1135	Z<2 Start	DDB_UNDERZ_2_3PH_START
Under Impedance 3Phase Stage 2 Start		
1136	Z<2 Start A	DDB_UNDERZ_2_PH_A_START
Under Impedance Phase A Stage 2 Start		
1137	Z<2 Start B	DDB_UNDERZ_2_PH_B_START
Under Impedance Phase B Stage 2 Start		
1138	Z<2 Start C	DDB_UNDERZ_2_PH_C_START
Under Impedance Phase C Stage 2 Start		
1139	S2>1 Start	DDB_PWRNPS_1_START
NPS Overpower Stage 1 Start		
1140	Power1 Start	DDB_POWER_1_START
Power Stage 1 Start		
1141	Power2 Start	DDB_POWER_2_START
Power Stage 2 Start		
1142	SPower1 Start	DDB_SPOWER_1_START
Sensitive Power Stage 1 Start		
1143	SPower2 Start	DDB_SPOWER_2_START
Sensitive Power Stage 2 Start		
1144	Power3 Start	DDB_POWER_3_START
Power Stage 3 Start		
1145	Power4 Start	DDB_POWER_4_START
Power Stage 4 Start		
1146	SPower3 Start	DDB_SPOWER_3_START
Sensitive Phase Power Stage 3 Start		
1147	SPower4 Start	DDB_SPOWER_4_START
Sensitive Phase Power Stage 4 Start		
1164	V<3 Start	DDB_PUV_3_3PH_START
3rd Stage Phase U/V Start 3ph		
1165	V<3 Start A/AB	DDB_PUV_3_PH_A_START
3rd Stage Phase U/V Start A/AB		
1166	V<3 Start B/BC	DDB_PUV_3_PH_B_START
3rd Stage Phase U/V Start B/BC		
1167	V<3 Start C/CA	DDB_PUV_3_PH_C_START
3rd Stage Phase U/V Start C/CA		
1168	V/Hz>1 Start	DDB_VPERHZ_START
1st Stage Volts per Hz Start		
1169	V/Hz>2 Start	DDB_VPERHZ_START2
Volts per Hz Stage 2 Start		
1170	V/Hz>3 Start	DDB_VPERHZ_START3
Volts per Hz Stage 3 Start		
1171	V/Hz>4 Start	DDB_VPERHZ_START4
Volts per Hz Stage 4 Start		
1172	F<1 Start	DDB_UFREQ_1_START
Under Frequency Stage 1 Start		
1173	F<2 Start	DDB_UFREQ_2_START
Under Frequency Stage 2 Start		
1174	F<3 Start	DDB_UFREQ_3_START
Under Frequency Stage 3 Start		
1175	F<4 Start	DDB_UFREQ_4_START
Under Frequency Stage 4 Start		
1176	F>1 Start	DDB_OFREQ_1_START
Over Frequency Stage 1 Start		
1177	F>2 Start	DDB_OFREQ_2_START

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
Over Frequency Stage 2 Start		
1178	Freq Band1 Start	DDB_TAF1_START1
Turbine Abnormal Frequency Band 1 Start		
1179	Freq Band2 Start	DDB_TAF1_START2
Turbine Abnormal Frequency Band 2 Start		
1180	Freq Band3 Start	DDB_TAF1_START3
Turbine Abnormal Frequency Band 3 Start		
1181	Freq Band4 Start	DDB_TAF1_START4
Turbine Abnormal Frequency Band 4 Start		
1182	Freq Band5 Start	DDB_TAF1_START5
Turbine Abnormal Frequency Band 5 Start		
1183	Freq Band6 Start	DDB_TAF1_START6
Turbine Abnormal Frequency Band 6 Start		
1184	df/dt>1 Start	DDB_DFDT_1_START
df/dt>1 Start		
1185	df/dt>2 Start	DDB_DFDT_2_START
df/dt>2 Start		
1186	df/dt>3 Start	DDB_DFDT_3_START
df/dt>3 Start		
1187	df/dt>4 Start	DDB_DFDT_4_START
df/dt>4 Start		
1200	Hot Spot>1 Start	DDB_XFORMER_HOT_SPOT_1_START
HotSpot>1 Start		
1201	Hot Spot>2 Start	DDB_XFORMER_HOT_SPOT_2_START
HotSpot>2 Start		
1202	Hot Spot>3 Start	DDB_XFORMER_HOT_SPOT_3_START
HotSpot>3 Start		
1203	Top Oil>1 start	DDB_XFORMER_TOP_OIL_1_START
Top Oil>1 Start		
1204	Top Oil>2 start	DDB_XFORMER_TOP_OIL_2_START
Top Oil>2 Start		
1205	Top Oil>3 start	DDB_XFORMER_TOP_OIL_3_START
Top Oil>3 Start		
1232	CLI1 Alarm Start	DDB_CL_INPUT_1_ALARM_START
Current Loop Input 1 Alarm Start		
1233	CLI2 Alarm Start	DDB_CL_INPUT_2_ALARM_START
Current Loop Input 2 Alarm Start		
1234	CLI3 Alarm Start	DDB_CL_INPUT_3_ALARM_START
Current Loop Input 3 Alarm Start		
1235	CLI4 Alarm Start	DDB_CL_INPUT_4_ALARM_START
Current Loop Input 4 Alarm Start		
1236	CLI1 Trip Start	DDB_CL_INPUT_1_TRIP_START
Current Loop Input 1 Trip Start		
1237	CLI2 Trip Start	DDB_CL_INPUT_2_TRIP_START
Current Loop Input 2 Trip Start		
1238	CLI3 Trip Start	DDB_CL_INPUT_3_TRIP_START
Current Loop Input 3 Trip Start		
1239	CLI4 Trip Start	DDB_CL_INPUT_4_TRIP_START
Current Loop Input 4 Trip Start		
1248	VTS Fast Block	DDB_VTS_FAST_BLOCK
VTS Fast Block		
1249	VTS Slow Block	DDB_VTS_SLOW_BLOCK
VTS Slow Block		
1250	VTS Acc Ind	DDB_VTS_ACCELERATE_INPUT
VTS Accelerate Indication		
1251	VTS Volt Dep	DDB_VTS_ANY_VOLTAGE_DEP_FN
Any Voltage Dependent		
1252	VTS IA>	DDB_VTS_IA_OPERATED

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
Ia Over Threshold		
1253	VTS IB>	DDB_VTS_IB_OPERATED
Ib Over Threshold		
1254	VTS IC>	DDB_VTS_IC_OPERATED
Ic Over Threshold		
1255	VTS VA>	DDB_VTS_VA_OPERATED
Va Over Threshold		
1256	VTS VB>	DDB_VTS_VB_OPERATED
Vb Over Threshold		
1257	VTS VC>	DDB_VTS_VC_OPERATED
Vc Over Threshold		
1258	VTS I2>	DDB_VTS_I2_OPERATED
I2 Over Threshold		
1259	VTS V2>	DDB_VTS_V2_OPERATED
V2 Over Threshold		
1260	VTS IA delta>	DDB_VTS_DELTA_IA_OPERATED
Superimposed Ia Over Threshold		
1261	VTS IB delta>	DDB_VTS_DELTA_IB_OPERATED
Superimposed Ib Over Threshold		
1262	VTS IC delta>	DDB_VTS_DELTA_IC_OPERATED
Superimposed Ic Over Threshold		
1263	CTS-1 Block	DDB_CTS_BLOCK
CTS-1 Block		
1264	CTS-2 Block	DDB_CTS_2_BLOCK
CTS-2 Block		
1265	Diff CTS BLK	DDB_DIFF_CTS_BLK
differential CTS		
1266	Diff CTS CT1	DDB_DIFF_CTS_CT1
differential CTS		
1267	Diff CTS CT2	DDB_DIFF_CTS_CT2
differential CTS		
1269	CctFail Blk A	DDB_CIR_FLT_A
Circuitry Fault Alarm A		
1270	CctFail Blk B	DDB_CIR_FLT_B
Circuitry Fault Alarm B		
1271	CctFail Blk C	DDB_CIR_FLT_C
Circuitry Fault Alarm C		
1272	2nd Har Blk A	DDB_2ND_HAR_BLKA
2nd Harmonic A		
1273	2nd Har Blk B	DDB_2ND_HAR_BLKB
2nd Harmonic B		
1274	2nd Har Blk C	DDB_2ND_HAR_BLKC
2nd Harmonic C		
1275	5nd Har Blk A	DDB_5TH_HAR_BLKA
5th Har Blk A		
1276	5nd Har Blk B	DDB_5TH_HAR_BLKB
5th Har Blk B		
1277	5nd Har Blk C	DDB_5TH_HAR_BLKC
5th Har Blk C		
1278	Control Trip	DDB_CONTROL_TRIP
Control Trip		
1279	Control Close	DDB_CONTROL_CLOSE
Control Close		
1280	Close in Prog	DDB_CONTROL_CLOSE_IN_PROGRESS
Control Close in Progress		
1281	Lockout Alarm	DDB_CB_LOCKOUT_ALARM
Composite Lockout Alarm		
1282	CB Open 3 ph	DDB_CB_OPEN

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
3 ph CB Open		
1283	CB Closed 3 ph	DDB_CB_CLOSED
3 ph CB Closed		
1284	All Poles Dead	DDB_ALL_POLEDEAD
All Poles Dead		
1285	Any Pole Dead	DDB_ANY_POLEDEAD
Any Pole Dead		
1286	Pole Dead A	DDB_PHASE_A_POLEDEAD
Phase A Pole Dead		
1287	Pole Dead B	DDB_PHASE_B_POLEDEAD
Phase B Pole Dead		
1288	Pole Dead C	DDB_PHASE_C_POLEDEAD
Phase C Pole Dead		
1289	BFail SEF Trip-1	DDB_CBF_SEF_STAGE_TRIP
CBF Current Prot SEF Stage Trip		
1290	BFail Non I Tr-1	DDB_CBF_NON_CURRENT_STAGE_TRIP
CBF Non Current Prot Stage Trip		
1291	BFail SEF Trip	DDB_CURRENT_PROT_SEF_TRIP
CBF Current Prot SEF Trip		
1292	BFail Non I Trip	DDB_CBF_NON_CURRENT_PROT_TRIP
CBF Non Current Prot Trip		
1293	Freq High	DDB_FREQ_ABOVE_RANGE_LIMIT
Freq High		
1294	Freq Low	DDB_FREQ_BELOW_RANGE_LIMIT
Freq Low		
1295	Freq Not found	DDB_FREQ_NOT_FOUND
Freq Not Found		
1297	64S F Band Block	DDB_STEFI_LOW_F_BLOCK
64S 100% Stator Earth Fault - System frequency in blocking band		
1298	64S Fail	DDB_STEFI_FAIL
64S 100% Stator Earth Fault - Injection failure		
1304	RTD 1 Alarm	DDB_RTD_1_ALARM
RTD 1 Alarm		
1305	RTD 2 Alarm	DDB_RTD_2_ALARM
RTD 2 Alarm		
1306	RTD 3 Alarm	DDB_RTD_3_ALARM
RTD 3 Alarm		
1307	RTD 4 Alarm	DDB_RTD_4_ALARM
RTD 4 Alarm		
1308	RTD 5 Alarm	DDB_RTD_5_ALARM
RTD 5 Alarm		
1309	RTD 6 Alarm	DDB_RTD_6_ALARM
RTD 6 Alarm		
1310	RTD 7 Alarm	DDB_RTD_7_ALARM
RTD 7 Alarm		
1311	RTD 8 Alarm	DDB_RTD_8_ALARM
RTD 8 Alarm		
1312	RTD 9 Alarm	DDB_RTD_9_ALARM
RTD 9 Alarm		
1313	RTD 10 Alarm	DDB_RTD_10_ALARM
RTD 10 Alarm		
1314	Blk Rmt. CB Ops	DDB_BLOCK_REMOTE_CB_OPS
Blocks remote CB Trip/Close commands when asserted		
1328	Live Gen	DDB_SYSCHECKS_GEN_LIVE
Live Gen		
1329	Dead Gen	DDB_SYSCHECKS_GEN_DEAD
Dead Gen		
1330	Live Bus	DDB_SYSCHECKS_BUS_LIVE

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
Live Bus		
1331	Dead Bus	DDB_SYSCHECKS_BUS_DEAD
Dead Bus		
1332	Check Sync 1 OK	DDB_CHECKSYNC_1_OK
Check Sync 1 OK		
1333	Check Sync 2 OK	DDB_CHECKSYNC_2_OK
Check Sync 2 OK		
1335	SysChks Inactive	DDB_SYSCHECKS_INACTIVE
SysChks Inactive		
1336	CS1 Enabled	DDB_CHECKSYNC_1_ENABLED
CS1 Enabled		
1337	CS2 Enabled	DDB_CHECKSYNC_2_ENABLED
CS2 Enabled		
1338	SysSplit Enabled	DDB_SYSTEM_SPLIT_ENABLED
SysSplit Enabled		
1339	CS1 Slipfreq>	DDB_CS1_SLIP_ABOVE_SETTING
Check Synch 1 Slip > Setting		
1340	CS1 Slipfreq<	DDB_CS1_SLIP_BELOW_SETTING
Check Synch 1 Slip < Setting		
1341	CS2 Slipfreq>	DDB_CS2_SLIP_ABOVE_SETTING
Check Synch 2 Slip > Setting		
1342	CS2 Slipfreq<	DDB_CS2_SLIP_BELOW_SETTING
Check Synch 2 Slip < Setting		
1343	CS Vgen<	DDB_SYSCHECKS_VGEN_UV
Gen volts less than CS undervoltage setting		
1344	CS Vbus<	DDB_SYSCHECKS_VBUS_UV
Bus volts less than CS undervoltage setting		
1345	CS Vgen>	DDB_SYSCHECKS_VGEN_OV
Gen volts greater than CS overvoltage setting		
1346	CS Vbus>	DDB_SYSCHECKS_VBUS_OV
Bus volts greater than CS overvoltage setting		
1347	CS Freq Low	DDB_SYSCHECKS_FGEN_UF
Gen freq less than CS underfreq setting		
1348	CS Freq High	DDB_SYSCHECKS_FGEN_OF
Gen freq greater than CS overfreq setting		
1349	CS Vgen>Vbus	DDB_SYSCHECKS_VGEN_DIFF_HIGH
Gen volts greater than (bus volts + CS diff voltage setting)		
1350	CS Vgen<Vbus	DDB_SYSCHECKS_VBUS_DIFF_HIGH
Bus volts greater than (line volts + CS diff voltage setting)		
1351	CS1 Fgen>Fbus	DDB_CS1_GEN_FREQ_GT_BUS_FREQ
Gen freq greater than (bus freq + CS1 slip freq setting)		
1352	CS1 Fgen<Fbus	DDB_CS1_GEN_FREQ_LT_BUS_FREQ
Bus freq greater than (line freq + CS1 slip freq setting)		
1353	CS1 Ang Not OK +	DDB_CS1_ANG_NOT_OK_POS
Gen angle in range (CS1 ang setting to +180 deg)		
1354	CS1 Ang Not OK -	DDB_CS1_ANG_NOT_OK_NEG
Gen angle in range (-CS1 ang setting to -180 deg)		
1355	CS2 Fgen>Fbus	DDB_CS2_GEN_FREQ_GT_BUS_FREQ
Gen freq greater than (bus freq + CS2 slip freq setting)		
1356	CS2 Fgen<Fbus	DDB_CS2_GEN_FREQ_LT_BUS_FREQ
Bus freq greater than (gen freq + CS2 slip freq setting)		
1357	CS2 Ang Not OK +	DDB_CS2_ANG_NOT_OK_POS
Gen angle in range (CS2 angle setting to +180 deg)		
1358	CS2 Ang Not OK -	DDB_CS2_ANG_NOT_OK_NEG
Gen angle in range (-CS2 angle setting to -180 deg)		
1359	CS Ang Rot ACW	DDB_SYSCHECKS_ANG_ACW
Gen/Bus phase angle is rotating anti-clockwise		
1360	CS Ang Rot CW	DDB_SYSCHECKS_ANG_CW

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
Gen/Bus phase angle is rotating clockwise		
1361	CS Guard Enabled	DDB_CHECKSYNC_GUARD_ON
Check Synch Guard on		
1362	Man Check Synch	DDB_MAN_SYSCHECKS
Manual check synchronization conditions are satisfied		
1363	CS Guard Enable	DDB_CHECKSYNC_GUARD_IN
Check Synch Guard input		
1364	HMI Access Lvl 1	DDB_UIPASSWORD_ONE
bit 0 of the level access for HMI interface		
1365	HMI Access Lvl 2	DDB_UIPASSWORD_TWO
bit 1 of the level access for HMI interface		
1366	FPort AccessLvl1	DDB_FCURPASSWORD_ONE
bit 0 of the level access for the front port interface		
1367	FPort AccessLvl2	DDB_FCURPASSWORD_TWO
bit 1 of the level access for the front port interface		
1368	RPrt1 AccessLvl1	DDB_REMOTEPASSWORD_ONE
bit 0 of the level access for the rear port 1 interface		
1369	RPrt1 AccessLvl2	DDB_REMOTEPASSWORD_TWO
bit 1 of the level access for the rear port 1 interface		
1370	RPrt2 AccessLvl1	DDB_REMOTE2PASSWORD_ONE
bit 0 of the level access for the rear port 2 interface		
1371	RPrt2 AccessLvl2	DDB_REMOTE2PASSWORD_TWO
bit 1 of the level access for the rear port 2 interface		
1372	Active Group 1	DDB_CS103_GROUP1_CHANGED
Setting group 1 change		
1373	Active Group 2	DDB_CS103_GROUP2_CHANGED
Setting group 2 change		
1374	Active Group 3	DDB_CS103_GROUP3_CHANGED
Setting group 3 change		
1375	Active Group 4	DDB_CS103_GROUP4_CHANGED
Setting group 4 change		
1376	Control Input 1	DDB_CONTROL_1
Control Input 1		
1377	Control Input 2	DDB_CONTROL_2
Control Input 2		
1378	Control Input 3	DDB_CONTROL_3
Control Input 3		
1379	Control Input 4	DDB_CONTROL_4
Control Input 4		
1380	Control Input 5	DDB_CONTROL_5
Control Input 5		
1381	Control Input 6	DDB_CONTROL_6
Control Input 6		
1382	Control Input 7	DDB_CONTROL_7
Control Input 7		
1383	Control Input 8	DDB_CONTROL_8
Control Input 8		
1384	Control Input 9	DDB_CONTROL_9
Control Input 9		
1385	Control Input 10	DDB_CONTROL_10
Control Input 10		
1386	Control Input 11	DDB_CONTROL_11
Control Input 11		
1387	Control Input 12	DDB_CONTROL_12
Control Input 12		
1388	Control Input 13	DDB_CONTROL_13
Control Input 13		
1389	Control Input 14	DDB_CONTROL_14

