# MiCOM P40 Agile

## P14N

**Technical Manual**
**Feeder Management IED**

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# 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            DISCLAIMER

It is the responsibility of the user to verify and validate the suitability of all GE Grid Automation products. This equipment must be used within its design limits. The proper application including the configuration and setting of this product to suit the power system assets is the responsibility of the user, who is also required to ensure that all local or regional safety guidelines are adhered to. Incorrect application of this product could risk damage to property/the environment, personal injuries or fatalities and shall be the sole responsibility of the person/entity applying and qualifying the product for use.

The content of this document has been developed to provide guidance to properly install, configure and maintain this product for its intended applications. This guidance is not intended to cover every possible contingency that may arise during commissioning, operation, service, or maintenance activities. Should you encounter any circumstances not clearly addressed in this document, please contact your local GE service site.

The information contained in this document is subject to change without notice.

**IT IS THE SOLE RESPONSIBILITY OF THE USER TO SECURE THEIR NETWORK AND ASSOCIATED DEVICES AGAINST CYBER SECURITY INTRUSIONS OR ATTACKS. GE GRID AUTOMATION AND ITS AFFILIATES ARE NOT LIABLE FOR ANY DAMAGES AND/OR LOSSES ARISING FROM OR RELATED TO SUCH SECURITY INTRUSION OR ATTACKS.**

### 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'.

## 2.4        COMPLIANCE

The device has undergone a range of extensive testing and certification processes to ensure and prove compatibility with all target markets. A detailed description of these criteria can be found in the Technical Specifications chapter.

# 3          PRODUCT SCOPE

The P14N feeder management IED has been designed for the protection of a wide range of overhead lines and underground cables. The P14N provides integral non-directional overcurrent and earth-fault protection and is suitable for application on solidly earthed, impedance earthed, Petersen coil earthed, and isolated systems.

In addition to the protection features, the devices include many other features to aid with power system diagnosis and fault analysis.

The P14N can be used in various applications, depending on the chosen firmware. There are two different models according to which firmware is installed: P14NB, P14NZ

- The P14NB is the base device for general application
- The P14NZ is for high impedance earth fault applications

All models are available with a range of Input/Output options, which are described in the hardware design chapter and summarised in the ordering options.

A major advantage of the P40 Agile platform is its backward compatibility with the K-series products. The P40 Agile products have been designed such that the case, back panel terminal layout and pin-outs are identical to their K-series predecessors and can be retrofitted without the usual overhead associated with replacing and rewiring devices. This allows easy upgrade of the protection system with minimum impact and minimum shutdown time of the feeder.

## 3.1          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.

# 4 FEATURES AND FUNCTIONS

## 4.1 PROTECTION FUNCTIONS

The P14N models offer the following protection functions:

| ANSI | IEC 61850 | Protection Function | P14NB | P14NZ |
|------|-----------|---------------------|-------|-------|
| 37 | | Undercurrent detection (low load) | Yes | Yes |
| 46 | NgcPTOC | Negative sequence overcurrent | Yes | Yes |
| 46BC | | Broken Conductor | Yes | Yes |
| 49 | ThmPTTR | Thermal Overload | Yes | Yes |
| 50 SOTF | | Switch onto Fault | Yes | Yes |
| 50BF | RBRF | CB Failure | Yes | Yes |
| 50 | OcpPTOC | Definite time overcurrent protection | 6 stages | 6 stages |
| 50N | EfdPTOC | Neutral/Ground Definite time overcurrent protection Measured and Derived (standard EF CT), Derived (SEF CT) | 4 stages | 4 stages |
| 51 | OcpPTOC | IDMT overcurrent protection (stages) | Yes | Yes |
| 51N | EfdPTOC | Neutral/Ground IDMT overcurrent protection | Yes | Yes |
| 64N | RefPDIF | Restricted Earth Fault | Yes | Yes |
| | | Sensitive Earth Fault (with SEF CT only) | Yes | Yes |
| 68 | | 2nd Harmonic Blocking | Yes | Yes |
| 79 | RREC | Autoreclose (3 phases) | No | 4 shots |
| | | Cold load pick up | Yes | Yes |
| | | High Impedance Earth Fault | No | Yes |
| | | Blocking scheme | Yes | Yes |
| | | Programmable curves | Yes | Yes |
| | | CB Monitoring | Yes | Yes |
| 86 | | Latching output contacts (Lockout) | Yes | Yes |

## 4.2 CONTROL FUNCTIONS

| Feature | IEC 61850 | ANSI |
|---------|-----------|------|
| Power-up diagnostics and continuous self-monitoring | | |
| Fully customizable menu texts | | |
| Function keys | FnkGGIO | |
| Alternative setting groups (4) | | |
| Programmable LEDs | LedGGIO | |
| Programmable hotkeys | | |
| Watchdog contacts | | |
| Read-only mode | | |
| NERC compliant cyber-security | | |
| Programmable allocation of digital inputs and outputs | | |
| Control inputs | PloGGIO1 | |
| Graphical programmable scheme logic (PSL) | | |
| Circuit breaker control, status & condition monitoring | XCBR | 52 |

| Feature | IEC 61850 | ANSI |
|---|---|---|
| Trip circuit and coil supervision | | |
| CT supervision (only for products with VT inputs) | | |
| VT supervision (only for products with VT inputs) | TVTR | |
| Fault locator (only for products with VT inputs) | RFLO | |

## 4.3  MEASUREMENT FUNCTIONS

The device offers the following measurement functions:

| Measurement Function | Details |
|---|---|
| Measurements<br>(Exact range of measurements depend on the device model) | Measured currents and calculated sequence and RMS currents<br>Measured voltages and calculated sequence and RMS voltages<br>Power and energy quantities<br>Peak, fixed and rolling demand values<br>Frequency measurements<br>Others measurements |
| Disturbance records (waveform capture, oscillography)<br>Channels / duration each or total / samples per cycle | 9 / 10, 5 / 24 |
| Fault Records | 10 |
| Maintenance Records | 10 |
| Event Records / Event logging | 2048 |
| Time Stamping of Opto-inputs | Yes |

## 4.4  COMMUNICATION FUNCTIONS

The device offers the following communication functions:

| Communication Function | Details |
|---|---|
| Local HMI | Yes |
| Multi-language HMI (English, French, German, Italian, Portuguese, Spanish, Russian) | Yes |
| Front port | USB |
| 1st rear port | RS485 or IRIG-B |
| 2nd rear port (optional) | RS485 or IRIG-B or single channel Ethernet or dual redundant Ethernet |
| Serial Protocols available | IEC 60870-5-103, MODBUS, Courier, DNP3 |
| Ethernet Protocols available | IEC 61850, DNP3 over Ethernet, PRP, HSR |
| Virtual inputs | 64 |
| Cyber-security | Yes |
| Enhanced Studio (S1 Agile) | Yes |

# 5        LOGIC DIAGRAMS

This technical manual contains many logic diagrams, which should help to explain the functionality of the device. Although this manual has been designed to be as specific as possible to the chosen product, it may contain diagrams, which have elements applicable to other products. If this is the case, a qualifying note will accompany the relevant part.

The logic diagrams follow a convention for the elements used, using defined colours and shapes. A key to this convention is provided below. We recommend viewing the logic diagrams in colour rather than in black and white. The electronic version of the technical manual is in colour, but the printed version may not be. If you need coloured diagrams, they can be provided on request by calling the contact centre and quoting the diagram number.

**Key:**

| | | | |
|---|---|---|---|
| Energising Quantity | ⟶ | AND gate | & |
| Internal Signal | | OR gate | 1 |
| DDB Signal | | XOR gate | XOR |
| Internal function | | NOT gate | |
| Setting cell | | Logic 0 | 0 |
| Setting value | | Timer | |
| Hardcoded setting | | Pulse / Latch | |
| Measurement Cell | | SR Latch | S / Q / R |
| Internal Calculation | | SR Latch Reset Dominant | S / Q / R$_D$ |
| Derived setting | | Latched on positive edge | ↑ |
| HMI key | | Inverted logic input | |
| Connection / Node | | Soft switch | 1 / 2 |
| Switch | | Multiplier | X |
| Switch | | Comparator for detecting undervalues | |
| Bandpass filter | | Comparator for detecting overvalues | |
| V00063 | | | |

**Figure 1: Key to logic diagrams**

# 6          FUNCTIONAL OVERVIEW
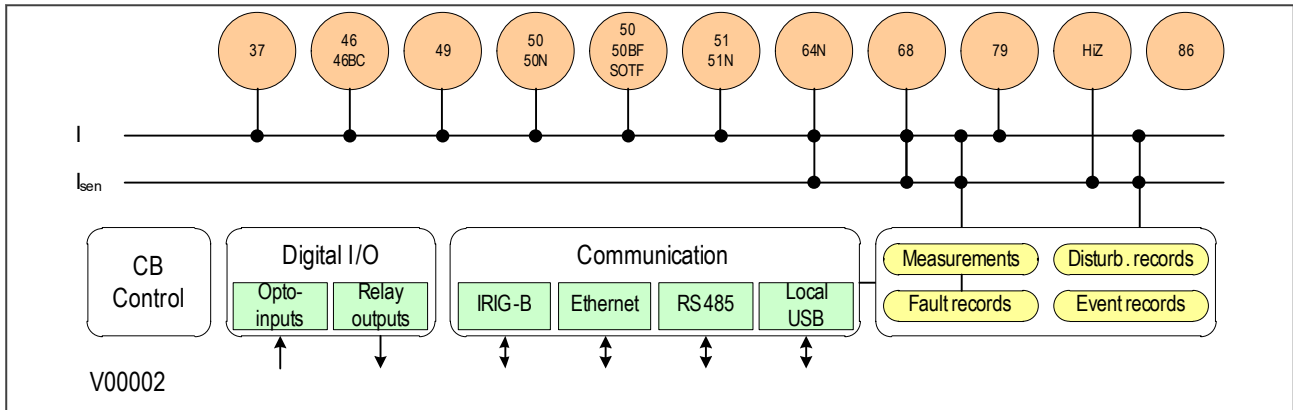


**Figure 2: Functional Overview**

# 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:**<br>**Refer to equipment documentation. Failure to do so could result in damage to the equipment** |
| ⚡ | **Warning:**<br>**Risk of electric shock** |
| ☀ | **Warning:**<br>**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:**<br>All personnel involved in installing, commissioning, or servicing this equipment must be familiar with the correct working procedures. |
| ⚠️ | **Caution:**<br>Consult the equipment documentation before installing, commissioning, or servicing the equipment. |
| ⚠️ | **Caution:**<br>Always use the equipment as specified. Failure to do so will jeopardise the protection provided by the equipment. |
| ⚡ | **Warning:**<br>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:**<br>Isolate the equipment before working on the terminal strips. |
| ⚡ | **Warning:**<br>Use a suitable protective barrier for areas with restricted space, where there is a risk of electric shock due to exposed terminals. |
| ⚠️ | **Caution:**<br>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.

CE

## 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.

c(UL)us

# 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 P40Agile 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)
- An I/O board consisting of output relay contacts and digital opto-inputs
- Communication modules
- Power supply

All 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.
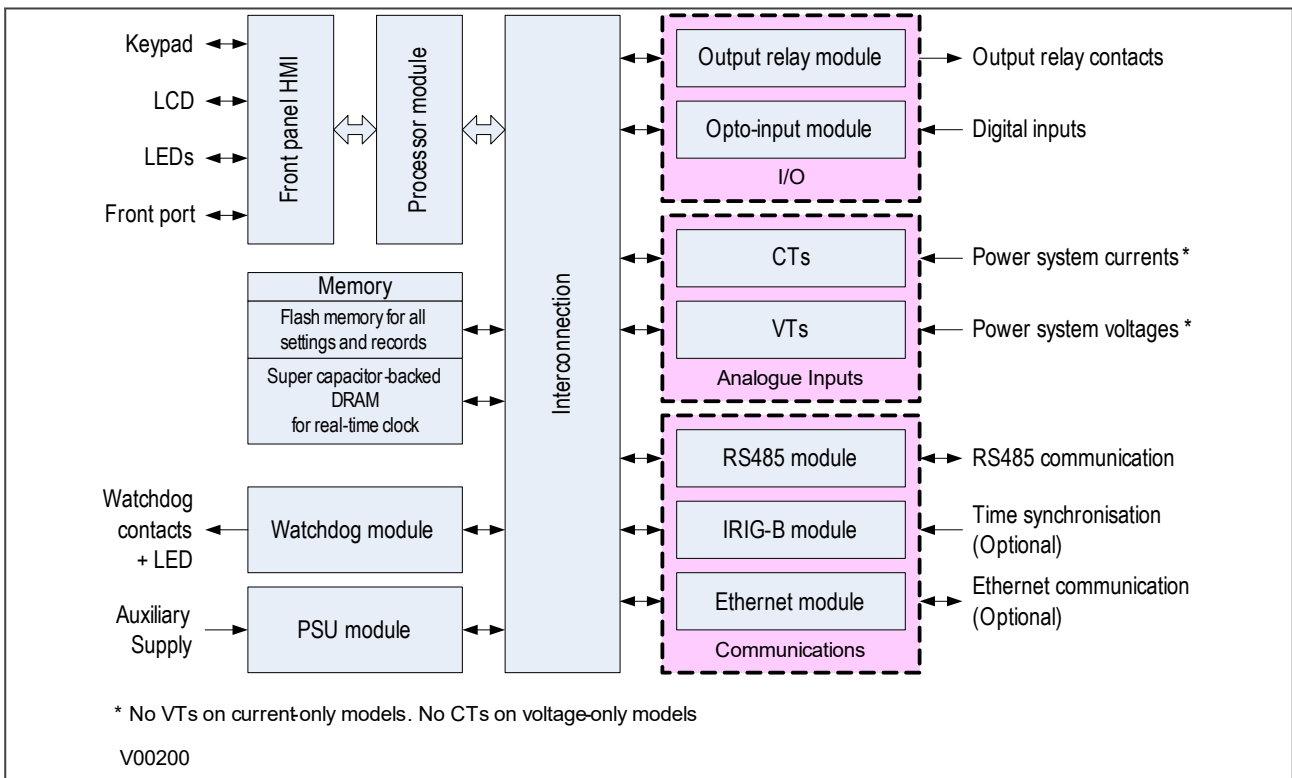


**Figure 3: Hardware design overview**

## 2.1  MEMORY AND REAL TIME CLOCK

The IED contains flash memory for storing the following operational information:

- Fault, Maintenance and Disturbance Records
- Events
- Alarms
- Measurement values
- Latched trips
- Latched contacts

Flash memory is non-volatile and therefore no backup battery is required.

A dedicated Supercapacitor keeps the on board real time clock operational for up to four days after power down.

# 3          MECHANICAL IMPLEMENTATION

All products based on the P40Agile platform have common hardware architecture. The hardware comprises two main parts; the cradle and the housing.

The cradle consists of the front panel which is attached to a carrier board into which all of the hardware boards and modules are connected. The products have been designed such that all the boards and modules comprising the product are fixed into the cradle and are not intended to be removed or inserted after the product has left the factory.

The housing comprises the housing metalwork and connectors at the rear into which the boards in the cradle plug into.



R00103
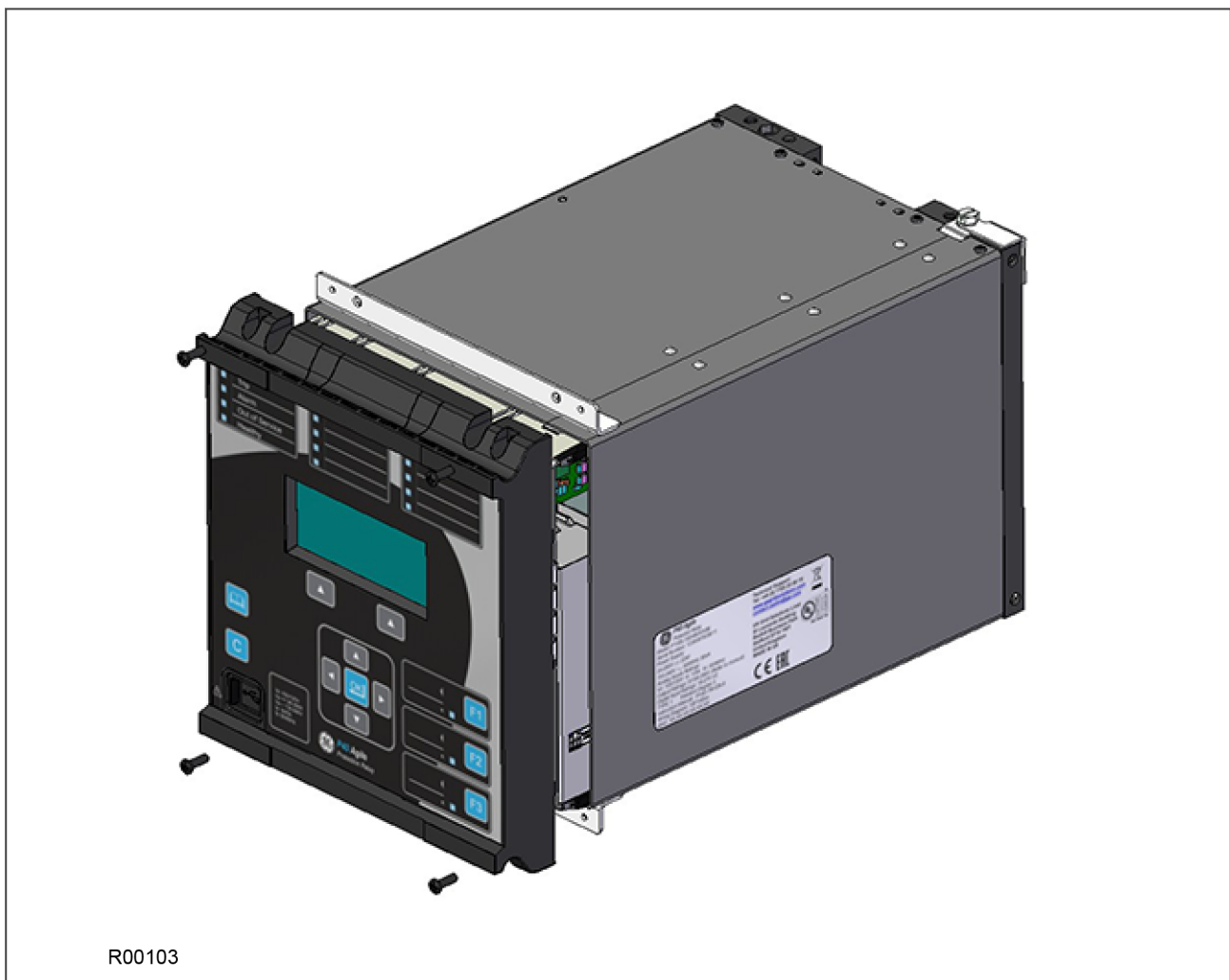
**Figure 4: Exploded view of IED**

## 3.1       HOUSING VARIANTS

The P40 Agile range of products are implemented in one of three 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: 20TE, 30TE and 40TE. The products in the P40Agile range can be used as a K-series refit and the cases, cradle, and pin-outs are completely inter-compatible. The case dimensions and compatibility criteria are as follows:

| Case width (TE) | Case width (mm) | Equivalent K series |
|---|---|---|
| 20TE | 102.4 mm (4 inches) | KCGG140/142 |
| 30TE | 154.2 mm (6 inches) | KCEG140/142 |
| 40TE | 203.2 mm (8 inches) | KCEG140/142 |

## 3.2 20TE REAR PANEL

The 20TE rear panel consists of two MIDOS heavy duty terminal blocks.



R00202
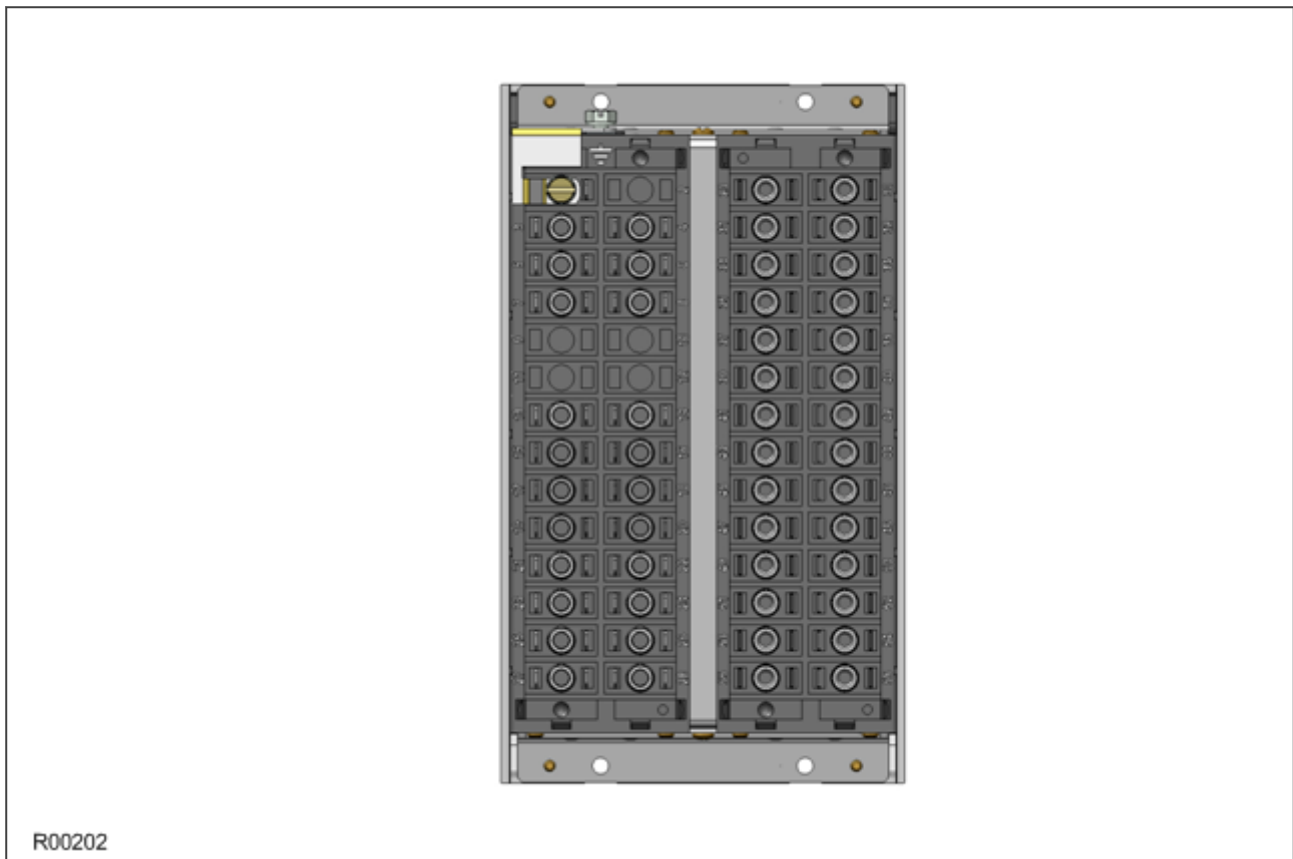
**Figure 5: 20TE rear panel**

## 3.3 30TE REAR PANEL

The 30TE rear panel consists of either:

- Three MIDOS heavy duty terminal blocks
- Two MIDOS heavy duty terminal blocks and a communication board
- Two MIDOS heavy duty terminal blocks and a blanking panel
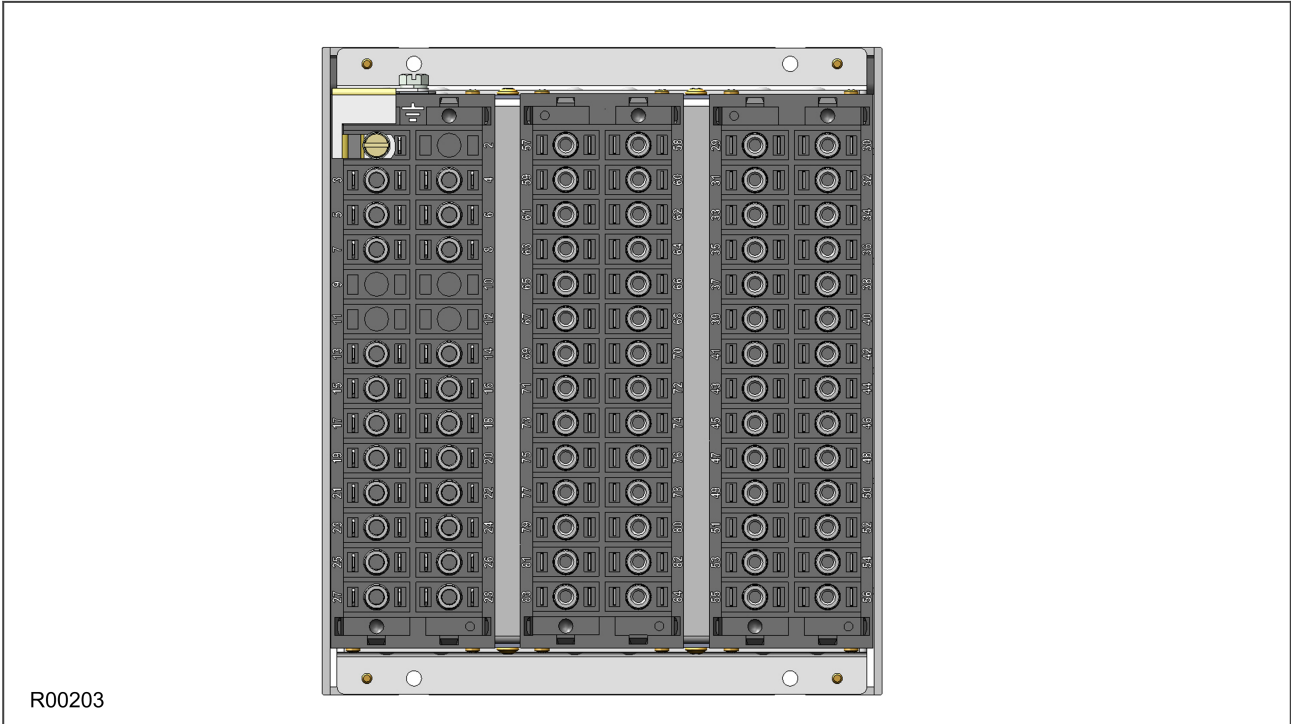
**Figure 6: 30TE Three-MIDOS block rear panel**
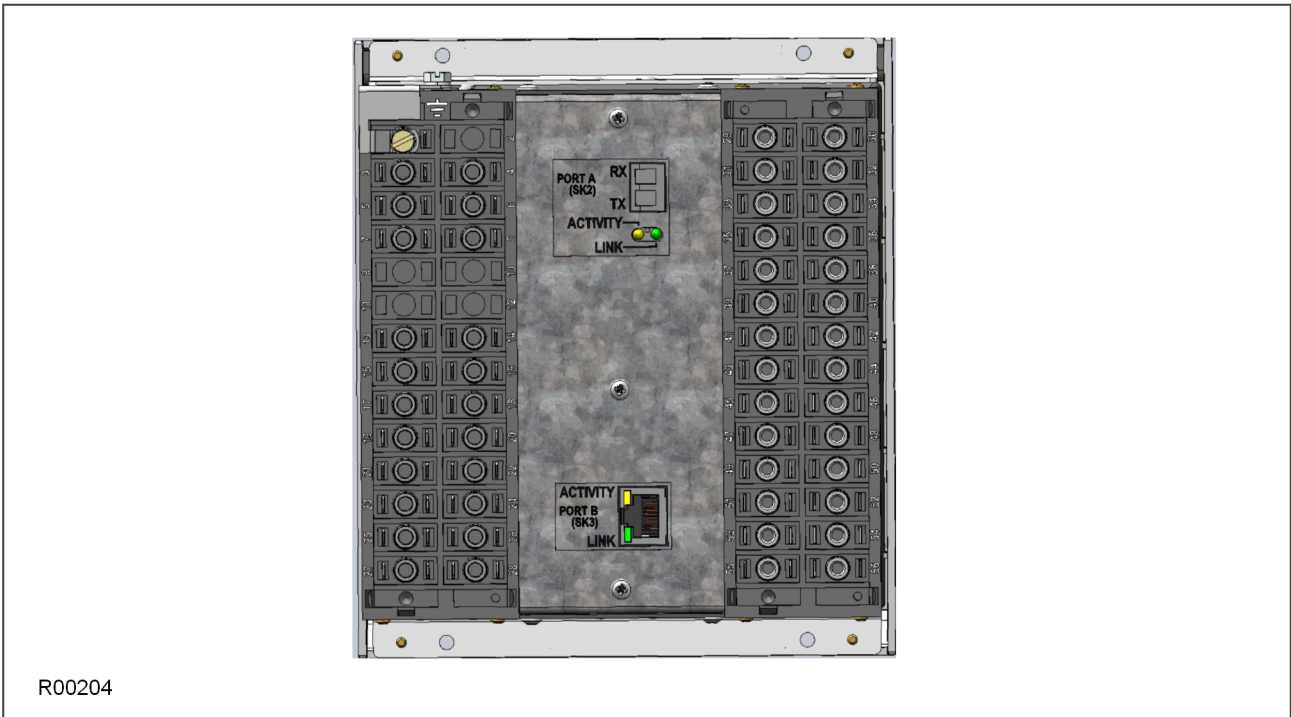


**Figure 7: 30TE Two-MIDOS block + communications rear panel**
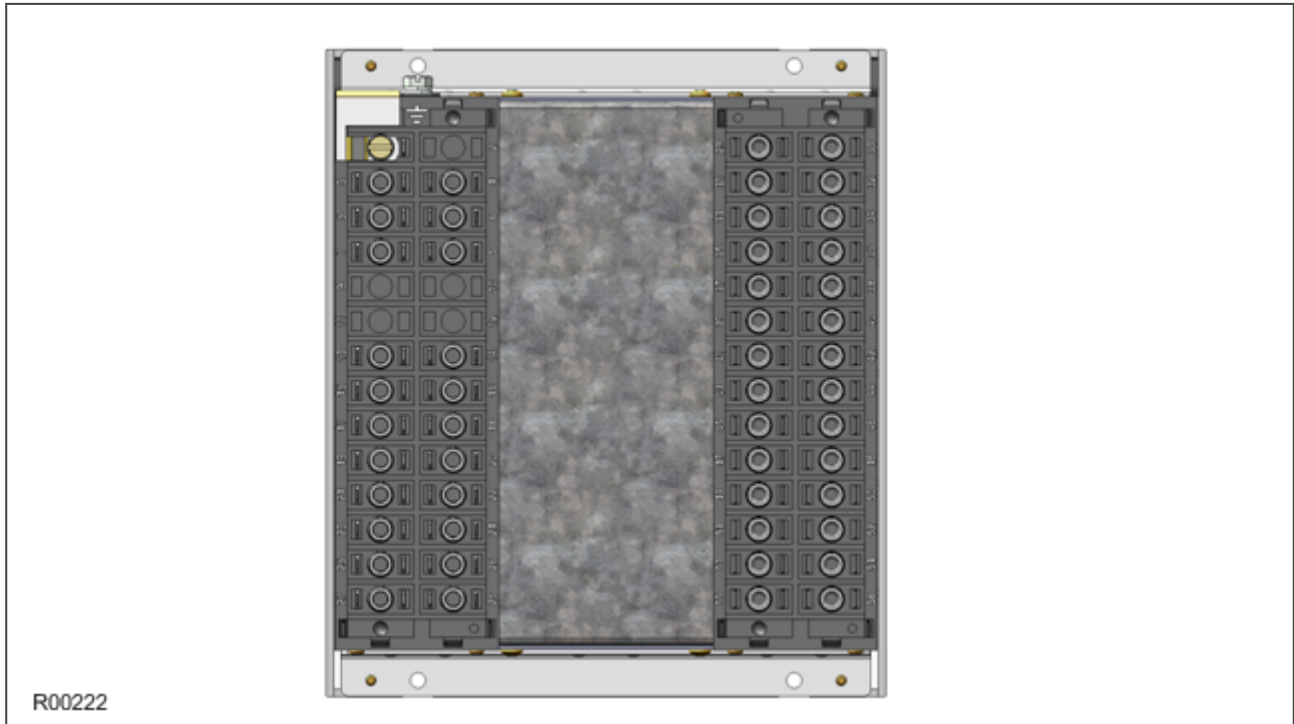
**Figure 8: 30TE Two-MIDOS block + blanking plate**

## 3.4      40TE REAR PANEL

The 40TE rear panel consists of:

- Three MIDOS heavy duty terminal blocks and a communication board
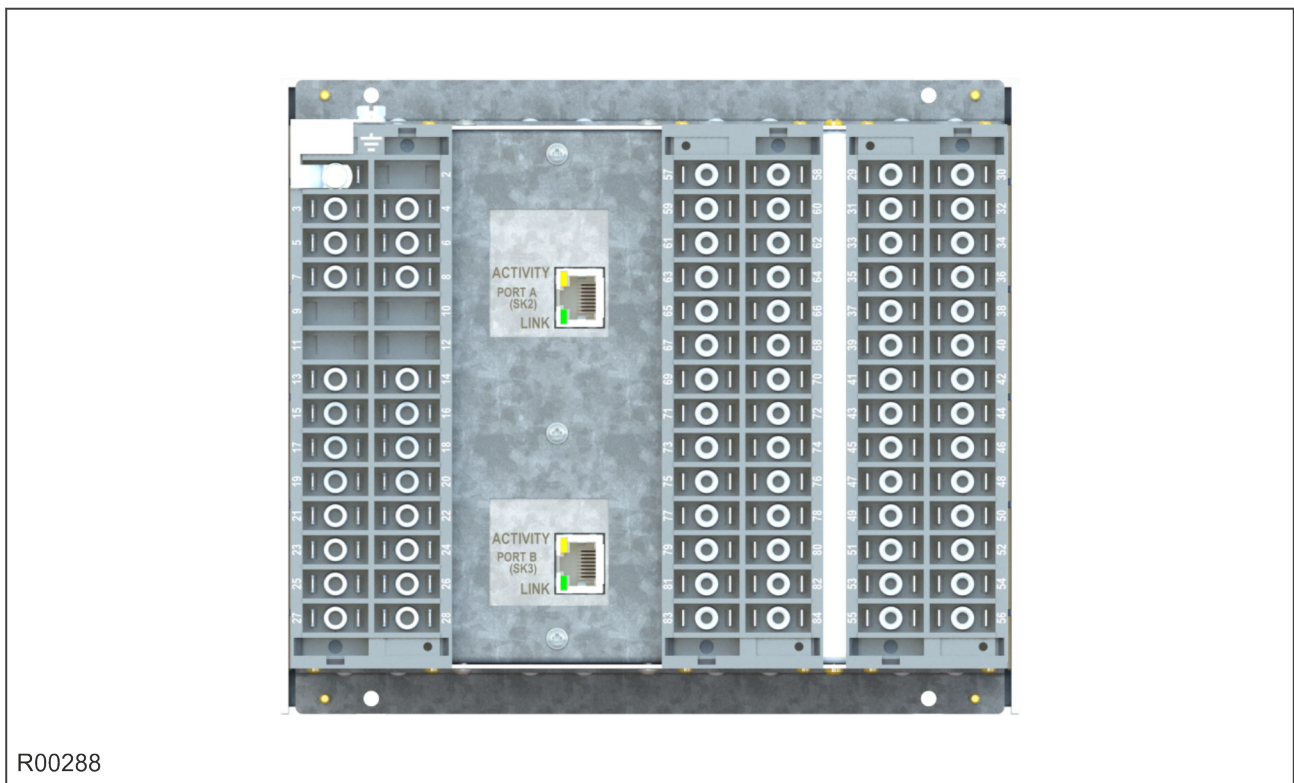


**Figure 9: 40TE Three-MIDOS block + communications rear panel**

# 4        TERMINAL CONNECTIONS

## 4.1        I/O OPTIONS

| Component | I/O option A | I/O option B | I/O option C | I/O option D | I/O option E | I/O option F | I/O option G | I/O option H | I/O option J |
|---|---|---|---|---|---|---|---|---|---|
| Digital inputs | 8 (1 group of 3 and 1 group of 5) | 11 (2 groups of 3 and 1 group of 5) | 11 (1 group of 3, 1 group of 5 and 3 individual) | 13 (1 group of 3 and 2 groups of 5) | 3 (1 group of 3) | 6 (1 group of 3 and 3 individual) | 7 1 group of 5 and 2 individual) | 10 1 group of 3, 1 group of 5 and 2 individual) | 12 (2 groups of 5 and 2 individual) |
| Output relays | 8 (NO) | 12 (NO) | 12 (11 NO, 1 NC) | 12 (NO) | 4 (NO) | 8 (7 NO, 1 NC) | 8 (NO) | 12 (NO) | 12 (NO) |

> *Note:*
> *I/O options C, F, G, H and J are suitable for Trip Circuit Supervision (TCS) applications.*

> *Note:*
> *For details of terminal connections, refer to the Wiring Diagrams Appendix.*

# 5        FRONT PANEL

## 5.1        20TE FRONT PANEL



R00100

**Figure 10: Front panel (20TE)**

The figures show the front panels for the 20TE variant.