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
Control Input 14		
1390	Control Input 15	DDB_CONTROL_15
Control Input 15		
1391	Control Input 16	DDB_CONTROL_16
Control Input 16		
1392	Control Input 17	DDB_CONTROL_17
Control Input 17		
1393	Control Input 18	DDB_CONTROL_18
Control Input 18		
1394	Control Input 19	DDB_CONTROL_19
Control Input 19		
1395	Control Input 20	DDB_CONTROL_20
Control Input 20		
1396	Control Input 21	DDB_CONTROL_21
Control Input 21		
1397	Control Input 22	DDB_CONTROL_22
Control Input 22		
1398	Control Input 23	DDB_CONTROL_23
Control Input 23		
1399	Control Input 24	DDB_CONTROL_24
Control Input 24		
1400	Control Input 25	DDB_CONTROL_25
Control Input 25		
1401	Control Input 26	DDB_CONTROL_26
Control Input 26		
1402	Control Input 27	DDB_CONTROL_27
Control Input 27		
1403	Control Input 28	DDB_CONTROL_28
Control Input 28		
1404	Control Input 29	DDB_CONTROL_29
Control Input 29		
1405	Control Input 30	DDB_CONTROL_30
Control Input 30		
1406	Control Input 31	DDB_CONTROL_31
Control Input 31		
1407	Control Input 32	DDB_CONTROL_32
Control Input 32		
1408	Virtual Input 01	DDB_GOOSEIN_1
Virtual Input 01		
1409	Virtual Input 02	DDB_GOOSEIN_2
Virtual Input 02		
1410	Virtual Input 03	DDB_GOOSEIN_3
Virtual Input 03		
1411	Virtual Input 04	DDB_GOOSEIN_4
Virtual Input 04		
1412	Virtual Input 05	DDB_GOOSEIN_5
Virtual Input 05		
1413	Virtual Input 06	DDB_GOOSEIN_6
Virtual Input 06		
1414	Virtual Input 07	DDB_GOOSEIN_7
Virtual Input 07		
1415	Virtual Input 08	DDB_GOOSEIN_8
Virtual Input 08		
1416	Virtual Input 09	DDB_GOOSEIN_9
Virtual Input 09		
1417	Virtual Input 10	DDB_GOOSEIN_10
Virtual Input 10		
1418	Virtual Input 11	DDB_GOOSEIN_11

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
Virtual Input 11		
1419	Virtual Input 12	DDB_GOOSEIN_12
Virtual Input 12		
1420	Virtual Input 13	DDB_GOOSEIN_13
Virtual Input 13		
1421	Virtual Input 14	DDB_GOOSEIN_14
Virtual Input 14		
1422	Virtual Input 15	DDB_GOOSEIN_15
Virtual Input 15		
1423	Virtual Input 16	DDB_GOOSEIN_16
Virtual Input 16		
1424	Virtual Input 17	DDB_GOOSEIN_17
Virtual Input 17		
1425	Virtual Input 18	DDB_GOOSEIN_18
Virtual Input 18		
1426	Virtual Input 19	DDB_GOOSEIN_19
Virtual Input 19		
1427	Virtual Input 20	DDB_GOOSEIN_20
Virtual Input 20		
1428	Virtual Input 21	DDB_GOOSEIN_21
Virtual Input 21		
1429	Virtual Input 22	DDB_GOOSEIN_22
Virtual Input 22		
1430	Virtual Input 23	DDB_GOOSEIN_23
Virtual Input 23		
1431	Virtual Input 24	DDB_GOOSEIN_24
Virtual Input 24		
1432	Virtual Input 25	DDB_GOOSEIN_25
Virtual Input 25		
1433	Virtual Input 26	DDB_GOOSEIN_26
Virtual Input 26		
1434	Virtual Input 27	DDB_GOOSEIN_27
Virtual Input 27		
1435	Virtual Input 28	DDB_GOOSEIN_28
Virtual Input 28		
1436	Virtual Input 29	DDB_GOOSEIN_29
Virtual Input 29		
1437	Virtual Input 30	DDB_GOOSEIN_30
Virtual Input 30		
1438	Virtual Input 31	DDB_GOOSEIN_31
Virtual Input 31		
1439	Virtual Input 32	DDB_GOOSEIN_32
Virtual Input 32		
1440	Virtual Input 33	DDB_GOOSEIN_33
Virtual Input 33		
1441	Virtual Input 34	DDB_GOOSEIN_34
Virtual Input 34		
1442	Virtual Input 35	DDB_GOOSEIN_35
Virtual Input 35		
1443	Virtual Input 36	DDB_GOOSEIN_36
Virtual Input 36		
1444	Virtual Input 37	DDB_GOOSEIN_37
Virtual Input 37		
1445	Virtual Input 38	DDB_GOOSEIN_38
Virtual Input 38		
1446	Virtual Input 39	DDB_GOOSEIN_39
Virtual Input 39		
1447	Virtual Input 40	DDB_GOOSEIN_40

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
Virtual Input 40		
1448	Virtual Input 41	DDB_GOOSEIN_41
Virtual Input 41		
1449	Virtual Input 42	DDB_GOOSEIN_42
Virtual Input 42		
1450	Virtual Input 43	DDB_GOOSEIN_43
Virtual Input 43		
1451	Virtual Input 44	DDB_GOOSEIN_44
Virtual Input 44		
1452	Virtual Input 45	DDB_GOOSEIN_45
Virtual Input 45		
1453	Virtual Input 46	DDB_GOOSEIN_46
Virtual Input 46		
1454	Virtual Input 47	DDB_GOOSEIN_47
Virtual Input 47		
1455	Virtual Input 48	DDB_GOOSEIN_48
Virtual Input 48		
1456	Virtual Input 49	DDB_GOOSEIN_49
Virtual Input 49		
1457	Virtual Input 50	DDB_GOOSEIN_50
Virtual Input 50		
1458	Virtual Input 51	DDB_GOOSEIN_51
Virtual Input 51		
1459	Virtual Input 52	DDB_GOOSEIN_52
Virtual Input 52		
1460	Virtual Input 53	DDB_GOOSEIN_53
Virtual Input 53		
1461	Virtual Input 54	DDB_GOOSEIN_54
Virtual Input 54		
1462	Virtual Input 55	DDB_GOOSEIN_55
Virtual Input 55		
1463	Virtual Input 56	DDB_GOOSEIN_56
Virtual Input 56		
1464	Virtual Input 57	DDB_GOOSEIN_57
Virtual Input 57		
1465	Virtual Input 58	DDB_GOOSEIN_58
Virtual Input 58		
1466	Virtual Input 59	DDB_GOOSEIN_59
Virtual Input 59		
1467	Virtual Input 60	DDB_GOOSEIN_60
Virtual Input 60		
1468	Virtual Input 61	DDB_GOOSEIN_61
Virtual Input 61		
1469	Virtual Input 62	DDB_GOOSEIN_62
Virtual Input 62		
1470	Virtual Input 63	DDB_GOOSEIN_63
Virtual Input 63		
1471	Virtual Input 64	DDB_GOOSEIN_64
Virtual Input 64		
1504	Quality VIP 1	DDB_VIP_QUALITY_1
GOOSE Virtual input 1 Quality bit		
1505	Quality VIP 2	DDB_VIP_QUALITY_2
GOOSE Virtual input 2 Quality bit		
1506	Quality VIP 3	DDB_VIP_QUALITY_3
GOOSE Virtual input 3 Quality bit		
1507	Quality VIP 4	DDB_VIP_QUALITY_4
GOOSE Virtual input 4 Quality bit		
1508	Quality VIP 5	DDB_VIP_QUALITY_5

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
GOOSE Virtual input 5 Quality bit		
1509	Quality VIP 6	DDB_VIP_QUALITY_6
GOOSE Virtual input 6 Quality bit		
1510	Quality VIP 7	DDB_VIP_QUALITY_7
GOOSE Virtual input 7 Quality bit		
1511	Quality VIP 8	DDB_VIP_QUALITY_8
GOOSE Virtual input 8 Quality bit		
1512	Quality VIP 9	DDB_VIP_QUALITY_9
GOOSE Virtual input 9 Quality bit		
1513	Quality VIP 10	DDB_VIP_QUALITY_10
GOOSE Virtual input 10 Quality bit		
1514	Quality VIP 11	DDB_VIP_QUALITY_11
GOOSE Virtual input 11 Quality bit		
1515	Quality VIP 12	DDB_VIP_QUALITY_12
GOOSE Virtual input 12 Quality bit		
1516	Quality VIP 13	DDB_VIP_QUALITY_13
GOOSE Virtual input 13 Quality bit		
1517	Quality VIP 14	DDB_VIP_QUALITY_14
GOOSE Virtual input 14 Quality bit		
1518	Quality VIP 15	DDB_VIP_QUALITY_15
GOOSE Virtual input 15 Quality bit		
1519	Quality VIP 16	DDB_VIP_QUALITY_16
GOOSE Virtual input 16 Quality bit		
1520	Quality VIP 17	DDB_VIP_QUALITY_17
GOOSE Virtual input 17 Quality bit		
1521	Quality VIP 18	DDB_VIP_QUALITY_18
GOOSE Virtual input 18 Quality bit		
1522	Quality VIP 19	DDB_VIP_QUALITY_19
GOOSE Virtual input 19 Quality bit		
1523	Quality VIP 20	DDB_VIP_QUALITY_20
GOOSE Virtual input 20 Quality bit		
1524	Quality VIP 21	DDB_VIP_QUALITY_21
GOOSE Virtual input 21 Quality bit		
1525	Quality VIP 22	DDB_VIP_QUALITY_22
GOOSE Virtual input 22 Quality bit		
1526	Quality VIP 23	DDB_VIP_QUALITY_23
GOOSE Virtual input 23 Quality bit		
1527	Quality VIP 24	DDB_VIP_QUALITY_24
GOOSE Virtual input 24 Quality bit		
1528	Quality VIP 25	DDB_VIP_QUALITY_25
GOOSE Virtual input 25 Quality bit		
1529	Quality VIP 26	DDB_VIP_QUALITY_26
GOOSE Virtual input 26 Quality bit		
1530	Quality VIP 27	DDB_VIP_QUALITY_27
GOOSE Virtual input 27 Quality bit		
1531	Quality VIP 28	DDB_VIP_QUALITY_28
GOOSE Virtual input 28 Quality bit		
1532	Quality VIP 29	DDB_VIP_QUALITY_29
GOOSE Virtual input 29 Quality bit		
1533	Quality VIP 30	DDB_VIP_QUALITY_30
GOOSE Virtual input 30 Quality bit		
1534	Quality VIP 31	DDB_VIP_QUALITY_31
GOOSE Virtual input 31 Quality bit		
1535	Quality VIP 32	DDB_VIP_QUALITY_32
GOOSE Virtual input 32 Quality bit		
1536	Quality VIP 33	DDB_VIP_QUALITY_33
GOOSE Virtual input 33 Quality bit		
1537	Quality VIP 34	DDB_VIP_QUALITY_34

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
GOOSE Virtual input 34 Quality bit		
1538	Quality VIP 35	DDB_VIP_QUALITY_35
GOOSE Virtual input 35 Quality bit		
1539	Quality VIP 36	DDB_VIP_QUALITY_36
GOOSE Virtual input 36 Quality bit		
1540	Quality VIP 37	DDB_VIP_QUALITY_37
GOOSE Virtual input 37 Quality bit		
1541	Quality VIP 38	DDB_VIP_QUALITY_38
GOOSE Virtual input 38 Quality bit		
1542	Quality VIP 39	DDB_VIP_QUALITY_39
GOOSE Virtual input 39 Quality bit		
1543	Quality VIP 40	DDB_VIP_QUALITY_40
GOOSE Virtual input 40 Quality bit		
1544	Quality VIP 41	DDB_VIP_QUALITY_41
GOOSE Virtual input 41 Quality bit		
1545	Quality VIP 42	DDB_VIP_QUALITY_42
GOOSE Virtual input 42 Quality bit		
1546	Quality VIP 43	DDB_VIP_QUALITY_43
GOOSE Virtual input 43 Quality bit		
1547	Quality VIP 44	DDB_VIP_QUALITY_44
GOOSE Virtual input 44 Quality bit		
1548	Quality VIP 45	DDB_VIP_QUALITY_45
GOOSE Virtual input 45 Quality bit		
1549	Quality VIP 46	DDB_VIP_QUALITY_46
GOOSE Virtual input 46 Quality bit		
1550	Quality VIP 47	DDB_VIP_QUALITY_47
GOOSE Virtual input 47 Quality bit		
1551	Quality VIP 48	DDB_VIP_QUALITY_48
GOOSE Virtual input 48 Quality bit		
1552	Quality VIP 49	DDB_VIP_QUALITY_49
GOOSE Virtual input 49 Quality bit		
1553	Quality VIP 50	DDB_VIP_QUALITY_50
GOOSE Virtual input 50 Quality bit		
1554	Quality VIP 51	DDB_VIP_QUALITY_51
GOOSE Virtual input 51 Quality bit		
1555	Quality VIP 52	DDB_VIP_QUALITY_52
GOOSE Virtual input 52 Quality bit		
1556	Quality VIP 53	DDB_VIP_QUALITY_53
GOOSE Virtual input 53 Quality bit		
1557	Quality VIP 54	DDB_VIP_QUALITY_54
GOOSE Virtual input 54 Quality bit		
1558	Quality VIP 55	DDB_VIP_QUALITY_55
GOOSE Virtual input 55 Quality bit		
1559	Quality VIP 56	DDB_VIP_QUALITY_56
GOOSE Virtual input 56 Quality bit		
1560	Quality VIP 57	DDB_VIP_QUALITY_57
GOOSE Virtual input 57 Quality bit		
1561	Quality VIP 58	DDB_VIP_QUALITY_58
GOOSE Virtual input 58 Quality bit		
1562	Quality VIP 59	DDB_VIP_QUALITY_59
GOOSE Virtual input 59 Quality bit		
1563	Quality VIP 60	DDB_VIP_QUALITY_60
GOOSE Virtual input 60 Quality bit		
1564	Quality VIP 61	DDB_VIP_QUALITY_61
GOOSE Virtual input 61 Quality bit		
1565	Quality VIP 62	DDB_VIP_QUALITY_62
GOOSE Virtual input 62 Quality bit		
1566	Quality VIP 63	DDB_VIP_QUALITY_63

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
GOOSE Virtual input 63 Quality bit		
1567	Quality VIP 64	DDB_VIP_QUALITY_64
GOOSE Virtual input 64 Quality bit		
1600	PubPres VIP 1	DDB_VIP_PUB_PRES_1
GOOSE Virtual input 1 publisher bit		
1601	PubPres VIP 2	DDB_VIP_PUB_PRES_2
GOOSE Virtual input 2 publisher bit		
1602	PubPres VIP 3	DDB_VIP_PUB_PRES_3
GOOSE Virtual input 3 publisher bit		
1603	PubPres VIP 4	DDB_VIP_PUB_PRES_4
GOOSE Virtual input 4 publisher bit		
1604	PubPres VIP 5	DDB_VIP_PUB_PRES_5
GOOSE Virtual input 5 publisher bit		
1605	PubPres VIP 6	DDB_VIP_PUB_PRES_6
GOOSE Virtual input 6 publisher bit		
1606	PubPres VIP 7	DDB_VIP_PUB_PRES_7
GOOSE Virtual input 7 publisher bit		
1607	PubPres VIP 8	DDB_VIP_PUB_PRES_8
GOOSE Virtual input 8 publisher bit		
1608	PubPres VIP 9	DDB_VIP_PUB_PRES_9
GOOSE Virtual input 9 publisher bit		
1609	PubPres VIP 10	DDB_VIP_PUB_PRES_10
GOOSE Virtual input 10 publisher bit		
1610	PubPres VIP 11	DDB_VIP_PUB_PRES_11
GOOSE Virtual input 11 publisher bit		
1611	PubPres VIP 12	DDB_VIP_PUB_PRES_12
GOOSE Virtual input 12 publisher bit		
1612	PubPres VIP 13	DDB_VIP_PUB_PRES_13
GOOSE Virtual input 13 publisher bit		
1613	PubPres VIP 14	DDB_VIP_PUB_PRES_14
GOOSE Virtual input 14 publisher bit		
1614	PubPres VIP 15	DDB_VIP_PUB_PRES_15
GOOSE Virtual input 15 publisher bit		
1615	PubPres VIP 16	DDB_VIP_PUB_PRES_16
GOOSE Virtual input 16 publisher bit		
1616	PubPres VIP 17	DDB_VIP_PUB_PRES_17
GOOSE Virtual input 17 publisher bit		
1617	PubPres VIP 18	DDB_VIP_PUB_PRES_18
GOOSE Virtual input 18 publisher bit		
1618	PubPres VIP 19	DDB_VIP_PUB_PRES_19
GOOSE Virtual input 19 publisher bit		
1619	PubPres VIP 20	DDB_VIP_PUB_PRES_20
GOOSE Virtual input 20 publisher bit		
1620	PubPres VIP 21	DDB_VIP_PUB_PRES_21
GOOSE Virtual input 21 publisher bit		
1621	PubPres VIP 22	DDB_VIP_PUB_PRES_22
GOOSE Virtual input 22 publisher bit		
1622	PubPres VIP 23	DDB_VIP_PUB_PRES_23
GOOSE Virtual input 23 publisher bit		
1623	PubPres VIP 24	DDB_VIP_PUB_PRES_24
GOOSE Virtual input 24 publisher bit		
1624	PubPres VIP 25	DDB_VIP_PUB_PRES_25
GOOSE Virtual input 25 publisher bit		
1625	PubPres VIP 26	DDB_VIP_PUB_PRES_26
GOOSE Virtual input 26 publisher bit		
1626	PubPres VIP 27	DDB_VIP_PUB_PRES_27
GOOSE Virtual input 27 publisher bit		
1627	PubPres VIP 28	DDB_VIP_PUB_PRES_28