It consists of:

- LCD display
- Keypad
- USB port
- 4 × fixed function tri-colour LEDs
- 4 × programmable tri-colour LEDs

## 5.2        30TE FRONT PANEL



R00101

**Figure 11: Front panel (30TE)**

The figures show the front panels for the 30TE variant.

It consists of:

- LCD display
- Keypad
- USB port
- 4 x fixed function tri-colour LEDs
- 8 x programmable tri-colour LEDs
- 3 x function keys
- 3 x tri-colour LEDs for the function keys

## 5.3          40TE FRONT PANEL



R00102

**Figure 12: Front panel (40TE)**

The figure shows the front panel for the 40TE variant.

It consists of:

- LCD display
- Keypad
- USB port
- 4 x fixed function tri-colour LEDs
- 8 x programmable tri-colour LEDs
- 3 x function keys
- 3 x tri-colour LEDs for the function keys

## 5.4          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. | △ |

## 5.5 LIQUID CRYSTAL DISPLAY

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

## 5.6 USB PORT

The USB port is situated on the front panel in the bottom left hand corner, 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.**

## 5.7      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.

## 5.8      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.

## 5.9      PROGRAMABLE LEDS

The device has a number of programmable LEDs. All of the programmable LEDs on the unit are tri-colour and can be set to RED, YELLOW or GREEN.

In the 20TE case, four programmable LEDs are available. In 30TE and 40TE, eight are available.

# CHAPTER 4

# SOFTWARE DESIGN

# 1          CHAPTER OVERVIEW

This chapter describes the software design of the IED.

This chapter contains the following sections:

## 2         SOFTWARE DESIGN OVERVIEW

The range of products based on the P40 Agile platform can be conceptually categorised 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.
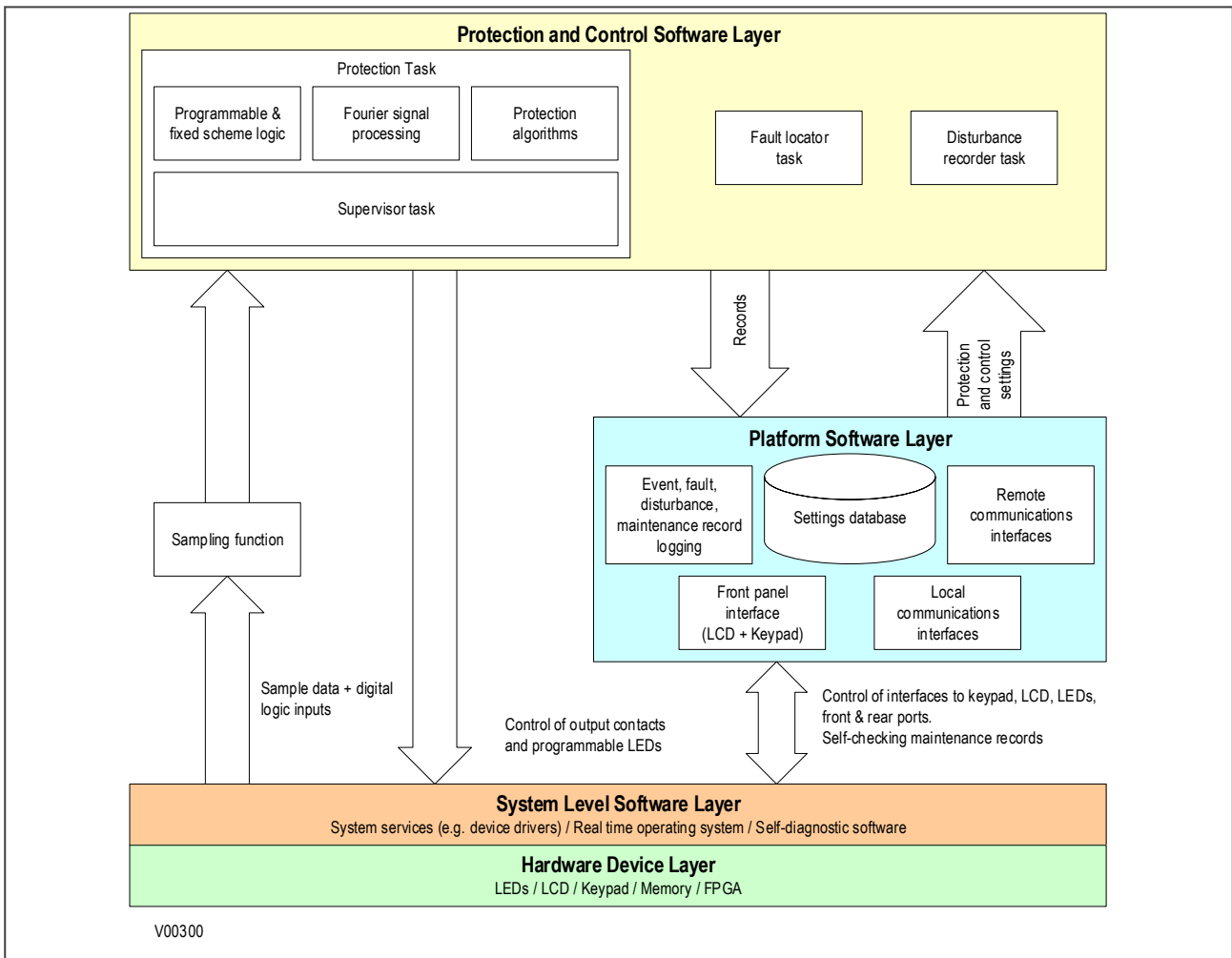


**Figure 13: Software structure**

The software 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 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.

## 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 (which is used to back up the SRAM)
- The integrity of the non-volatile memory, which 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-isolated 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 supercapacitor or 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          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:

*(samples per cycle) × (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:
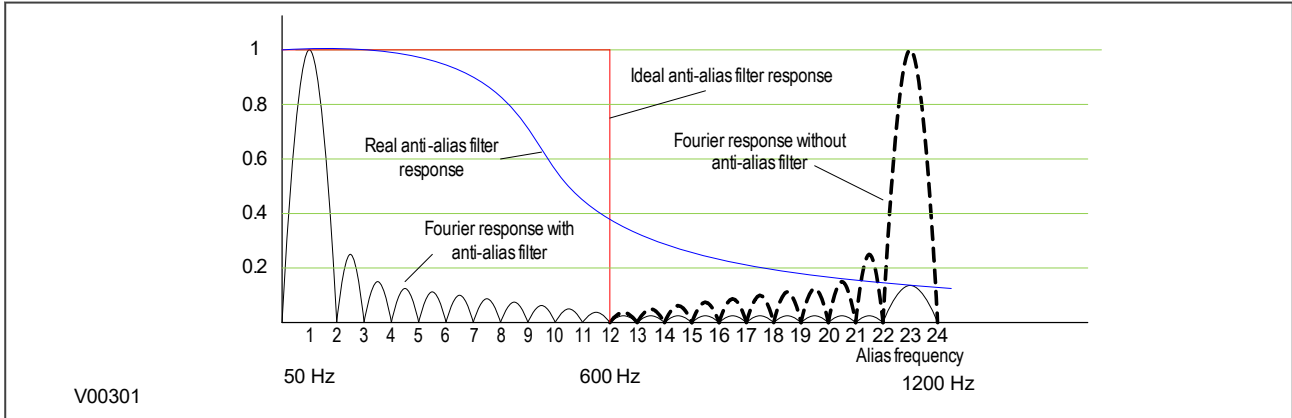


**Figure 14: Frequency Response (indicative only)**

## 5.4          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.

## 5.5          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 (flash memory). The operation of the record logging to 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 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.

## 5.6       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.

## 5.7       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.

## 5.8       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.
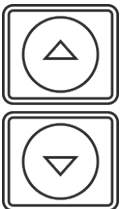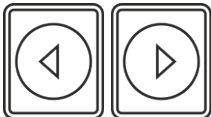
## 3        USING THE HMI PANEL

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.
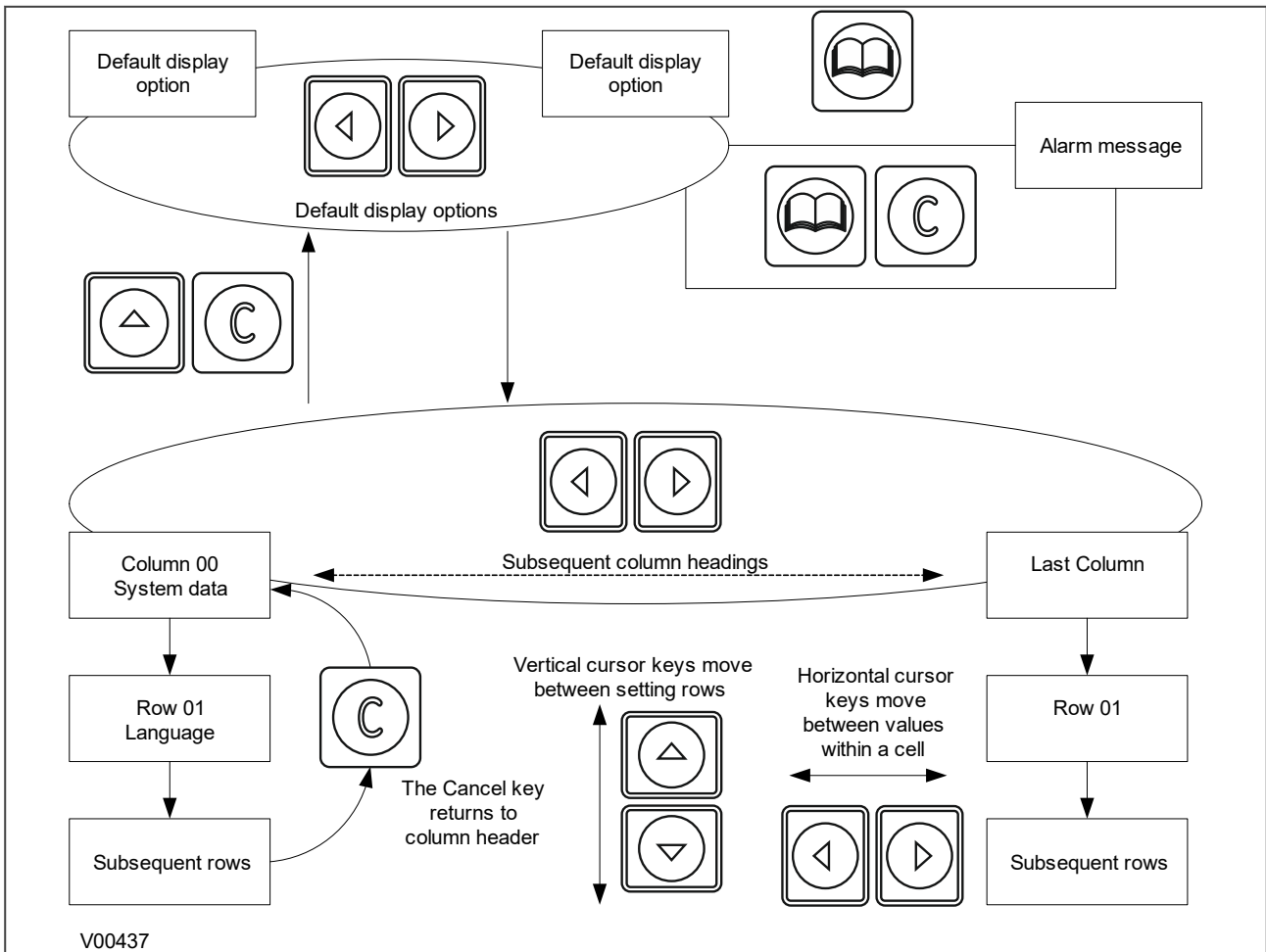


**Figure 15: Navigating the HMI**

## 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.
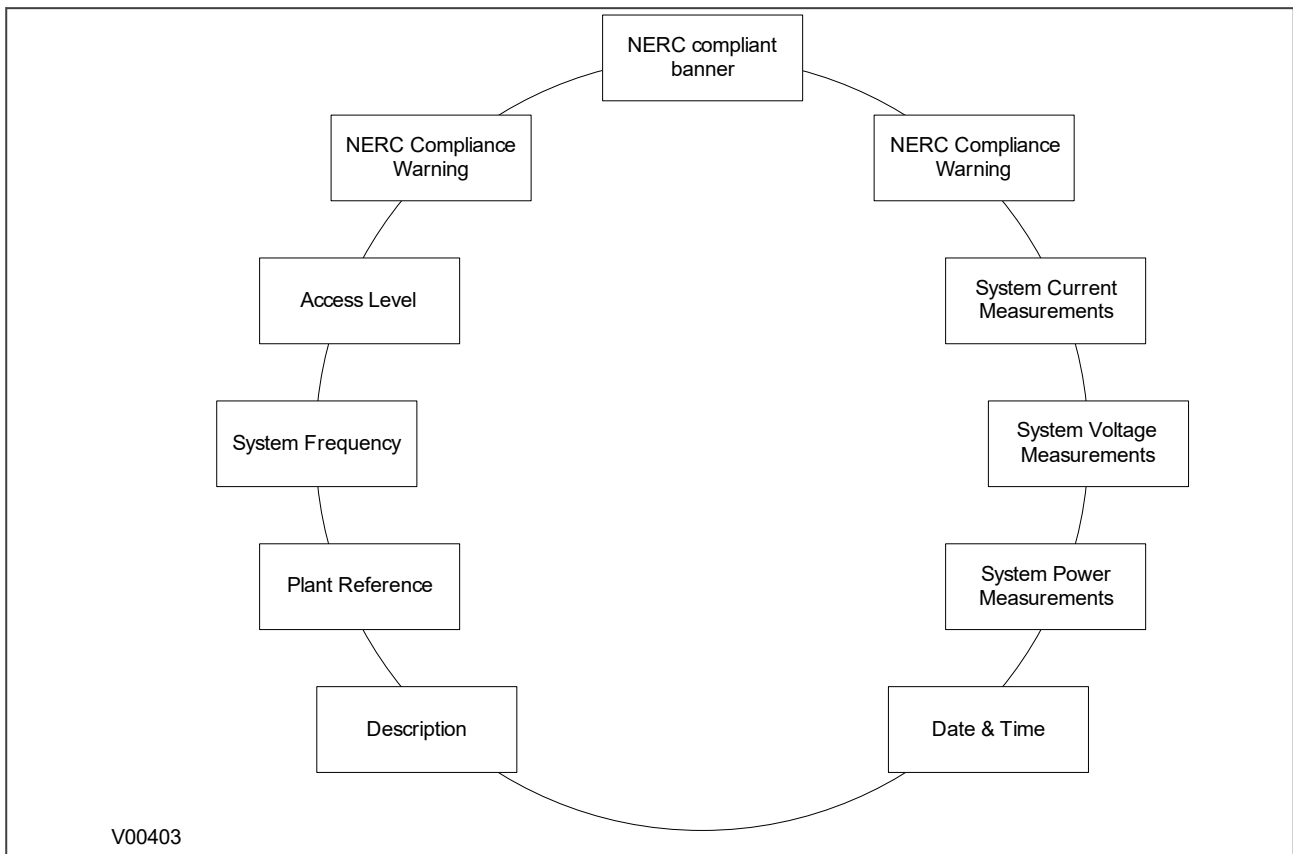


Figure 16: Default display navigation

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.

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)

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. These so called **Hotkeys** 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
- Circuit Breaker (CB) control functions

The availability of these functions is controlled by the **Direct Access** cell in the *CONFIGURATION* column. There are four options: `Disabled`, `Enabled`, `CB Ctrl only` and `Hotkey only`.

For the Setting Group selection and Control inputs, this cell must be set to either `Enabled` or `Hotkey only`. For CB Control functions, the cell must be set to `Enabled` or `CB Ctrl only`.

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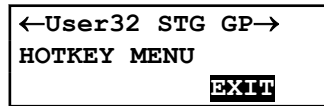
Press the right cursor key twice to get to the first control input, or the left cursor key to get to the last control input.

```
←STP GP User02→
Control Input 1
EXIT SET
```
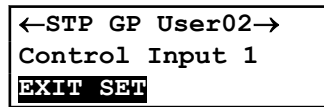
Now you can execute the chosen function (Set/Reset in this case).

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

### 3.9.3 CIRCUIT BREAKER CONTROL

You can open and close the controlled circuit breaker with the hotkey to the right, if enabled as described above. By default, hotkey access to the circuit breakers is disabled.

If hotkeyaccess to the circuit breakers has been enabled, the bottom right hand part of the display will read "Open or Close" depending on whether the circuit breaker is closed or open respectively:

For example:

```
Plant Reference
MiCOM
HOTKEY   CLOSE
```
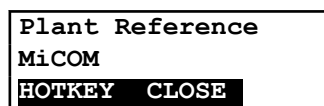
To close the circuit breaker (in this case), press the key directly below CLOSE. You will be given an option to cancel or confirm.

```
Execute
CB CLOSE
Cancel Confirm
```
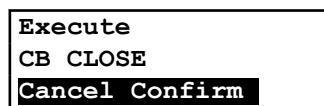
More detailed information on this can be found in the Monitoring and Control chapter.

### 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        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.

## 4.1        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.

## 4.2        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.

## 4.3        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.

## 4.4        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.

## 4.5        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, DNP over Ethernet (if applicable) 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
- DNPOE 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.

## 4.6          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.

# 5        SETTINGS GROUP SELECTION

You can select the setting group using opto inputs, a menu selection, and for some models the hotkey menu or function keys. You choose which method using the Setting Group setting in the *CONFIGURATION* column. There are two possibilities; Select via Menu, or Select via PSL. If you choose **Select via Menu**, you set the settings group using the **Active Settings** setting or with the hotkeys. If you choose **Select via PSL** , you set the settings group with DDB signals according to the following table:

| SG Select 1X | SG Select X1 | Selected Setting Group |
|---|---|---|
| 0 | 0 | 1 |
| 0 | 1 | 2 |
| 1 | 0 | 3 |
| 1 | 1 | 4 |

Each setting group has its own PSL. Once a PSL configuration has been designed it can be allocated to any one of the 4 setting groups. When downloading or extracting a PSL configuration, you will be prompted to enter the required setting group to which it will allocated.

CHAPTER 6

# CURRENT PROTECTION FUNCTIONS

# 1          CHAPTER OVERVIEW

The P14N provides a wide range of current protection functions. This chapter describes the operation of these functions including the principles, logic diagrams and applications.

This chapter contains the following sections:

# 2          OVERCURRENT PROTECTION PRINCIPLES

Most electrical power system faults result in an overcurrent of one kind or another. It is the job of protection devices, formerly known as 'relays' but now known as Intelligent Electronic Devices (IEDs) to protect the power system from faults. The general principle is to isolate the faults as quickly as possible to limit the danger and prevent fault currents flowing through systems, which can cause severe damage to equipment and systems. At the same time, we wish to switch off only the parts of the power grid that are absolutely necessary, to prevent unnecessary blackouts. The protection devices that control the tripping of the power grid's circuit breakers are highly sophisticated electronic units, providing an array of functionality to cover the different fault scenarios for a multitude of applications.

The described products offer a range of overcurrent protection functions including:

- Phase Overcurrent protection
- Earth Fault Overcurrent protection
- Negative Sequence Overcurrent protection
- Sensitive Earth Fault protection

To ensure that only the necessary circuit breakers are tripped and that these are tripped with the smallest possible delay, the IEDs in the protection scheme need to co-ordinate with each other. Various methods are available to achieve correct co-ordination between IEDs in a system. These are:

- By means of time alone
- By means of current alone
- By means of a combination of both time and current.

Grading by means of current alone is only possible where there is an appreciable difference in fault level between the two locations where the devices are situated. Grading by time is used by some utilities but can often lead to excessive fault clearance times at or near source substations where the fault level is highest.

For these reasons the most commonly applied characteristic in co-ordinating overcurrent devices is the IDMT (Inverse Definite Minimum Time) type.

## 2.1          IDMT CHARACTERISTICS

There are two basic requirements to consider when designing protection schemes:

- All faults should be cleared as quickly as possible to minimise damage to equipment
- Fault clearance should result in minimum disruption to the electrical power grid.

The second requirement means that the protection scheme should be designed such that only the circuit breaker(s) in the protection zone where the fault occurs, should trip.

These two criteria are actually in conflict with one another, because to satisfy (1), we increase the risk of shutting off healthy parts of the grid, and to satisfy (2) we purposely introduce time delays, which increase the amount of time a fault current will flow. With IDMT protection applied to radial feeders, this problem is exacerbated by the nature of faults in that the protection devices nearest the source, where the fault currents are largest, actually need the longest time delay.

IDMT characteristics are described by operating curves. Traditionally, these were defined by the performance of electromechanical relays. In numerical protection, equations are used to replicate these characteristics so that they can be used to grade with older equipment.

The old electromechanical relays countered this problem somewhat due to their natural operate time v. fault current characteristic, whereby the higher the fault current, the quicker the operate time. The characteristic typical of these electromechanical relays is called Inverse Definite Minimum Time or IDMT for short.

## 2.1.1 IEC 60255 IDMT CURVES

There are four well-known variants of this characteristic:

- Standard Inverse
- Very inverse
- Extremely inverse
- UK Long Time inverse

These equations and corresponding curves governing these characteristics are very well known in the power industry.

### Standard Inverse

This characteristic is commonly known as the 3/10 characteristic, i.e. at ten times setting current and TMS of 1 the relay will operate in 3 seconds.

The characteristic curve can be defined by the mathematical expression:

$$t_{op} = T \frac{0.14}{\left(\dfrac{I}{I_s}\right)^{0.02} - 1}$$

The standard inverse time characteristic is widely applied at all system voltages – as back up protection on EHV systems and as the main protection on HV and MV distribution systems.

In general, the standard inverse characteristics are used when:

- There are no co-ordination requirements with other types of protective equipment further out on the system, e.g. Fuses, thermal characteristics of transformers, motors etc.
- The fault levels at the near and far ends of the system do not vary significantly.
- There is minimal inrush on cold load pick up. Cold load inrush is that current which occurs when a feeder is energised after a prolonged outage. In general the relay cannot be set above this value but the current should decrease below the relay setting before the relay operates.

### Very Inverse

This type of characteristic is normally used to obtain greater time selectivity when the limiting overall time factor is very low, and the fault current at any point does not vary too widely with system conditions. It is particularly suitable, if there is a substantial reduction of fault current as the distance from the power source increases. The steeper inverse curve gives longer time grading intervals. Its operating time is approximately doubled for a reduction in setting from 7 to 4 times the relay current setting. This permits the same time multiplier setting for several relays in series.

The characteristic curve can be defined by the mathematical expression:

$$t_{op} = T \frac{13.5}{\left(\dfrac{I}{I_s}\right) - 1}$$

### Extremely Inverse

With this characteristic the operating time is approximately inversely proportional to the square of the current. The long operating time of the relay at peak values of load current make the relay particularly suitable for grading with fuses and also for protection of feeders which are subject to peak currents on switching in, such as feeders supplying refrigerators, pumps, water heaters etc., which remain connected even after a prolonged interruption of supply.

For cases where the generation is practically constant and discrimination with low tripping times is difficult to obtain, because of the low impedance per line section, an extremely inverse relay can be very useful since only a small difference of current is necessary to obtain an adequate time difference.

Another application for this relay is with auto reclosers in low voltage distribution circuits. As the majority of faults are of a transient nature, the relay is set to operate before the normal operating time of the fuse, thus preventing perhaps unnecessary blowing of the fuse.

Upon reclosure, if the fault persists, the recloser locks itself in the closed position and allows the fuse to blow to clear the fault.

This characteristic is also widely used for protecting plant against overheating since overheating is usually an I2t function.

This characteristic curve can be defined by the mathematical expression:

$$t_{op} = T \frac{80}{\left(\dfrac{I}{I_s}\right)^2 - 1}$$

### UK Long Time Inverse

This type of characteristic has a long time characteristic and may be used for protection of neutral earthing resistors (which normally have a 30 second rating). The relay operating time at 5 times current setting is 30 seconds at a TMS of 1.

This can be defined by:

$$t_{op} = T \frac{120}{\left(\dfrac{I}{I_s}\right) - 1}$$

In the above equations:

- $t_{op}$ is the operating time
- T is the time multiplier setting
- I is the measured current
- $I_s$ is the current threshold setting.

The ratio $I/I_s$ is sometimes defined as 'M' or 'PSM' (Plug Setting Multiplier).