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
GOOSE Virtual input 28 publisher bit		
1628	PubPres VIP 29	DDB_VIP_PUB_PRES_29
GOOSE Virtual input 29 publisher bit		
1629	PubPres VIP 30	DDB_VIP_PUB_PRES_30
GOOSE Virtual input 30 publisher bit		
1630	PubPres VIP 31	DDB_VIP_PUB_PRES_31
GOOSE Virtual input 31 publisher bit		
1631	PubPres VIP 32	DDB_VIP_PUB_PRES_32
GOOSE Virtual input 32 publisher bit		
1632	PubPres VIP 33	DDB_VIP_PUB_PRES_33
GOOSE Virtual input 33 publisher bit		
1633	PubPres VIP 34	DDB_VIP_PUB_PRES_34
GOOSE Virtual input 34 publisher bit		
1634	PubPres VIP 35	DDB_VIP_PUB_PRES_35
GOOSE Virtual input 35 publisher bit		
1635	PubPres VIP 36	DDB_VIP_PUB_PRES_36
GOOSE Virtual input 36 publisher bit		
1636	PubPres VIP 37	DDB_VIP_PUB_PRES_37
GOOSE Virtual input 37 publisher bit		
1637	PubPres VIP 38	DDB_VIP_PUB_PRES_38
GOOSE Virtual input 38 publisher bit		
1638	PubPres VIP 39	DDB_VIP_PUB_PRES_39
GOOSE Virtual input 39 publisher bit		
1639	PubPres VIP 40	DDB_VIP_PUB_PRES_40
GOOSE Virtual input 40 publisher bit		
1640	PubPres VIP 41	DDB_VIP_PUB_PRES_41
GOOSE Virtual input 41 publisher bit		
1641	PubPres VIP 42	DDB_VIP_PUB_PRES_42
GOOSE Virtual input 42 publisher bit		
1642	PubPres VIP 43	DDB_VIP_PUB_PRES_43
GOOSE Virtual input 43 publisher bit		
1643	PubPres VIP 44	DDB_VIP_PUB_PRES_44
GOOSE Virtual input 44 publisher bit		
1644	PubPres VIP 45	DDB_VIP_PUB_PRES_45
GOOSE Virtual input 45 publisher bit		
1645	PubPres VIP 46	DDB_VIP_PUB_PRES_46
GOOSE Virtual input 46 publisher bit		
1646	PubPres VIP 47	DDB_VIP_PUB_PRES_47
GOOSE Virtual input 47 publisher bit		
1647	PubPres VIP 48	DDB_VIP_PUB_PRES_48
GOOSE Virtual input 48 publisher bit		
1648	PubPres VIP 49	DDB_VIP_PUB_PRES_49
GOOSE Virtual input 49 publisher bit		
1649	PubPres VIP 50	DDB_VIP_PUB_PRES_50
GOOSE Virtual input 50 publisher bit		
1650	PubPres VIP 51	DDB_VIP_PUB_PRES_51
GOOSE Virtual input 51 publisher bit		
1651	PubPres VIP 52	DDB_VIP_PUB_PRES_52
GOOSE Virtual input 52 publisher bit		
1652	PubPres VIP 53	DDB_VIP_PUB_PRES_53
GOOSE Virtual input 53 publisher bit		
1653	PubPres VIP 54	DDB_VIP_PUB_PRES_54
GOOSE Virtual input 54 publisher bit		
1654	PubPres VIP 55	DDB_VIP_PUB_PRES_55
GOOSE Virtual input 55 publisher bit		
1655	PubPres VIP 56	DDB_VIP_PUB_PRES_56
GOOSE Virtual input 56 publisher bit		
1656	PubPres VIP 57	DDB_VIP_PUB_PRES_57

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
GOOSE Virtual input 57 publisher bit		
1657	PubPres VIP 58	DDB_VIP_PUB_PRES_58
GOOSE Virtual input 58 publisher bit		
1658	PubPres VIP 59	DDB_VIP_PUB_PRES_59
GOOSE Virtual input 59 publisher bit		
1659	PubPres VIP 60	DDB_VIP_PUB_PRES_60
GOOSE Virtual input 60 publisher bit		
1660	PubPres VIP 61	DDB_VIP_PUB_PRES_61
GOOSE Virtual input 61 publisher bit		
1661	PubPres VIP 62	DDB_VIP_PUB_PRES_62
GOOSE Virtual input 62 publisher bit		
1662	PubPres VIP 63	DDB_VIP_PUB_PRES_63
GOOSE Virtual input 63 publisher bit		
1663	PubPres VIP 64	DDB_VIP_PUB_PRES_64
GOOSE Virtual input 64 publisher bit		
1696	Virtual Output01	DDB_GOOSEOUT_1
Virtual Output 01		
1697	Virtual Output02	DDB_GOOSEOUT_2
Virtual Output 02		
1698	Virtual Output03	DDB_GOOSEOUT_3
Virtual Output 03		
1699	Virtual Output04	DDB_GOOSEOUT_4
Virtual Output 04		
1700	Virtual Output05	DDB_GOOSEOUT_5
Virtual Output 05		
1701	Virtual Output06	DDB_GOOSEOUT_6
Virtual Output 06		
1702	Virtual Output07	DDB_GOOSEOUT_7
Virtual Output 07		
1703	Virtual Output08	DDB_GOOSEOUT_8
Virtual Output 08		
1704	Virtual Output09	DDB_GOOSEOUT_9
Virtual Output 09		
1705	Virtual Output10	DDB_GOOSEOUT_10
Virtual Output 10		
1706	Virtual Output11	DDB_GOOSEOUT_11
Virtual Output 11		
1707	Virtual Output12	DDB_GOOSEOUT_12
Virtual Output 12		
1708	Virtual Output13	DDB_GOOSEOUT_13
Virtual Output 13		
1709	Virtual Output14	DDB_GOOSEOUT_14
Virtual Output 14		
1710	Virtual Output15	DDB_GOOSEOUT_15
Virtual Output 15		
1711	Virtual Output16	DDB_GOOSEOUT_16
Virtual Output 16		
1712	Virtual Output17	DDB_GOOSEOUT_17
Virtual Output 17		
1713	Virtual Output18	DDB_GOOSEOUT_18
Virtual Output 18		
1714	Virtual Output19	DDB_GOOSEOUT_19
Virtual Output 19		
1715	Virtual Output20	DDB_GOOSEOUT_20
Virtual Output 20		
1716	Virtual Output21	DDB_GOOSEOUT_21
Virtual Output 21		
1717	Virtual Output22	DDB_GOOSEOUT_22

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
Virtual Output 22		
1718	Virtual Output23	DDB_GOOSEOUT_23
Virtual Output 23		
1719	Virtual Output24	DDB_GOOSEOUT_24
Virtual Output 24		
1720	Virtual Output25	DDB_GOOSEOUT_25
Virtual Output 25		
1721	Virtual Output26	DDB_GOOSEOUT_26
Virtual Output 26		
1722	Virtual Output27	DDB_GOOSEOUT_27
Virtual Output 27		
1723	Virtual Output28	DDB_GOOSEOUT_28
Virtual Output 28		
1724	Virtual Output29	DDB_GOOSEOUT_29
Virtual Output 29		
1725	Virtual Output30	DDB_GOOSEOUT_30
Virtual Output 30		
1726	Virtual Output31	DDB_GOOSEOUT_31
Virtual Output 31		
1727	Virtual Output32	DDB_GOOSEOUT_32
Virtual Output 32		
1728	Virtual Output33	DDB_GOOSEOUT_33
Virtual Output 33		
1729	Virtual Output34	DDB_GOOSEOUT_34
Virtual Output 34		
1730	Virtual Output35	DDB_GOOSEOUT_35
Virtual Output 35		
1731	Virtual Output36	DDB_GOOSEOUT_36
Virtual Output 36		
1732	Virtual Output37	DDB_GOOSEOUT_37
Virtual Output 37		
1733	Virtual Output38	DDB_GOOSEOUT_38
Virtual Output 38		
1734	Virtual Output39	DDB_GOOSEOUT_39
Virtual Output 39		
1735	Virtual Output40	DDB_GOOSEOUT_40
Virtual Output 40		
1736	Virtual Output41	DDB_GOOSEOUT_41
Virtual Output 41		
1737	Virtual Output42	DDB_GOOSEOUT_42
Virtual Output 42		
1738	Virtual Output43	DDB_GOOSEOUT_43
Virtual Output 43		
1739	Virtual Output44	DDB_GOOSEOUT_44
Virtual Output 44		
1740	Virtual Output45	DDB_GOOSEOUT_45
Virtual Output 45		
1741	Virtual Output46	DDB_GOOSEOUT_46
Virtual Output 46		
1742	Virtual Output47	DDB_GOOSEOUT_47
Virtual Output 47		
1743	Virtual Output48	DDB_GOOSEOUT_48
Virtual Output 48		
1744	Virtual Output49	DDB_GOOSEOUT_49
Virtual Output 49		
1745	Virtual Output50	DDB_GOOSEOUT_50
Virtual Output 50		
1746	Virtual Output51	DDB_GOOSEOUT_51

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
Virtual Output 51		
1747	Virtual Output52	DDB_GOOSEOUT_52
Virtual Output 52		
1748	Virtual Output53	DDB_GOOSEOUT_53
Virtual Output 53		
1749	Virtual Output54	DDB_GOOSEOUT_54
Virtual Output 54		
1750	Virtual Output55	DDB_GOOSEOUT_55
Virtual Output 55		
1751	Virtual Output56	DDB_GOOSEOUT_56
Virtual Output 56		
1752	Virtual Output57	DDB_GOOSEOUT_57
Virtual Output 57		
1753	Virtual Output58	DDB_GOOSEOUT_58
Virtual Output 58		
1754	Virtual Output59	DDB_GOOSEOUT_59
Virtual Output 59		
1755	Virtual Output60	DDB_GOOSEOUT_60
Virtual Output 60		
1756	Virtual Output61	DDB_GOOSEOUT_61
Virtual Output 61		
1757	Virtual Output62	DDB_GOOSEOUT_62
Virtual Output 62		
1758	Virtual Output63	DDB_GOOSEOUT_63
Virtual Output 63		
1759	Virtual Output64	DDB_GOOSEOUT_64
Virtual Output 64		
1792	PSL Int. 1	DDB_PSLINT_1
PSL Internal connection		
1793	PSL Int. 2	DDB_PSLINT_2
PSL Internal connection		
1794	PSL Int. 3	DDB_PSLINT_3
PSL Internal connection		
1795	PSL Int. 4	DDB_PSLINT_4
PSL Internal connection		
1796	PSL Int. 5	DDB_PSLINT_5
PSL Internal connection		
1797	PSL Int. 6	DDB_PSLINT_6
PSL Internal connection		
1798	PSL Int. 7	DDB_PSLINT_7
PSL Internal connection		
1799	PSL Int. 8	DDB_PSLINT_8
PSL Internal connection		
1800	PSL Int. 9	DDB_PSLINT_9
PSL Internal connection		
1801	PSL Int. 10	DDB_PSLINT_10
PSL Internal connection		
1802	PSL Int. 11	DDB_PSLINT_11
PSL Internal connection		
1803	PSL Int. 12	DDB_PSLINT_12
PSL Internal connection		
1804	PSL Int. 13	DDB_PSLINT_13
PSL Internal connection		
1805	PSL Int. 14	DDB_PSLINT_14
PSL Internal connection		
1806	PSL Int. 15	DDB_PSLINT_15
PSL Internal connection		
1807	PSL Int. 16	DDB_PSLINT_16

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
PSL Internal connection		
1808	PSL Int. 17	DDB_PSLINT_17
PSL Internal connection		
1809	PSL Int. 18	DDB_PSLINT_18
PSL Internal connection		
1810	PSL Int. 19	DDB_PSLINT_19
PSL Internal connection		
1811	PSL Int. 20	DDB_PSLINT_20
PSL Internal connection		
1812	PSL Int. 21	DDB_PSLINT_21
PSL Internal connection		
1813	PSL Int. 22	DDB_PSLINT_22
PSL Internal connection		
1814	PSL Int. 23	DDB_PSLINT_23
PSL Internal connection		
1815	PSL Int. 24	DDB_PSLINT_24
PSL Internal connection		
1816	PSL Int. 25	DDB_PSLINT_25
PSL Internal connection		
1817	PSL Int. 26	DDB_PSLINT_26
PSL Internal connection		
1818	PSL Int. 27	DDB_PSLINT_27
PSL Internal connection		
1819	PSL Int. 28	DDB_PSLINT_28
PSL Internal connection		
1820	PSL Int. 29	DDB_PSLINT_29
PSL Internal connection		
1821	PSL Int. 30	DDB_PSLINT_30
PSL Internal connection		
1822	PSL Int. 31	DDB_PSLINT_31
PSL Internal connection		
1823	PSL Int. 32	DDB_PSLINT_32
PSL Internal connection		
1824	PSL Int. 33	DDB_PSLINT_33
PSL Internal connection		
1825	PSL Int. 34	DDB_PSLINT_34
PSL Internal connection		
1826	PSL Int. 35	DDB_PSLINT_35
PSL Internal connection		
1827	PSL Int. 36	DDB_PSLINT_36
PSL Internal connection		
1828	PSL Int. 37	DDB_PSLINT_37
PSL Internal connection		
1829	PSL Int. 38	DDB_PSLINT_38
PSL Internal connection		
1830	PSL Int. 39	DDB_PSLINT_39
PSL Internal connection		
1831	PSL Int. 40	DDB_PSLINT_40
PSL Internal connection		
1832	PSL Int. 41	DDB_PSLINT_41
PSL Internal connection		
1833	PSL Int. 42	DDB_PSLINT_42
PSL Internal connection		
1834	PSL Int. 43	DDB_PSLINT_43
PSL Internal connection		
1835	PSL Int. 44	DDB_PSLINT_44
PSL Internal connection		
1836	PSL Int. 45	DDB_PSLINT_45

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
PSL Internal connection		
1837	PSL Int. 46	DDB_PSLINT_46
PSL Internal connection		
1838	PSL Int. 47	DDB_PSLINT_47
PSL Internal connection		
1839	PSL Int. 48	DDB_PSLINT_48
PSL Internal connection		
1840	PSL Int. 49	DDB_PSLINT_49
PSL Internal connection		
1841	PSL Int. 50	DDB_PSLINT_50
PSL Internal connection		
1842	PSL Int. 51	DDB_PSLINT_51
PSL Internal connection		
1843	PSL Int. 52	DDB_PSLINT_52
PSL Internal connection		
1844	PSL Int. 53	DDB_PSLINT_53
PSL Internal connection		
1845	PSL Int. 54	DDB_PSLINT_54
PSL Internal connection		
1846	PSL Int. 55	DDB_PSLINT_55
PSL Internal connection		
1847	PSL Int. 56	DDB_PSLINT_56
PSL Internal connection		
1848	PSL Int. 57	DDB_PSLINT_57
PSL Internal connection		
1849	PSL Int. 58	DDB_PSLINT_58
PSL Internal connection		
1850	PSL Int. 59	DDB_PSLINT_59
PSL Internal connection		
1851	PSL Int. 60	DDB_PSLINT_60
PSL Internal connection		
1852	PSL Int. 61	DDB_PSLINT_61
PSL Internal connection		
1853	PSL Int. 62	DDB_PSLINT_62
PSL Internal connection		
1854	PSL Int. 63	DDB_PSLINT_63
PSL Internal connection		
1855	PSL Int. 64	DDB_PSLINT_64
PSL Internal connection		
1856	PSL Int. 65	DDB_PSLINT_65
PSL Internal connection		
1857	PSL Int. 66	DDB_PSLINT_66
PSL Internal connection		
1858	PSL Int. 67	DDB_PSLINT_67
PSL Internal connection		
1859	PSL Int. 68	DDB_PSLINT_68
PSL Internal connection		
1860	PSL Int. 69	DDB_PSLINT_69
PSL Internal connection		
1861	PSL Int. 70	DDB_PSLINT_70
PSL Internal connection		
1862	PSL Int. 71	DDB_PSLINT_71
PSL Internal connection		
1863	PSL Int. 72	DDB_PSLINT_72
PSL Internal connection		
1864	PSL Int. 73	DDB_PSLINT_73
PSL Internal connection		
1865	PSL Int. 74	DDB_PSLINT_74

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
PSL Internal connection		
1866	PSL Int. 75	DDB_PSLINT_75
PSL Internal connection		
1867	PSL Int. 76	DDB_PSLINT_76
PSL Internal connection		
1868	PSL Int. 77	DDB_PSLINT_77
PSL Internal connection		
1869	PSL Int. 78	DDB_PSLINT_78
PSL Internal connection		
1870	PSL Int. 79	DDB_PSLINT_79
PSL Internal connection		
1871	PSL Int. 80	DDB_PSLINT_80
PSL Internal connection		
1872	PSL Int. 81	DDB_PSLINT_81
PSL Internal connection		
1873	PSL Int. 82	DDB_PSLINT_82
PSL Internal connection		
1874	PSL Int. 83	DDB_PSLINT_83
PSL Internal connection		
1875	PSL Int. 84	DDB_PSLINT_84
PSL Internal connection		
1876	PSL Int. 85	DDB_PSLINT_85
PSL Internal connection		
1877	PSL Int. 86	DDB_PSLINT_86
PSL Internal connection		
1878	PSL Int. 87	DDB_PSLINT_87
PSL Internal connection		
1879	PSL Int. 88	DDB_PSLINT_88
PSL Internal connection		
1880	PSL Int. 89	DDB_PSLINT_89
PSL Internal connection		
1881	PSL Int. 90	DDB_PSLINT_90
PSL Internal connection		
1882	PSL Int. 91	DDB_PSLINT_91
PSL Internal connection		
1883	PSL Int. 92	DDB_PSLINT_92
PSL Internal connection		
1884	PSL Int. 93	DDB_PSLINT_93
PSL Internal connection		
1885	PSL Int. 94	DDB_PSLINT_94
PSL Internal connection		
1886	PSL Int. 95	DDB_PSLINT_95
PSL Internal connection		
1887	PSL Int. 96	DDB_PSLINT_96
PSL Internal connection		
1888	PSL Int. 97	DDB_PSLINT_97
PSL Internal connection		
1889	PSL Int. 98	DDB_PSLINT_98
PSL Internal connection		
1890	PSL Int. 99	DDB_PSLINT_99
PSL Internal connection		
1891	PSL Int. 100	DDB_PSLINT_100
PSL Internal connection		
1892	PSL Int. 101	DDB_PSLINT_101
PSL Internal connection		
1893	PSL Int. 102	DDB_PSLINT_102
PSL Internal connection		
1894	PSL Int. 103	DDB_PSLINT_103

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
PSL Internal connection		
1895	PSL Int. 104	DDB_PSLINT_104
PSL Internal connection		
1896	PSL Int. 105	DDB_PSLINT_105
PSL Internal connection		
1897	PSL Int. 106	DDB_PSLINT_106
PSL Internal connection		
1898	PSL Int. 107	DDB_PSLINT_107
PSL Internal connection		
1899	PSL Int. 108	DDB_PSLINT_108
PSL Internal connection		
1900	PSL Int. 109	DDB_PSLINT_109
PSL Internal connection		
1901	PSL Int. 110	DDB_PSLINT_110
PSL Internal connection		
1902	PSL Int. 111	DDB_PSLINT_111
PSL Internal connection		
1903	PSL Int. 112	DDB_PSLINT_112
PSL Internal connection		
1904	PSL Int. 113	DDB_PSLINT_113
PSL Internal connection		
1905	PSL Int. 114	DDB_PSLINT_114
PSL Internal connection		
1906	PSL Int. 115	DDB_PSLINT_115
PSL Internal connection		
1907	PSL Int. 116	DDB_PSLINT_116
PSL Internal connection		
1908	PSL Int. 117	DDB_PSLINT_117
PSL Internal connection		
1909	PSL Int. 118	DDB_PSLINT_118
PSL Internal connection		
1910	PSL Int. 119	DDB_PSLINT_119
PSL Internal connection		
1911	PSL Int. 120	DDB_PSLINT_120
PSL Internal connection		
1912	PSL Int. 121	DDB_PSLINT_121
PSL Internal connection		
1913	PSL Int. 122	DDB_PSLINT_122
PSL Internal connection		
1914	PSL Int. 123	DDB_PSLINT_123
PSL Internal connection		
1915	PSL Int. 124	DDB_PSLINT_124
PSL Internal connection		
1916	PSL Int. 125	DDB_PSLINT_125
PSL Internal connection		
1917	PSL Int. 126	DDB_PSLINT_126
PSL Internal connection		
1918	PSL Int. 127	DDB_PSLINT_127
PSL Internal connection		
1919	PSL Int. 128	DDB_PSLINT_128
PSL Internal connection		
1920	PSL Int. 129	DDB_PSLINT_129
PSL Internal connection		
1921	PSL Int. 130	DDB_PSLINT_130
PSL Internal connection		
1922	PSL Int. 131	DDB_PSLINT_131
PSL Internal connection		
1923	PSL Int. 132	DDB_PSLINT_132

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
PSL Internal connection		
1924	PSL Int. 133	DDB_PSLINT_133
PSL Internal connection		
1925	PSL Int. 134	DDB_PSLINT_134
PSL Internal connection		
1926	PSL Int. 135	DDB_PSLINT_135
PSL Internal connection		
1927	PSL Int. 136	DDB_PSLINT_136
PSL Internal connection		
1928	PSL Int. 137	DDB_PSLINT_137
PSL Internal connection		
1929	PSL Int. 138	DDB_PSLINT_138
PSL Internal connection		
1930	PSL Int. 139	DDB_PSLINT_139
PSL Internal connection		
1931	PSL Int. 140	DDB_PSLINT_140
PSL Internal connection		
1932	PSL Int. 141	DDB_PSLINT_141
PSL Internal connection		
1933	PSL Int. 142	DDB_PSLINT_142
PSL Internal connection		
1934	PSL Int. 143	DDB_PSLINT_143
PSL Internal connection		
1935	PSL Int. 144	DDB_PSLINT_144
PSL Internal connection		
1936	PSL Int. 145	DDB_PSLINT_145
PSL Internal connection		
1937	PSL Int. 146	DDB_PSLINT_146
PSL Internal connection		
1938	PSL Int. 147	DDB_PSLINT_147
PSL Internal connection		
1939	PSL Int. 148	DDB_PSLINT_148
PSL Internal connection		
1940	PSL Int. 149	DDB_PSLINT_149
PSL Internal connection		
1941	PSL Int. 150	DDB_PSLINT_150
PSL Internal connection		
1942	PSL Int. 151	DDB_PSLINT_151
PSL Internal connection		
1943	PSL Int. 152	DDB_PSLINT_152
PSL Internal connection		
1944	PSL Int. 153	DDB_PSLINT_153
PSL Internal connection		
1945	PSL Int. 154	DDB_PSLINT_154
PSL Internal connection		
1946	PSL Int. 155	DDB_PSLINT_155
PSL Internal connection		
1947	PSL Int. 156	DDB_PSLINT_156
PSL Internal connection		
1948	PSL Int. 157	DDB_PSLINT_157
PSL Internal connection		
1949	PSL Int. 158	DDB_PSLINT_158
PSL Internal connection		
1950	PSL Int. 159	DDB_PSLINT_159
PSL Internal connection		
1951	PSL Int. 160	DDB_PSLINT_160
PSL Internal connection		
1952	PSL Int. 161	DDB_PSLINT_161

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
PSL Internal connection		
1953	PSL Int. 162	DDB_PSLINT_162
PSL Internal connection		
1954	PSL Int. 163	DDB_PSLINT_163
PSL Internal connection		
1955	PSL Int. 164	DDB_PSLINT_164
PSL Internal connection		
1956	PSL Int. 165	DDB_PSLINT_165
PSL Internal connection		
1957	PSL Int. 166	DDB_PSLINT_166
PSL Internal connection		
1958	PSL Int. 167	DDB_PSLINT_167
PSL Internal connection		
1959	PSL Int. 168	DDB_PSLINT_168
PSL Internal connection		
1960	PSL Int. 169	DDB_PSLINT_169
PSL Internal connection		
1961	PSL Int. 170	DDB_PSLINT_170
PSL Internal connection		
1962	PSL Int. 171	DDB_PSLINT_171
PSL Internal connection		
1963	PSL Int. 172	DDB_PSLINT_172
PSL Internal connection		
1964	PSL Int. 173	DDB_PSLINT_173
PSL Internal connection		
1965	PSL Int. 174	DDB_PSLINT_174
PSL Internal connection		
1966	PSL Int. 175	DDB_PSLINT_175
PSL Internal connection		
1967	PSL Int. 176	DDB_PSLINT_176
PSL Internal connection		
1968	PSL Int. 177	DDB_PSLINT_177
PSL Internal connection		
1969	PSL Int. 178	DDB_PSLINT_178
PSL Internal connection		
1970	PSL Int. 179	DDB_PSLINT_179
PSL Internal connection		
1971	PSL Int. 180	DDB_PSLINT_180
PSL Internal connection		
1972	PSL Int. 181	DDB_PSLINT_181
PSL Internal connection		
1973	PSL Int. 182	DDB_PSLINT_182
PSL Internal connection		
1974	PSL Int. 183	DDB_PSLINT_183
PSL Internal connection		
1975	PSL Int. 184	DDB_PSLINT_184
PSL Internal connection		
1976	PSL Int. 185	DDB_PSLINT_185
PSL Internal connection		
1977	PSL Int. 186	DDB_PSLINT_186
PSL Internal connection		
1978	PSL Int. 187	DDB_PSLINT_187
PSL Internal connection		
1979	PSL Int. 188	DDB_PSLINT_188
PSL Internal connection		
1980	PSL Int. 189	DDB_PSLINT_189
PSL Internal connection		
1981	PSL Int. 190	DDB_PSLINT_190

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
PSL Internal connection		
1982	PSL Int. 191	DDB_PSLINT_191
PSL Internal connection		
1983	PSL Int. 192	DDB_PSLINT_192
PSL Internal connection		
1984	PSL Int. 193	DDB_PSLINT_193
PSL Internal connection		
1985	PSL Int. 194	DDB_PSLINT_194
PSL Internal connection		
1986	PSL Int. 195	DDB_PSLINT_195
PSL Internal connection		
1987	PSL Int. 196	DDB_PSLINT_196
PSL Internal connection		
1988	PSL Int. 197	DDB_PSLINT_197
PSL Internal connection		
1989	PSL Int. 198	DDB_PSLINT_198
PSL Internal connection		
1990	PSL Int. 199	DDB_PSLINT_199
PSL Internal connection		
1991	PSL Int. 200	DDB_PSLINT_200
PSL Internal connection		
1992	PSL Int. 201	DDB_PSLINT_201
PSL Internal connection		
1993	PSL Int. 202	DDB_PSLINT_202
PSL Internal connection		
1994	PSL Int. 203	DDB_PSLINT_203
PSL Internal connection		
1995	PSL Int. 204	DDB_PSLINT_204
PSL Internal connection		
1996	PSL Int. 205	DDB_PSLINT_205
PSL Internal connection		
1997	PSL Int. 206	DDB_PSLINT_206
PSL Internal connection		
1998	PSL Int. 207	DDB_PSLINT_207
PSL Internal connection		
1999	PSL Int. 208	DDB_PSLINT_208
PSL Internal connection		
2000	PSL Int. 209	DDB_PSLINT_209
PSL Internal connection		
2001	PSL Int. 210	DDB_PSLINT_210
PSL Internal connection		
2002	PSL Int. 211	DDB_PSLINT_211
PSL Internal connection		
2003	PSL Int. 212	DDB_PSLINT_212
PSL Internal connection		
2004	PSL Int. 213	DDB_PSLINT_213
PSL Internal connection		
2005	PSL Int. 214	DDB_PSLINT_214
PSL Internal connection		
2006	PSL Int. 215	DDB_PSLINT_215
PSL Internal connection		
2007	PSL Int. 216	DDB_PSLINT_216
PSL Internal connection		
2008	PSL Int. 217	DDB_PSLINT_217
PSL Internal connection		
2009	PSL Int. 218	DDB_PSLINT_218
PSL Internal connection		
2010	PSL Int. 219	DDB_PSLINT_219

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
PSL Internal connection		
2011	PSL Int. 220	DDB_PSLINT_220
PSL Internal connection		
2012	PSL Int. 221	DDB_PSLINT_221
PSL Internal connection		
2013	PSL Int. 222	DDB_PSLINT_222
PSL Internal connection		
2014	PSL Int. 223	DDB_PSLINT_223
PSL Internal connection		
2015	PSL Int. 224	DDB_PSLINT_224
PSL Internal connection		
2016	PSL Int. 225	DDB_PSLINT_225
PSL Internal connection		
2017	PSL Int. 226	DDB_PSLINT_226
PSL Internal connection		
2018	PSL Int. 227	DDB_PSLINT_227
PSL Internal connection		
2019	PSL Int. 228	DDB_PSLINT_228
PSL Internal connection		
2020	PSL Int. 229	DDB_PSLINT_229
PSL Internal connection		
2021	PSL Int. 230	DDB_PSLINT_230
PSL Internal connection		
2022	PSL Int. 231	DDB_PSLINT_231
PSL Internal connection		
2023	PSL Int. 232	DDB_PSLINT_232
PSL Internal connection		
2024	PSL Int. 233	DDB_PSLINT_233
PSL Internal connection		
2025	PSL Int. 234	DDB_PSLINT_234
PSL Internal connection		
2026	PSL Int. 235	DDB_PSLINT_235
PSL Internal connection		
2027	PSL Int. 236	DDB_PSLINT_236
PSL Internal connection		
2028	PSL Int. 237	DDB_PSLINT_237
PSL Internal connection		
2029	PSL Int. 238	DDB_PSLINT_238
PSL Internal connection		
2030	PSL Int. 239	DDB_PSLINT_239
PSL Internal connection		
2031	PSL Int. 240	DDB_PSLINT_240
PSL Internal connection		
2032	PSL Int. 241	DDB_PSLINT_241
PSL Internal connection		
2033	PSL Int. 242	DDB_PSLINT_242
PSL Internal connection		
2034	PSL Int. 243	DDB_PSLINT_243
PSL Internal connection		
2035	PSL Int. 244	DDB_PSLINT_244
PSL Internal connection		
2036	PSL Int. 245	DDB_PSLINT_245
PSL Internal connection		
2037	PSL Int. 246	DDB_PSLINT_246
PSL Internal connection		
2038	PSL Int. 247	DDB_PSLINT_247
PSL Internal connection		
2039	PSL Int. 248	DDB_PSLINT_248

ORDINAL	SIGNAL NAME	ELEMENT NAME
DESCRIPTION		
PSL Internal connection		
2040	PSL Int. 249	DDB_PSLINT_249
PSL Internal connection		
2041	PSL Int. 250	DDB_PSLINT_250
PSL Internal connection		
2042	PSL Int. 251	DDB_PSLINT_251
PSL Internal connection		
2043	PSL Int. 252	DDB_PSLINT_252
PSL Internal connection		
2044	PSL Int. 253	DDB_PSLINT_253
PSL Internal connection		
2045	PSL Int. 254	DDB_PSLINT_254
PSL Internal connection		
2046	PSL Int. 255	DDB_PSLINT_255
PSL Internal connection		
2047	PSL Int. 256	DDB_PSLINT_256
PSL Internal connection		

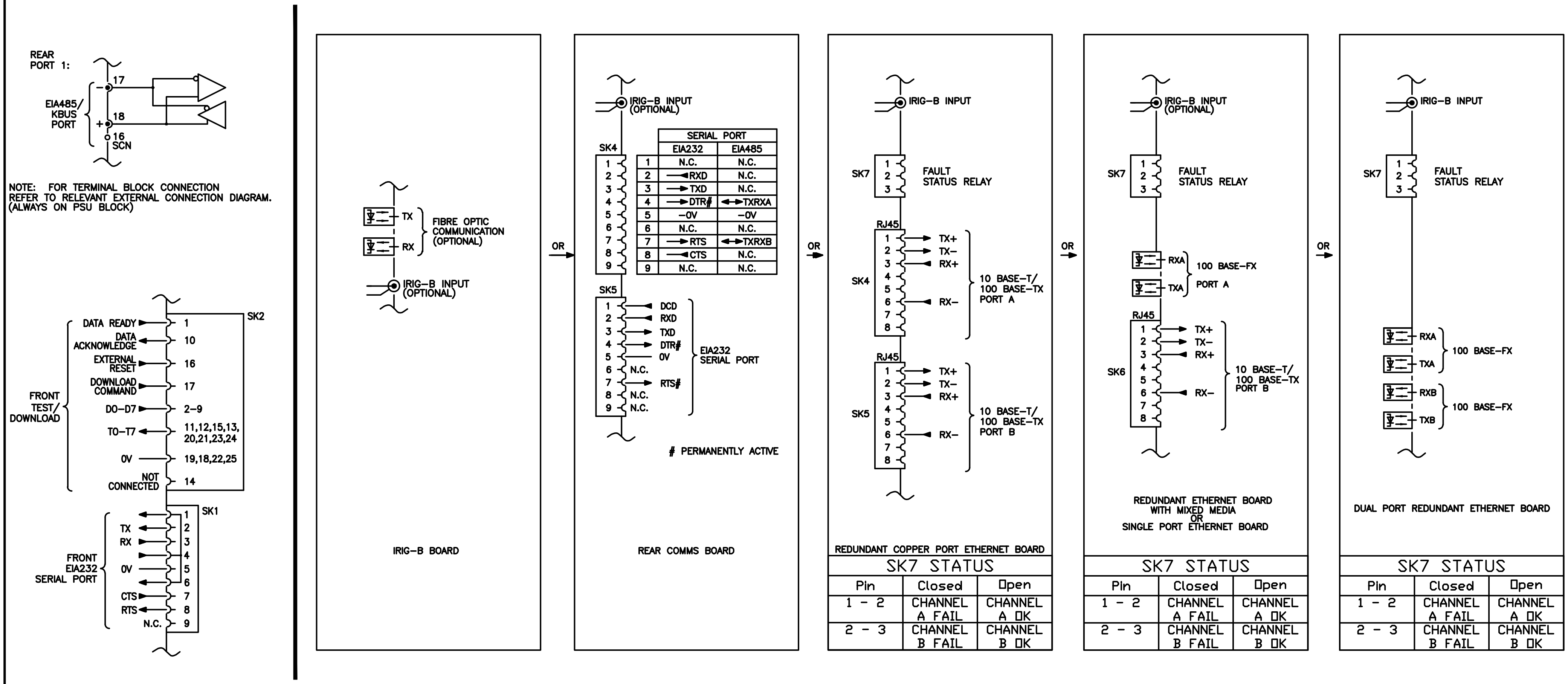
APPENDIX C

WIRING DIAGRAMS

MODEL	CORTEC OPTION*	EXTERNAL CONNECTION DIAGRAM TITLE	DRAWING-SHEET	ISSUE
Px4x	-	COMMS OPTIONS MICOM Px40 PLATFORM	10Px4001-1	K
P345	F	GENERATOR PROTECTION RELAY (80TE) WITH 90% & 100% (3rd HARMONIC) STATOR E/F & INTERTURN PROTECTION (24 I/P & 24 O/P = CLIO & RTD)	10P34501-1	F
	F	GENERATOR PROTECTION RELAY (80TE) WITH 100% STATOR E/F PROTECTION. VIA NEUTRAL EARTHING TRANSFROMER WITH SECONDARY LOADING RESISTOR (24 I/P & 24 O/P + CLIO & RTD)	10P34501-3	F
	F	GENERATOR PROTECTION RELAY (80TE) WITH 100% STATOR E/F PROTECTION. VIA NEUTRAL EARTHING TRANSFORMER. WITH PRIMARY LOADING RESISTOR (24 I/P & 24 O/P + CLIO & RTD)	10P34501-4	F
	F	GENERATOR PROTECTION RELAY (80TE) 100% STATOR EARTH FAULT (24 I/P & 24 O/P + CLIO & RTD)	10P34501-5	E
	F	GENERATOR PROTECTION RELAY (80TE) WITH 90% & 100% (3rd HARMONIC) STATOR E/ F & INTERTURN PROTECTION.(24 I/P & 24 O/P + CLIO & RTD)	10P34501-10	I
	F	GENERATOR PROTECTION RELAY (80TE) WITH 90% & 100% (3RD HARMONIC) STATOR E/F, INTERTURN PROTECTION & V CHK SYNC 24I/P & 24O/P + CLIO & RTD	10P34501-11	G
	F	GENERATOR PROTECTION RELAY (80TE) WITH 90% & 100% (3rd HARMONIC) STATOR E/ F PROTECTION & WATTMETRIC POWER (24 I/P & 24 O/P + CLIO & RTD)	10P34501-13	D
	F	GENERATOR PROTECTION RELAY (80TE) 100% STATOR E/F WITH GPM-S (24 I/P & 24 O/P + CLIO & RTD)	10P34501-14	C
	H	GENERATOR PROTECTION RELAY (80TE) WITH 90% & 100% (3rd HARMONIC) STATOR EARTH FAULT & INTERTURN PROTECTION (24 I/P & 32 O/P + RTD)	10P34502-1	H
	G	GENERATOR PROTECTION RELAY (80TE) WITH 90% & 100% (3rd HARMONIC) STATOR E/F, INTERTURN PROTECTION & V CHECK SYNC (32 I/P & 24 O/P + RTD)	10P34503-1	G
	J	GENERATOR PROTECTION RELAY (80TE) WITH V CHECK SYNC 90% & 100% (3rd HARMONIC) STATOR E/F & INTERTURN PROTECTION (32 I/P & 16 O/P + CLIO & RTD)	10P34504-1	H
	K	GENERATOR PROTECTION RELAY (80TE) WITH V CHECK SYNC 90% & 100% (3rd HARMONIC) STATOR E/F & INTERTURN PROTECTION (16 I/P & 32 O/P + CLIO & RTD)	10P34505-1	H
	P	GENERATOR PROTECTION RELAY (80TE) WITH V CHECK SYNC 90% & 100% (3rd HARMONIC) STATOR E/F & INTERTURN PROTECTION (24 I/P & 20 O/P + CLIO & RTD)	10P34506-1	H
	T	GENERATOR PROTECTION RELAY (80TE) WITH V CHECK SYNC 90% & 100%G (3rd HARMONIC) STATOR E/F & INTERTURN PROTECTION (16 I/P & 24 O/P + CLIO & RTD)	10P34507-1	H

* When selecting the applicable wiring diagram(s), refer to appropriate model's CORTEC.

PART	DESCRIPTION	MATERIAL



SK4 SERIAL PORT

	EIA232	EIA485
1	N.C.	N.C.
2	RXD	N.C.
3	TXD	N.C.
4	DTR#	TXRXA
5	–0V	–0V
6	N.C.	N.C.
7	RTS	TXRXB
8	CTS	N.C.
9	N.C.	N.C.