These curves are plotted as follows:
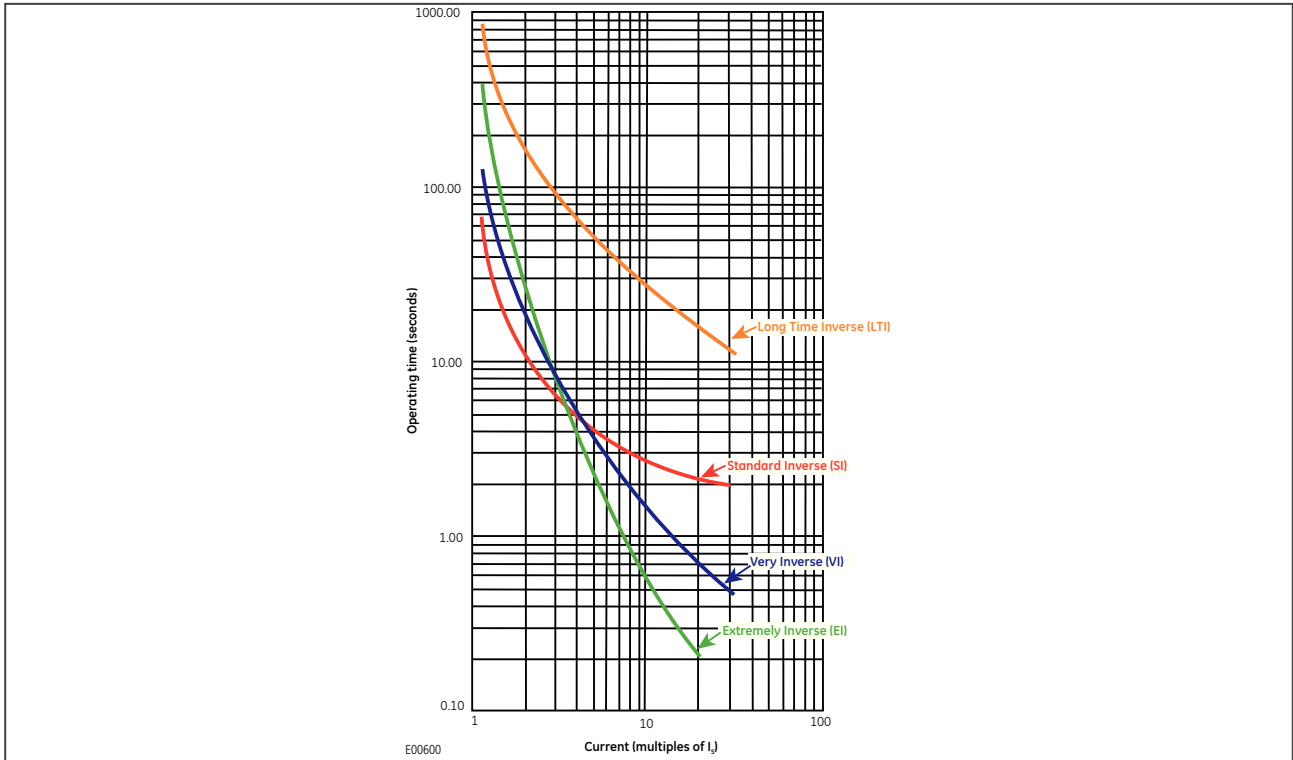
**Figure 17: IEC 60255 IDMT curves**

### 2.1.2    EUROPEAN STANDARDS

The IEC 60255 IDMT Operate equation is:

$$t_{op} = T\left(\frac{\beta}{M^{\alpha}-1} + L\right) + C$$

and the IEC 60255 IDMT Reset equation is:

$$t_r = T\left(\frac{\beta}{1-M^{\alpha}}\right)$$

where:

- $t_{op}$ is the operating time
- $t_r$ is the reset time
- T is the Time Multiplier setting
- M is the ratio of the measured current divided by the threshold current (I/Is)
- $\beta$ is a constant, which can be chosen to satisfy the required curve characteristic
- $\alpha$ is a constant, which can be chosen to satisfy the required curve characteristic
- C is a constant for adding Definite Time (Definite Time adder)
- L is a constant (usually only used for ANSI/IEEE curves)

The constant values for the IEC IDMT curves are as follows:

| Curve Description | β constant | α constant | L constant |
|---|---|---|---|
| IEC Standard Inverse Operate | 0.14 | 0.02 | 0 |
| IEC Standard Inverse Reset | 8.2 | 6.45 | 0 |

| Curve Description | β constant | α constant | L constant |
|---|---|---|---|
| IEC Very Inverse Operate | 13.5 | 1 | 0 |
| IEC Very Inverse Reset | 50.92 | 2.4 | 0 |
| IEC Extremely Inverse Operate | 80 | 2 | 0 |
| IEC Extremely Inverse Reset | 44.1 | 3.03 | 0 |
| UK Long Time Inverse Operate* | 120 | 1 | 0 |
| UK Rectifier Operate* | 45900 | 5.6 | 0 |

**Rapid Inverse (RI) characteristic**

The RI operate curve is represented by the following equation:

$$t_{op} = K \left( \frac{1}{0.339 - \frac{0.236}{M}} \right)$$

where:

- $t_{op}$ is the operating time
- K is the Time Multiplier setting
- M is the ratio of the measured current divided by the threshold current ($I/I_s$)

> *Note:*
> *\* When using UK Long Time Inverse, UK Rectifier or RI for the Operate characteristic, DT (Definite Time) is always used for the Reset characteristic.*

### 2.1.3 NORTH AMERICAN STANDARDS

The IEEE IDMT Operate equation is:

$$t_{op} = TD \left( \frac{\beta}{M^{\alpha} - 1} + L \right) + C$$

and the IEEE IDMT Reset equation is:

$$t_r = TD \left( \frac{\beta}{1 - M^{\alpha}} \right)$$

where:

- $t_{op}$ is the operating time
- $t_r$ is the reset time
- TD is the Time Dial setting
- M is the ratio of the measured current divided by the threshold current ($I/I_s$)
- β is a constant, which can be chosen to satisfy the required curve characteristic
- α is a constant, which can be chosen to satisfy the required curve characteristic
- C is a constant for adding Definite Time (Definite Time adder)
- L is a constant (usually only used for ANSI/IEEE curves)

The constant values for the IEEE curves are as follows:

| Curve Description | β constant | α constant | L constant |
|---|---|---|---|
| IEEE Moderately Inverse Operate | 0.0515 | 0.02 | 0.114 |
| IEEE Moderately Inverse Reset | 4.85 | 2 | 0 |
| IEEE Very Inverse Operate | 19.61 | 2 | 0.491 |
| IEEE Very Inverse Reset | 21.6 | 2 | 0 |
| IEEE Extremely Inverse Operate | 28.2 | 2 | 0.1217 |
| IEEE Extremely Inverse Reset | 29.1 | 2 | 0 |
| CO8 US Inverse Operate | 5.95 | 2 | 0.18 |
| CO8 US Inverse Reset | 5.95 | 2 | 0 |
| CO2 US Short Time Inverse Operate | 0.16758 | 0.02 | 0.11858 |
| CO2 US Short Time Inverse Reset | 2.261 | 2 | 0 |

The constant values for the ANSI curves are as follows:

| Curve Description | β constant | α constant | L constant |
|---|---|---|---|
| ANSI Normally Inverse Operate | 8.9341 | 2.0938 | 0.17966 |
| ANSI Normally Inverse Reset | 9 | 2 | 0 |
| ANSI Short Time Inverse Operate | 0.03393 | 1.2969 | 0.2663 |
| ANSI Short Time Inverse Reset | 0.5 | 2 | 0 |
| ANSI Long Time Inverse Operate | 2.18592 | 1 | 5.6143 |
| ANSI Long Time Inverse Reset | 15.75 | 2 | 0 |

*Note:*
*\* When using UK Long Time Inverse or UK Rectifier for the Operate characteristic, DT is always used for the Reset characteristic.*

## 2.1.4        IEC AND IEEE INVERSE CURVES
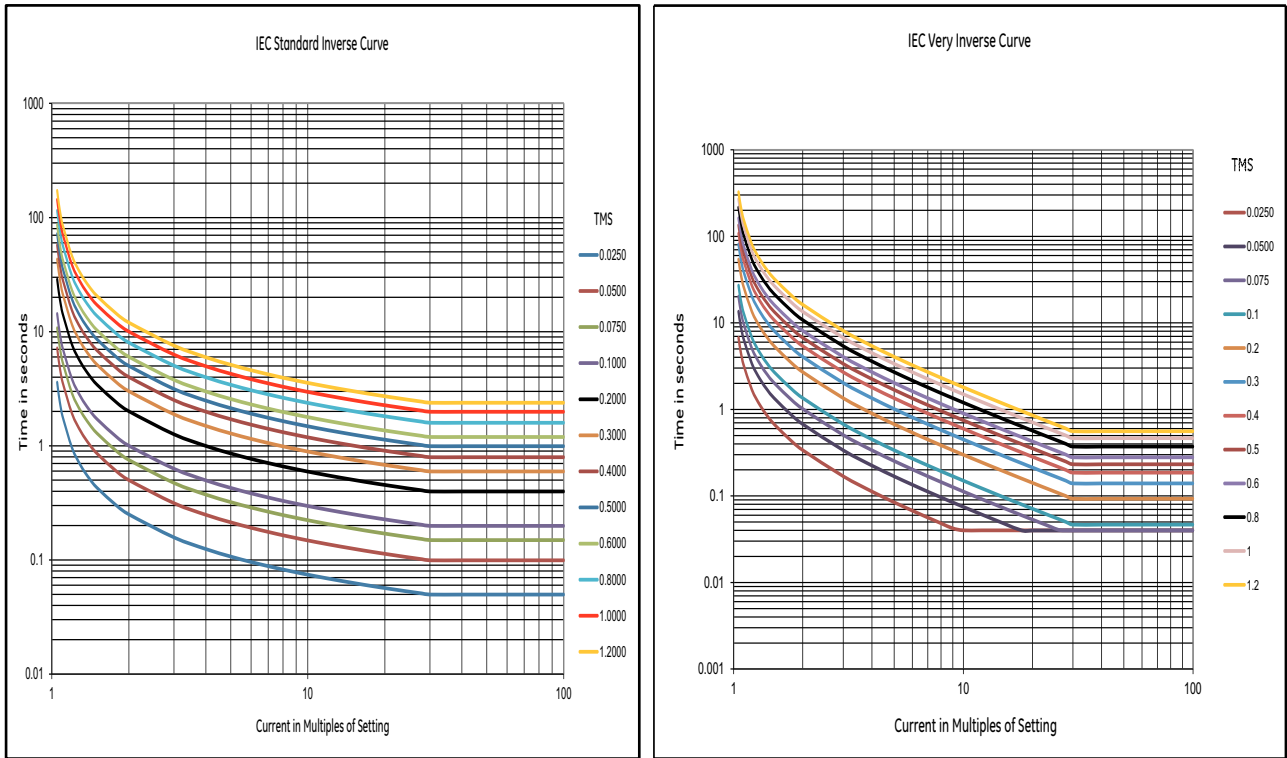


E00757

**Figure 18: IEC standard and very inverse curves**
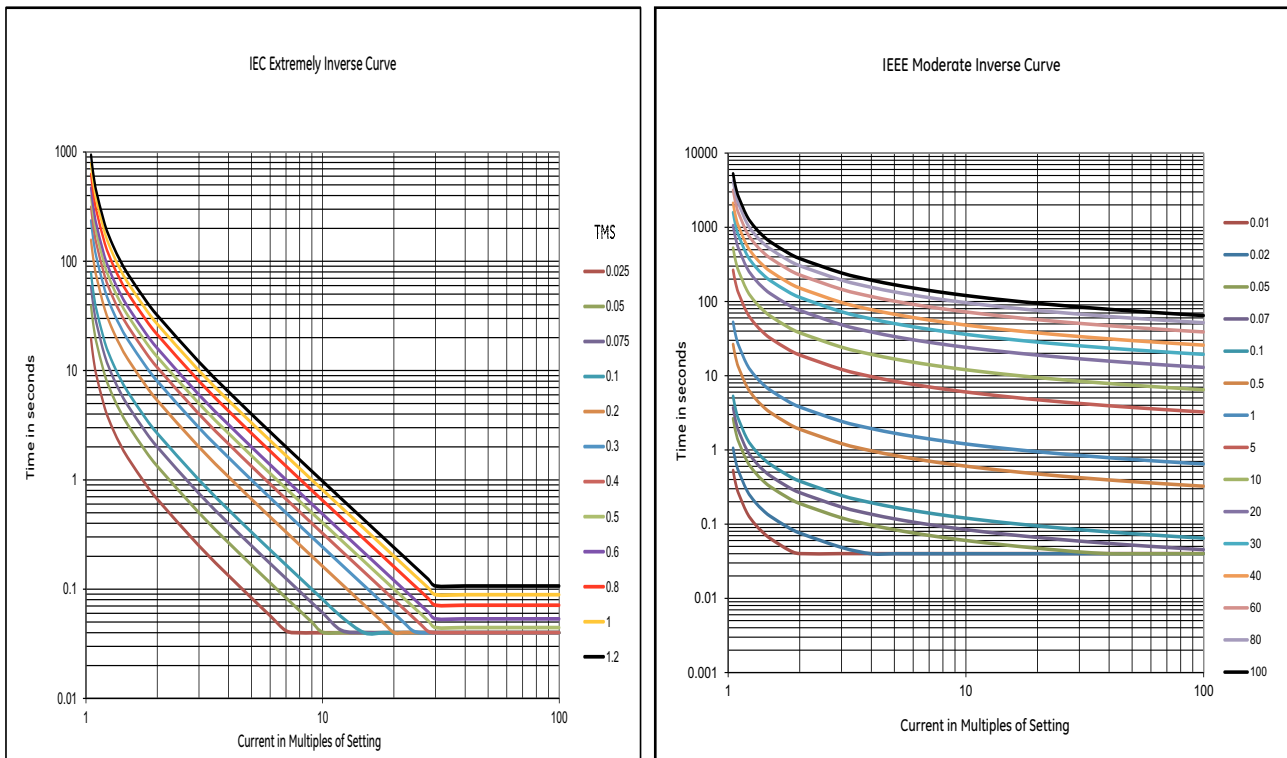


E00758

**Figure 19: IEC Extremely inverse and IEEE moderate inverse curves**
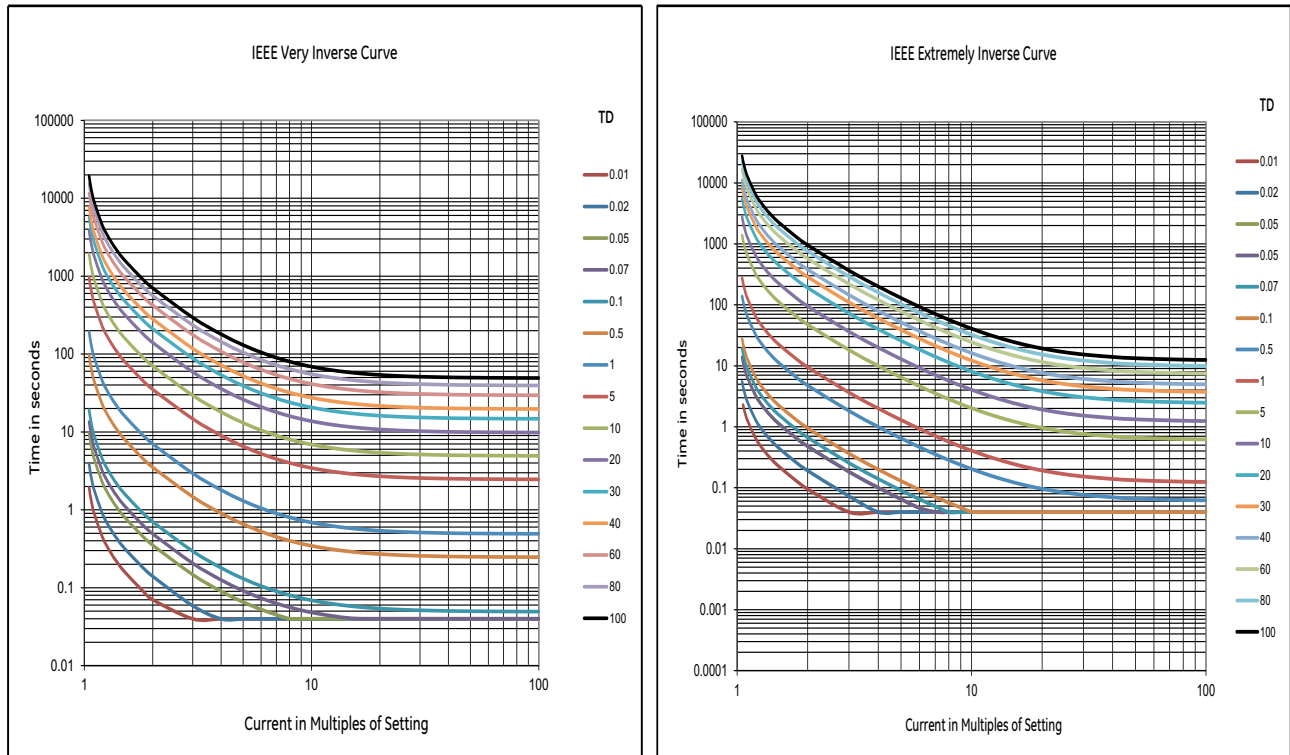
E00759

**Figure 20: IEEE very and extremely inverse curves**

### 2.1.5   DIFFERENCES BETWEEN THE NORTH AMERICAN AND EUROPEAN STANDARDS

The IEEE and US curves are set differently to the IEC/UK curves, with regard to the time setting. A time multiplier setting (TMS) is used to adjust the operating time of the IEC curves, whereas a time dial setting is used for the IEEE/US curves. The menu is arranged such that if an IEC/UK curve is selected, the *I> Time Dial* cell is not visible and vice versa for the TMS setting. For both IEC and IEEE/US type curves, a definite time adder setting is available, which will increase the operating time of the curves by the set value.

### 2.1.6   PROGRAMMABLE CURVES

As well as the standard curves as defined by various countries and standardising bodies, it is possible to program custom curves using the User Programmable Curve Tool, described in the Settings Application Software chapter. This is a user-friendly tool by which you can create curves either by formula or by entering data points. Programmable curves help you to match more closely the withstand characteristics of the electrical equipment than standard curves.

## 2.2   PRINCIPLES OF IMPLEMENTATION

The range of protection products provides a very wide range of protection functionality. Despite the diverse range of functionality provided, there is some commonality between the way many of the protection functions are implemented. It is important to describe some of these basic principles before going deeper into the individual protection functions.

A simple representation of protection functionality is shown in the following diagram:
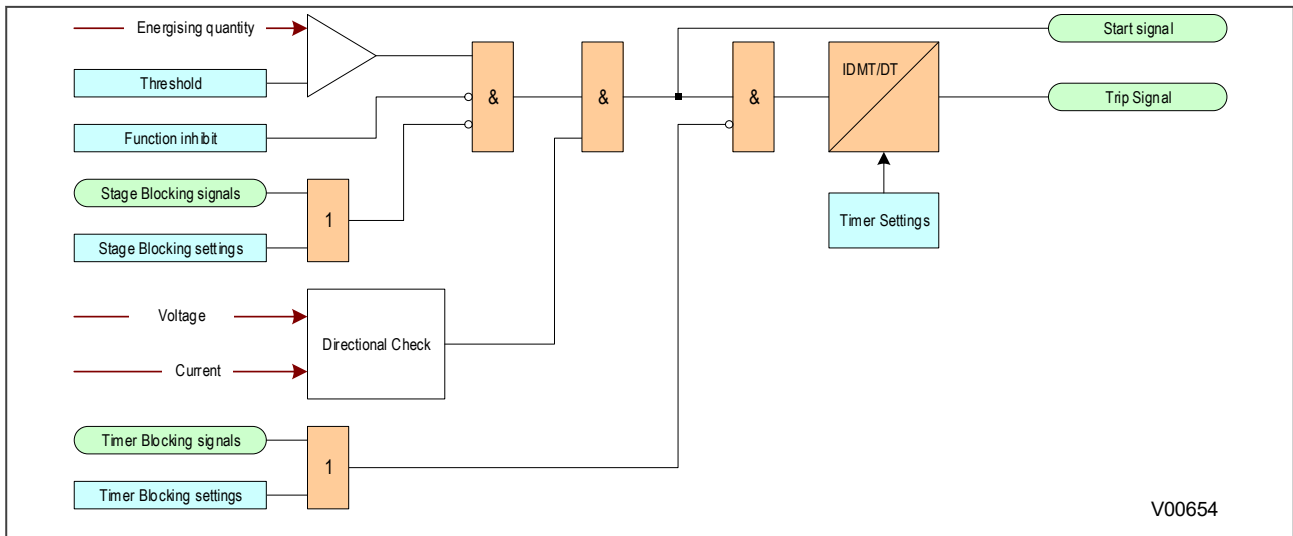
**Figure 21: Principle of protection function implementation**

An energising quantity is either a voltage input from a system voltage transformer, a current input from a system current transformer or another quantity derived from one or both of these. The energising quantities are extracted from the power system. The signals are converted to digital quantities where they can be processed by the IEDs internal processor.

In general, an energising quantity, be it a current, voltage, power, frequency, or phase quantity, is compared with a threshold value, which may be settable, or hard-coded depending on the function. If the quantity exceeds (for overvalues) or falls short of (for undervalues) the threshold, a signal is produced, which when gated with the various inhibit and blocking functions becomes the Start signal for that protection function. This Start signal is generally made available to Fixed Scheme Logic (FSL) and Programmable Scheme Logic (PSL) for further processing. It is also passed through a timer function to produce the Trip signal. The timer function may be an IDMT curve, or a Definite Time delay, depending on the function. This timer may also be blocked with timer blocking signals and settings. The timer can be configured by a range of settings to define such parameters as the type of curve, The Time Multiplier Setting, the IDMT constants, the Definite Time delay etc.

In GE products, there are usually several independent stages for each of the functions, and for three-phase functions, there are usually independent stages for each of the three phases.

Typically some stages use an Inverse Definite Minimum time (IDMT) timer function, and others use a Definite Time timer (DT) function. If the DT time delay is set to '0', then the function is known to be "instantaneous". In many instances, the term 'instantaneous protection" is used loosely to describe Definite Time protection stages, even when the stage may not theoretically be instantaneous.

Many protection functions require a direction-dependent decision. Such functions can only be implemented where both current and voltage inputs are available. For such functions, a directional check is required, whose output can block the Start signal should the direction of the fault be wrong.

> *Note:*
> *In the logic diagrams and descriptive text, it is usually sufficient to show only the first stage, as the design principles for subsequent stages are usually the same (or at least very similar). Where there are differences between the functionality of different stages, this is clearly indicated.*

## 2.2.1 TIMER HOLD FACILITY

The Timer Hold facility is available for stages with IDMT functionality , and is controlled by the timer reset settings for the relevant stages (e.g. *I>1 tReset*, *I>2 tReset* ). These cells are not visible for the IEEE/US curves if an inverse time reset characteristic has been selected, because in this case the reset time is determined by the time dial setting (TDS).

This feature may be useful in certain applications, such as when grading with upstream electromechanical overcurrent relays, which have inherent reset time delays. If you set the hold timer to a value other than zero, the resetting of the protection element timers will be delayed for this period. This allows the element to behave in a similar way to an electromechanical relay. If you set the hold timer to zero, the overcurrent timer for that stage will reset instantaneously as soon as the current falls below a specified percentage of the current setting (typically 95%).

Another situation where the timer hold facility may be used to reduce fault clearance times is for intermittent faults. An example of this may occur in a plastic insulated cable. In this application it is possible that the fault energy melts and reseals the cable insulation, thereby extinguishing the fault. This process repeats to give a succession of fault current pulses, each of increasing duration with reducing intervals between the pulses, until the fault becomes permanent.

When the reset time is instantaneous, the device will repeatedly reset and not be able to trip until the fault becomes permanent. By using the Timer Hold facility the device will integrate the fault current pulses, thereby reducing fault clearance time.

# 3          PHASE OVERCURRENT PROTECTION

Phase current faults are faults where fault current flows between two or more phases of a power system. The fault current may be between the phase conductors only or, between two or more phase conductors and earth.

Although not as common as earth faults (single phase to earth), phase faults are typically more severe.

## 3.1          PHASE OVERCURRENT PROTECTION IMPLEMENTATION

Phase Overcurrent Protection is configured in the *OVERCURRENT* column of the relevant settings group.

The product provides six stages of segregated three-phase overcurrent protection, each with independent time delay characteristics. The settings are independent for each stage, but for each stage, the settings apply to all phases.

Stages 1, 2 and 5 provide a choice of operate and reset characteristics, where you can select between:

- A range of IDMT (Inverse Definite Minimum Time) curves based on IEC and IEEE standards
- A range of programmable user-defined curves
- DT (Definite Time) characteristic

For stage 1, this is achieved using the following settings:

- *I>1 Function* for the overcurrent operate characteristic
- *I>1 Reset Char* for the overcurrent reset characteristic
- *I>1 Usr Rst Char* for the reset characteristic for user-defined curves

The setting names for other stages follow the same principles.

The IDMT-equipped stages, (1,2 and 5) also provide a Timer Hold facility. Stage 1 for example, is configured using the cells *I>1 tReset*. This setting does not apply to IEEE curves.

Stages 3, 4 and 6 have definite time characteristics only.

## 3.2         NON-DIRECTIONAL OVERCURRENT LOGIC
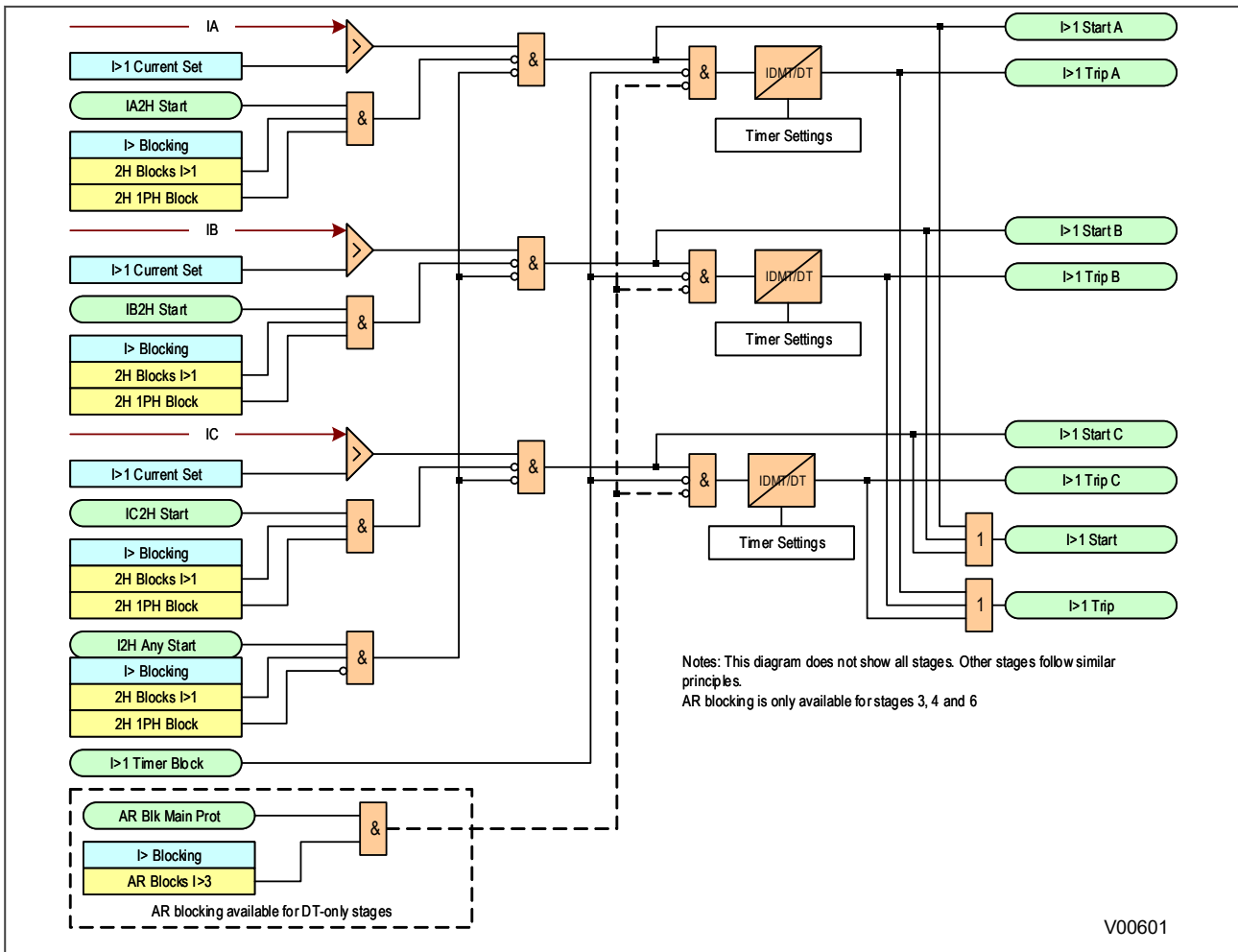


**Figure 22: Non-directional Overcurrent Logic diagram**

Phase Overcurrent Modules are level detectors that detect when the current magnitude exceeds a set threshold. When this happens, a Start signal is generated unless it is inhibited by a blocking signal. This Start signal initiates the timer module, which can be configured as an IDMT timer or DT timer, depending on the stage number. The Start signal is also available for use in the PSL. For each stage, there are three Phase Overcurrent Modules, one for each phase. The three Start signals from each of these phases are combined to form a 3-phase Start signal.

The Start signals can be blocked by the Second Harmonic blocking function; on a per phase basis (single-phase blocking) or for all three phases at once (three-phase blocking). The relevant bits are set in the *I> Blocking* cell and this is combined with the relevant second harmonic blocking DDBs.

The timer can be configured with several settings depening on which type of timer is selected. Taking stage 1 as an example:

The setting *I>1 Time Delay* sets the DT time delay

The setting *I>1 TMS* sets the Time Multiplier setting for IEC IDMT curves

The setting *I>1 Time Dial* sets the Time Multiplier setting for IEEE/US IDMT curves

The setting *I>1 DT Adder* adds a fixed time delay to the IDMT operate characteristic

The setting *I>1 tRESET* determines the reset time for the DT characteristic

The outputs of the timer modules are the single-phase trip signals. These trip signals are combined to form a 3-phase Trip signal.

The timer modules can be blocked by a Phase Overcurrent Timer Block (for example *I>1 Timer Block*).

For DT-only stages, the DT timer can be blocked by the Autoreclose function. An Autoreclose blocking signal is produced by the DDB signal *AR Blk Main Prot* and the relevant settings in the *I> Blocking* cell.

## 3.3 CURRENT SETTING THRESHOLD SELECTION

The Phase Overcurrent protection threshold setting can be influenced by the Cold Load Pickup (CLP)and the Voltage Dependent Overcurrent (V DepOC) functions, should this functionality be used.

The Overcurrent function selects the threshold setting according to the following diagram:
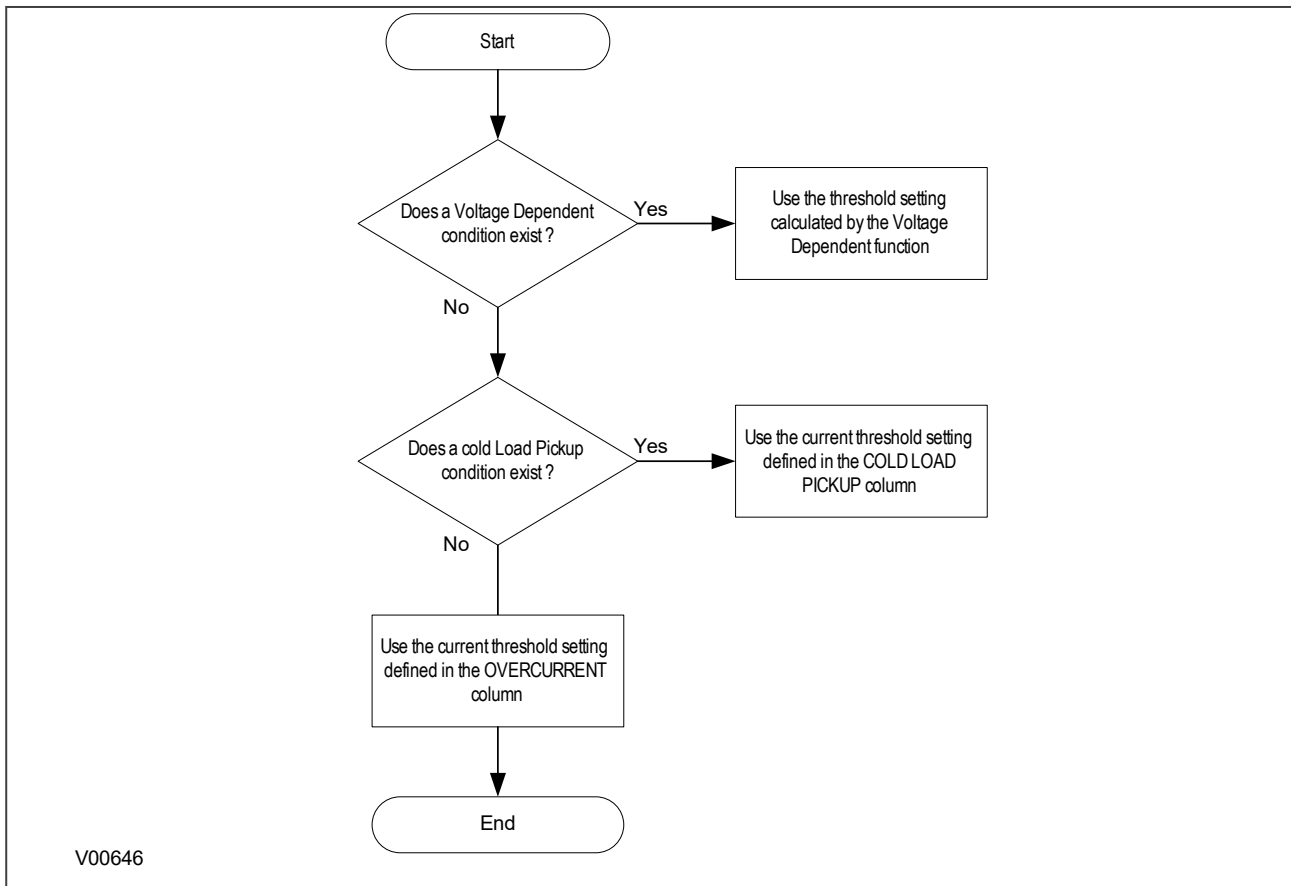


**Figure 23: Selecting the current threshold setting**

## 3.4 TIMER SETTING SELECTION

The timer settings used depend on whether there is a Selective Overcurrent condition or a Cold Load Pickup condition (if this functionality is used). The protection function selects the settings according to the following flow diagram:
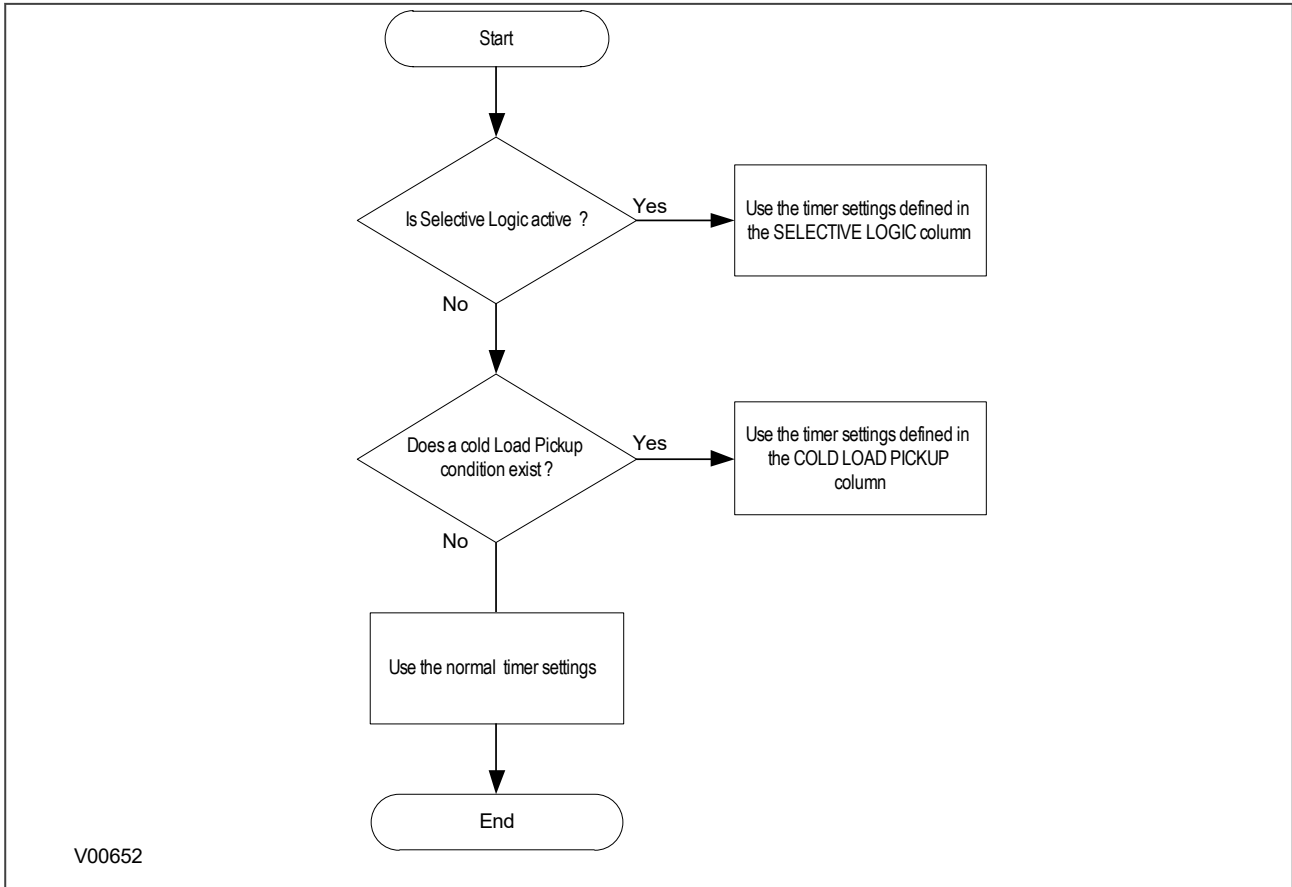
**Figure 24: Selecting the timer settings**

## 3.5    APPLICATION NOTES

### 3.5.1    SETTING GUIDELINES

Standard principles should be applied in calculating the necessary current and time settings. The example detailed below shows a typical setting calculation and describes how the settings are applied.