SK7 STATUS

Pin	Closed	Open
1 – 2	CHANNEL A FAIL	CHANNEL A OK
2 – 3	CHANNEL B FAIL	CHANNEL B OK

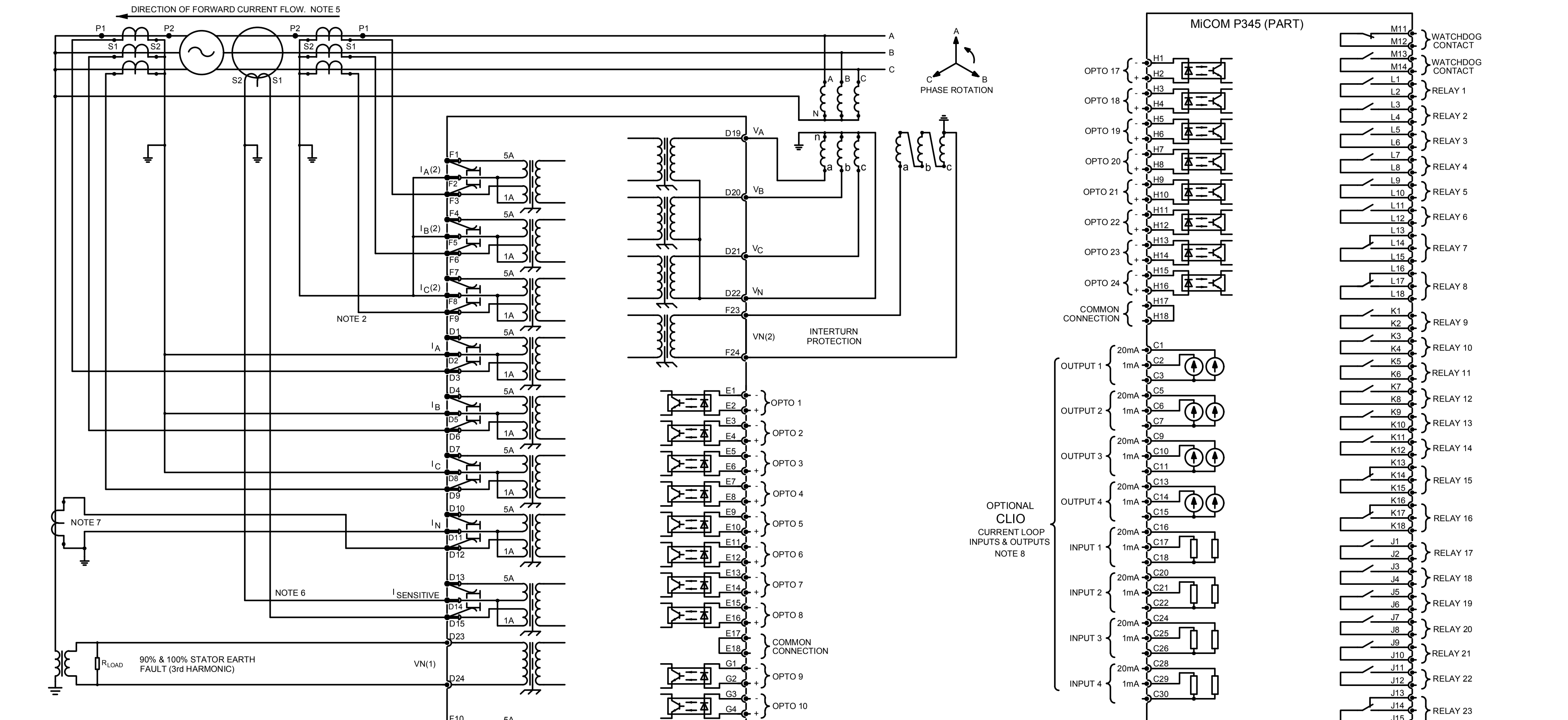
SK7 STATUS

Pin	Closed	Open
1 – 2	CHANNEL A FAIL	CHANNEL A OK
2 – 3	CHANNEL B FAIL	CHANNEL B OK

SK7 STATUS

Pin	Closed	Open
1 – 2	CHANNEL A FAIL	CHANNEL A OK
2 – 3	CHANNEL B FAIL	CHANNEL B OK

Date: 20/03/2018	Name: S WOOTTON	Drg Title: EXTERNAL CONNECTION DIAGRAM: COMMS OPTIONS MICOM Px40 PLATFORM	Next Stage:	Drg No: 10PX4001	ECN No: CID005362	Revision: K	Iteration: 3
Date:	Chkd:						
Sub-contractor reference:		CAD DATA 1:1 DIMENSIONS: mm DO NOT SCALE	Linear Tol mm: Angular Tol deg:	Grid Solutions	PLM No: A20022917	Sht: 1 Next Sht: –	Status: IN WORK
Finish:							



NOTES:
1. (a) C.T. SHORTING LINKS
(b) TERMINAL
(c) PIN TERMINAL (P.C.B. TYPE)
2. C.T. CONNECTIONS SHOWN AND ARE 1A CONNECTED AND ARE TYPICAL ONLY.
3. FOR COMMS OPTIONS SEE DRAWING 10Px4001.
4. I 100% STEF USES THE 1A INPUT FOR CURRENT <2A & 5A INPUT FOR CURRENTS 2A-10A FOR BETTER SENSITIVITY.
5. DIRECTION OF FORWARD CURRENTS FLOW FOR OPERATION OF DIRECTIONAL SEF PROTECTION.
6. DIRECTIONAL SEF FOR PARALLEL GENERATORS CONNECTED DIRECTLY TO THE BUSBARS.
7. 90% STATOR EARTH FAULT FOR SOLIDLY EARTHED OR PRIMARY RESISTANCE EARTHED GENERATORS.
8. FOR 0-10mA, 0-20mA, 4-20mA RANGE USE 20mA INPUTS & OUTPUTS FOR 0-1mA RANGE USE 1mA INPUTS & OUTPUTS.

Issue: F	Revision: CID006234 Outlines updated to GE Format	Title: EXT. CONN DIAG: GENERATOR PROTECTION RELAY (80TE) WITH 90% & 100% (3rd HARMONIC) STATOR E/F & INTERTURN PROT. (24 I/P & 24 O/P + CLIO & RTD)	
Date: 4/30/2020	Name: S.J.BURTON	Drg No: 10P34501	Sht: 1
Date:	Chkd:		Next Sht: 2

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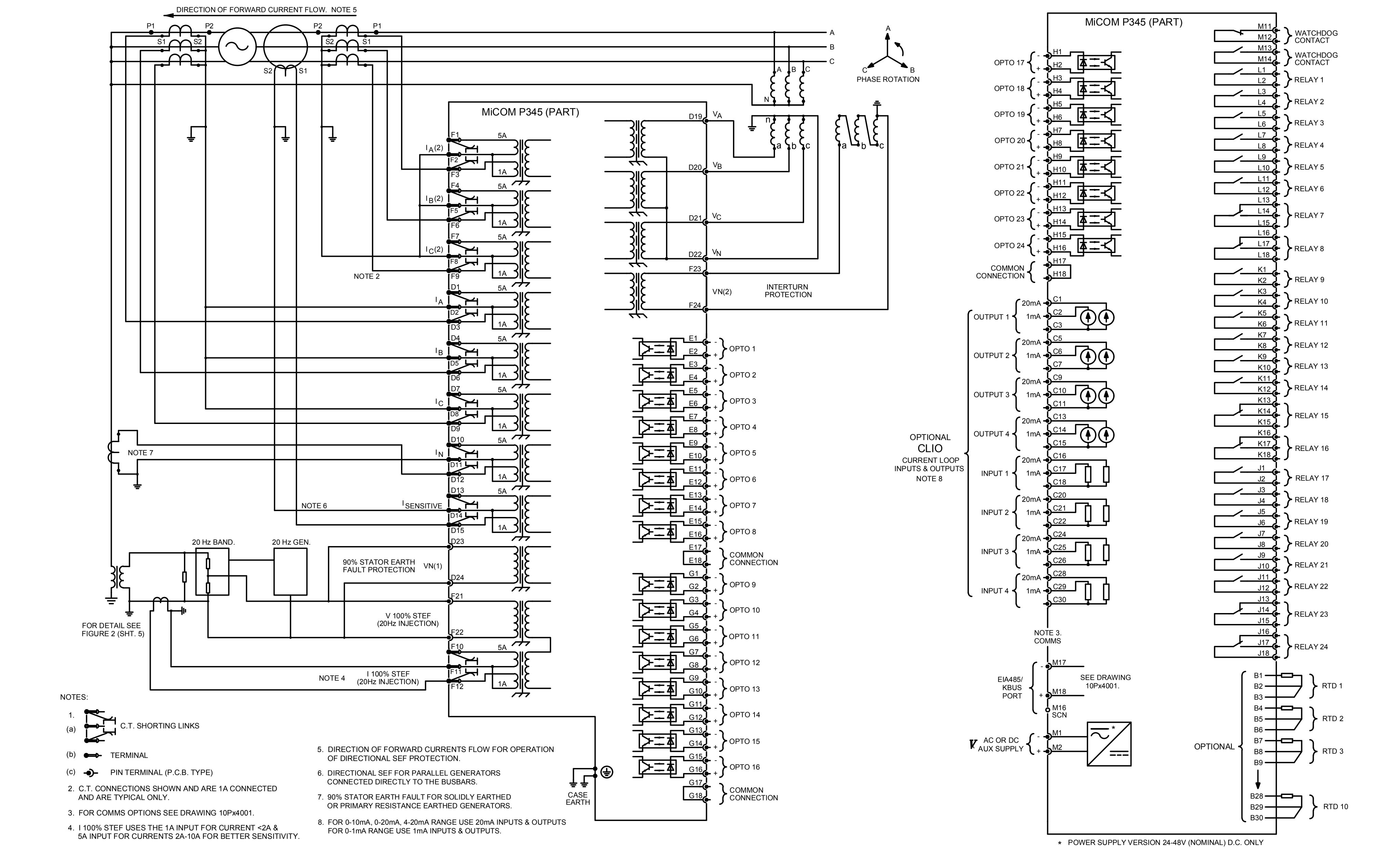

NOTES:

1. (a) C.T. SHORTING LINKS
(b) TERMINAL
(c) PIN TERMINAL (P.C.B. TYPE)
2. C.T. CONNECTIONS SHOWN AND ARE 1A CONNECTED AND ARE TYPICAL ONLY.
3. FOR COMMS OPTIONS SEE DRAWING 10Px4001.
4. I 100% STEF USES THE 1A INPUT FOR CURRENT <2A & 5A INPUT FOR CURRENTS 2A-10A FOR BETTER SENSITIVITY.
5. DIRECTION OF FORWARD CURRENTS FLOW FOR OPERATION OF DIRECTIONAL SEF PROTECTION.
6. DIRECTIONAL SEF FOR PARALLEL GENERATORS CONNECTED DIRECTLY TO THE BUSBARS.
7. 90% STATOR EARTH FAULT FOR SOLIDLY EARTHED OR PRIMARY RESISTANCE EARTHED GENERATORS.
8. FOR 0-10mA, 0-20mA, 4-20mA RANGE USE 20mA INPUTS & OUTPUTS FOR 0-1mA RANGE USE 1mA INPUTS & OUTPUTS.

Issue: F	Revision: CID006234 Outlines updated to GE Format	Title:	EXT. CONN. DIAG: GENERATOR PROT. RELAY (80TE) WITH 100% STATOR EARTH FAULT PROT. VIA NEUTRAL EARTHING TRANS. WITH SECONDARY LOADING RESISTOR (24 I/P & 24 O/P + CLIO & RTD)
Date: 4/30/2020	Name: S.J.BURTON	Drg No: 10P34501	Sht: 3
Date:	Chkd:		Next Sht: 4

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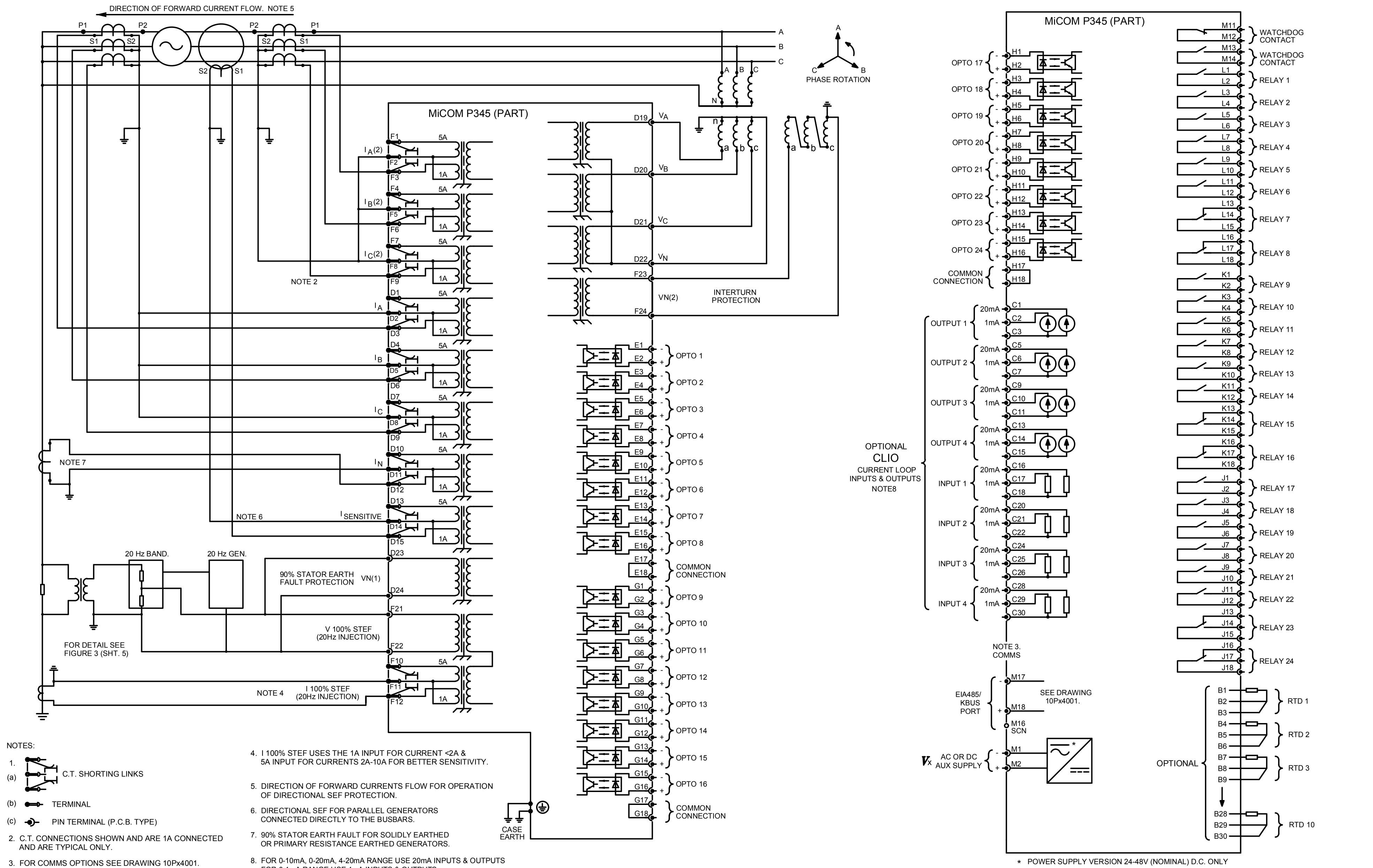

NOTES:

1. (a) C.T. SHORTING LINKS
(b) TERMINAL
(c) PIN TERMINAL (P.C.B. TYPE)
2. C.T. CONNECTIONS SHOWN AND ARE 1A CONNECTED AND ARE TYPICAL ONLY.
3. FOR COMMS OPTIONS SEE DRAWING 10Px4001.
4. I 100% STEF USES THE 1A INPUT FOR CURRENT <2A & 5A INPUT FOR CURRENTS 2A-10A FOR BETTER SENSITIVITY.
5. DIRECTION OF FORWARD CURRENTS FLOW FOR OPERATION OF DIRECTIONAL SEF PROTECTION.
6. DIRECTIONAL SEF FOR PARALLEL GENERATORS CONNECTED DIRECTLY TO THE BUSBARS.
7. 90% STATOR EARTH FAULT FOR SOLIDLY EARTHED OR PRIMARY RESISTANCE EARTHED GENERATORS.
8. FOR 0-10mA, 0-20mA, 4-20mA RANGE USE 20mA INPUTS & OUTPUTS FOR 0-1mA RANGE USE 1mA INPUTS & OUTPUTS.