This example is for a device feeding a LV switchboard and makes the following assumptions:

- CT Ratio = 500/1
- Full load current of circuit = 450A
- Slowest downstream protection = 100A Fuse

The current setting on the device must account for both the maximum load current and the reset ratio, therefore:

**I>** must be greater than: 450/drop-off = 450/0.95 = 474A.

The device allows the current settings to be applied in either primary or secondary quantities. This is done by setting the **Setting Values** cell of the *CONFIGURATION* column. When this cell is set to primary, all phase overcurrent setting values are scaled by the programmed CT ratio.

In this example, assuming primary currents are to be used, the ratio should be programmed as 500/1.

The required setting is therefore 0.95A in terms of secondary current or 475A in terms of primary.

A suitable time delayed characteristic will now need to be chosen. When co-ordinating with downstream fuses, the applied characteristic should be closely matched to the fuse characteristic. Therefore, assuming IDMT co-ordination is to be used, an Extremely Inverse (EI) characteristic would normally be chosen. This is found under the **I>1 Function** cell as `IEC E Inverse`.

Finally, a suitable time multiplier setting (TMS) must be calculated and entered in cell *I>1 TMS.*

# 4    NEGATIVE SEQUENCE OVERCURRENT PROTECTION

When applying standard phase overcurrent protection, the overcurrent elements must be set significantly higher than the maximum load current. This limits the element's sensitivity. Most protection schemes also use an earth fault element operating from residual current, which improves sensitivity for earth faults. However, certain faults may arise which can remain undetected by such schemes. Negative Phase Sequence Overcurrent elements can help in such cases.

Any unbalanced fault condition will produce a negative sequence current component. Therefore, a negative phase sequence overcurrent element can be used for both phase-to-phase and phase-to-earth faults. Negative Phase Sequence Overcurrent protection offers the following advantages:

- Negative phase sequence overcurrent elements are more sensitive to resistive phase-to-phase faults, where phase overcurrent elements may not operate.

- In certain applications, residual current may not be detected by an earth fault element due to the system configuration. For example, an earth fault element applied on the delta side of a delta-star transformer is unable to detect earth faults on the star side. However, negative sequence current will be present on both sides of the transformer for any fault condition, irrespective of the transformer configuration. Therefore, a negative phase sequence overcurrent element may be used to provide time-delayed back-up protection for any uncleared asymmetrical faults downstream.

## 4.1    NEGATIVE SEQUENCE OVERCURRENT PROTECTION IMPLEMENTATION

Negative Sequence Overcurrent Protection is implemented in the *NEG SEQ O/C* column of the relevant settings group.

The product provides four stages of negative sequence overcurrent protection with independent time delay characteristics.

Stages 1, 2 provide a choice of operate and reset characteristics, where you can select between:

- A range of standard IDMT (Inverse Definite Minimum Time) curves

- A range of User-defined curves

- DT (Definite Time)

For stage 1, this is achieved using the following settings:

- *I2>1 Function* for the overcurrent operate characteristic

- *I2>1 Reset Char* for the overcurrent reset characteristic

- *I2>1 Usr RstChar* for the reset characteristic for user-defined curves

The setting names for other stages follow the same principles.

The IDMT-equipped stages, (1 and 2) also provide a Timer Hold facility. Stage 1, for example, is configured using the cells *I2>1 tRESET*. This setting is not applicable for curves based on the IEEE standard.

Stages 3 and 4 have definite time characteristics only.

## 4.2       NON-DIRECTIONAL NEGATIVE SEQUENCE OVERCURRENT LOGIC
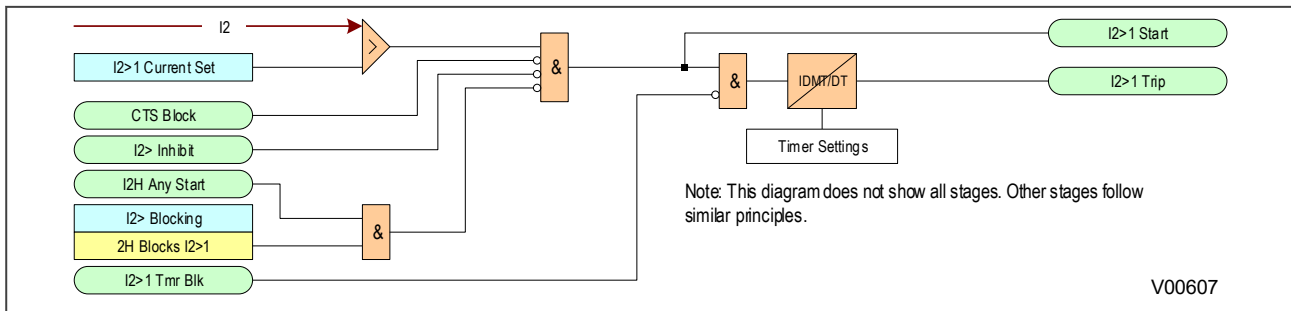


**Figure 25: Negative Sequence Overcurrent logic - non-directional operation**

For Negative Phase Sequence Overcurrent Protection, the energising quanitity *I2>* is compared with the threshold voltage *I2>1 Current Set*. If the value exceeds this setting a Start signal (*I2>1 Start*) is generated, provided there are no blocks.

The function can be blocked if a CTS or second harmonic condition is detected.

The *I2>1 Start* signal is fed into a timer to produce the *I2>1 trip* signal. The timer can be blocked by the timer block signal *I2>1 Tmr Blk*.

This diagram and description applies to each stage.

## 4.3       APPLICATION NOTES

### 4.3.1      SETTING GUIDELINES (CURRENT THRESHOLD)

A negative phase sequence element can be connected in the primary supply to the transformer and set as sensitively as required to protect for secondary phase-to-earth or phase-to-phase faults. This function will also provide better protection than the phase overcurrent function for internal transformer faults. The NPS overcurrent protection should be set to coordinate with the low-side phase and earth elements for phase-to-earth and phase-to-phase faults.

The current pick-up threshold must be set higher than the negative phase sequence current due to the maximum normal load imbalance. This can be set practically at the commissioning stage, making use of the measurement function to display the standing negative phase sequence current. The setting should be at least 20% above this figure.

Where the negative phase sequence element needs to operate for specific uncleared asymmetric faults, a precise threshold setting would have to be based on an individual fault analysis for that particular system due to the complexities involved. However, to ensure operation of the protection, the current pick-up setting must be set approximately 20% below the lowest calculated negative phase sequence fault current contribution to a specific remote fault condition.

### 4.3.2      SETTING GUIDELINES (TIME DELAY)

Correct setting of the time delay for this function is vital. You should also be very aware that this element is applied primarily to provide back-up protection to other protection devices or to provide an alarm. It would therefore normally have a long time delay.

The time delay set must be greater than the operating time of any other protection device (at minimum fault level) that may respond to unbalanced faults such as phase overcurrent elements and earth fault elements.

# 5         EARTH FAULT PROTECTION

Earth faults are overcurrent faults where the fault current flows to earth. Earth faults are the most common type of fault.

Earth faults can be measured directly from the system by means of:

- A separate current Transformer (CT) located in a power system earth connection
- A separate Core Balance Current Transformer (CBCT), usually connected to the SEF transformer input
- A residual connection of the three line CTs, where the Earth faults can be derived mathematically by summing the three measured phase currents.

Depending on the device model, it will provide one or more of the above means for Earth fault protection.

## 5.1       EARTH FAULT PROTECTION ELEMENTS

Earth fault protection is implemented in the columns *EARTH FAULT 1* and *EARTH FAULT 2* of the relevant settings group.

Each column contains an identical set of elements. *EARTH FAULT 1* (EF1) is used for earth fault current that is measured directly from the system (measured). *EARTH FAULT 2* (EF2) uses quantities derived internally from summing the three-phase currents.

The product provides four stages of Earth Fault protection with independent time delay characteristics, for each *EARTH FAULT* column.

Stages 1 and 2 provide a choice of operate and reset characteristics, where you can select between:

- A range of IDMT (Inverse Definite Minimum Time) curves
- A range of User-defined curves
- DT (Definite Time)

For the EF1 column, this is achieved using the cells:

- ***IN1>(n) Function*** for the overcurrent operate characteristics
- ***IN1>(n) Reset Char*** for the overcurrent reset characteristic
- ***IN1>(n) Usr RstChar*** for the reset characteristic for user-defined curves

For the EF2 column, this is achieved using the cells:

- ***IN2>(n) Function*** for the overcurrent operate characteristics
- ***IN2>(n) Reset Char*** for the overcurrent reset characteristic
- I***N2>(n) Usr RstChar*** for the reset characteristic for user-defined curves

where (n) is the number of the stage.

Stages 1 and 2 provide a Timer Hold facility. This is configured using the cells ***IN1>(n) tReset*** for EF1 and ***IN2>(n) tReset*** for EF2.

Stages 3 and 4 can have definite time characteristics only.

The fact that both EF1 and EF2 elements may be enabled at the same time leads to a number of applications advantages. For example, some applications may require directional earth fault protection for upstream equipment and backup earth fault protection for downstream equipment. This can be achieved with a single IED, rather than two.

## 5.2 NON-DIRECTIONAL EARTH FAULT LOGIC
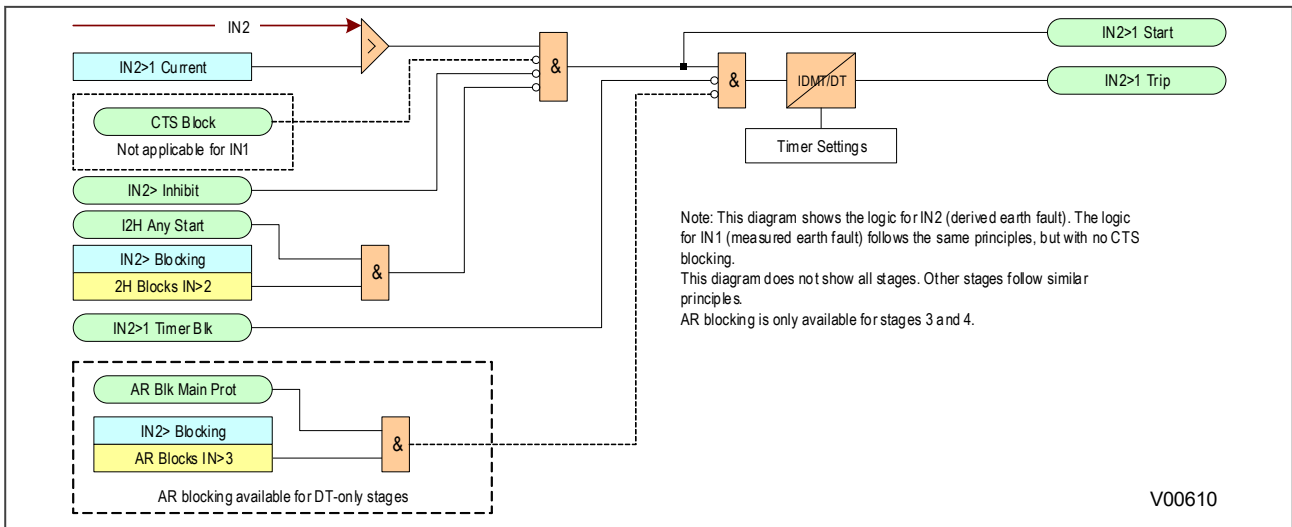


**Figure 26: Non-directional EF logic (single stage)**

The Earth Fault current is compared with a set threshold (**IN1>(n) Current**) for each stage. If it exceeds this threshold, a Start signal is triggered, providing it is not blocked. This can be blocked by the second harmonic blocking function, or an Inhibit Earth Fault DDB signal.

The autoreclose logic can be set to block the Earth Fault trip after a prescribed number of shots (set in *AUTORECLOSE* column). This is achieved using the **AR Blk Main Prot** setting. this can also be blocked by the relevant timer block signal **IN1>(n)TimerBlk** DDB signal.

Earth Fault protection can follow the same IDMT characteristics as described in the Overcurrent Protection Principles section. Please refer to that section for details of IDMT characteristics.

The diagram and description also applies to the Earth Fault 2 element (IN2).

## 5.3 IDG CURVE

The IDG curve is commonly used for time delayed earth fault protection in the Swedish market. This curve is available in stage 1 of the Earth Fault protection.

The IDG curve is represented by the following equation:

$$t_{op} = 5.8 - 1.35 \, log_e \left( \frac{I}{IN > Setting} \right)$$

where:

$t_{op}$ is the operating time

I is the measured current

IN> Setting is an adjustable setting, which defines the start point of the characteristic

> *Note:*
> *Although the start point of the characteristic is defined by the "IN>" setting, the actual current threshold is a different setting called "IDG Is". The "IDG Is" setting is set as a multiple of "IN>".*

> *Note:*
> *When using an IDG Operate characteristic, DT is always used with a value of zero for the Rest characteristic.*

An additional setting "IDG Time" is also used to set the minimum operating time at high levels of fault current.
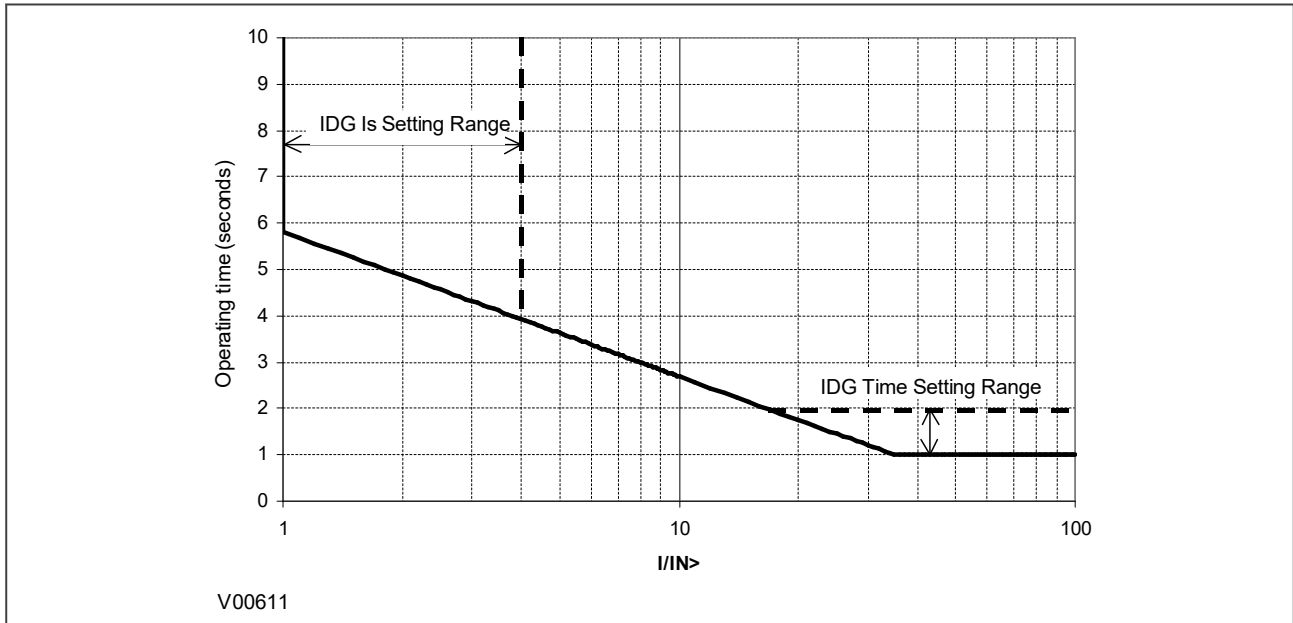


**Figure 27: IDG Characteristic**

# 6          SENSITIVE EARTH FAULT PROTECTION

With some earth faults, the fault current flowing to earth is limited by either intentional resistance (as is the case with some HV systems) or unintentional resistance (e.g. in very dry conditions and where the substrate is high resistance, such as sand or rock).

To provide protection in such cases, it is necessary to provide an earth fault protection system with a setting that is considerably lower than for normal line protection. Such sensitivity cannot be provided with conventional CTs, therefore the SEF input would normally be fed from a core balance current transformer (CBCT) mounted around the three phases of the feeder cable. The SEF transformer should be a special measurement class transformer.

## 6.1          SEF PROTECTION IMPLEMENTATION

The product provides four stages of SEF protection with independent time delay characteristics.

Stages 1, 2 provide a choice of operate and reset characteristics, where you can select between:

- A range of IDMT (Inverse Definite Minimum Time) curves
- A range of User-defined curves
- DT (Definite Time)

This is achieved using the cells

- ***ISEF>(n) Function*** for the overcurrent operate characteristic
- ***ISEF>(n) Reset Char*** for the overcurrent reset characteristic
- ***ISEF>(n) Usr RstChar*** for the reset characteristic for user -defined curves

where (n) is the number of the stage.

Stages 1 and 2 also provide a Timer Hold facility. This is configured using the cells ***ISEF>(n) tReset***.

Stages 3 and 4 have definite time characteristics only.

## 6.2          NON-DIRECTIONAL SEF LOGIC
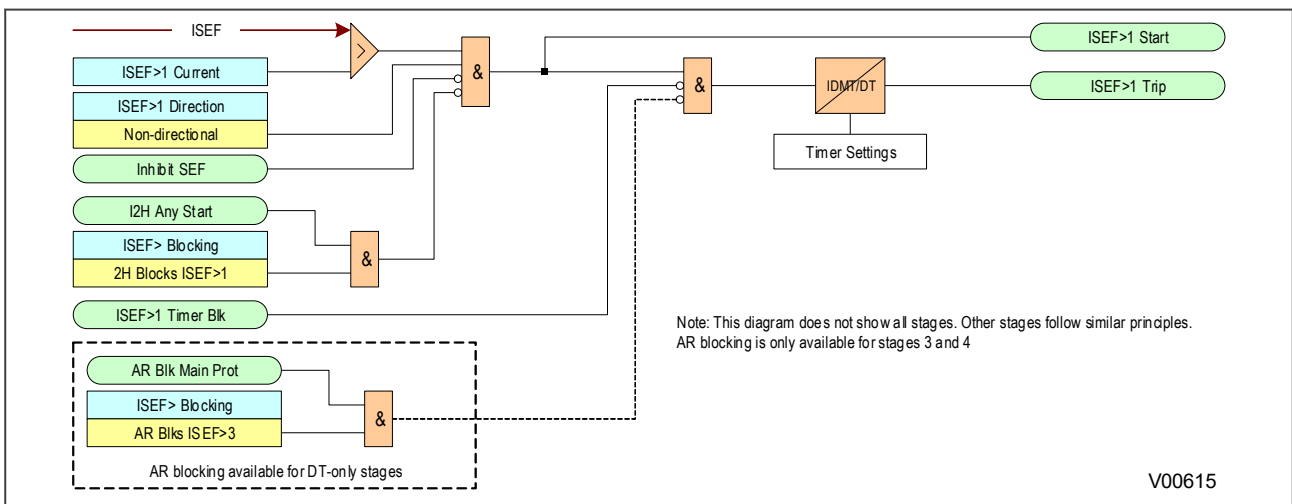


Figure 28: Non-directional SEF logic

The SEF current is compared with a set threshold (***ISEF>(n) Current***) for each stage. If it exceeds this threshold, a Start signal is triggered, providing it is not blocked. This can be blocked by the second harmonic blocking function, or an Inhibit SEF DDB signal.

The autoreclose logic can be set to block the SEF trip after a prescribed number of shots (set in *AUTORECLOSE* column). This is achieved using the **AR Blk Main Prot** setting. This can also be blocked by the relevant timer block signal **ISEF>(n)TimerBlk** DDB signal.

SEF protection can follow the same IDMT characteristics as described in the Overcurrent Protection Principles section. Please refer to this section for details of IDMT characteristics.

## 6.3    EPATR B CURVE

The EPATR B curve is commonly used for time-delayed Sensitive Earth Fault protection in certain markets. This curve is only available in the Sensitive Earth Fault protection stages 1 and 2. It is based on primary current settings, employing a SEF CT ratio of 100:1 A.

The EPATR_B curve has 3 separate segments defined in terms of the primary current. It is defined as follows:

| Segment | Primary Current Range Based on 100A:1A CT Ratio | Current/Time Characteristic |
|---------|--------------------------------------------------|-----------------------------|
| 1 | ISEF = 0.5A to 6.0A | $t = 432 \times TMS/ISEF\ 0.655$ secs |
| 2 | ISEF = 6.0A to 200A | $t = 800 \times TMS/ISEF$ secs |
| 3 | ISEF above 200A | $t = 4 \times TMS$ secs |

where TMS (time multiplier setting) is 0.025 - 1.2 in steps of 0.025.
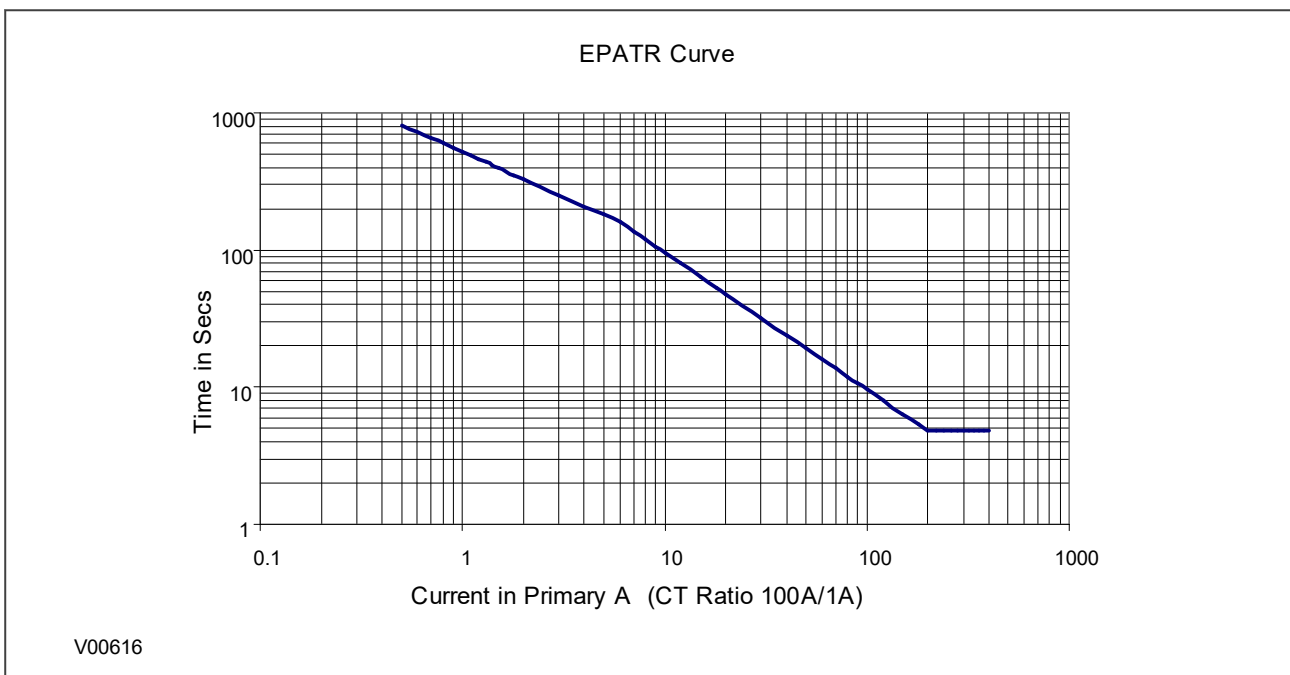


**Figure 29: EPATR B characteristic shown for TMS = 1.0**

> *Note:*
> *SEF CT ratios are user settable.*

## 6.4    APPLICATION NOTES

### 6.4.1    INSULATED SYSTEMS

When insulated systems are used, it is not possible to detect faults using standard earth fault protection. It is possible to use a residual overvoltage device to achieve this, but even with this method full discrimination is not possible. Fully discriminative earth fault protection on this type of system can only be achieved by using a SEF

(Sensitive Earth Fault) element. This type of protection detects the resultant imbalance in the system charging currents that occurs under earth fault conditions. A core balanced CT must be used for this application. This eliminates the possibility of spill current that may arise from slight mismatches between residually connected line CTs. It also enables a much lower CT ratio to be applied, thereby allowing the required protection sensitivity to be more easily achieved.

The following diagram shows an insulated system with a C-phase fault.
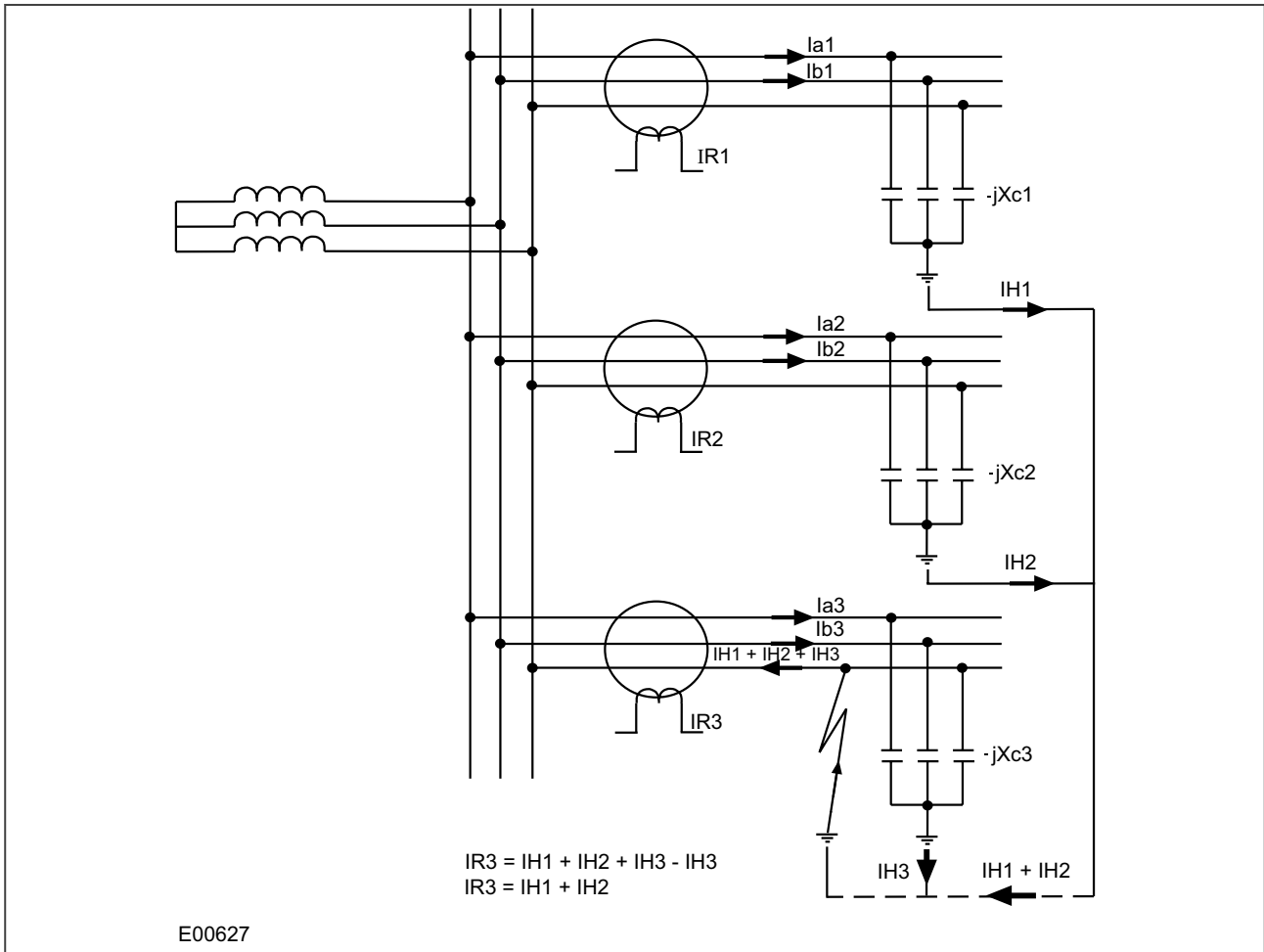


**Figure 30: Current distribution in an insulated system with C phase fault**

The protection elements on the healthy feeder see the charging current imbalance for their own feeder. The protection element on the faulted feeder, however, sees the charging current from the rest of the system (IH1 and IH2 in this case). Its own feeder's charging current (IH3) is cancelled out.

With reference to the associated vector diagram, it can be seen that the C-phase to earth fault causes the voltages on the healthy phases to rise by a factor of $\sqrt{3}$. The A-phase charging current (Ia1), leads the resultant A phase voltage by 90°. Likewise, the B-phase charging current leads the resultant Vb by 90°.
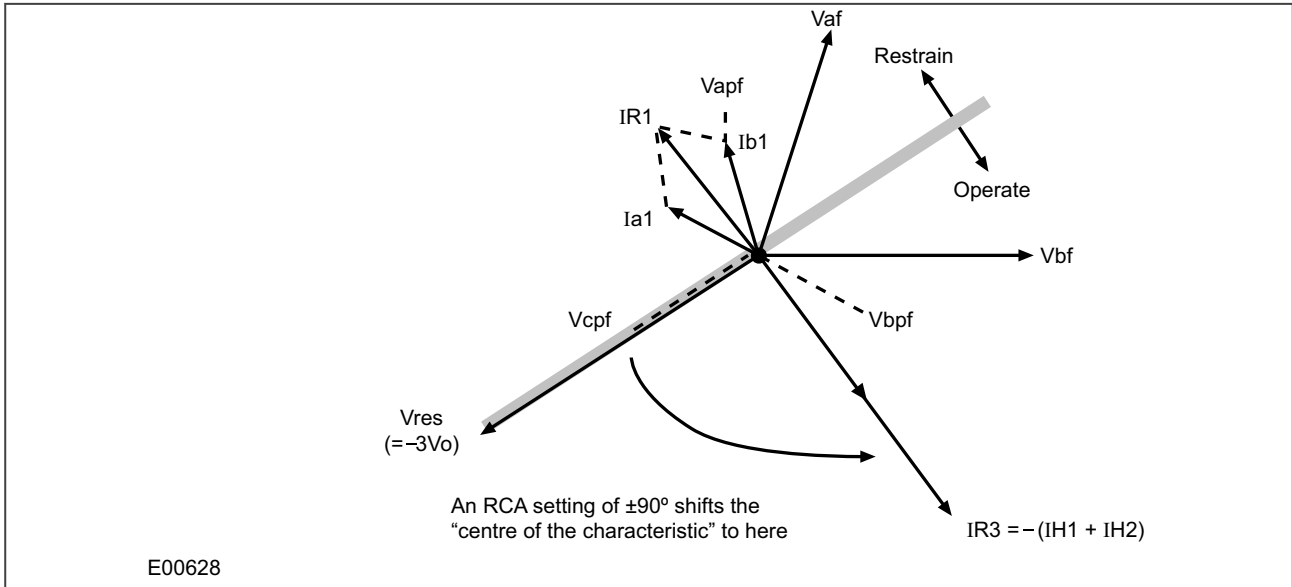
**Figure 31: Phasor diagrams for insulated system with C phase fault**

The current imbalance detected by a core balanced current transformer on the healthy feeders is the vector addition of Ia1 and Ib1. This gives a residual current which lags the polarising voltage (–3Vo) by 90°. As the healthy phase voltages have risen by a factor of √3, the charging currents on these phases are also √3 times larger than their steady state values. Therefore, the magnitude of the residual current IR1, is equal to 3 times the steady state per phase charging current.

The phasor diagram indicates that the residual currents on the healthy and faulted feeders (IR1 and IR3 respectively) are in anti-phase. A directional element (if available) could therefore be used to provide discriminative earth fault protection.

If the polarising is shifted through +90°, the residual current seen by the relay on the faulted feeder will lie within the operate region of the directional characteristic and the current on the healthy feeders will fall within the restrain region.

The required characteristic angle setting for the SEF element when applied to insulated systems, is +90°. This is for the case when the protection is connected such that its direction of current flow for operation is from the source busbar towards the feeder. If the forward direction for operation were set such that it is from the feeder into the busbar, then a –90° RCA would be required.