Issue: F	Revision: CID006234 Outlines updated to GE Format	Title: EXT. CONN. DIAG: GENERATOR PROT. RELAY (80TE) WITH 100% STATOR EARTH FAULT PROT. VIA NEUTRAL EARTHING TRANS. WITH PRIMARY LOADING RESISTOR (24 I/P & 24 O/P + CLIO & RTD)	
Date: 4/30/2020	Name: S.J.BURTON	Drg No: 10P34501	Sht: 4
Date:	Chkd:		Next Sht: 5

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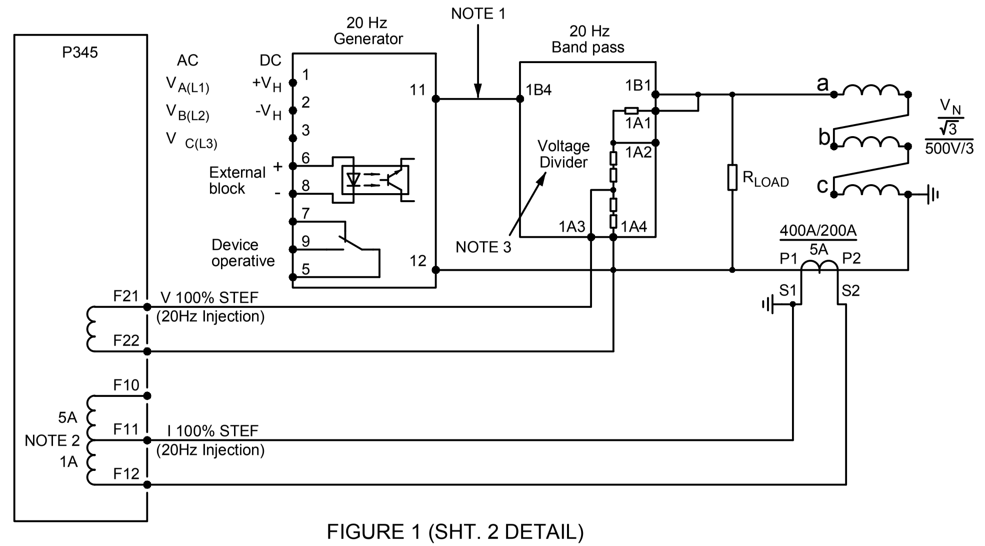

FIGURE 1 (SHT. 2 DETAIL)

100% STATOR EARTH FAULT PROTECTION (20Hz INJECTION) VIA TERMINAL EARTHING TRANSFORMER BROKEN DELTA WITH SECONDARY LOADING RESISTOR

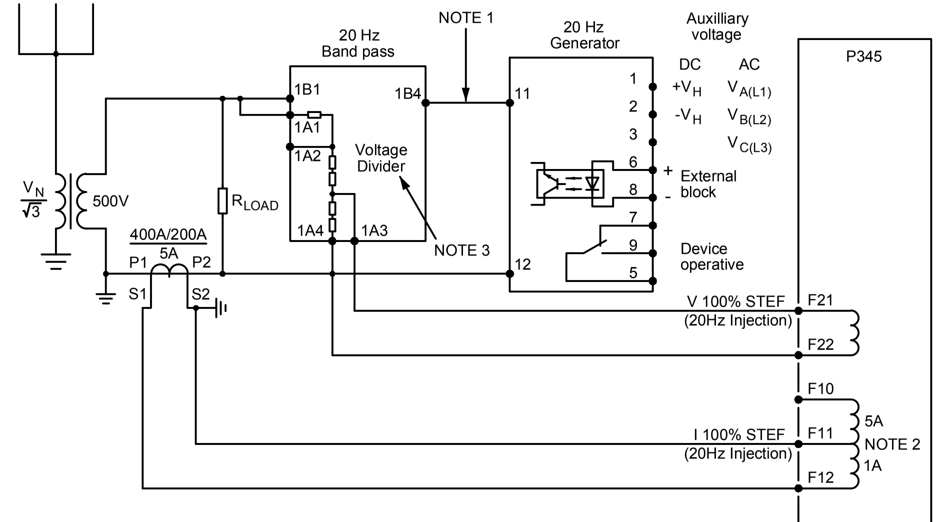

FIGURE 2 (SHT. 3 DETAIL)

100% STATOR EARTH FAULT PROTECTION (20Hz INJECTION) VIA NEUTRAL EARTHING TRANSFORMER DELTA WITH SECONDARY LOADING RESISTOR

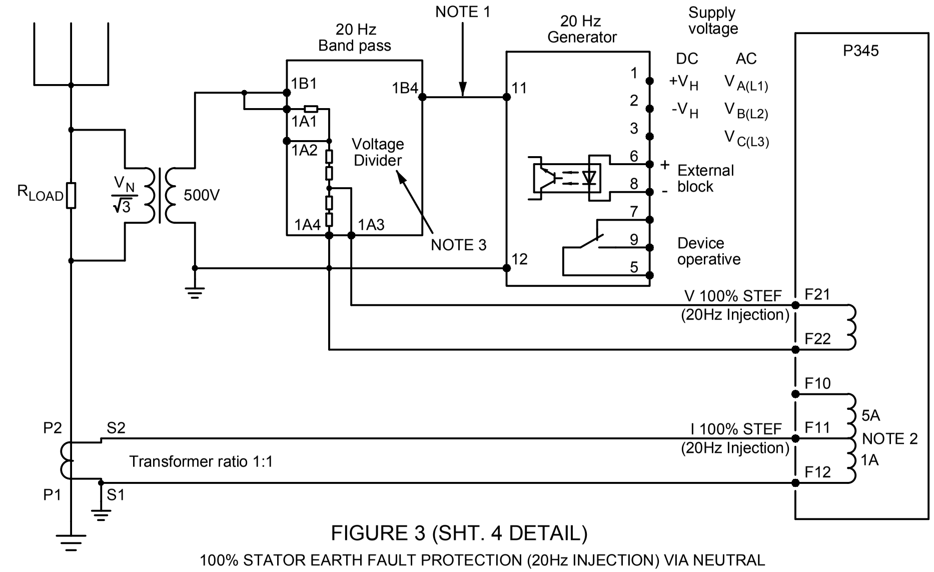

FIGURE 3 (SHT. 4 DETAIL)

100% STATOR EARTH FAULT PROTECTION (20Hz INJECTION) VIA NEUTRAL EARTHING TRANSFORMER WITH PRIMARY LOADING RESISTOR

NOTES

1. WIRING BETWEEN GENERATOR & BANDPASS FILTER TO BE SHIELDED IF IN DIFFERENT PANELS
2. FOR CURRENTS <2A USE 1A INPUTS & FOR CURRENTS 2A-10A USE 5A INPUTS
3. EACH OF THE 5 RESISTORS IN THE VOLTAGE DIVIDER (500V/200V) CIRCUIT = 330 OHMS 80 WATTS

Issue: E	Revision: CID006234 Outlines updated to GE Format	Title:	EXTERNAL CONN. DIAG: GENERATOR PROTECTION RELAY (80TE) 100% STATOR EARTH FAULT (24 I/P & 24 O/P + CLIO & RTD)
Date: 4/30/2020	Name: S.J.BURTON	Drg No:	10P34501
Date:	Chkd:	Sht: 5	Next Sht: 6

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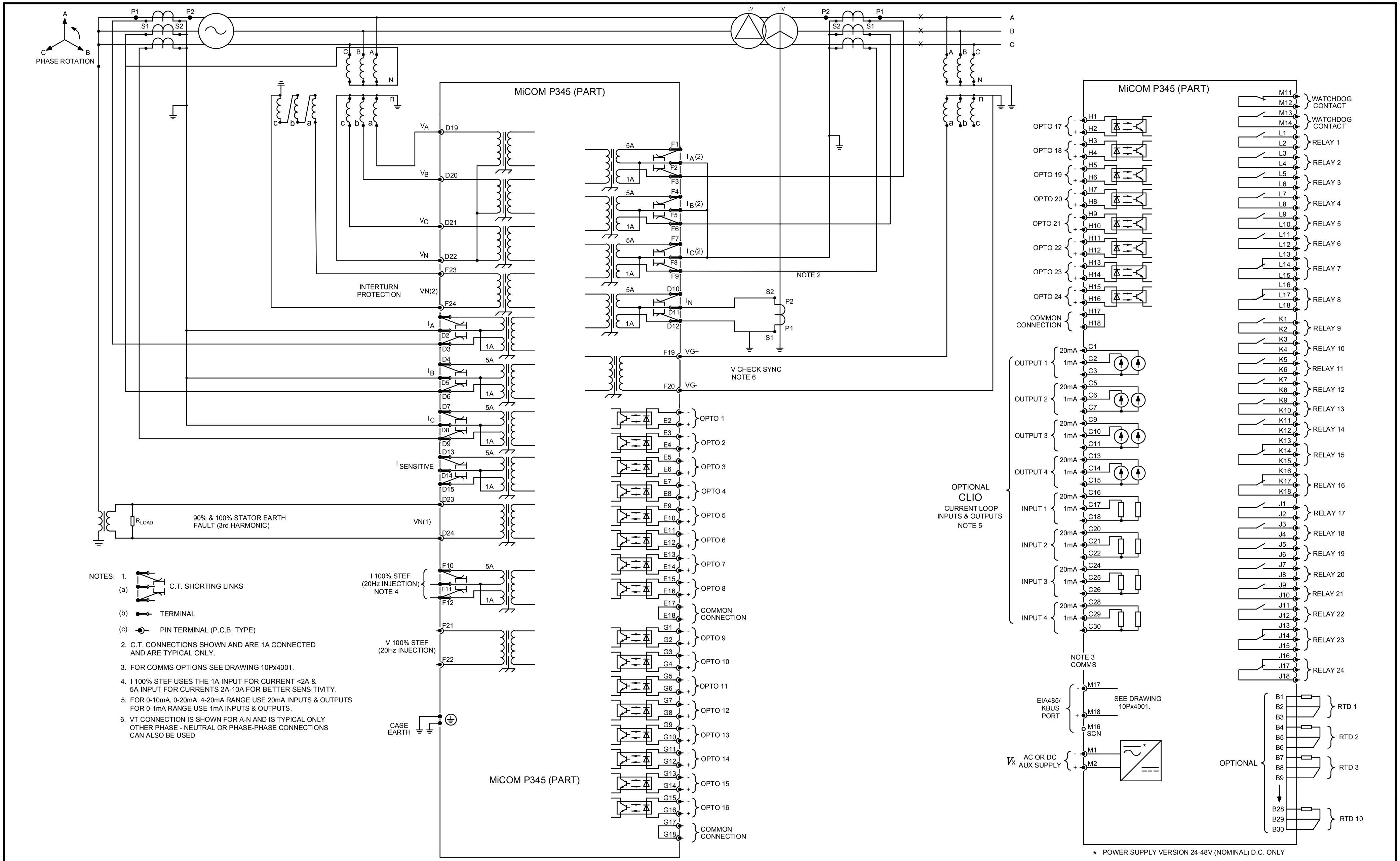

Issue: I	Revision: CID006234 Outlines updated to GE Format		Title: EXT. CONN DIAGRAM: GEN TRANSF PROT RELAY (80TE) WITH 90% & 100% (3rd HRM) STR EARTH FAULT & INTERTURN PROT.(24 I/P & 24 O/P + CLIO & RTD)
Date: 4/30/2020	Name: S.J.BURTON	GE PROPRIETARY AND CONFIDENTIAL INFORMATION	Drg No: 10P34501
Date: 05/03/2014	Chkd: G.LLOYD		Sht: 10 Next Sht: 11

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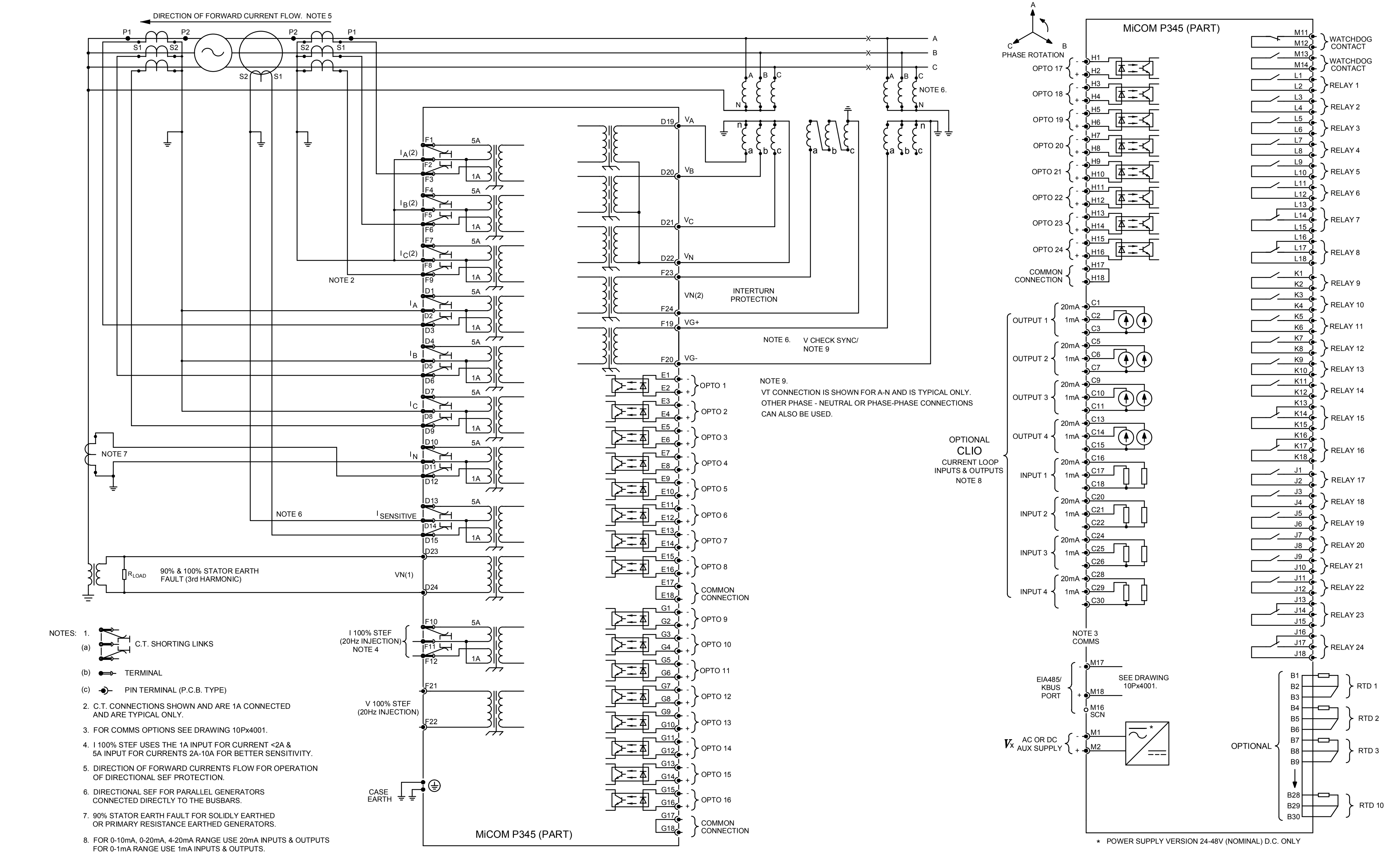


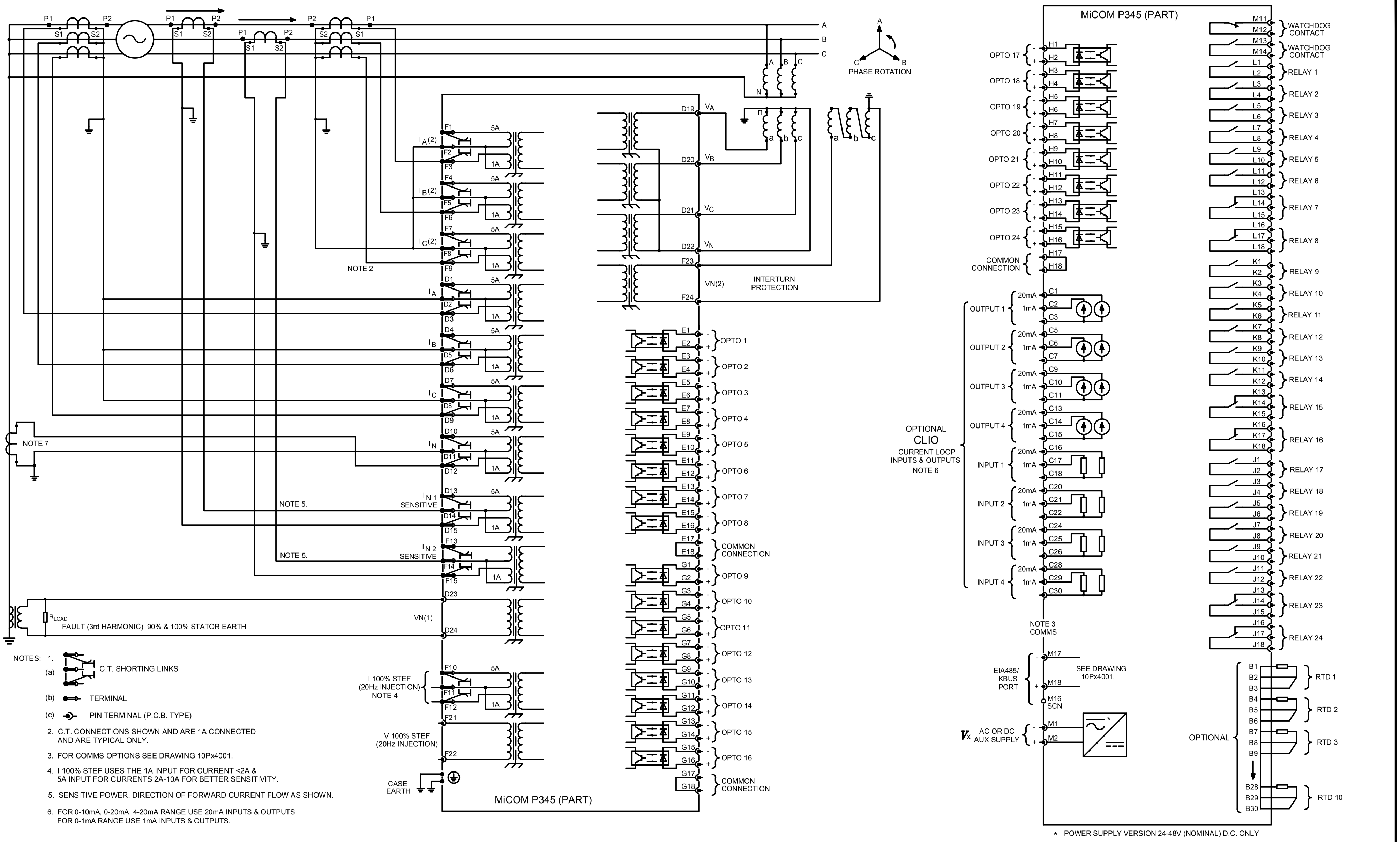
NOTE 9.
VT CONNECTION IS SHOWN FOR A-N AND IS TYPICAL ONLY.
OTHER PHASE - NEUTRAL OR PHASE-PHASE CONNECTIONS CAN ALSO BE USED.

* POWER SUPPLY VERSION 24-48V (NOMINAL) D.C. ONLY

NOTES:

1. (a) C.T. SHORTING LINKS
   (b) TERMINAL
   (c) PIN TERMINAL (P.C.B. TYPE)
2. C.T. CONNECTIONS SHOWN AND ARE 1A CONNECTED AND ARE TYPICAL ONLY.
3. FOR COMMS OPTIONS SEE DRAWING 10Px4001.
4. I 100% STEF USES THE 1A INPUT FOR CURRENT <2A & 5A INPUT FOR CURRENTS 2A-10A FOR BETTER SENSITIVITY.
5. DIRECTION OF FORWARD CURRENTS FLOW FOR OPERATION OF DIRECTIONAL SEF PROTECTION.
6. DIRECTIONAL SEF FOR PARALLEL GENERATORS CONNECTED DIRECTLY TO THE BUSBARS.
7. 90% STATOR EARTH FAULT FOR SOLIDLY EARTHED OR PRIMARY RESISTANCE EARTHED GENERATORS.
8. FOR 0-10mA, 0-20mA, 4-20mA RANGE USE 20mA INPUTS & OUTPUTS FOR 0-1mA RANGE USE 1mA INPUTS & OUTPUTS.