> *Note:*
> *Discrimination can be provided without the need for directional control. This can only be achieved, however, if it is possible to set the IED in excess of the charging current of the protected feeder and below the charging current for the rest of the system.*

## 6.4.2    SETTING GUIDELINES (INSULATED SYSTEMS)

The residual current on the faulted feeder is equal to the sum of the charging currents flowing from the rest of the system. Further, the addition of the two healthy phase charging currents on each feeder gives a total charging current which has a magnitude of three times the per phase value. Therefore, the total imbalance current is equal to three times the per phase charging current of the rest of the system. A typical setting may therefore be in the order of 30% of this value, i.e. equal to the per phase charging current of the remaining system. Practically though, the required setting may well be determined on site, where suitable settings can be adopted based on practically obtained results.

When using a core-balanced transformer, care must be taken in the positioning of the CT with respect to the earthing of the cable sheath:
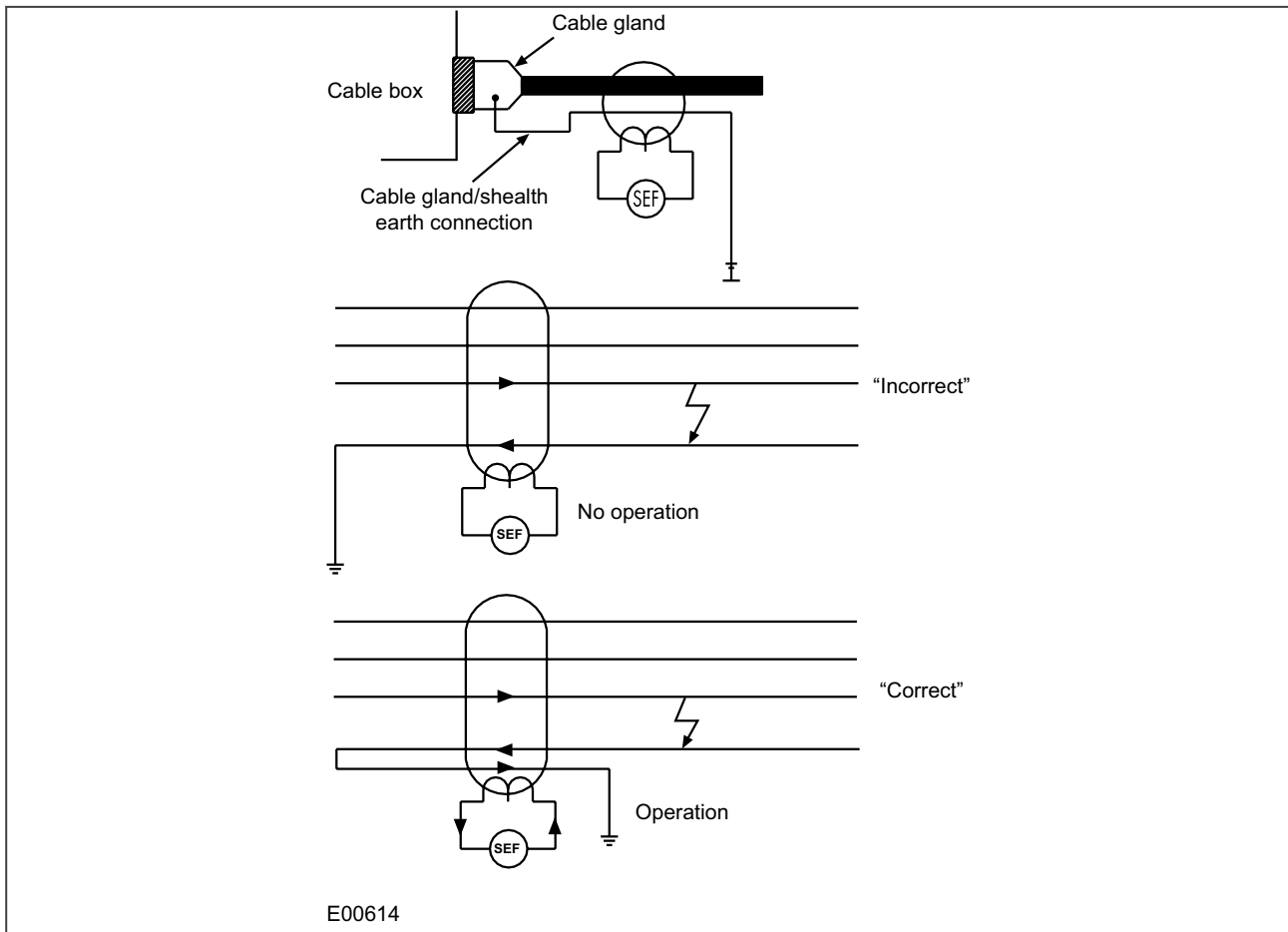
**Figure 32: Positioning of core balance current transformers**

If the cable sheath is terminated at the cable gland and directly earthed at that point, a cable fault (from phase to sheath) will not result in any unbalanced current in the core balance CT. Therefore, prior to earthing, the connection must be brought back through the CBCT and earthed on the feeder side. This then ensures correct relay operation during earth fault conditions.

# 7          COLD LOAD PICKUP

When a feeder circuit breaker is closed in order to energise a load, the current levels that flow for a period of time following energisation may be far greater than the normal load levels. Consequently, overcurrent settings that have been applied to provide overcurrent protection may not be suitable during this period of energisation (cold load), as they may initiate undesired tripping of the circuit breaker. This scenario can be prevented with Cold Load Pickup (CLP) functionality.

The Cold Load Pick-Up (CLP) logic works by either:

- Blocking one or more stages of the overcurrent protection for a set duration
- Raising the overcurrent settings of selected stages, for the cold loading period.

The CLP logic therefore provides stability, whilst maintaining protection during the start-up.

## 7.1        IMPLEMENTATION

Cold Load Pickup Protection is configured in the *COLD LOAD PICKUP* column of the relevant settings group.

This function acts upon the following protection functions:

- All overcurrent stages (both non-directional and directional if applicable)
- All Earth Fault 1 stages (both non-directional and directional if applicable)
- All Earth Fault 2 stages (both non-directional and directional if applicable)

The principle of operation is identical for the 3-phase overcurrent protection and the first stages of Earth Fault overcurrent protection for both EF1 and EF2.

CLP operation occurs when the circuit breaker remains open for a time greater than ***tcold*** and is subsequently closed. CLP operation is applied after ***tcold*** and remains for a set time delay of ***tclp*** following closure of the circuit breaker. The status of the circuit breaker is provided either by means of the CB auxiliary contacts or by means of an external device via logic inputs. Whilst CLP operation is in force, the CLP settings are enabled After the time delay ***tclp*** has elapsed, the normal overcurrent settings are applied and the CLP settings are disabled.

If desired, instead of applying different current setting thresholds for the cold load time, it is also possible to completely block the overcurrrent operation during this time, for any of the overcurrent stages.

Voltage-dependent operation can also affect the overcurrent settings. If a Voltage Dependent condition arises, this takes precedence over the CLP function. If the CLP condition prevails and the Voltage Dependent function resets, the device will operate using the CLP settings. Time-delayed elements are reset to zero if they are disabled during the transitions between normal settings and CLP settings.

## 7.2    CLP LOGIC
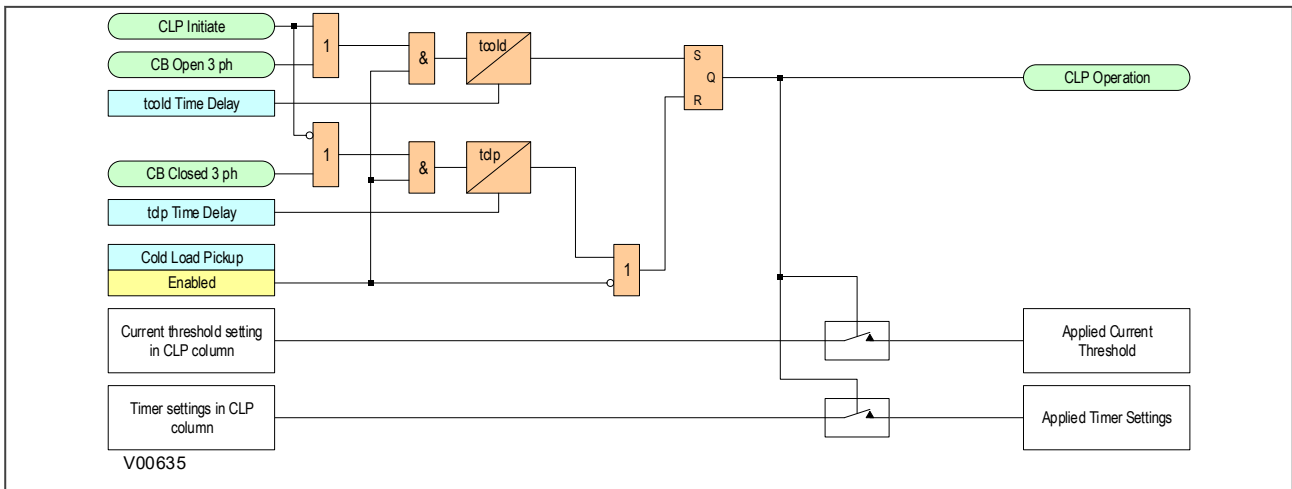


**Figure 33: Cold Load Pickup logic**

The CLP Operation signal indicates that CLP logic is in operation. This only happens when CLP is enabled AND CLP is initiated either externally or from a CB Open condition after the *tcold* period has elapsed. The CLP Operation indicator goes low when CLP is disabled or when the external CLP trigger is removed or when there is a CB closed condition.

*tcold* and *tclp* are initiated via the CB open and CB closed signals generated within the device. These signals are produced by connecting auxiliary contacts from the circuit breaker or starting device to the IED's opto-inputs

If dual CB contacts are not available (one for Open (52a) and for Close (52b)) you can configure the device to be driven from a single contact (either 52a or 52b). The device would then simply invert one signal to provide the other. This option is available using the **CB status input** cell in the *CB CONTROL* column. The setting can be set to `None`, `52a`, `52b` or `52a` and `52b`.

## 7.3    APPLICATION NOTES

### 7.3.1    CLP FOR RESISTIVE LOADS

A typical example of where CLP logic may be used is for resistive heating loads such as such as air conditioning systems. Resistive loads typically offer less resistance when cold than when warm, hence the start-up current will be higher.

To set up the CLP, you need to select `Enable` from the **I> status** option to enable the settings of the temporary current and time settings. These settings should be chosen in accordance with the expected load profile. Where it is not necessary to alter the setting of a particular stage, the CLP settings should be set to the same level as the standard overcurrent settings.

It may not be necessary to alter the protection settings following a short supply interruption. In this case a suitable *tcold* timer setting can be used.

### 7.3.2    CLP FOR MOTOR FEEDERS

In general, a dedicated motor protection device would protect feeders supplying motor loads. However, if CLP logic is available in a feeder device, this may be used to modify the overcurrent settings during start-up.

Depending on the magnitude and duration of the motor starting current, it may be sufficient to simply block operation of instantaneous elements. If the start duration is long, the time-delayed protection settings may also need to be raised. A combination of both blocking and raising of the overcurrent settings may be adopted. The CLP overcurrent settings in this case must be chosen with regard to the motor starting characteristic.

This may be useful where instantaneous earth fault protection needs to be applied to the motor. During motor start-up conditions, it is likely that incorrect operation of the earth fault element would occur due to asymmetric CT saturation. This is due to the high level of starting current causing saturation of one or more of the line CTs feeding the overcurrent/earth fault protection. The resultant transient imbalance in the secondary line current quantities is therefore detected by the residually connected earth fault element. For this reason, it is normal to either apply a nominal time delay to the element, or to use a series stabilising resistor.

The CLP logic may be used to allow reduced operating times or current settings to be applied to the earth fault element under normal running conditions. These settings could then be raised prior to motor starting, by means of the logic.

### 7.3.3 CLP FOR SWITCH ONTO FAULT CONDITIONS

In some feeder applications, fast tripping may be required if a fault is already present on the feeder when it is energised. Such faults may be due to a fault condition not having been removed from the feeder, or due to earthing clamps having been left on following maintenance. In either case, it is desirable to clear the fault condition quickly, rather than waiting for the time delay imposed by IDMT overcurrent protection.

The CLP logic can cater for this situation. Selected overcurrent/earth fault stages could be set to instantaneous operation for a defined period following circuit breaker closure (typically 200 ms). Therefore, instantaneous fault clearance would be achieved for a switch onto fault (SOTF) condition.

# 8        SELECTIVE LOGIC

With Selective Logic you can use the Start signals to control the time delays of upstream IEDs, as an alternative to simply blocking them. This provides an alternative approach to achieving non-cascading types of overcurrent scheme.

## 8.1        SELECTIVE LOGIC IMPLEMENTATION

Selective Logic is set in the *SELECTIVE LOGIC* column of the relevant settings group.

The Selective Logic function works by temporarily increasing the time delay settings of the chosen overcurrent elements. This logic is initiated by issuing signals to an upstream IED.

This function acts on the following protection functions:

- Non-Directional/Directional phase overcurrent (3rd, 4th and 6th stages)
- Non-Directional/Directional earth fault – 1 (3rd and 4th stages)
- Non-Directional/Directional earth fault – 2 (3rd and 4th stages)
- Non-Directional/Directional sensitive earth fault (3rd and 4th stages)

*Note:*
*In the event of a conflict between Selective Logic and CLP, Selective Logic takes precedence.*

## 8.2        SELECTIVE LOGIC DIAGRAM
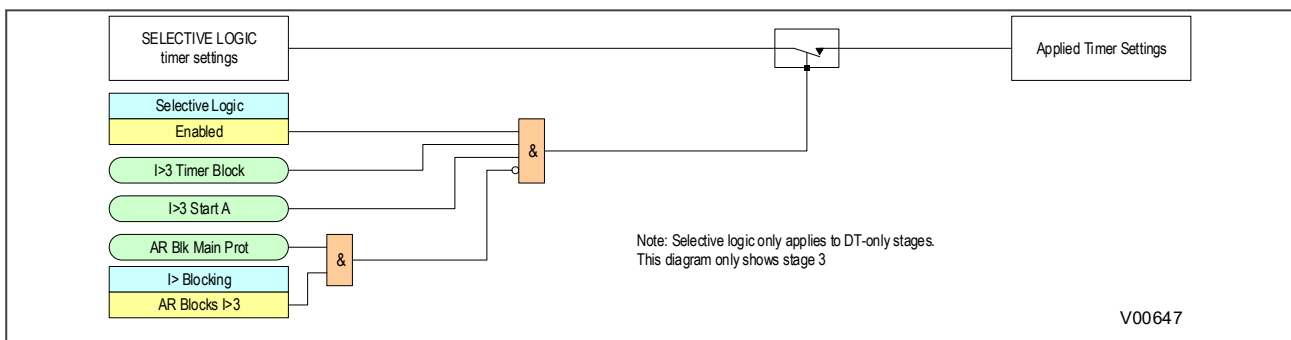


**Figure 34: Selective Logic**

The logic diagram is shown for overcurrent phase A, but is valid for all three phases for each of the stages. The principle of operation is also identical for earth fault protection.

When the selective logic function is enabled, the action of the blocking input is as follows:

### No block applied

In the event of a fault condition that continuously asserts the start output, the function will assert a trip signal after the normal time delay has elapsed.

### Logic input block applied

In the event of a fault condition that continuously asserts the start output, the function will assert a trip signal after the selective logic time delay has elapsed.

### Auto-reclose input block applied

In the event of a fault condition that continuously asserts the start output, when an auto-reclose block is applied the function will not trip. The auto-reclose block also overrides the logic input block and will block the selective logic timer.

> *Note:*
> *The Auto-reclose function outputs two signals that block protection, namely;* **AR Blk Main Prot** *and* **AR Blk SEF Prot***.*

**AR Blk Main Prot** is common to Phase Overcurrent, Earth Fault 1 and Earth Fault 2, whereas **AR Blk SEF Prot** is used for SEF protection.

# 9          THERMAL OVERLOAD PROTECTION

The heat generated within an item of plant is the resistive loss. The thermal time characteristic is therefore based on the equation $I^2Rt$. Over-temperature conditions occur when currents in excess of their maximum rating are allowed to flow for a period of time.

Temperature changes during heating follow exponential time constants. The device provides two characteristics for thermal overload protection; a single time constant characteristic and a dual time constant characteristic. You select these according to the application.

## 9.1          SINGLE TIME CONSTANT CHARACTERISTIC

This characteristic is used to protect cables, dry type transformers and capacitor banks.

The single constant thermal characteristic is given by the equation:

$$t = -\tau \, log_e \left[ \frac{I^2 - \left( KI_{FLC} \right)^2}{I^2 - I_p{}^2} \right]$$

where:

- t = time to trip, following application of the overload current I
- $\tau$ = heating and cooling time constant of the protected plant
- I = largest phase current
- $I_{FLC}$ full load current rating (the Thermal Trip setting)
- $I_p$ = steady state pre-loading before application of the overload
- K = a constant, settable between 1 and 1.5, with the default value of 1.05 (*k factor*)

## 9.2          DUAL TIME CONSTANT CHARACTERISTIC

This characteristic is used to protect equipment such as oil-filled transformers with natural air cooling. The thermal model is similar to that with the single time constant, except that two timer constants must be set.

For marginal overloading, heat will flow from the windings into the bulk of the insulating oil. Therefore, at low current, the replica curve is dominated by the long time constant for the oil. This provides protection against a general rise in oil temperature.

For severe overloading, heat accumulates in the transformer windings, with little opportunity for dissipation into the surrounding insulating oil. Therefore at high current levels, the replica curve is dominated by the short time constant for the windings. This provides protection against hot spots developing within the transformer windings.

Overall, the dual time constant characteristic serves to protect the winding insulation from ageing and to minimise gas production by overheated oil. Note however that the thermal model does not compensate for the effects of ambient temperature change.

The dual time constant thermal characteristic is given by the equation:

$$0.4e^{(-t/\tau_1)} + 0.6e^{(-t/\tau_2)} = \left[ \frac{I^2 - \left( KI_{FLC} \right)^2}{I^2 - I_p{}^2} \right]$$

where:

- $\tau_1$ = heating and cooling time constant of the transformer windings
- $\tau_2$ = heating and cooling time constant of the insulating oil

## 9.3 THERMAL OVERLOAD PROTECTION IMPLEMENTATION

The device incorporates a current-based thermal characteristic, using Fourier based load current to model heating and cooling of the protected plant. The element can be set with both alarm and trip stages.

Thermal Overload Protection is implemented in the *THERMAL OVERLOAD* column of the relevant settings group.

This column contains the settings for the characteristic type, the alarm and trip thresholds and the time constants.

## 9.4 THERMAL OVERLOAD PROTECTION LOGIC
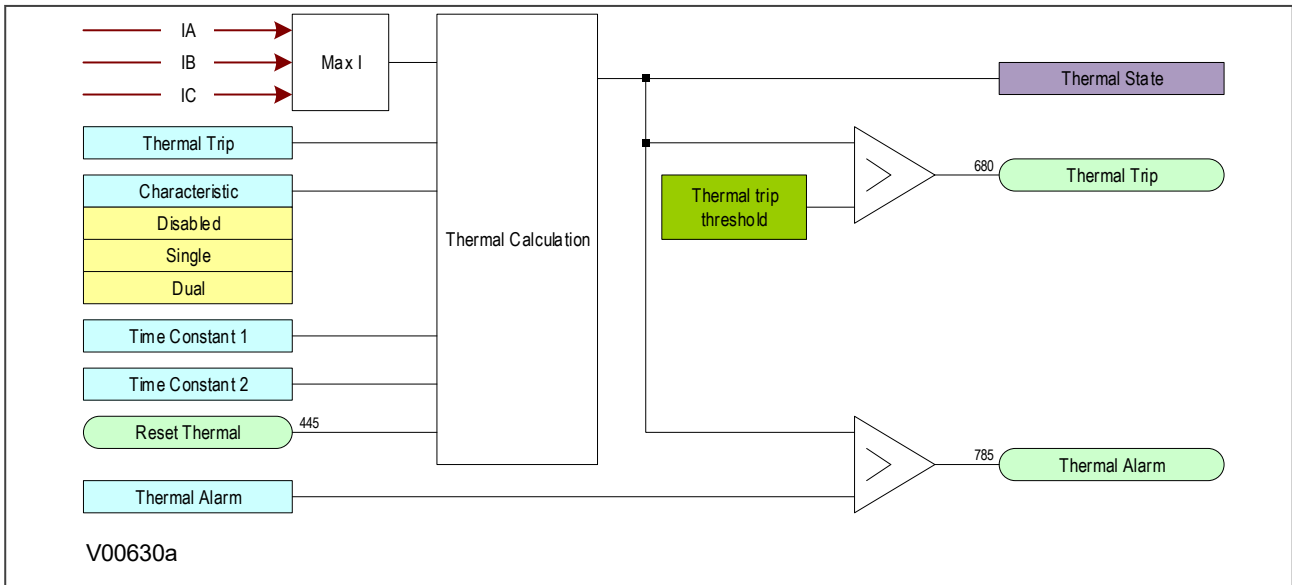


**Figure 35: Thermal overload protection logic diagram**

The magnitudes of the three phase input currents are compared and the largest magnitude is taken as the input to the thermal overload function. If this current exceeds the thermal trip threshold setting a start condition is asserted.

The Start signal is applied to the chosen thermal characteristic module, which has three outputs signals; alarm trip and thermal state measurement. The thermal state measurement is made available in one of the *MEASUREMENTS* columns.

The thermal state can be reset by either a digital signal (Opto, GOOSE, InterMiCOM), if assigned to this function using programmable scheme logic or the HMI panel menu.

## 9.5 APPLICATION NOTES

### 9.5.1 SETTING GUIDELINES FOR DUAL TIME CONSTANT CHARACTERISTIC

The easiest way of solving the dual time constant thermal equation is to express the current in terms of time and to use a spreadsheet to calculate the current for a series of increasing operating times using the following equation, then plotting a graph.

$$I = \sqrt{\frac{0.4I_p{}^2.e^{(-t/\tau 1)} + 0.6I_p{}^2.e^{(-t/\tau 2)} - k^2.I_{FLC}{}^2}{0.4e^{(-t/\tau 1)} + 0.6e^{(-t/\tau 2)} - 1}}$$

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | **Time constant 1 =** | | 300 | seconds | | |
| 3 | **Time constant 2 =** | | 7200 | seconds | | |
| 4 | **Pre-overload current Ip =** | | 0.9 | per unit | | |
| 5 | **Full load current =** | | 1 | Amps | | |
| 6 | | | | | Figures based | |
| 7 | **OP Time (t)** | **Overload current (I)** | | | on equation | |
| 8 | 1 | 14.40852032 | | | | |
| 9 | 1.5 | 11.7805774 | | | | |
| 10 | 2 | 10.21617905 | | | | |
| 11 | 2.5 | 9.150045407 | | | | |
| 12 | 3 | 8.364131776 | | | | |
| 13 | 3.5 | 7.754150044 | | | | |
| 14 | 4 | 7.263123888 | | | | |
| 15 | 4.5 | 6.856949012 | | | | |

E00728

**Figure 36: Spreadsheet calculation for dual time constant thermal characteristic**



Time constant 1 = 5 mins
Time constant 2 = 120 mins
Pre-overload current = 0.9 pu
Thermal setting = 1 Amp
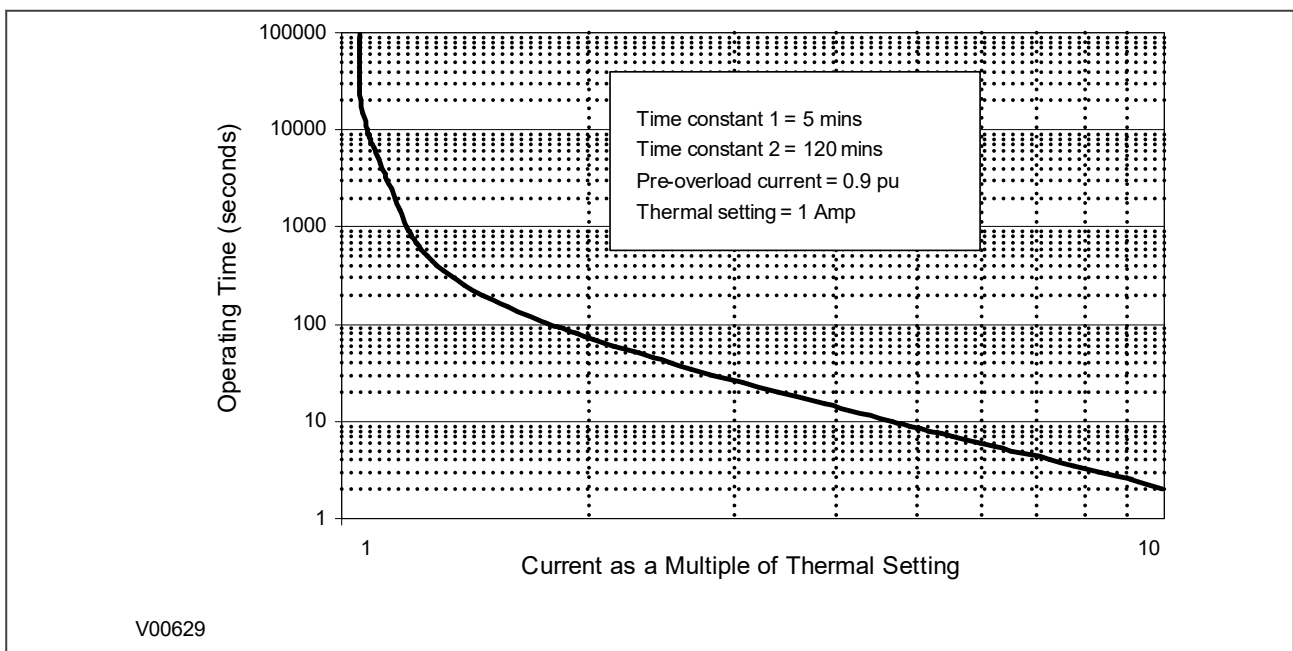
V00629

**Figure 37: Dual time constant thermal characteristic**

The current setting is calculated as:

Thermal Trip = Permissible continuous loading of the transformer item/CT ratio.

For an oil-filled transformer with rating 400 to 1600 kVA, the approximate time constants are:

- $\tau_1$ = 5 minutes
- $\tau_2$ = 120 minutes

An alarm can be raised on reaching a thermal state corresponding to a percentage of the trip threshold. A typical setting might be "Thermal Alarm" = 70% of thermal capacity.

> *Note:*
> *The thermal time constants given in the above tables are typical only. Reference should always be made to the plant manufacturer for accurate information.*

## 9.5.2 SETTING GUIDELINES FOR SINGLE TIME CONSTANT CHARACTERISTIC

The time to trip varies depending on the load current carried before application of the overload, i.e. whether the overload was applied from hot or cold.

The thermal time constant characteristic may be rewritten as:

$$e^{(-t/\tau)} = {}_e\left[\frac{\theta - \theta_p}{\theta - 1}\right]$$

where:

- $\theta$ = thermal state = $I^2/K^2 I_{FLC}^2$

- $\theta_p$ = pre-fault thermal state = $I_p^2/K^2 I_{FLC}^2$

- $I_p$ is the pre-fault thermal state

- $I_{FLC}$ is the full load current

> *Note:*
> *A current of 105%Is ($KI_{FLC}$) has to be applied for several time constants to cause a thermal state measurement of 100%.*

The current setting is calculated as:

Thermal Trip = Permissible continuous loading of the plant item/CT ratio.

The following tables show the approximate time constant in minutes, for different cable rated voltages with various conductor cross-sectional areas, and other plant equipment.

| Area mm$^2$ | 6 - 11 kV | 22 kV | 33 kV | 66 kV |
|---|---|---|---|---|
| 25 – 50 | 10 minutes | 15 minutes | 40 minutes | – |
| 70 – 120 | 15 minutes | 25 minutes | 40 minutes | 60 minutes |
| 150 | 25 minutes | 40 minutes | 40 minutes | 60 minutes |
| 185 | 25 minutes | 40 minutes | 60 minutes | 60 minutes |
| 240 | 40 minutes | 40 minutes | 60 minutes | 60 minutes |
| 300 | 40 minutes | 60 minutes | 60 minutes | 90 minutes |

| Plant type | Time Constant (Minutes) |
|---|---|
| Dry-type transformer <400 kVA | 40 |
| Dry-type transformers 400 – 800 kVA | 60 - 90 |
| Air-core Reactors | 40 |
| Capacitor Banks | 10 |
| Overhead Lines with cross section > 100 mm$^2$ | 10 |
| Overhead Lines | 10 |
| Busbars | 60 |

# 10      BROKEN CONDUCTOR PROTECTION

One type of unbalanced fault is the 'Series' or 'Open Circuit' fault. This type of fault can arise from, among other things, broken conductors. Series faults do not cause an increase in phase current and so cannot be detected by overcurrent protection. However, they do produce an imbalance, resulting in negative phase sequence current, which can be detected.

It is possible to apply a negative phase sequence overcurrent element to detect broken conductors. However, on a lightly loaded line, the negative sequence current resulting from a series fault condition may be very close to, or less than, the full load steady state imbalance arising from CT errors and load imbalances, making it very difficult to distinguish. A regular negative sequence element would therefore not work at low load levels. To overcome this, the device incorporates a special Broken Conductor protection element.

The Broken Conductor element measures the ratio of negative to positive phase sequence current (I2/I1). This ratio is approximately constant with variations in load current, therefore making it more sensitive to series faults than standard negative sequence protection.

## 10.1      BROKEN CONDUCTOR PROTECTION IMPLEMENTATION

Broken Conductor protection is implemented in the *BROKEN CONDUCTOR* column of the relevant settings group.

This column contains the settings to enable the function, for the pickup threshold and the time delay.

## 10.2      BROKEN CONDUCTOR PROTECTION LOGIC

The ratio of $I_2/I_1$ is calculated and compared with the threshold setting. If the threshold is exceeded, the delay timer is initiated. The CTS block signal is used to block the operation of the delay timer.
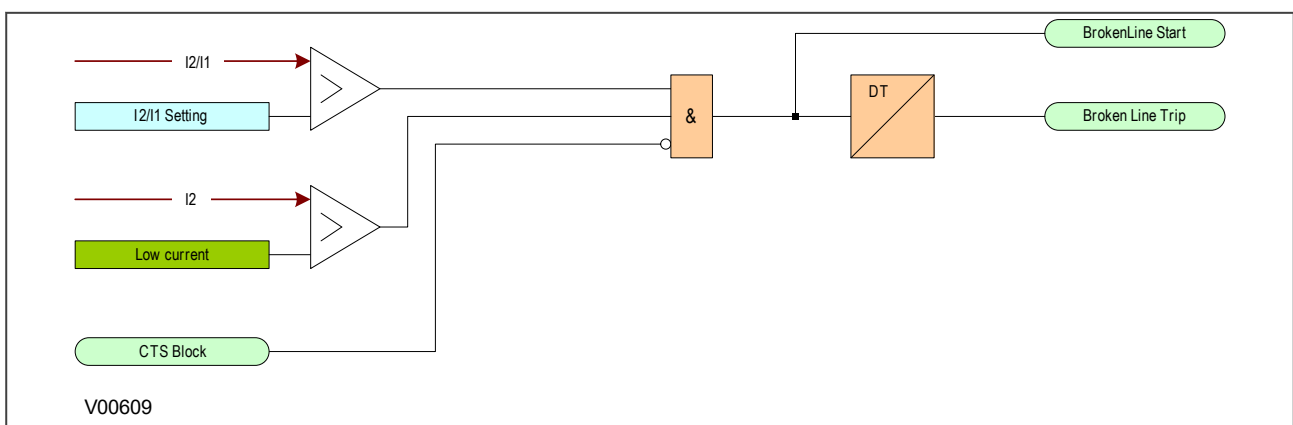


**Figure 38: Broken conductor logic**

## 10.3      APPLICATION NOTES

### 10.3.1      SETTING GUIDELINES

For a broken conductor affecting a single point earthed power system, there will be little zero sequence current flow and the ratio of $I_2/I_1$ that flows in the protected circuit will approach 100%. In the case of a multiple earthed power system (assuming equal impedance's in each sequence network), the ratio $I_2/I_1$ will be 50%.

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 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.

> *Note:*
> *A minimum value of 8% negative phase sequence current is required for successful operation.*

Since sensitive settings have been employed, we can expect that the element will operate for any unbalanced condition occurring on the system (for example, during a single pole autoreclose cycle). For this reason, a long time delay is necessary to ensure co-ordination with other protection devices. A 60 second time delay setting may be typical.

The following example was recorded by an IED during commissioning:

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

$$I_2 = 50A$$

therefore the quiescent $I_2/I_1$ ratio = 0.1

To allow for tolerances and load variations a setting of 20% of this value may be typical: Therefore set:

$$I_2/I_1 = 0.2$$

In a double circuit (parallel line) application, using a 40% setting will ensure that the broken conductor protection will operate only for the circuit that is affected. A setting of 0.4 results in no pick-up for the parallel healthy circuit.

Set $I_2/I_1$ Time Delay = 60 s to allow adequate time for short circuit fault clearance by time delayed protections.

# 11        BLOCKED OVERCURRENT PROTECTION

With Blocked Overcurrent schemes, you connect the start contacts from downstream IEDs to the timer blocking inputs of upstream IEDs. This allows identical current and time settings to be used on each of the IEDs in the scheme, as the device nearest to the fault does not receive a blocking signal and so trips discriminatively. This type of scheme therefore reduces the number of required grading stages, and consequently fault clearance times.

The principle of Blocked Overcurrent protection may be extended by setting fast-acting overcurrent elements on the incoming feeders to a substation, which are then arranged to be blocked by start contacts from the devices protecting the outgoing feeders. The fast-acting element is thus allowed to trip for a fault condition on the busbar, but is stable for external feeder faults due to the blocking signal.

This type of scheme provides much reduced fault clearance times for busbar faults than would be the case with conventional time-graded overcurrent protection. The availability of multiple overcurrent and earth fault stages in the GE IEDs allows additional time-graded overcurrent protection for back-up purposes.

## 11.1       BLOCKED OVERCURRENT IMPLEMENTATION

Blocked Overcurrent schemes are implemented using the PSL. The start outputs, available from each stage of the overcurrent and earth fault elements (including the sensitive earth fault element) can be mapped to output relay contacts. These outputs can then be connected to the relevant timer block inputs of the upstream IEDs via opto-inputs.

## 11.2       BLOCKED OVERCURRENT LOGIC

To facilitate the implementation of blocked overcurrent schemes, the device provides the following logic to provide a Blocked Overcurrent Start signal *I> BlockStart*:
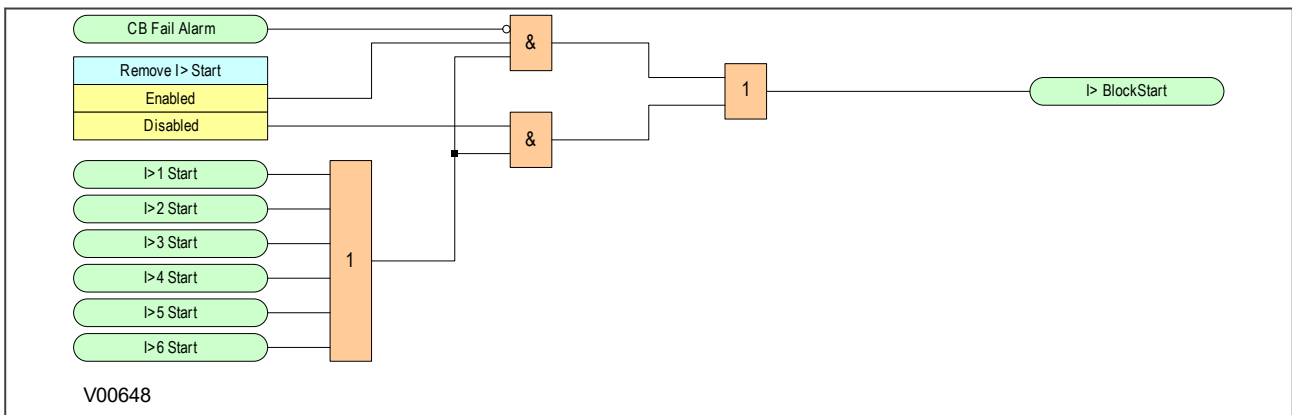


**Figure 39: Blocked Overcurrent logic**

The *I> BlockStart* signal is derived from the logical OR of the phase overcurrent start outputs. This output is then gated with the *CB Fail Alarm* DDB signal and the setting *Remove I> Start* setting.

## 11.3       BLOCKED EARTH FAULT LOGIC

To facilitate the implementation of blocked overcurrent schemes, the device provides the following logic to provide the Blocked Earth Fault signal *IN/SEF>Blk Start*:
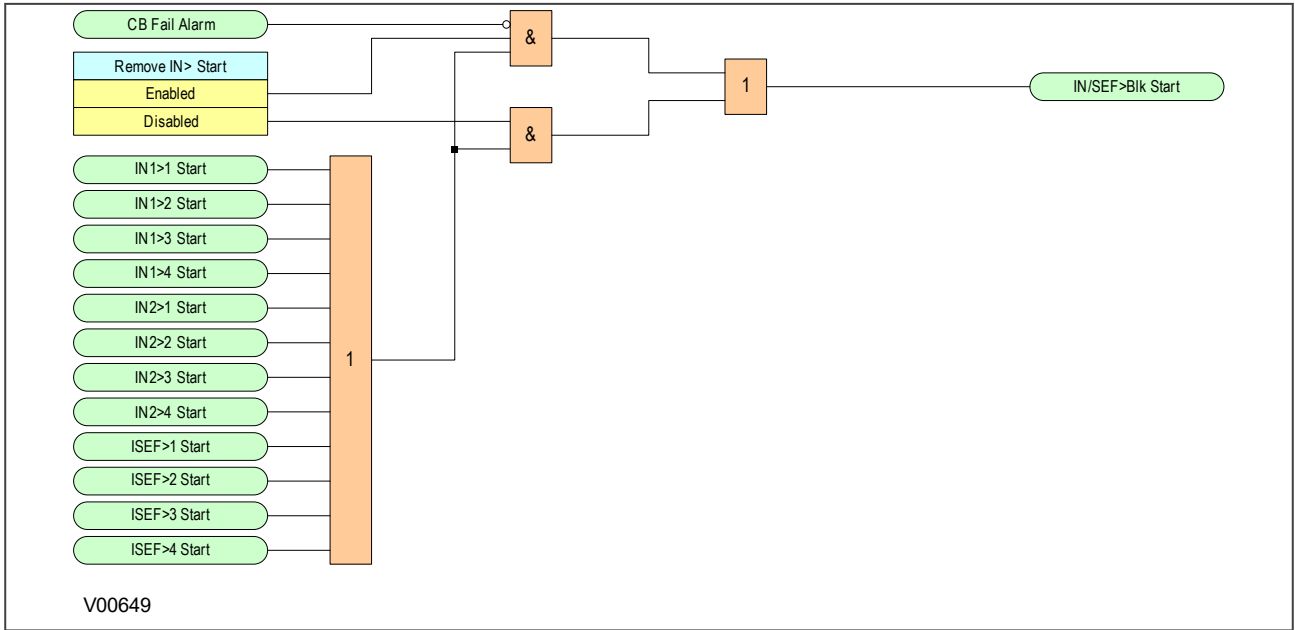
**Figure 40: Blocked Earth Fault logic**

The *IN/SEF>Blk Start* signal is derived from the logical OR of the phase overcurrent start outputs. This output is then gated with the *CB Fail Alarm* DDB signal and the *Remove IN> Start* setting.

## 11.4    APPLICATION NOTES

### 11.4.1    BUSBAR BLOCKING SCHEME
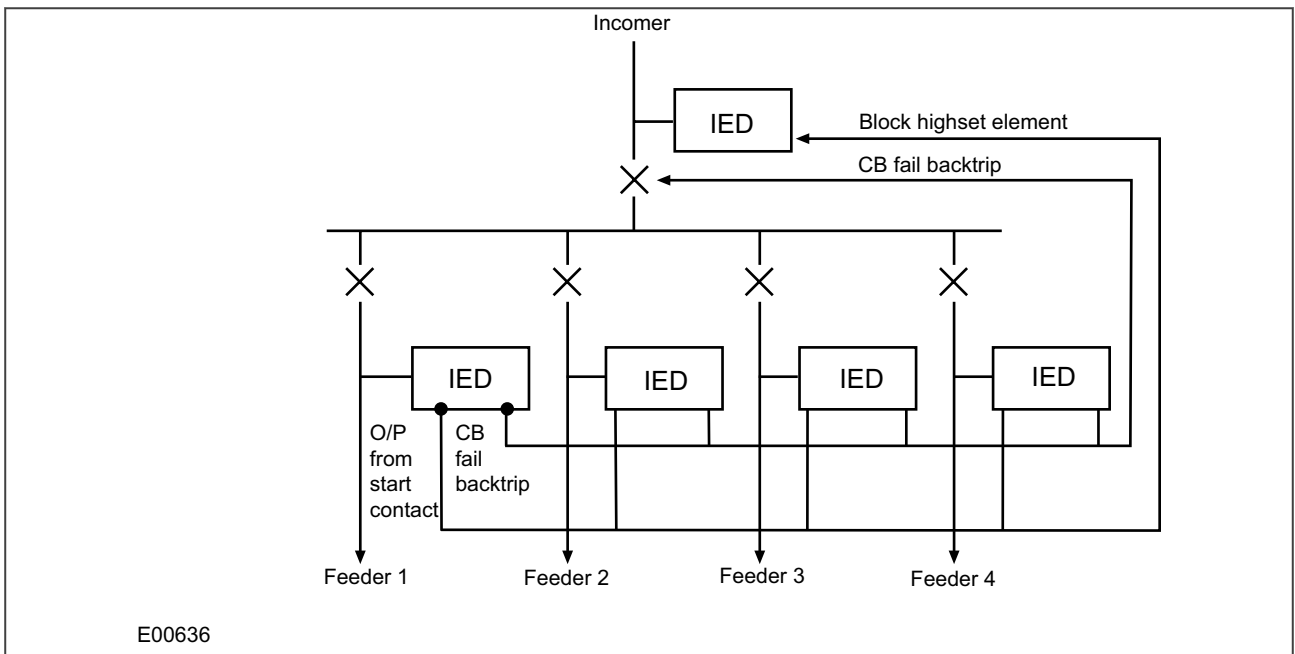


**Figure 41: Simple busbar blocking scheme**
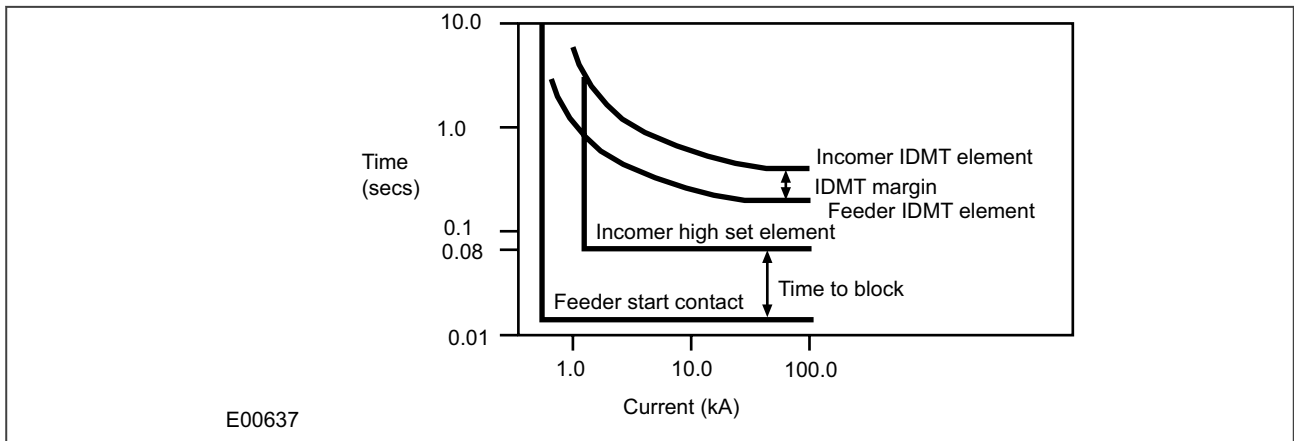
**Figure 42: Simple busbar blocking scheme characteristics**

For further guidance on the use of blocked busbar schemes, refer to GE.

## 12        SECOND HARMONIC BLOCKING

When a transformer is initially connected to a source of AC voltage, there may be a substantial surge of current through the primary winding called inrush current.

Inrush current is a regularly occurring phenomenon and should not be considered a fault, as we do not wish the protection device to issue a trip command whenever a transformer, or machine is switched on. This presents a problem to the protection device, because it should always trip on an internal fault. The problem is that typical internal transformer faults may produce overcurrents which are not necessarily greater than the inrush current. Furthermore faults tend to manifest themselves on switch on, due to the high inrush currents. For this reason, we need to find a mechanism that can distinguish between fault current and inrush current. Fortunately this is possible due to the different natures of the respective currents. An inrush current waveform is rich in harmonics (particularly the second), whereas an internal fault current consists only of the fundamental. We can thus develop a restraining method based on the harmonic content of the inrush current. The mechanism by which this is achieved is called second harmonic blocking.

### 12.1        SECOND HARMONIC BLOCKING IMPLEMENTATION

Second harmonic blocking can be applied to the following overcurrent protection types:

- Phase Overcurrent protection (POC)
- Earth Fault protection (derived and measured) (EF1 and EF2)
- Sensitive Earth Fault protection (SEF)
- Negative Phase Sequence Overcurrent protection (NPSOC)

Second harmonic blocking is implemented in the *SECURITY CONFIG* column of the relevant setting group.

Second harmonic blocking is applicable to all stages of each of the elements. Each protection element has a relevant blocking setting with which the type of blocking is defined.

For phase overcurrent, 2nd harmonic blocking can be applied to each phase individually (phase segregated), or to all three phases at once (cross-block). This is determined by the ***I> Blocking*** setting.

## 12.2    SECOND HARMONIC BLOCKING LOGIC (POC INPUT)
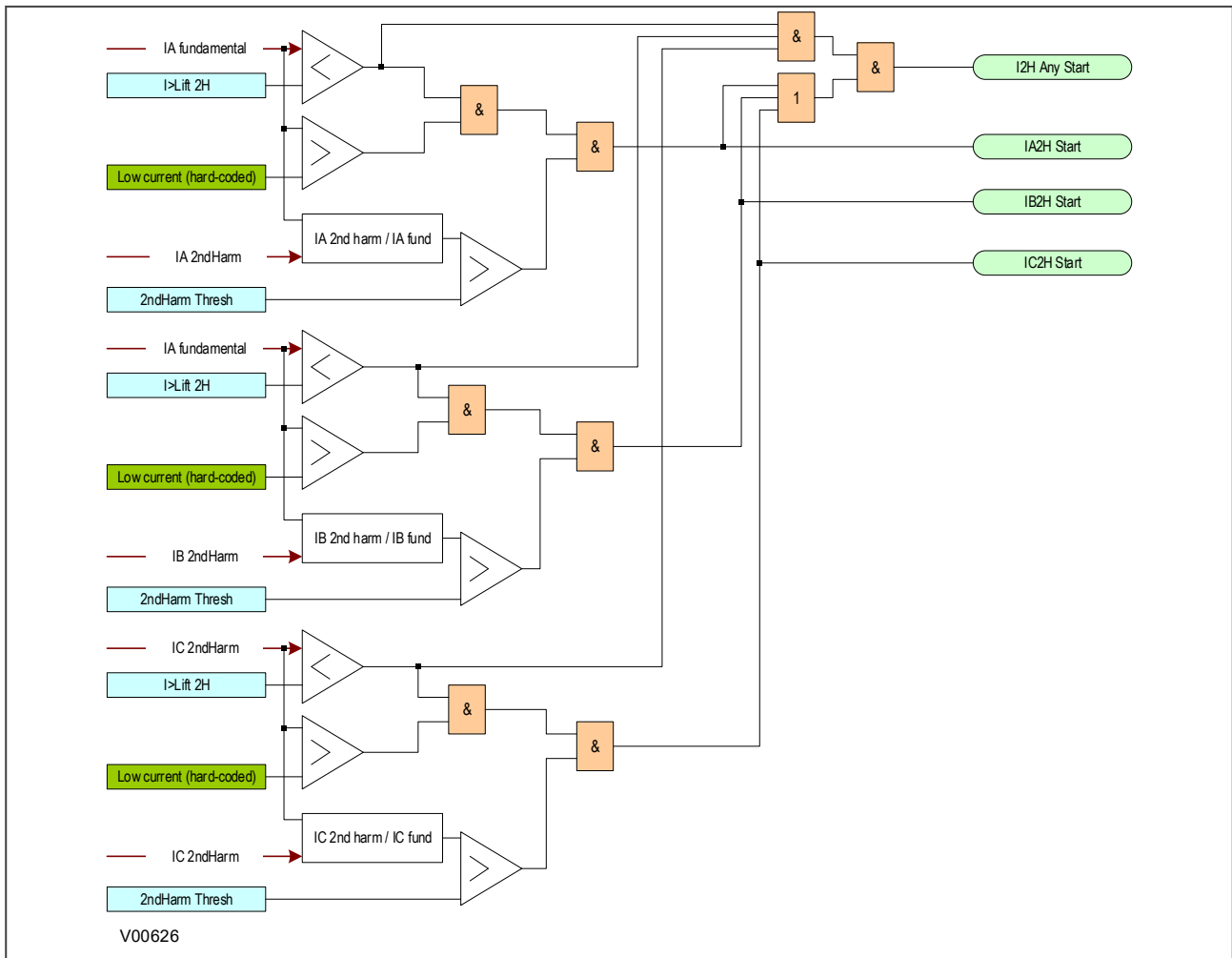


**Figure 43: 2nd Harmonic Blocking Logic (POC Input)**

The function works by identifying and measuring the inrush currents present in the phase currents at switch on. It does this by comparing the value of the second harmonic current components to the value of the fundamental component. If this ratio exceeds the set thresholds, then the blocking signal is generated. The threshold is defined by the **2ndHarm Thresh** setting.

We only want the function to block the protection if the fundamental current component is within the normal range. If this exceeds the normal range, then this is indicative of a fault, which must be protected. For this reason there is another settable trigger **I>lift 2H**, which when exceeded, stops the 2nd harmonic blocking function.

## 12.3    APPLICATION NOTES

### 12.3.1    SETTING GUIDELINES

During the energization period, the second harmonic component of the inrush current may be as high as 70%. The second harmonic level may be different for each phase, which is why phase segregated blocking is available.

If the setting is too low, the 2nd harmonic blocking may prevent tripping during some internal transformer faults. If the setting is too high, the blocking may not operate for low levels of inrush current which could result in undesired tripping of the overcurrent element during the energization period. In general, a setting of 15% to 20% is suitable.

# 13        HIGH IMPEDANCE FAULT DETECTION

A High Impedance Fault, also known as a *Downed Conductor*, happens when a primary conductor makes unwanted electrical contact with a road surface, pathway, tree etc., whereby due to the high impedance of the fault path, the fault current is restricted to a level below that which can be reliably detected by standard overcurrent devices. Even in cases where the instantaneous fault current may exceed the thresholds, the duration of this transient is usually so small that the standard overcurrent IED will not pick up. It is quite a challenging problem to detect such faults, and it requires a special method combining multiple techniques.

Due to the high impedance and transient nature of such faults it is not possible to derive the fault calculation from short-circuit computing. HIF detection therefore relies on the detection of the fault current and voltage waveform signatures. These waveforms may be very different from fault to fault, but they often have commonalities typified by:

- Third harmonic content
- The transient bursting (intermittent change of amplitude)

We can use these phenomena to detect the fault.

We may need to establish the direction of the fault. For this, we can use instantaneous power measurement. Hence we can see there are three components necessary to provide a reliable HIF detection function:

- Component harmonic Analysis (CHA)
- Fundamental Analysis (FA) (with or without directional analysis (DIR)

## 13.1      HIGH IMPEDANCE FAULT PROTECTION IMPLEMENTATION

## 13.2      HIGH IMPEDANCE FAULT PROTECTION LOGIC
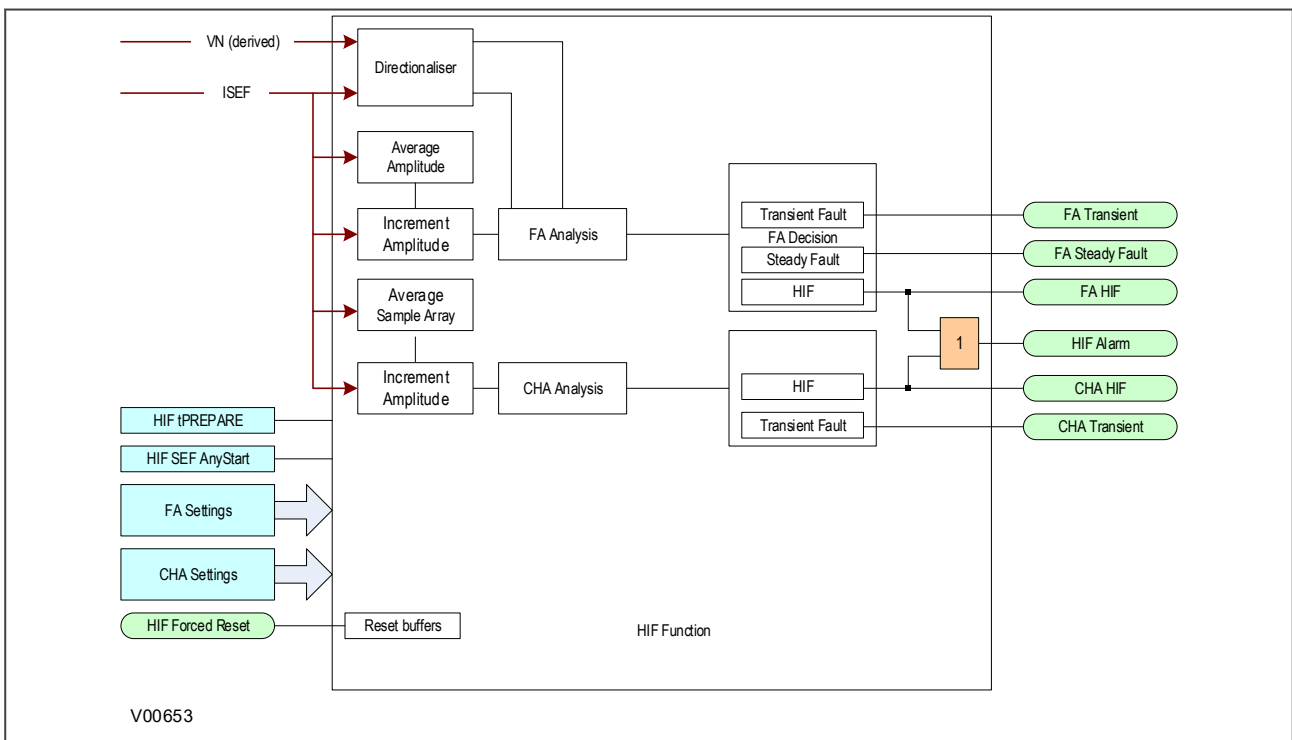


**Figure 44: HIF Protection Logic**

# CHAPTER 7

# RESTRICTED EARTH FAULT PROTECTION

# 1          CHAPTER OVERVIEW

The device provides extensive Restricted Earth Fault functionality. This chapter describes the operation of this function including the principles of operation, logic diagrams and applications.

This chapter contains the following sections:

# 2          REF PROTECTION PRINCIPLES

Winding-to-core faults in a transformer can be caused by insulation breakdown. Such faults can have very low fault currents, but they still need to be picked up. If such faults are not identified, this could result in extreme damage to very expensive equipment.

Often the associated fault currents are lower than the nominal load current. Neither overcurrent nor percentage differential protection is sufficiently sensitive in this case. We therefore require a different type of protection arrangement. Not only should the protection arrangement be sensitive, but it must create a protection zone, which is limited to each transformer winding. Restricted Earth Fault protection (REF) is the protection mechanism used to protect individual transformer winding sets.

The following figure shows a REF protection arrangement for protecting the delta side of a delta-star transformer.
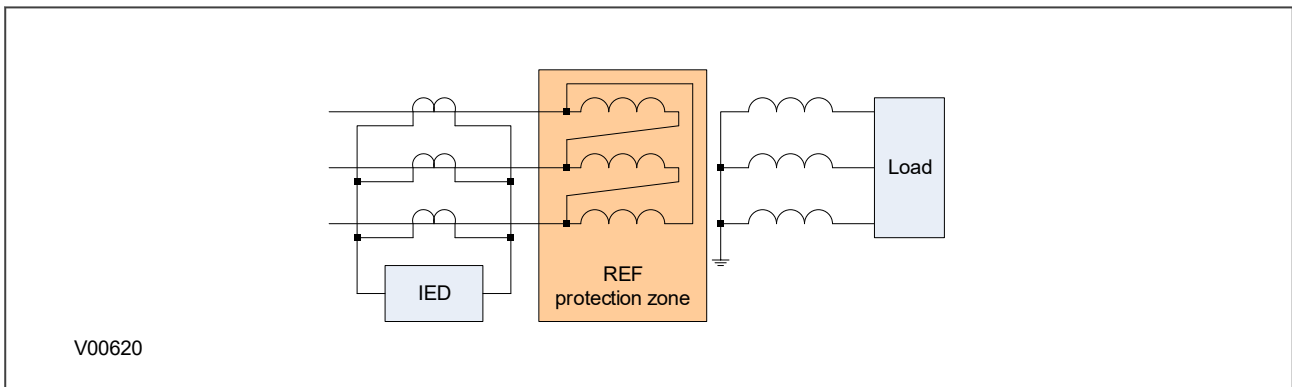


**Figure 45: REF protection for delta side**

The current transformers measuring the currents in each phase are connected in parallel. The currents from all three phases are summed to form a differential current, sometimes known as a spill current. Under normal operating conditions the currents of the three phases add up to zero resulting in zero spill current. A fault on the star side will also not result in a spill current, as the fault current would simply circulate in the delta windings. However, if any of the three delta windings were to develop a fault, the impedance of the faulty winding would change and that would result in a mismatch between the phase currents, resulting in a spill current. If the spill current is large enough, it will trigger a trip command.

The following figure shows a REF protection arrangement for the star side of a delta-star transformer.
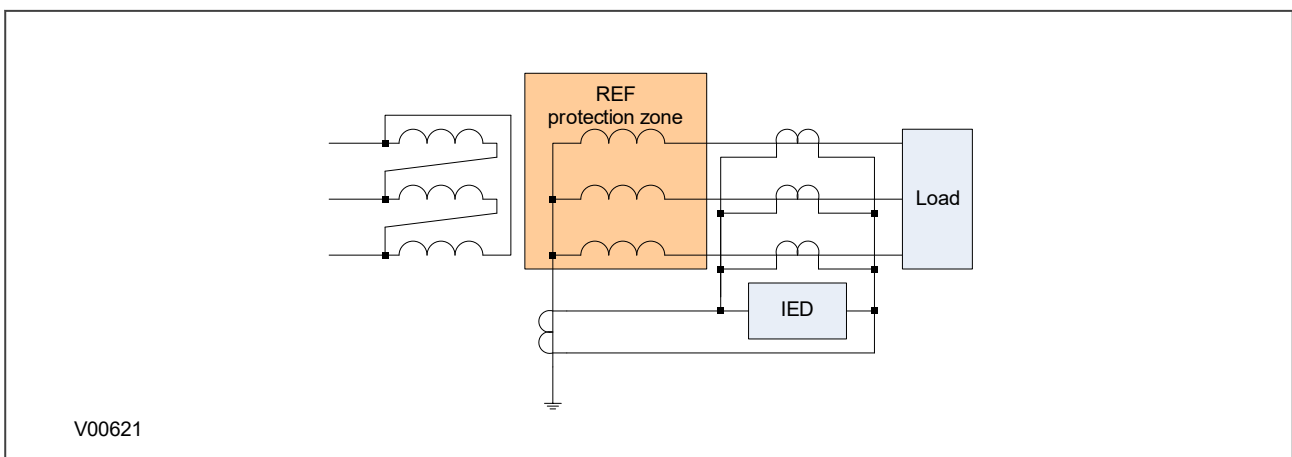


**Figure 46: REF protection for star side**

Here we have a similar arrangement of current transformers connected in parallel. The difference is that we need to measure the zero sequence current in the neutral line as well. An external unbalanced fault causes zero sequence current to flow through the neutral line, resulting in uneven currents in the phases, which could cause

the protection to maloperate. By measuring this zero sequence current and placing it in parallel with the other three, the currents are balanced, resulting in stable operation. Now only a fault inside the star winding can create an imbalance sufficient to cause a trip.

## 2.1 RESISTANCE-EARTHED STAR WINDINGS

Most distribution systems use resistance-earthed systems to limit the fault current. Consider the diagram below, which depicts an earth fault on the star winding of a resistance-earthed Dyn transformer (Dyn = Delta-Star with star-point neutral connection).
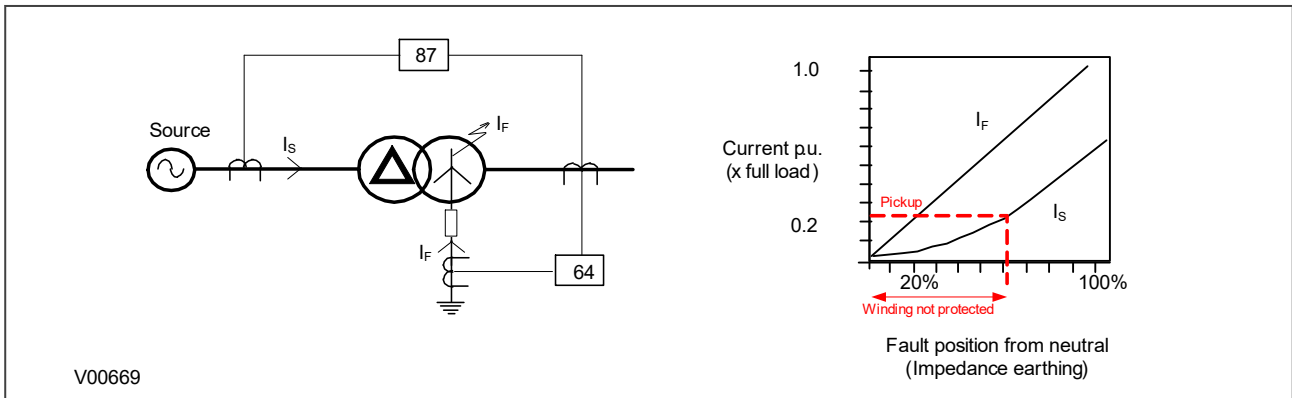


**Figure 47: REF Protection for resistance-earthed systems**

The value of fault current ($I_F$) depends on two factors:

- The value of earthing resistance (which makes the fault path impedance negligible)
- The fault point voltage (which is governed by the fault location).

Because the fault current ($I_F$) is governed by the resistance, its value is directly proportional to the location of the fault.

A restricted earth fault element is connected to measure $I_F$ directly. This provides very sensitive earth fault protection. The overall differential protection is less sensitive, since it only measures the HV current $I_S$. The value of $I_S$ is limited by the number of faulty secondary turns in relation to the HV turns.

## 2.2 SOLIDLY-EARTHED STAR WINDINGS

Most transmission systems use solidly-earthed systems. Consider the diagram below, which depicts an earth fault on the star winding of a solidly-earthed Dyn transformer.
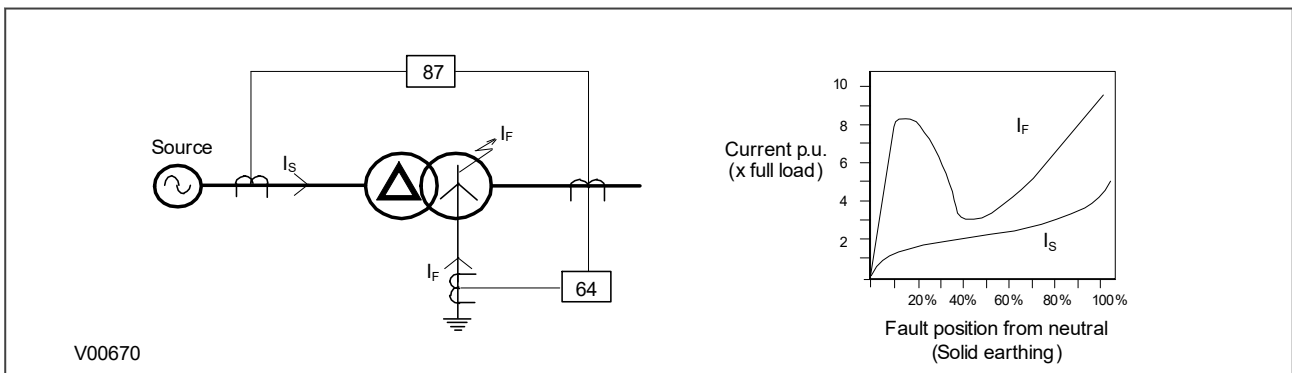


**Figure 48: REF Protection for solidly earthed system**

In this case, the fault current $I_F$ is dependent on:

- The leakage reactance of the winding
- The impedance in the fault path
- The fault point voltage (which is governed by the fault location)

In this case, the value of fault current ($I_F$) varies with the fault location in a complex manner.

A restricted earth fault element is connected to measure $I_F$ directly. This provides very sensitive earth fault protection.

For solidly earthed systems, the operating current for the transformer differential protection is still significant for faults over most of the winding. For this reason, independent REF protection may not have been previously considered, especially where an additional device would have been needed. But with this product, it can be applied without extra cost.