Issue: G	Revision: CID006234 Outlines updated to GE Format		Title: EXT. CONNECTION DIAGRAM: GENERATOR PROTECTION RELAY (80TE) WITH 90% & 100% (3RD HRM) STR EARTH FAULT, INTERTURN PROT & V CHK SYNC 24I/P & 24O/P + CLIO & RTD		
Date: 4/30/2020	Name: S.J.BURTON	GE PROPRIETARY AND CONFIDENTIAL INFORMATION	Drg No: 10P34501	Sht: 11	© UK Grid Solutions Ltd St Leonards Building Harry Kerr Drive, Stafford. ST16 1WT, UK
Date:	Chkd:			Next Sht: -	



Issue: D	Revision: CID006234 Outlines updated to GE Format	Title: EXT.CONN DIAG:GENERATOR PROTECTION RELAY (80TE) WITH 90% & 100% (3RD HARMONIC) STATOR E/F & WATTMETRIC POWER. 24 I/P & 24 O/P + CLIO & RTD
Date: 4/30/2020	Name: S.J.BURTON	Drg No: 10P34501
Date: 05/03/2014	Chkd: G.LIOYD	Sht: 13 Next Sht: -

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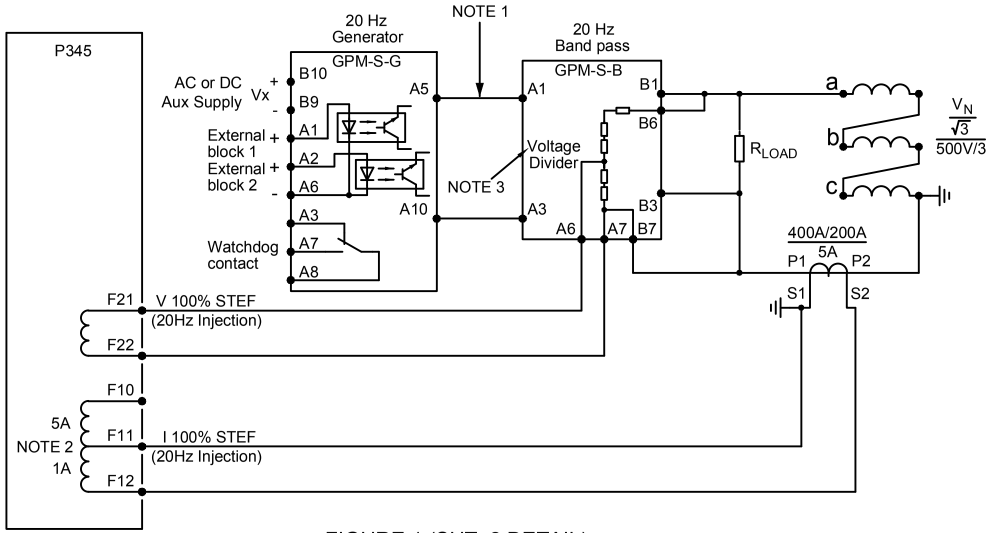


FIGURE 1 (SHT. 2 DETAIL)

100% STATOR EARTH FAULT PROTECTION (20Hz INJECTION) VIA TERMINAL EARTHING TRANSFORMER BROKEN DELTA WITH SECONDARY LOADING RESISTOR

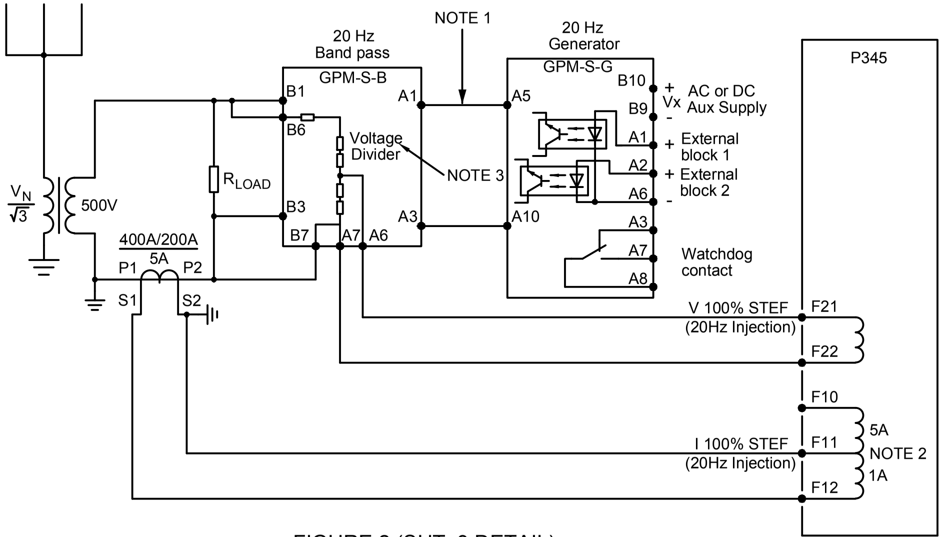


FIGURE 2 (SHT. 3 DETAIL)

100% STATOR EARTH FAULT PROTECTION (20Hz INJECTION) VIA NEUTRAL EARTHING TRANSFORMER DELTA WITH SECONDARY LOADING RESISTOR

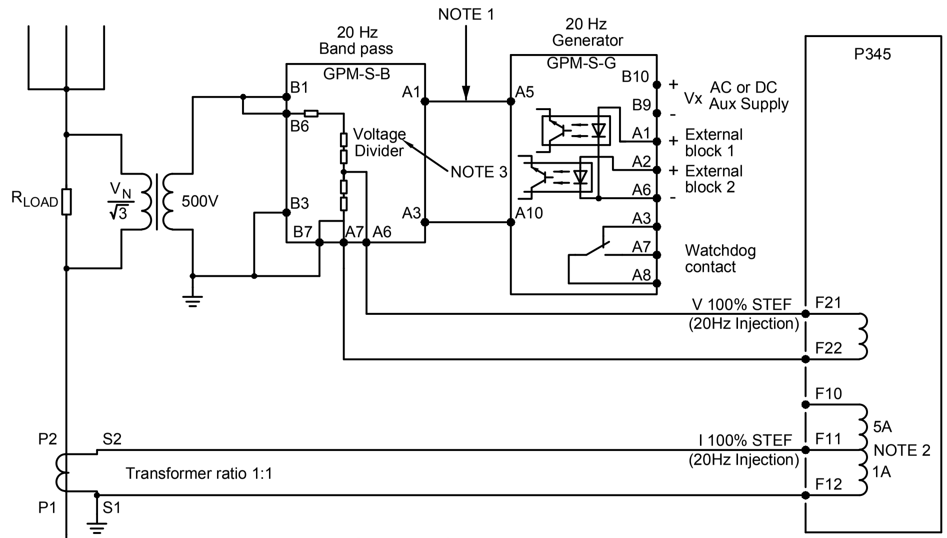


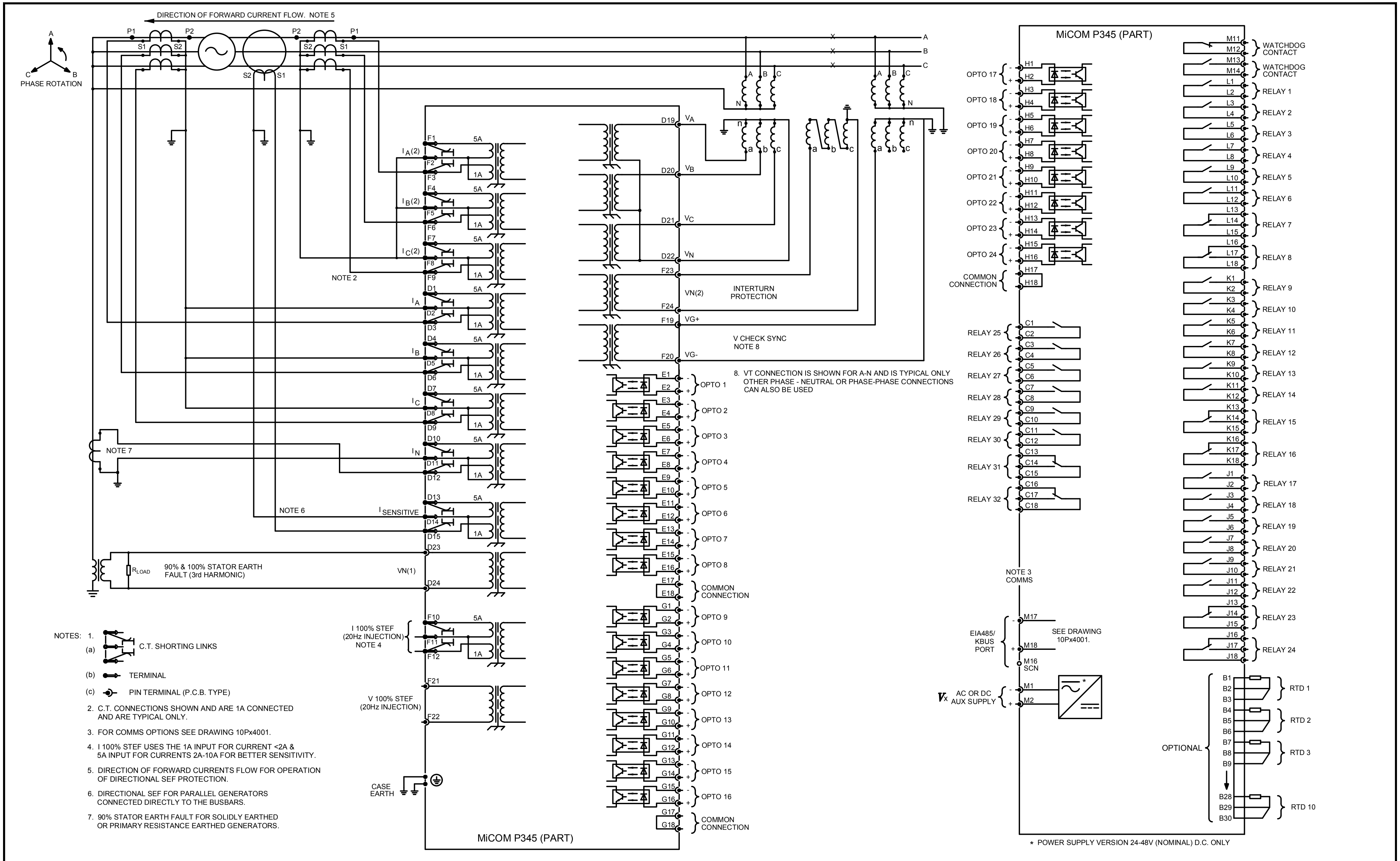
FIGURE 3 (SHT. 4 DETAIL)

100% STATOR EARTH FAULT PROTECTION (20Hz INJECTION) VIA NEUTRAL EARTHING TRANSFORMER WITH PRIMARY LOADING RESISTOR

NOTES

1. WIRING BETWEEN GENERATOR & BANDPASS FILTER TO BE SHIELDED IF IN DIFFERENT PANELS
2. FOR CURRENTS <2A USE 1A INPUTS & FOR CURRENTS 2A-10A USE 5A INPUTS
3. EACH OF THE 5 RESISTORS IN THE VOLTAGE DIVIDER (500V/200V) CIRCUIT = 330 OHMS 50 WATTS
4. FAULTS SHOULD BE CLEARED WITHIN 10 SECONDS TO AVOID DAMAGE TO THE DIVIDER INPUT OF THE GPM-S-B

Issue: C	Revision: CID006234 Outlines updated to GE Format	Title:	EXTERNAL CONN.DIAG: GENERATOR PROTECTION RELAY (80TE) 100% STATOR E/F WITH GPM-S (24 I/P & 24 O/P + CLIO & RTD)
Date: 4/30/2020	Name: S.J.BURTON	Drg No:	10P34501
Date:	Chkd: G. LLOYD	Sht: 14	Next Sht: -



Issue: H	Revision: CID006234 Outlines updated to GE Format		Title: EXT. CONN. DIAGRAM: GENERATOR PROTECTION RELAY (80TE) WITH 90% & 100% (3rd HARMONIC) STATOR EARTH FAULT & INTERTURN PROT. (24 I/P & 32 O/P + RTD)
Date: 4/30/2020	Name: S.J.BURTON	GE PROPRIETARY AND CONFIDENTIAL INFORMATION	Drg No: 10P34502
Date:	Chkd:		Sht: 1 / Next Sht: 2

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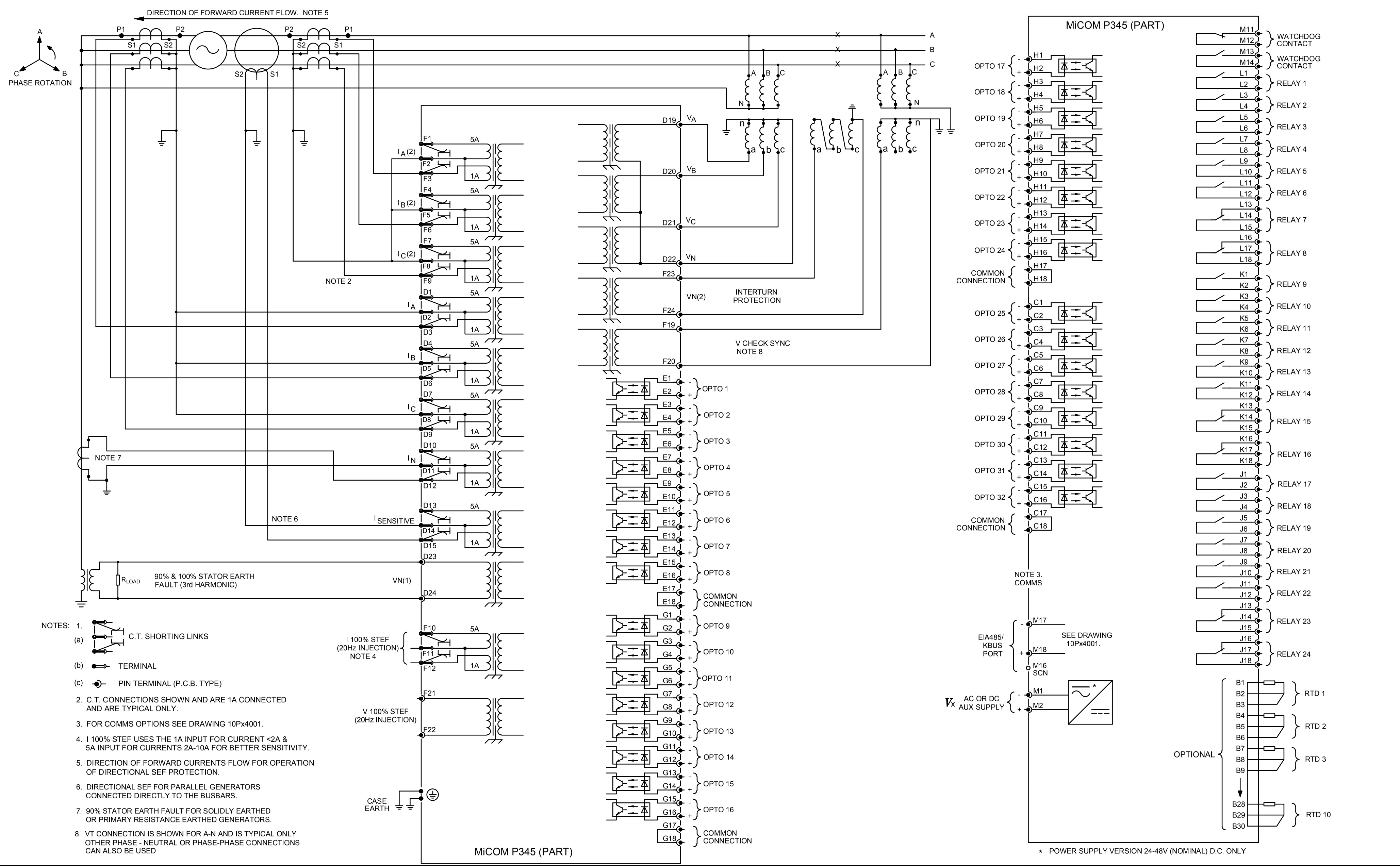
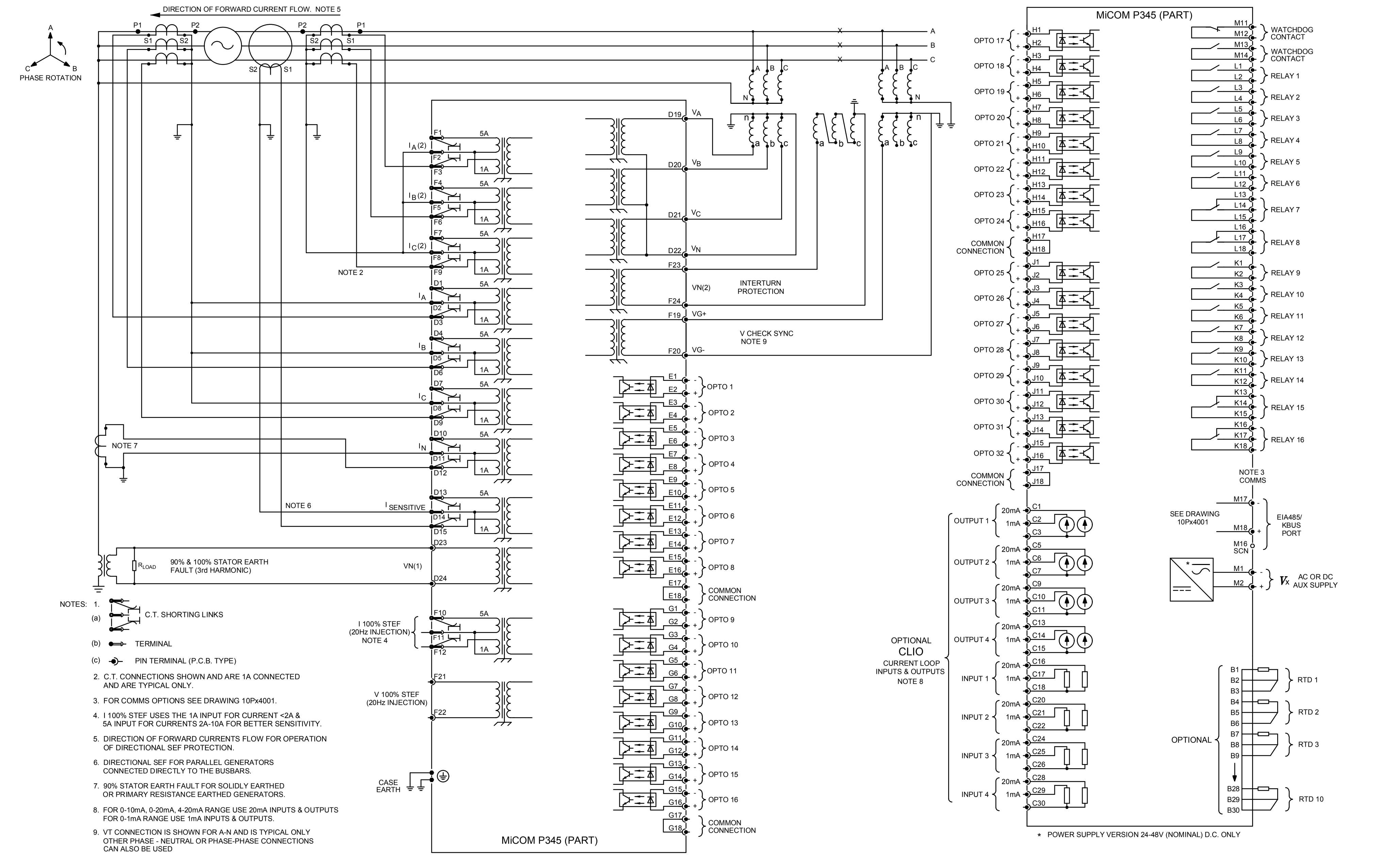


NOTES:
1. (a) C.T. SHORTING LINKS
(b) TERMINAL
(c) PIN TERMINAL (P.C.B. TYPE)
2. C.T. CONNECTIONS SHOWN AND ARE 1A CONNECTED AND ARE TYPICAL ONLY.
3. FOR COMMS OPTIONS SEE DRAWING 10Px4001.
4. I 100% STEF USES THE 1A INPUT FOR CURRENT <2A & 5A INPUT FOR CURRENTS 2A-10A FOR BETTER SENSITIVITY.
5. DIRECTION OF FORWARD CURRENTS FLOW FOR OPERATION OF DIRECTIONAL SEF PROTECTION.
6. DIRECTIONAL SEF FOR PARALLEL GENERATORS CONNECTED DIRECTLY TO THE BUSBARS.
7. 90% STATOR EARTH FAULT FOR SOLIDLY EARTHED OR PRIMARY RESISTANCE EARTHED GENERATORS.
8. VT CONNECTION IS SHOWN FOR A-N AND IS TYPICAL ONLY OTHER PHASE - NEUTRAL OR PHASE-PHASE CONNECTIONS CAN ALSO BE USED

Issue: G	Revision: CID006234 Outlines updated to GE Format		Title: EXT. CONN. DIAGRAM: GEN. PROT. RELAY (80TE) + 90% & 100% (3rd HARM) STATOR EARTH FAULT, INTERTURN PROT.& V CHECK SYNC (32 I/P & 24 O/P + RTD)		
Date: 4/30/2020	Name: S.J.BURTON	GE PROPRIETARY AND CONFIDENTIAL INFORMATION	Drg No: 10P34503	Sht: 1	© UK Grid Solutions Ltd St Leonards Building Harry Kerr Drive, Stafford. ST16 1WT, UK
Date:	Chkd:			Next Sht: 2	



NOTES:
1. (a) C.T. SHORTING LINKS
(b) TERMINAL
(c) PIN TERMINAL (P.C.B. TYPE)
2. C.T. CONNECTIONS SHOWN AND ARE 1A CONNECTED AND ARE TYPICAL ONLY.
3. FOR COMMS OPTIONS SEE DRAWING 10Px4001.
4. I 100% STEF USES THE 1A INPUT FOR CURRENT <2A & 5A INPUT FOR CURRENTS 2A-10A FOR BETTER SENSITIVITY.
5. DIRECTION OF FORWARD CURRENTS FLOW FOR OPERATION OF DIRECTIONAL SEF PROTECTION.
6. DIRECTIONAL SEF FOR PARALLEL GENERATORS CONNECTED DIRECTLY TO THE BUSBARS.
7. 90% STATOR EARTH FAULT FOR SOLIDLY EARTHED OR PRIMARY RESISTANCE EARTHED GENERATORS.
8. FOR 0-10mA, 0-20mA, 4-20mA RANGE USE 20mA INPUTS & OUTPUTS FOR 0-1mA RANGE USE 1mA INPUTS & OUTPUTS.
9. VT CONNECTION IS SHOWN FOR A-N AND IS TYPICAL ONLY OTHER PHASE - NEUTRAL OR PHASE-PHASE CONNECTIONS CAN ALSO BE USED

Issue: H	Revision: CID006234 Outlines updated to GE Format	Title: EXT. CONNECTION DIAGRAM: GEN. PROT. RELAY (80TE) + V CHECK SYNC 90% & 100% (3rd HARMONIC) STATOR EARTH FAULT & INTERTURN PROT. (32 I/P & 16 O/P + CLIO & RTD)	
Date: 4/30/2020	Name: S.J.BURTON	Drg No: 10P34504	Sht: 1
Date:	Chkd:		Next Sht: 2

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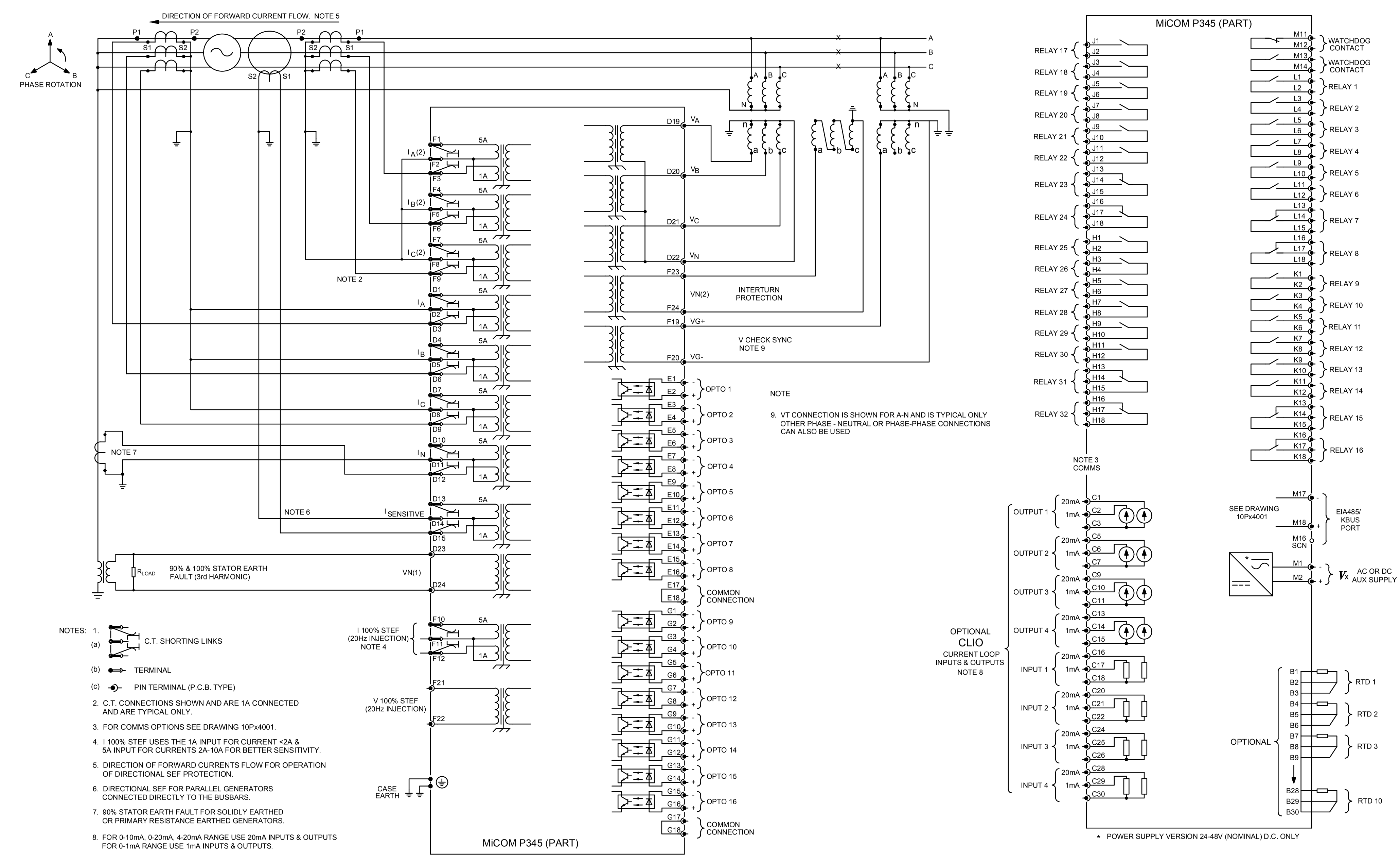

NOTE

9. VT CONNECTION IS SHOWN FOR A-N AND IS TYPICAL ONLY OTHER PHASE - NEUTRAL OR PHASE-PHASE CONNECTIONS CAN ALSO BE USED

NOTES:
1. (a) C.T. SHORTING LINKS
(b) TERMINAL
(c) PIN TERMINAL (P.C.B. TYPE)
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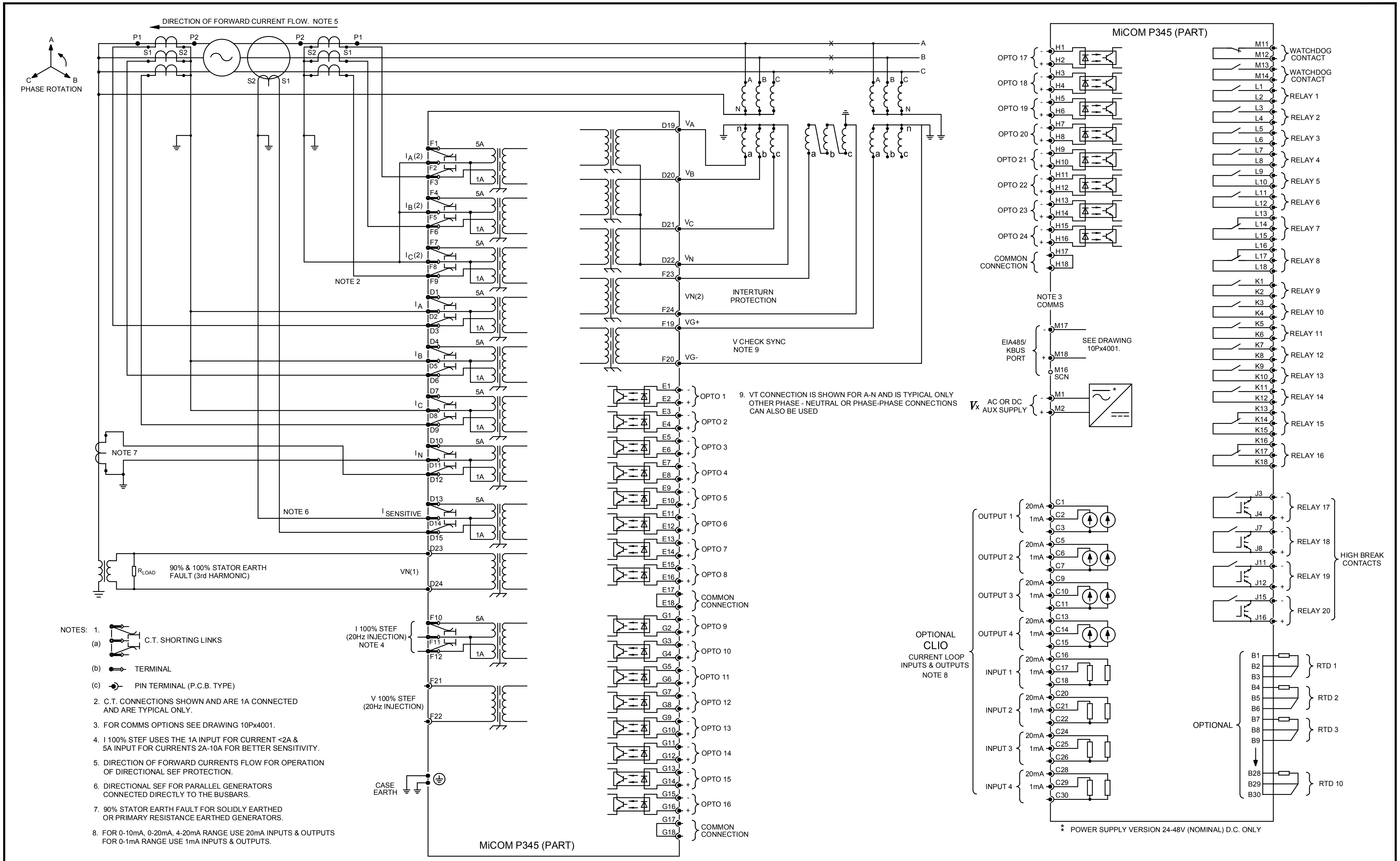
6. DIRECTIONAL SEF FOR PARALLEL GENERATORS CONNECTED DIRECTLY TO THE BUSBARS.
7. 90% STATOR EARTH FAULT FOR SOLIDLY EARTHED OR PRIMARY RESISTANCE EARTHED GENERATORS.
8. FOR 0-10mA, 0-20mA, 4-20mA RANGE USE 20mA INPUTS & OUTPUTS FOR 0-1mA RANGE USE 1mA INPUTS & OUTPUTS.

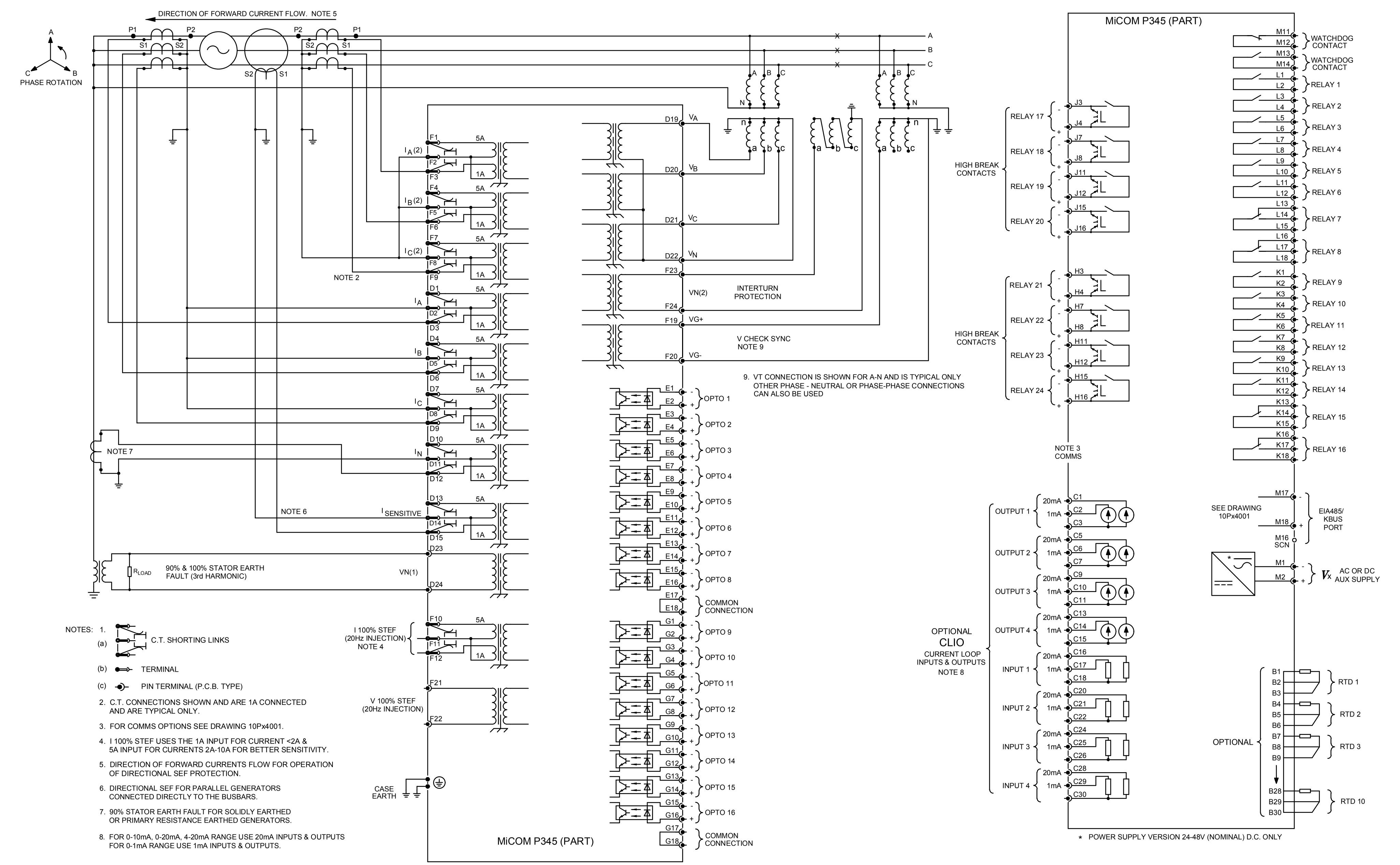
Issue:	Revision:	Title:
H	CID006234 Outlines updated to GE Format	EXT. CONNECTION DIAGRAM: GEN. PROT. RELAY (80TE) + V CHECK SYNC 90% & 100% (3rd HARMONIC) STATOR EARTH FAULT & INTERTURN PROT. (16 I/P & 32 O/P + CLIO & RTD)

Date: 4/30/2020	Name: S.J.BURTON	GE PROPRIETARY AND CONFIDENTIAL INFORMATION	Drg No: 10P34505	Sht: 1	©UK Grid Solutions Ltd
Date:	Chkd:			Next Sht: 2	St Leonards Building, Harry Kerr Drive, Stafford. ST16 1WT, UK



NOTES:
1. (a) C.T. SHORTING LINKS
(b) TERMINAL
(c) PIN TERMINAL (P.C.B. TYPE)
2. C.T. CONNECTIONS SHOWN AND ARE 1A CONNECTED AND ARE TYPICAL ONLY.
3. FOR COMMS OPTIONS SEE DRAWING 10Px4001.
4. I 100% STEF USES THE 1A INPUT FOR CURRENT <2A & 5A INPUT FOR CURRENTS 2A-10A FOR BETTER SENSITIVITY.
5. DIRECTION OF FORWARD CURRENTS FLOW FOR OPERATION OF DIRECTIONAL SEF PROTECTION.
6. DIRECTIONAL SEF FOR PARALLEL GENERATORS CONNECTED DIRECTLY TO THE BUSBARS.
7. 90% STATOR EARTH FAULT FOR SOLIDLY EARTHED OR PRIMARY RESISTANCE EARTHED GENERATORS.
8. FOR 0-10mA, 0-20mA, 4-20mA RANGE USE 20mA INPUTS & OUTPUTS FOR 0-1mA RANGE USE 1mA INPUTS & OUTPUTS.

Issue: H	Revision: CID006234 Outlines updated to GE Format	Title: EXT. CONNECTION DIAGRAM: GEN. PROT. RELAY (80TE) + V CHECK SYNC 90% & 100% (3rd HARMONIC) STATOR EARTH FAULT & INTERTURN PROT. (24 I/P & 20 O/P + CLIO & RTD)		
Date: 4/30/2020	Name: S.J.BURTON	Drg No: 10P34506	Sht: 1	©UK Grid Solutions Ltd St Leonards Building Harry Kerr Drive, Stafford. ST16 1WT, UK
Date:	Chkd:		Next Sht: 2	



9. VT CONNECTION IS SHOWN FOR A-N AND IS TYPICAL ONLY OTHER PHASE - NEUTRAL OR PHASE-PHASE CONNECTIONS CAN ALSO BE USED

NOTES:
1. (a) C.T. SHORTING LINKS
(b) TERMINAL
(c) PIN TERMINAL (P.C.B. TYPE)
2. C.T. CONNECTIONS SHOWN AND ARE 1A CONNECTED AND ARE TYPICAL ONLY.
3. FOR COMMS OPTIONS SEE DRAWING 10Px4001.
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8. FOR 0-10mA, 0-20mA, 4-20mA RANGE USE 20mA INPUTS & OUTPUTS FOR 0-1mA RANGE USE 1mA INPUTS & OUTPUTS.

Issue: H	Revision: CID006234 Outlines updated to GE Format	Title: EXT. CONNECTION DIAGRAM: GEN. PROT. RELAY (80TE) + V CHECK SYNC 90% & 100% (3rd HARMONIC) STATOR EARTH FAULT & INTERTURN PROT. (16 I/P & 24 O/P + CLIO & RTD)	
Date: 4/30/2020	Name: S.J.BURTON	Drg No: 10P34507	Sht: 1
Date: 17/03/2012	Chkd: G.LLOYD		Next Sht: 2

Imagination at work

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