## 2.3      THROUGH FAULT STABILITY

In an ideal world, the CTs either side of a differentially protected system would be identical with identical characteristics to avoid creating a differential current. However, in reality CTs can never be identical, therefore a certain amount of differential current is inevitable. As the through-fault current in the primary increases, the discrepancies introduced by imperfectly matched CTs is magnified, causing the differential current to build up. Eventually, the value of the differential current reaches the pickup current threshold, causing the protection element to trip. In such cases, the differential scheme is said to have lost stability. To specify a differential scheme's ability to restrain from tripping on external faults, we define a parameter called 'through-fault stability limit', which is the maximum through-fault current a system can handle without losing stability.

## 2.4      RESTRICTED EARTH FAULT TYPES

There are two different types of Restricted Earth Fault; Low Impedance REF (also known as Biased REF) and High Impedance REF. Each method compensates for the effect of through-fault errors in a different manner.

With Low Impedance REF, the through-fault current is measured and this is used to alter the sensitivity of the REF element accordingly by applying a bias characteristic. So the higher the through fault current, the higher the differential current must be for the device to issue a trip signal, Often a transient bias component is added to improve stability during external faults.

Low impedance protection used to be considered less secure than high impedance protection. This is no longer true as numerical IEDs apply sophisticated algorithms to match the performance of high-impedance schemes. Some advantages of using Low Impedance REF are listed below:

- There is no need for dedicated CTs. As a result CT cost is substantially reduced.
- The wiring is simpler as it does not require an external resistor or Metrosil.
- Common phase current inputs can be used.
- It provides internal CT ratio mismatch compensation. It can match CT ratios up to 1:40 resulting flexibility in substation design and reduced cost.
- Advanced algorithms make the protection secure.

With High Impedance REF, there is no bias characteristic, and the trip threshold is set to a constant level. However, the High Impedance differential technique ensures that the impedance of the circuit is sufficiently high such that the differential voltage under external fault conditions is lower than the voltage needed to drive differential current through the device. This ensures stability against external fault conditions so the device will operate only for faults occurring inside the protected zone.

High Impedance REF protection responds to a voltage across the differential junction points. During external faults, even with severe saturation of some of the CTs, the voltage does not rise above certain level, because the other

CTs will provide a lower-impedance path compared with the device input impedance. The principle has been used for more than half a century. Some advantages of using High Impedance REF are listed below:

- It provides a simple proven algorithm, which is fast, robust and secure.
- It is less sensitive to CT saturation.

## 2.4.1    LOW IMPEDANCE REF PRINCIPLE

Low Impedance REF can be used for either delta windings or star windings in both solidly grounded and resistance grounded systems. The connection to a modern IED is as follows:
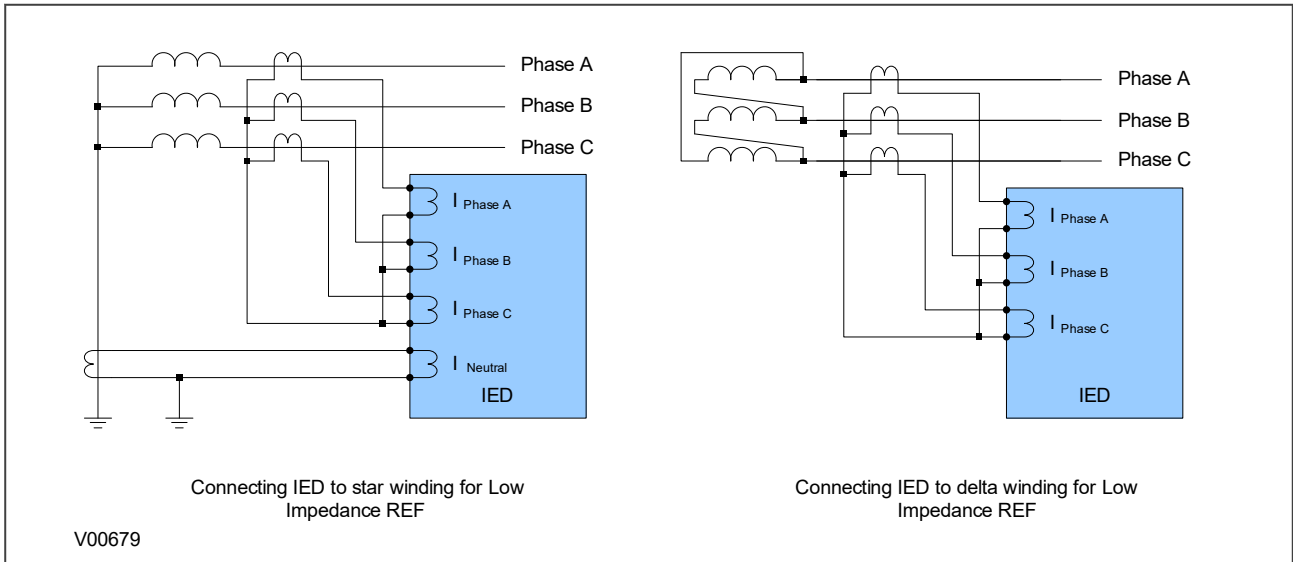
**Figure 49: Low Impedance REF Connection**

### 2.4.1.1    LOW IMPEDANCE BIAS CHARACTERISTIC

Usually, a triple slope biased characteristic is used as follows:
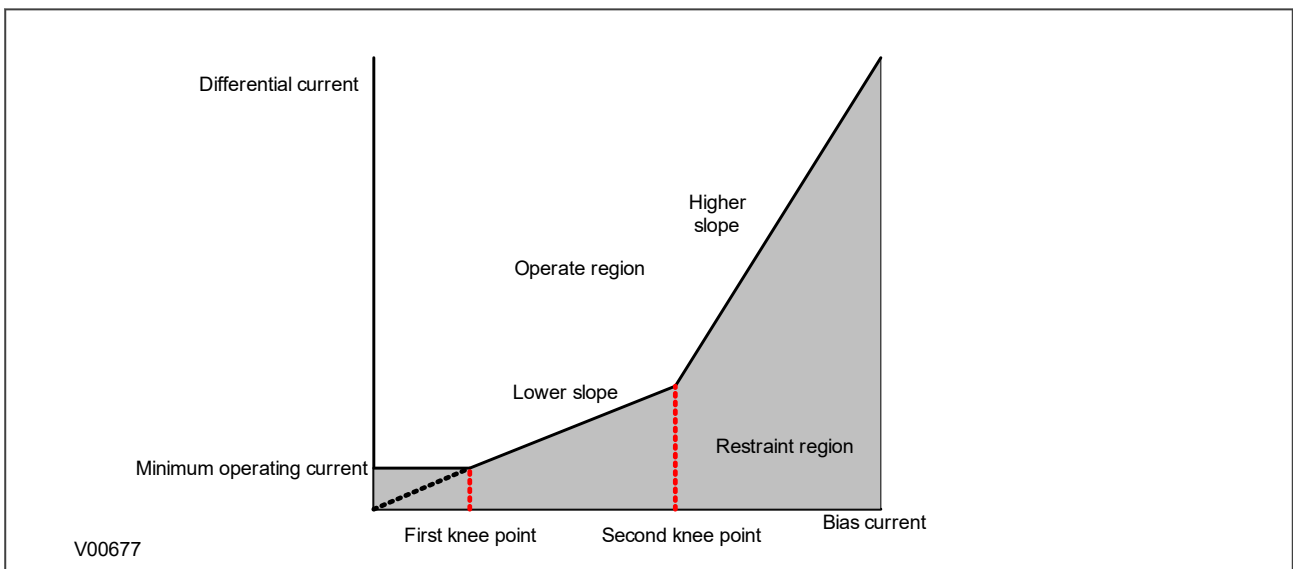
**Figure 50: Three-slope REF bias characteristic**

The flat area of the characteristic is the minimum differential current required to cause a trip (operate current) at low bias currents. From the first kneepoint onwards, the operate current increases linearly with bias current, as shown by the lower slope on the characteristic. This lower slope provides sensitivity for internal faults. From the

second knee point onwards, the operate current further increases linearly with bias current, but at a higher rate. The second slope provides stability under through fault conditions.

> *Note:*
> *In Restricted Earth Fault applications, Bias Current Compensation is also known as Low Impedance REF.*

### 2.4.2 HIGH IMPEDANCE REF PRINCIPLE

This scheme is very sensitive and can protect against low levels of fault current, typical of winding faults.

High Impedance REF protection is based on the differential principle. It works on the circulating current principle as shown in the following diagram.
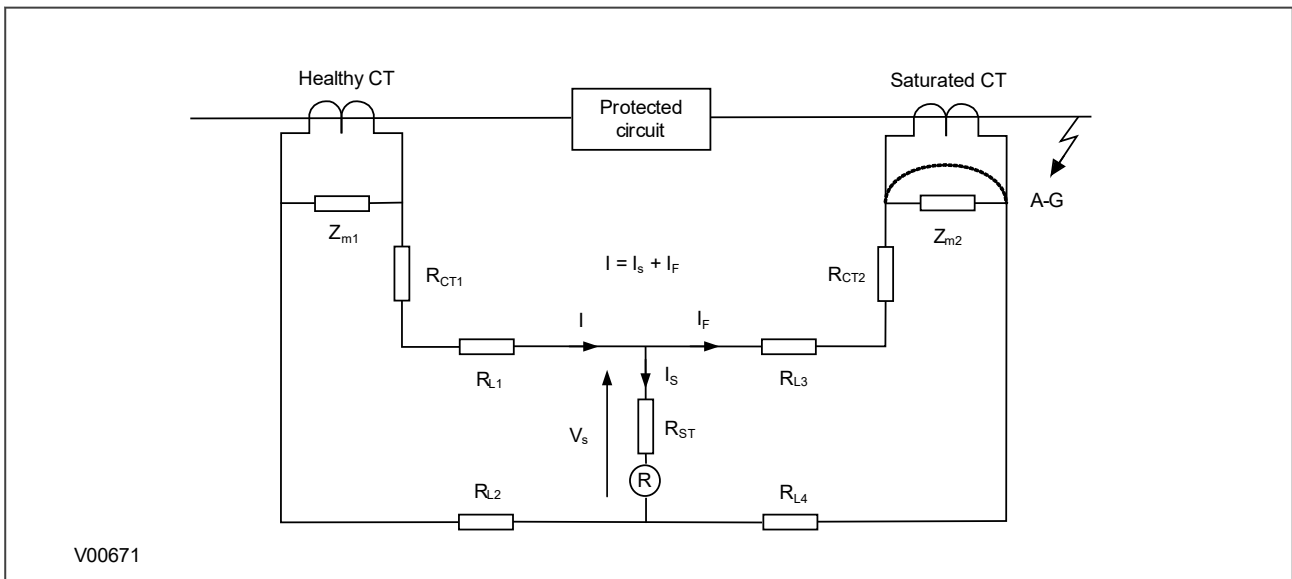


**Figure 51: High Impedance REF principle**

When subjected to heavy through faults the line current transformer may enter saturation unevenly, resulting in imbalance. To ensure stability under these conditions a series connected external resistor is required, so that most of the unbalanced current will flow through the saturated CT. As a result, the current flowing through the device will be less than the setting, therefore maintaining stability during external faults.

Voltage across REF element $V_S = I_F (R_{CT2} + R_{L3} + R_{L4})$

Stabilising resistor $R_{ST} = V_S/I_S - R_R$

where:

- $I_F$ = maximum secondary through fault current
- $R_R$ = device burden
- $R_{CT}$ = CT secondary winding resistance
- $R_{L2}$ and $R_{L3}$ = Resistances of leads from the device to the current transformer
- $R_{ST}$ = Stabilising resistor

High Impedance REF can be used for either delta windings or star windings in both solidly grounded and resistance grounded systems. The connection to a modern IED are as follows:

V00680
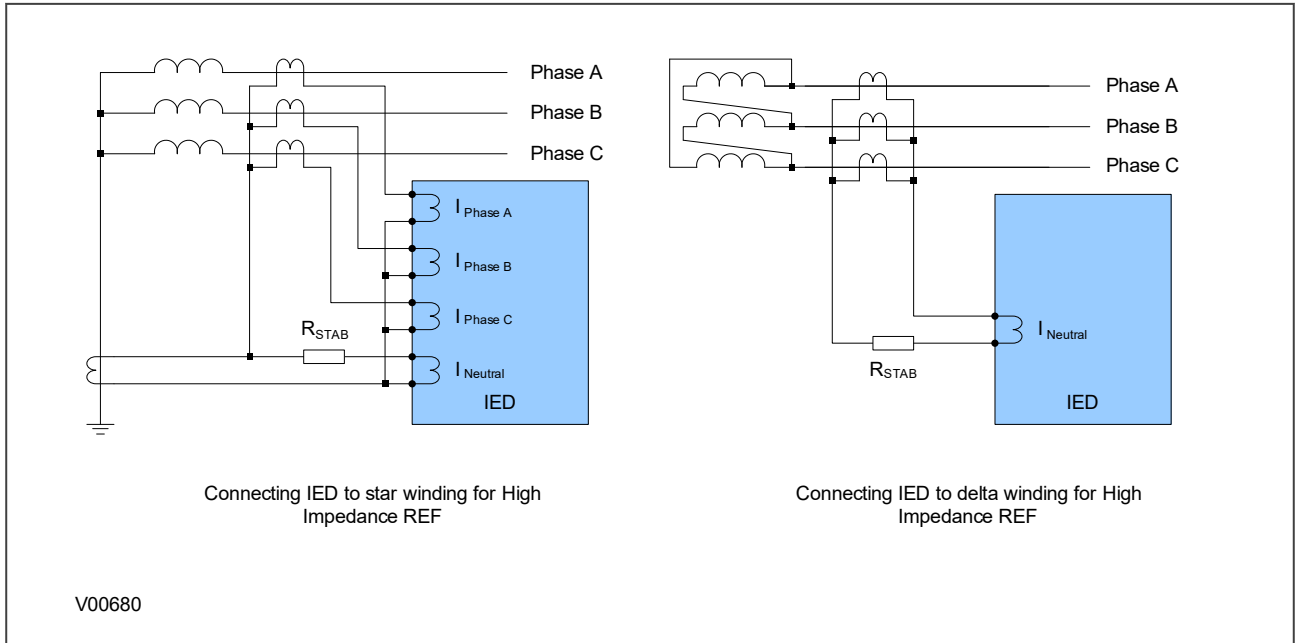
**Figure 52: High Impedance REF Connection**

# 3        RESTRICTED EARTH FAULT PROTECTION IMPLEMENTATION

## 3.1        RESTRICTED EARTH FAULT PROTECTION SETTINGS

Restricted Earth Fault Protection is implemented in the Restricted E/F column of the relevant settings group. It is here that the constants and bias currents are set.

The REF protection may be configured to operate as either a high impedance or biased element.

## 3.2        LOW IMPEDANCE REF

### 3.2.1        SETTING THE BIAS CHARACTERISTIC

Low impedance REF uses a bias charactersitic for increasing sensitivity and stabilising for through faults. The current required to trip the differential IED is called the Operate current. This Operate current is a function of the differential current and the bias current according to the bias characteristic.

The differential current is defined as follows:

$$I_{diff} = \left( \overline{I}_A + \overline{I}_B + \overline{I}_C \right) + K\overline{I}_N$$

The bias current is as follows:

$$I_{bias} = \frac{1}{2}\left\{ \max\left[ |I_A|, |I_B|, |I_C| \right] + K|I_N| \right\}$$

where:

- K = Neutral CT ratio / Line CT ratio
- IN = current measured by the neutral CT

The allowable range for K is:

>   *0.05 < K < 15 for standard CTs*

>   *0.05 < K < 20 for sensitive CTs*

The operate current is calculated according to the following characteristic:
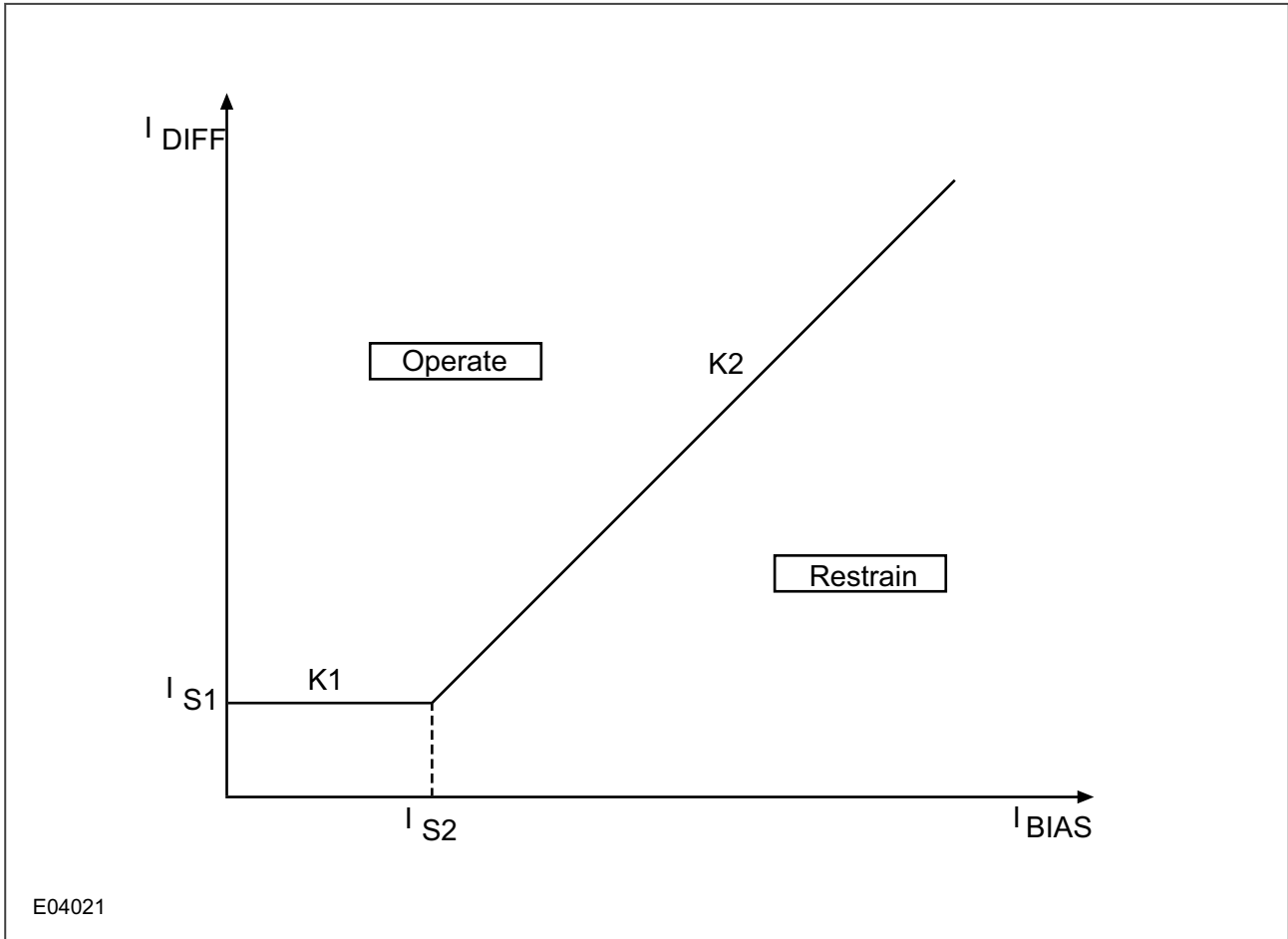
**Figure 53: REF bias characteristic**

The following settings are provided to define this bias characteristic:

- **IREF> Is1**: sets the minimum trip threshold
- **IREF> Is2**: sets the bias current kneepoint whereby the required trip current starts increasing
- **IREF> k1**: defines the first slope (often set to 0%)
- **IREF> k2**: defines the second slope

> *Note:*
> *Is1 and Is2 are relative to the line CT, which is always the reference CT.*

### 3.2.2    DELAYED BIAS

The bias quantity used is actually delayed by one cycle. It is the maximum value of the mean bias quantities calculated within the previous cycle, where the mean bias is the fundamental bias current. This means the bias level, and thus through-fault stability is maintained after an external fault has been cleared.

The algorithm, shown below, is executed eight times per cycle.

$$I_{bias} = Maximum \; [I_{bias} \, (n), \; I_{bias} \, (n\text{-}1), \; ...I_{bias}, \; (n - (K\text{-}1))]$$

It is this delayed bias that is used to calculate the operating current.

## 3.3     HIGH IMPEDANCE REF

The device provides a high impedance restricted earth fault protection function. An external resistor is required to provide stability in the presence of saturated line current transformers. Current transformer supervision signals do not block the high impedance REF protection. The appropriate logic must be configured in PSL to block the high impedance REF when any of the above signals is asserted.

### 3.3.1     HIGH IMPEDANCE REF CALCULATION PRINCIPLES

The primary operating current (Iop) is a function of the current transformer ratio, the device operate current (**IREF>Is**), the number of current transformers in parallel with a REF element (n) and the magnetizing current of each current transformer (Ie) at the stability voltage (Vs). This relationship can be expressed in three ways:

1.     The maximum current transformer magnetizing current to achieve a specific primary operating current with a particular operating current:

$$I_e < \frac{1}{n}\left( \frac{I_{op}}{CT\ ratio} - \left[IREF > Is\right] \right)$$

2.     The maximum current setting to achieve a specific primary operating current with a given current transformer magnetizing current:

$$\left[IREF > Is\right] < \left( \frac{I_{op}}{CT\ ratio} - nI_e \right)$$

3.     The protection primary operating current for a particular operating current with a particular level of magnetizing current:

$$I_{op} = \left(CT\ ratio\right)\left( \left[IREF > Is\right] + nI_e \right)$$

To achieve the required primary operating current with the current transformers that are used, you must select a current setting for the high impedance element, as shown in item 2 above. You can calculate the value of the stabilising resistor (R$_{ST}$) in the following manner.

$$R_{st} = \frac{Vs}{\left[IREF > Is\right]} = \frac{I_F\left(R_{CT} + 2R_L\right)}{\left[IREF > Is\right]}$$

where:

- R$_{CT}$ = the resistance of the CT winding
- R$_L$ = the resistance of the lead from the CT to the IED.

> *Note:*
> *The above formula assumes negligible relay burden.*

We recommend a stabilizing resistor, which is continuously adjustable up to its maximum declared resistance.

# 4        APPLICATION NOTES

## 4.1        STAR WINDING RESISTANCE EARTHED

Consider the following resistance earthed star winding below.
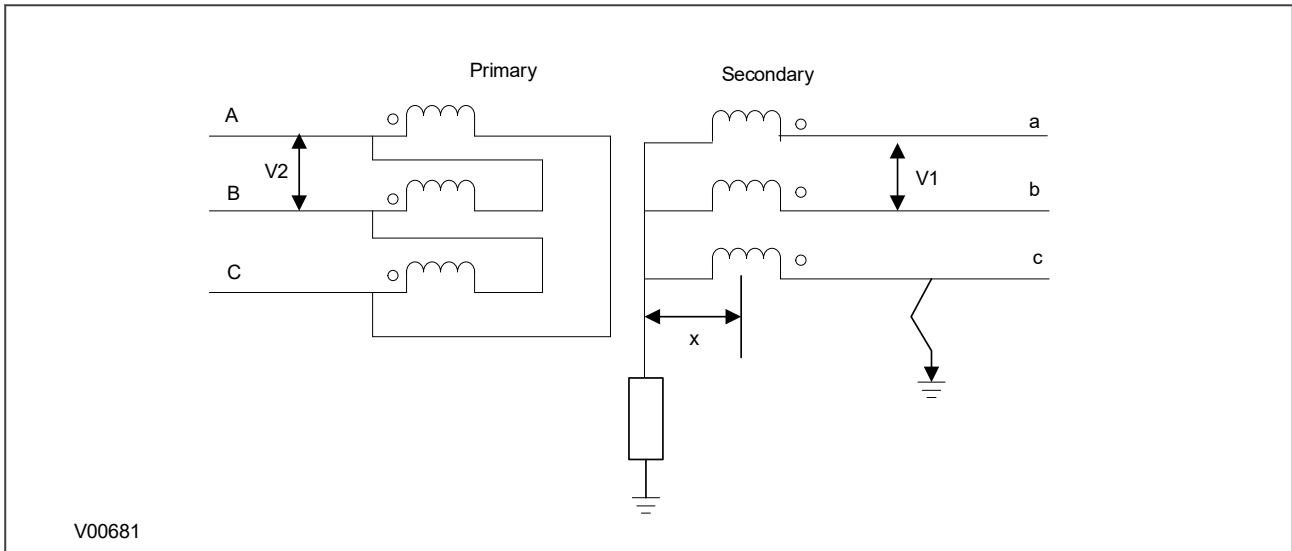


**Figure 54: Star winding, resistance earthed**

An earth fault on such a winding causes a current which is dependent on the value of earthing impedance. This earth fault current is proportional to the distance of the fault from the neutral point since the fault voltage is directly proportional to this distance.

The ratio of transformation between the primary winding and the short circuited turns also varies with the position of the fault. Therefore the current that flows through the transformer terminals is proportional to the square of the fraction of the winding which is short circuited.

The earthing resistor is rated to pass the full load current $I_{FLC} = V1/\sqrt{3}R$

Assuming that $V1 = V2$ then $T2 = \sqrt{3}T1$

For a fault at x PU distance from the neutral, the fault current $If = xV1/\sqrt{3}R$

Therefore the secondary fault current referred to the primary is $I_{primary} = x^2.I_{FLC}/\sqrt{3}$

If the fault is a single end fed fault, the primary current should be greater than 0.2 pu (Is1 default setting) for the differential protection to operate. Therefore $x^2/\sqrt{3} > 20\%$

The following diagram shows that 41% of the winding is protected by the differential element.

| X in % | Idiff in % |
|--------|-----------|
| 10 | 0.58 |
| 20 | 2.31 |
| 30 | 5.20 |
| 40 | 9.24 |
| 50 | 14.43 |
| 60 | 20.00 |
| 70 | 28.29 |
| 80 | 36.95 |
| 90 | 46.77 |
| 100 | 57.74 |

59% of unprotected winding

41% of protected winding

V00682
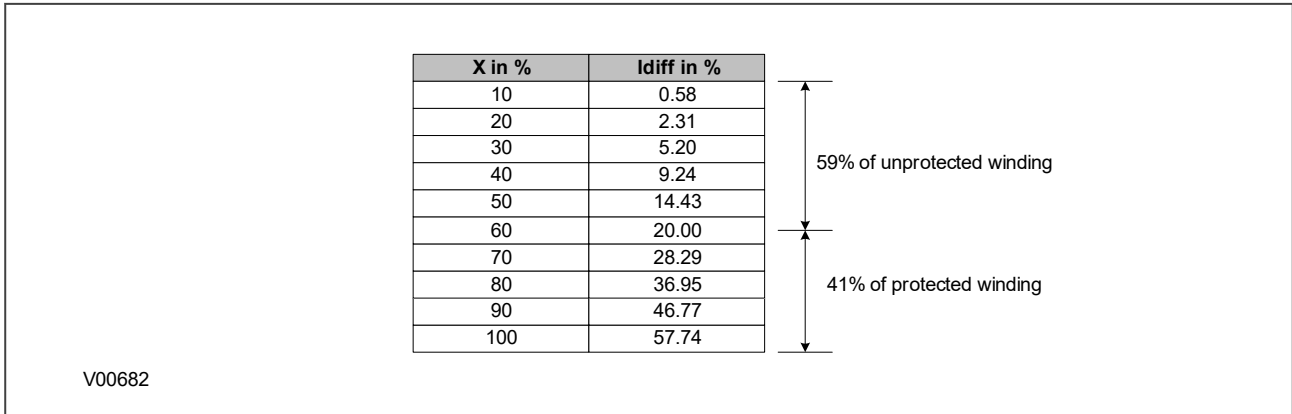
**Figure 55: Percentage of winding protected**

## 4.2 LOW IMPEDANCE REF PROTECTION APPLICATION

### 4.2.1 SETTING GUIDELINES FOR BIASED OPERATION

Two bias settings are provided in the REF characteristic. The K1 level of bias is applied up to through currents of Is2, which is normally set to the rated current of the transformer. K1 is normally be set to 0% to give optimum sensitivity for internal faults. However, if any CT mismatch is present under normal conditions, then K1 may be increased accordingly, to compensate. We recommend a setting of 20% in this case.

K2 bias is applied for through currents above Is2 and would typically be set to 150%.

According to ESI 48-3 1977, typical settings for the Is1 thresholds are 10-60% of the winding rated current when solidly earthed and 10-25% of the minimum earth fault current for a fault at the transformer terminals when resistance earthed.

### 4.2.2 LOW IMPEDANCE REF SCALING FACTOR

The three line CTs are connected to the three-phase CTs, and the neutral CT is connected to the neutral CT input. These currents are then used internally to derive both a bias and a differential current quantity for use by the low impedance REF protection. The advantage of this mode of connection is that the line and neutral CTs are not differentially connected, so the neutral CT can also be used to provide the measurement for the Standby Earth Fault Protection. Also, no external components such as stabilizing resistors or Metrosils are required.

Line CTs 1000:1

Phase A
Phase B
Phase C

I Phase A
I Phase B
I Phase C
I Neutral

Neutral CT 200:1

$I_N$

IED

V00683
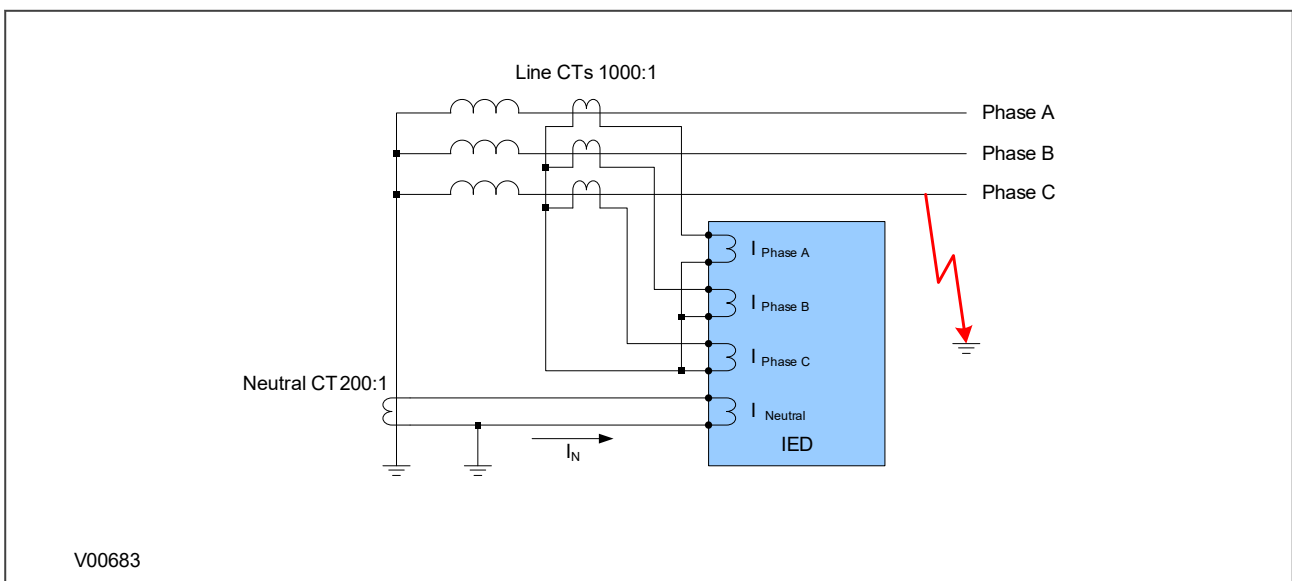
**Figure 56: Low Impedance REF Scaling Factor**

Another advantage of Low Impedance REF protection is that you can use a neutral CT with a lower ratio than the line CTs in order to provide better earth fault sensitivity. In the bias calculation, the device applies a scaling factor to the neutral current. This scaling factor is as follows:

*Scaling factor = K = Neutral CT ratio / Line CT ratio*

This results in the following differential and bias current equations:

$$I_{diff} = \left( \overline{I}_A + \overline{I}_B + \overline{I}_C \right) + K \overline{I}_N$$

$$I_{bias} = \frac{1}{2} \left\{ \max \left[ |I_A|, |I_B|, |I_C| \right] + K |I_N| \right\}$$

### 4.2.3    PARAMETER CALCULATIONS

Consider a solidly earthed 90 MVA 132 kV transformer with a REF-protected star winding. Assume line CTS with a ratio of 400:1.

*Is1* is set to 10% of the winding nominal current:

*= (0.1 x 90 x 10⁶) / ( √3 x 132 x 10³)*

*= 39 Amps primary*

*= 39/400 = 0.0975 Amps secondary (approx 0.1 A)*

*Is2* is set to the rated current of the transformer:

*= 90 x 10⁶ / ( √3 x 132 x 10³)*

*= 390 Amps primary*

*= 390/400 = 0.975 Amps secondary (approx 1 A)*

Set *K1* to 0% and *K2* to 150%

## 4.3    HIGH IMPEDANCE REF PROTECTION APPLICATION

### 4.3.1    HIGH IMPEDANCE REF OPERATING MODES

In the examples below, the respective Line CTS and measurement CTs must have the same CT ratios and similar magnetising characteristics.
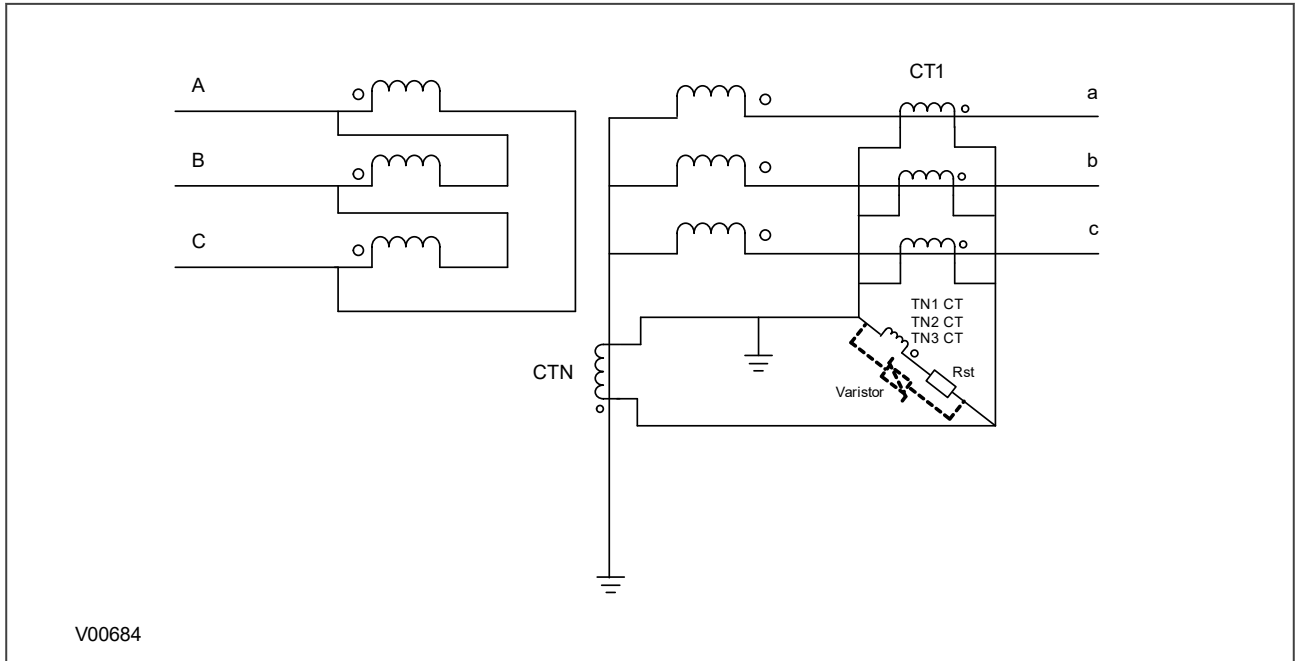
**Figure 57: Hi-Z REF protection for a grounded star winding**
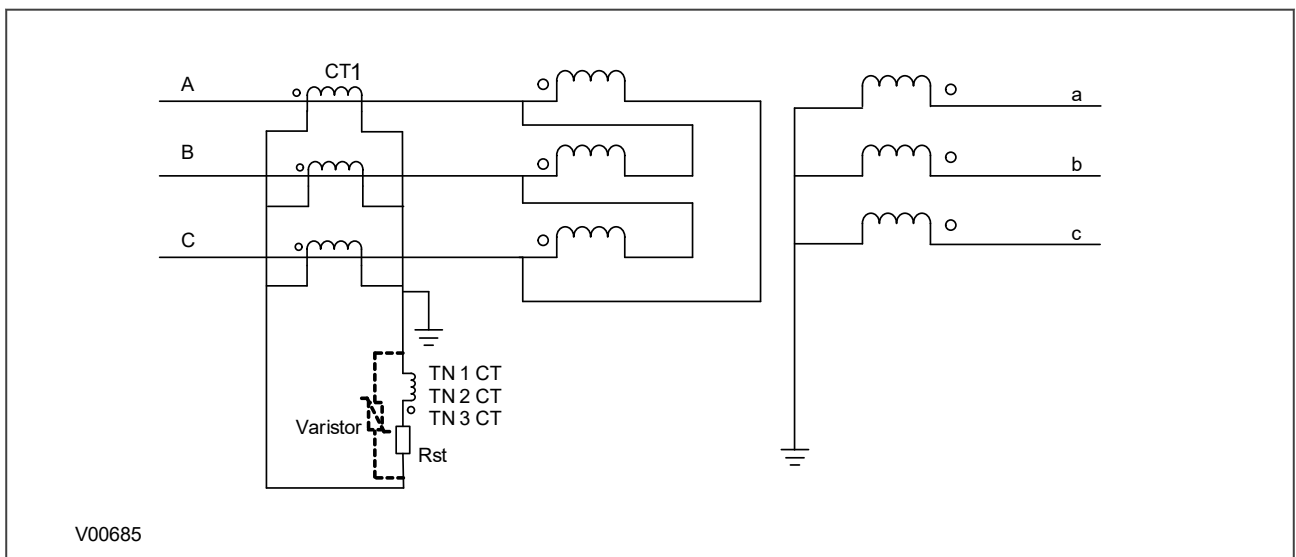


**Figure 58: Hi-Z REF protection for a delta winding**

V00686
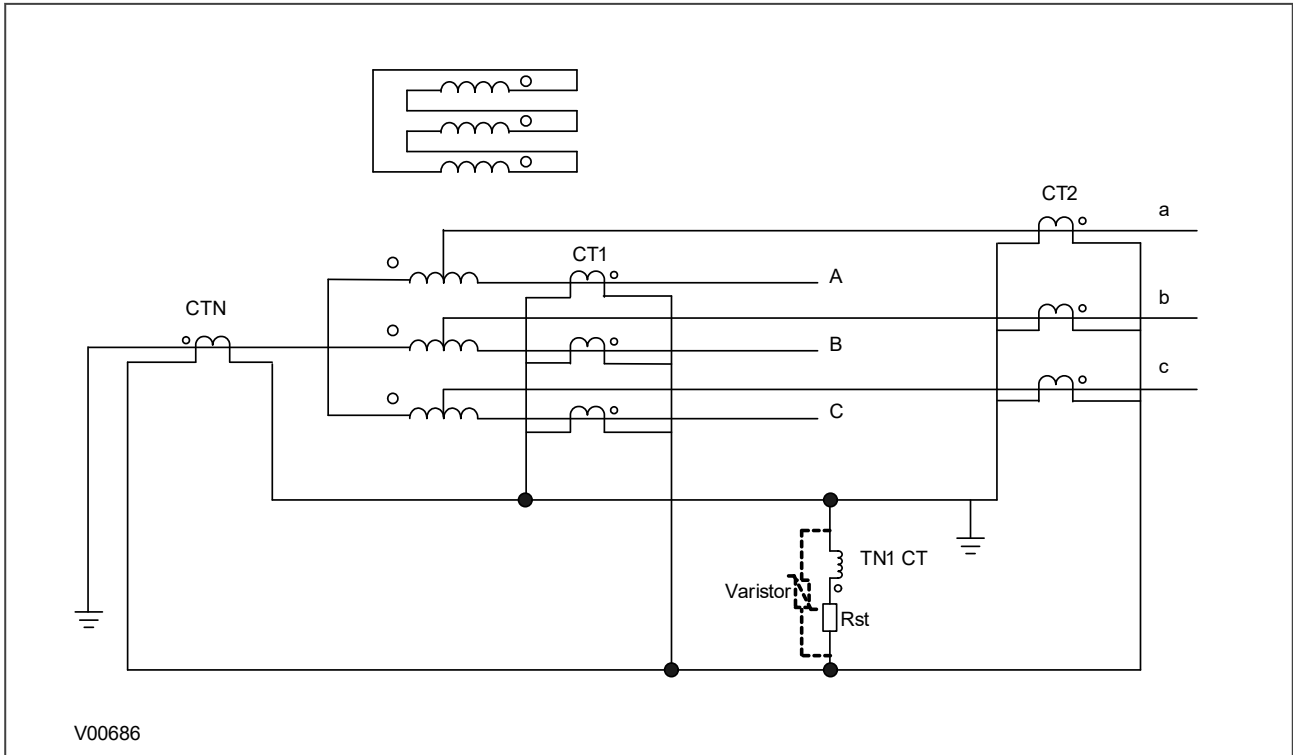
**Figure 59: Hi-Z REF Protection for autotransformer configuration**

### 4.3.2        SETTING GUIDELINES FOR HIGH IMPEDANCE OPERATION

This scheme is very sensitive and can protect against low levels of fault current in resistance grounded systems. In this application, the *IREF>Is* settings should be chosen to provide a primary operating current less than 10-25% of the minimum earth fault level.

This scheme can also be used in a solidly grounded system. In this application, the *IREF>Is* settings should be chosen to provide a primary operating current between 10% and 60 % of the winding rated current.

The following diagram shows the application of a high impedance REF element to protect the LV winding of a power transformer.

V00687
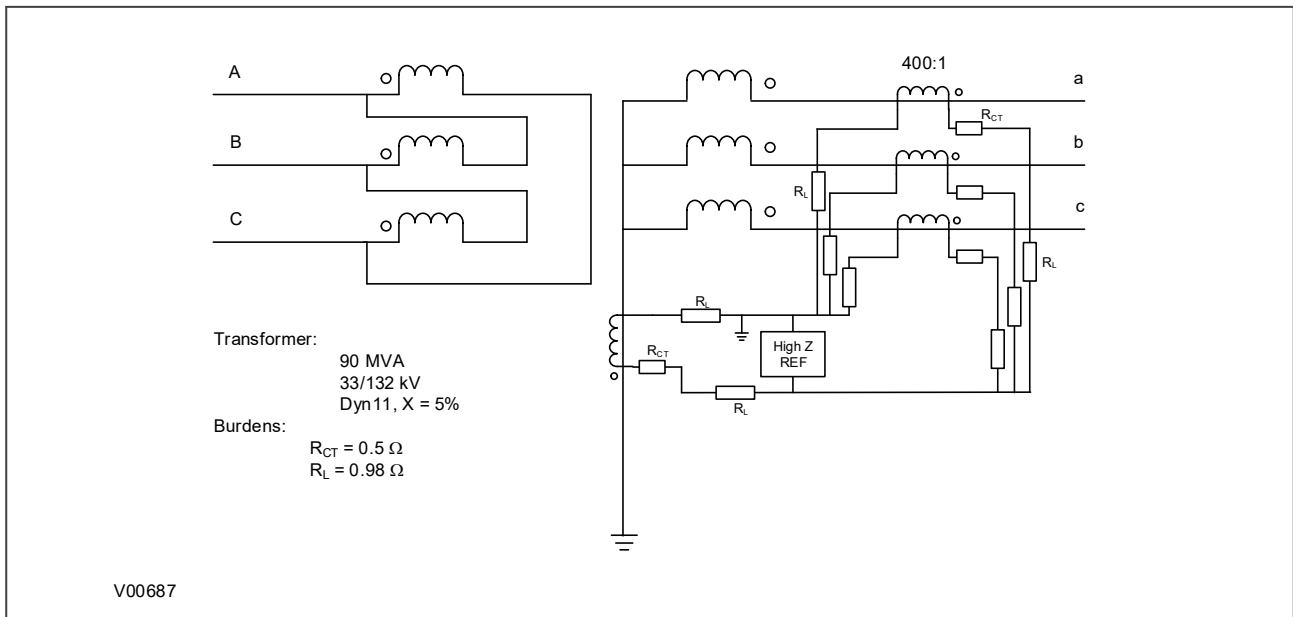
**Figure 60: High Impedance REF for the LV winding**

### 4.3.2.1 STABILITY VOLTAGE CALCULATION

The transformer full load current, IFLC, is:

$$I_{FLC} = (90 \times 10^6) / (132 \times 10^3 \times \sqrt{3}) = 394 \ A$$

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

$$I_F = I_{FLC} / X_{TX} = 394 / 0.05 = 7873 \ A$$

The required stability voltage, VS, and assuming one CT saturated is:

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

The following figure can be used to determine the K factor and the operating time. The K factor is valid when:

- $5 \leq X/R \leq 120$

and

- $0.5In \leq I \ f \leq 40In$

We recommend a value of VK/VS = 4.

With the transformer at full load current and percentage impedance voltage of 394A and 5% respectively, the prospective fault current is 7873 A and the required stability voltage Vs (assuming that one CT is saturated) is:

$$V_S = 0.9 \times 7873 \times (0.5 + 2 \times 0.98) / 400 = 45.5 \ V$$

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

### 4.3.2.2 PRIMARY CURRENT CALCULATION

The primary operating current should be between 10 and 60 % of the winding rated current. Assuming that the relay effective setting or primary operating current is approximately 30% of the full load current, the calculation below shows that a setting of less than 0.3 A is required.

$$Effective \ setting = 0.3I_{FLC} / CT \ Ratio = 0.3 \times 394 / 400 = approximately \ 0.3 \ A$$

### 4.3.2.3 STABILISING RESISTOR CALCULATION

Assuming that a setting of 0.1A is selected the value of the stabilizing resistor, $R_{ST}$, required is

$$R_{ST} = V_s \,/\, (IREF> Is1\ (HV)) = 45.5\,/\,0.1 = 455\ ohms$$

To achieve an average operating time of 40 ms, Vk/Vs should be 3.5.

The Kneepoint voltage is:

$$V_K = 4V_s = 4\ x\ 45.5 = 182\ V.$$

If the actual $V_K$ is greater than 4 times $V_s$, then the K factor increases. In this case, $V_s$ should be recalculated.

> *Note:*
> *K can reach a maximum value of approximately 1.*

### 4.3.2.4 CURRENT TRANSFORMER CALCULATION

The effective primary operating current setting is:

$$I_P = N(I_s + nI_e)$$

By re-arranging this equation, you can calculate the excitation current for each of the current transformers at the stability voltage. This turns out to be:

$$I_e = (0.3 - 0.1)\,/\,4 = 0.05\ A$$

In summary, the current transformers used for this application must have a kneepoint voltage of 182 V or higher (note that maximum Vk/Vs that may be considered is 16 and the maximum K factor is 1), with a secondary winding resistance of 0.5 ohms or lower and a magnetizing current at 45.5 V of less than 0.05 A.

Assuming a CT kneepoint voltage of 200 V, the peak voltage can be estimated as:

$$V_P = 2\ \sqrt{2}V_K(V_F\text{-}V_K) = 2\ \sqrt{2}(200)(9004\text{-}200) = 3753\ V$$

This value is above the peak voltage of 3000 V and therefore a non-linear resistor is required.

> *Note:*
> *The kneepoint voltage value used in the above formula should be the actual voltage obtained from the CT magnetizing characteristic and not a calculated value.*

> *Note:*
> *One stabilizing resistor, part No. ZB9016 756, and one varistor, part No. 600A/S1/S256 might be used.*

# CHAPTER 8

# CB FAIL PROTECTION

# 1        CHAPTER OVERVIEW

The device provides a Circuit Breaker Fail Protection function. This chapter describes the operation of this function including the principles, logic diagrams and applications.

This chapter contains the following sections:

## 2          CIRCUIT BREAKER FAIL PROTECTION

When a fault occurs, one or more protection devices will operate and issue a trip command to the relevant circuit breakers. Operation of the circuit breaker is essential to isolate the fault and prevent, or at least limit, damage to the power system. For transmission and sub-transmission systems, slow fault clearance can also threaten system stability.

For these reasons, it is common practice to install Circuit Breaker Failure protection (CBF). CBF protection monitors the circuit breaker and establishes whether it has opened within a reasonable time. If the fault current has not been interrupted following a set time delay from circuit breaker trip initiation, the CBF protection will operate, whereby the upstream circuit breakers are back-tripped to ensure that the fault is isolated.

CBF operation can also reset all start output contacts, ensuring that any blocks asserted on upstream protection are removed.

# 3          CIRCUIT BREAKER FAIL IMPLEMENTATION

Circuit Breaker Failure Protection is implemented in the CB FAIL column of the relevant settings group.

## 3.1          CIRCUIT BREAKER FAIL TIMERS

The circuit breaker failure protection incorporates two timers, **CB Fail 1 Timer** and **CB Fail 2 Timer**, allowing configuration for the following scenarios:

- Simple CBF, where only **CB Fail 1 Timer** is enabled. For any protection trip, the **CB Fail 1 *Timer*** is started, and normally reset when the circuit breaker opens to isolate the fault. If breaker opening is not detected, the CB Fail 1 Timer times out and closes an output contact assigned to breaker fail (using the programmable scheme logic). This contact is used to back-trip upstream switchgear, generally tripping all infeeds connected to the same busbar section.

- A retripping scheme, plus delayed back-tripping. Here, **CB Fail 1 Timer** is used to issue a trip command to a second trip circuit of the same circuit breaker. This requires the circuit breaker to have duplicate circuit breaker trip coils. This mechanism is known as retripping. If retripping fails to open the circuit breaker, a back-trip may be issued following an additional time delay. The back-trip uses **CB Fail 2 Timer**, which was also started at the instant of the initial protection element trip.

You can configure the CBF elements **CB Fail 1 Timer** and **CBF Fail 2 Timer** to operate for trips triggered by protection elements within the device. Alternatively you can use an external protection trip by allocating one of the opto-inputs to the **External Trip** DDB signal in the PSL.

You can reset the CBF from a breaker open indication (from the pole dead logic) or from a protection reset. In these cases resetting is only allowed if the undercurrent elements have also been reset. The resetting mechanism is determined by the settings **NonIProt Rst** and **Ext Prot Rst**.

The resetting options are summarised in the following table:

| Initiation (Menu Selectable) | CB Fail Timer Reset Mechanism |
|---|---|
| Current based protection (e.g.50/51/46/21/87) | IA< operates AND IB< operates AND IC< operates AND IN< operates or through Ext Rst DDB in PSL |
| Sensitive Earth Fault element | ISEF< Operates or Ext Rst SEF DDB |
| Non-current based protection (e.g. 27/59/81/32L) | Three options are available: All I< and IN< elements operate or Ext Rst CBF DDB Protection element reset AND (all I< and IN< elements operate or Ext Rst DDB CB open (all 3 poles) AND all I< and IN< elements operate |
| External protection | Three options are available. All I< and IN< elements operate External trip reset AND all I< and IN< elements operate CB open (all 3 poles) AND all I< and IN< elements operate |

## 3.2          ZERO CROSSING DETECTION

When there is a fault and the circuit breaker interrupts the CT primary current, the flux in the CT core decays to a residual level. This decaying flux introduces a decaying DC current in the CT secondary circuit known as subsidence current. The closer the CT is to its saturation point, the higher the subsidence current.

The time constant of this subsidence current depends on the CT secondary circuit time constant and it is generally long. If the protection clears the fault, the CB Fail function should reset fast to avoid maloperation due to the subsidence current. To compensate for this the device includes a zero-crossing detection algorithm, which ensures that the CB Fail re-trip and back-trip signals are not asserted while subsidence current is flowing. If all the samples within half a cycle are greater than or smaller than 0 A (10 mS for a 50 Hz system), then zero crossing detection is asserted, thereby blocking the operation of the CB Fail function. The zero-crossing detection algorithm is used

after the circuit breaker in the primary system has opened ensuring that the only current flowing in the AC secondary circuit is the subsidence current.

# 4        CIRCUIT BREAKER FAIL LOGIC
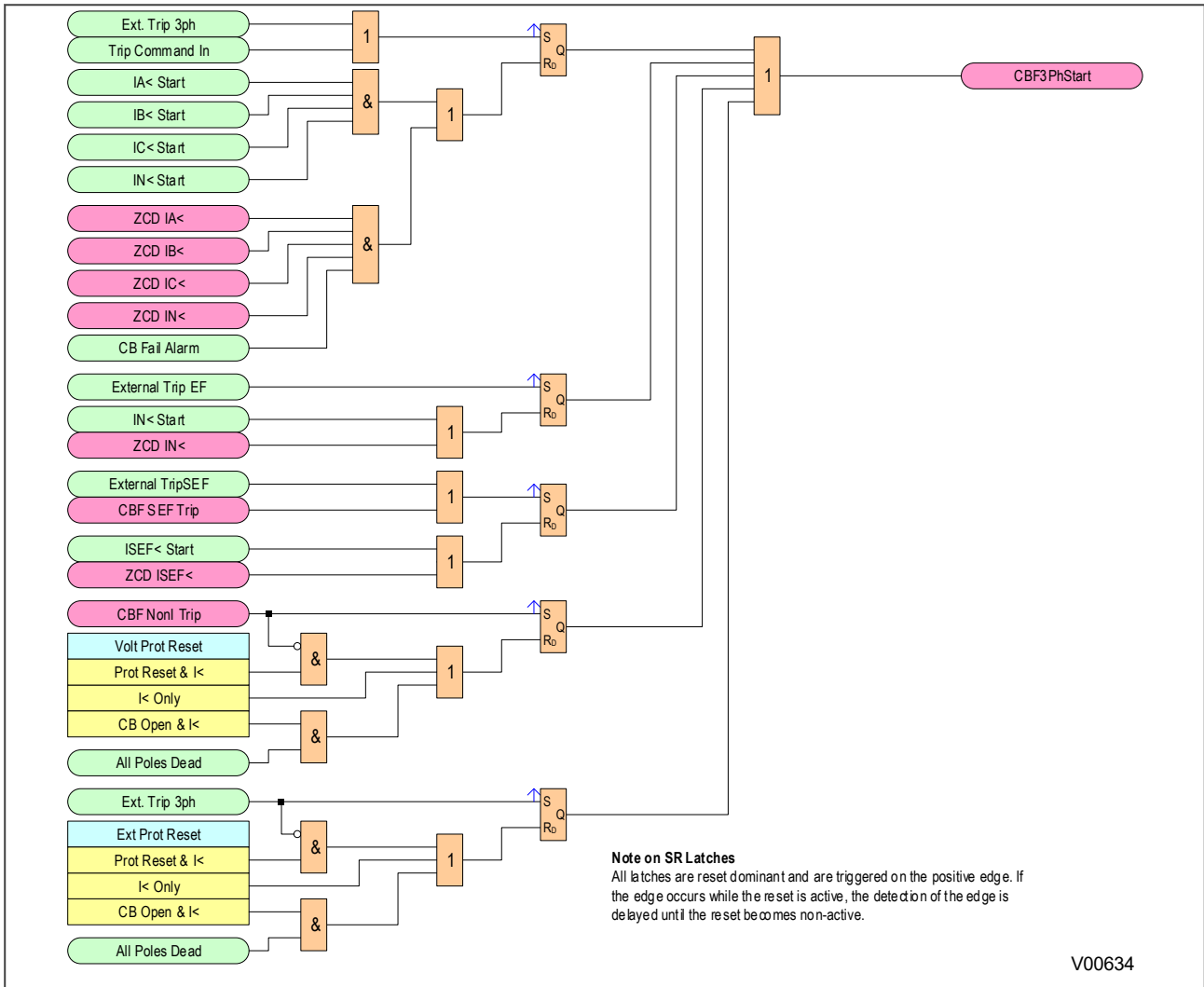


Figure 61: Circuit Breaker Fail logic - three phase start
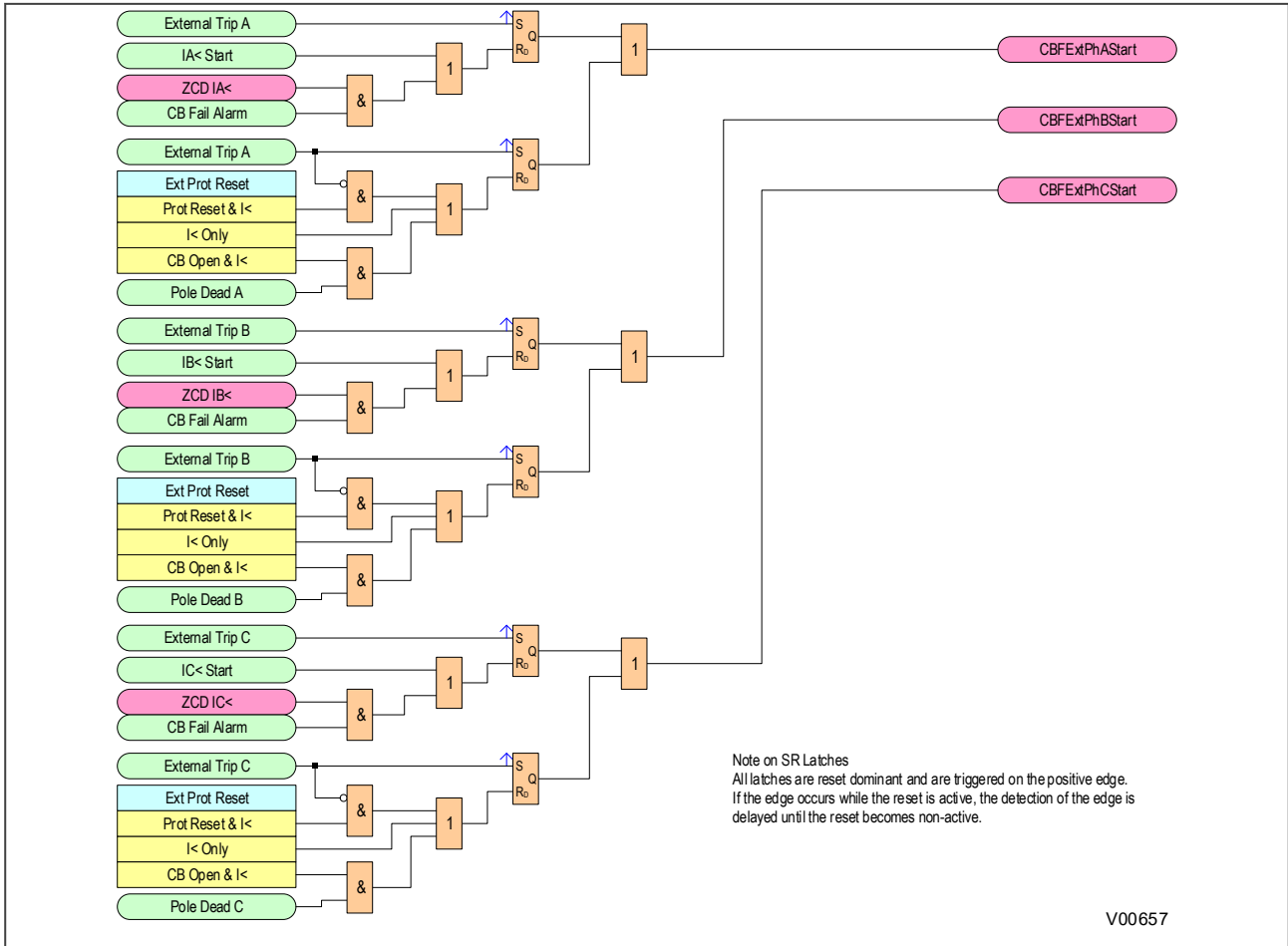
Figure 62: Circuit Breaker Fail logic - single phase start
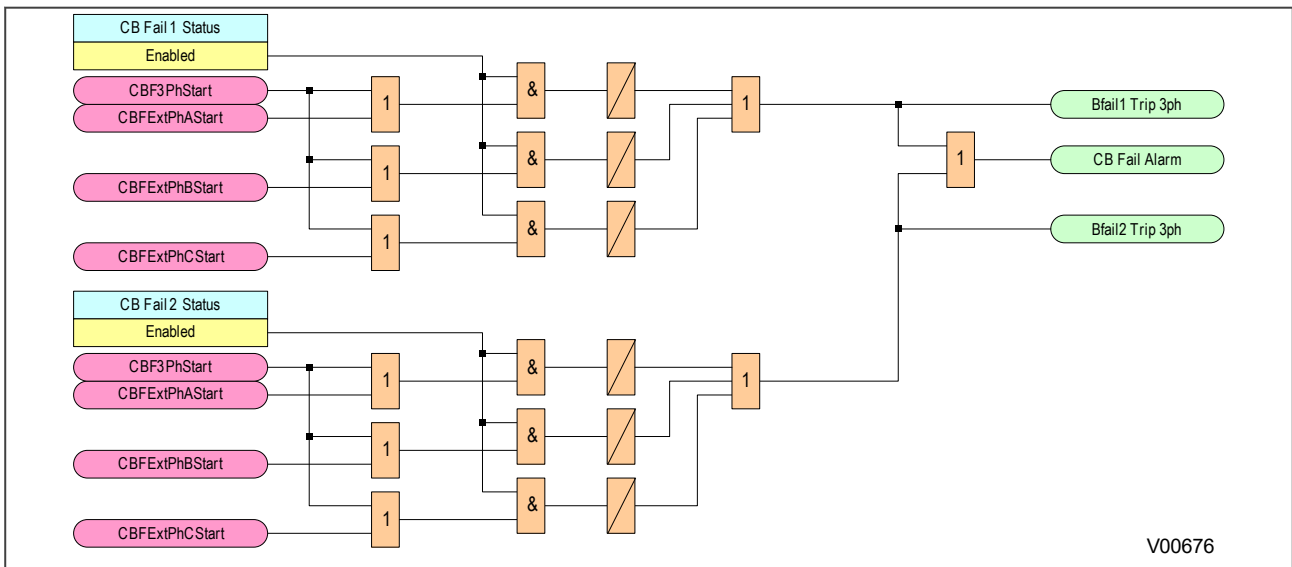


Figure 63: Circuit Breaker Fail Trip and Alarm

## 5          UNDERCURRENT AND ZCD LOGIC FOR CB FAIL
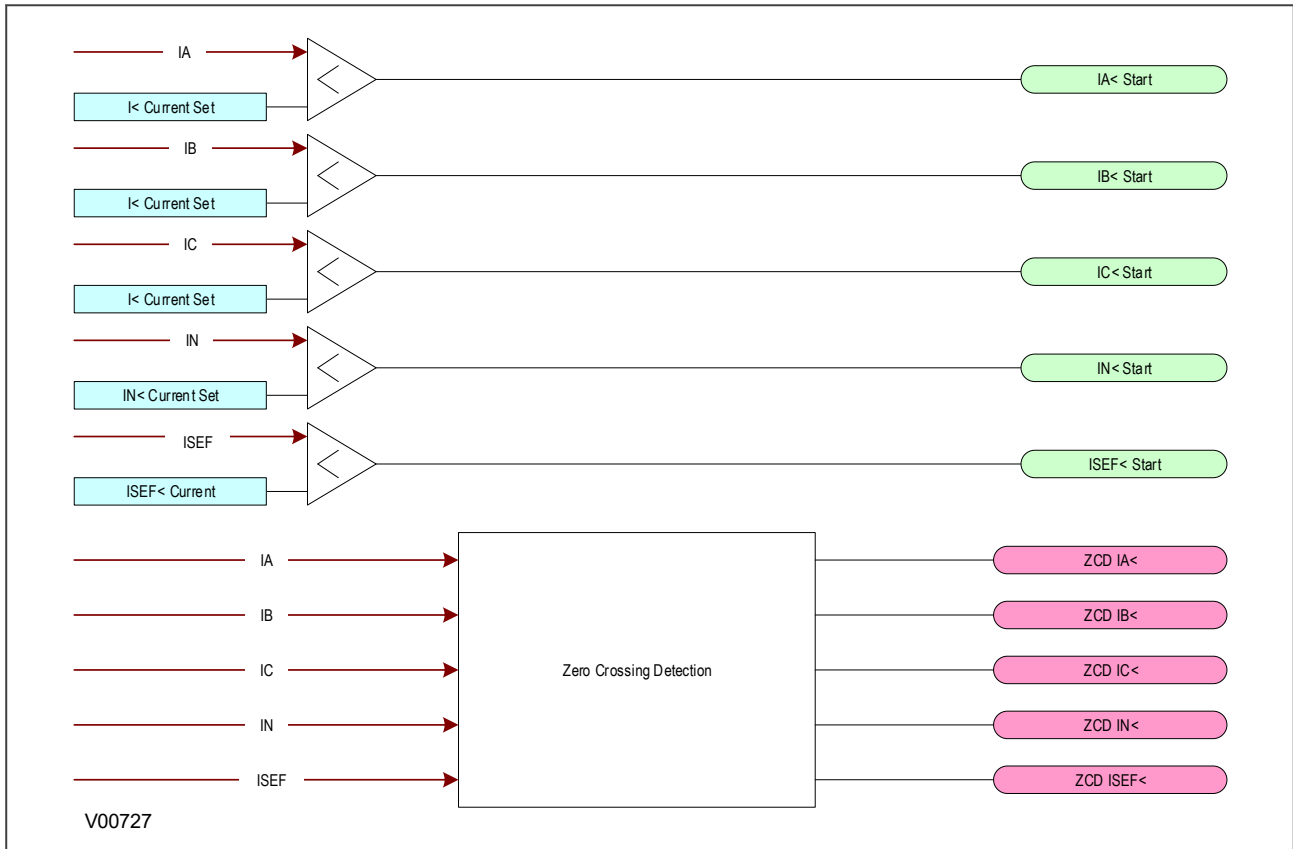


**Figure 64: Undercurrent and Zero Crossing Detection Logic for CB Fail**

## 6 CB FAIL SEF PROTECTION LOGIC
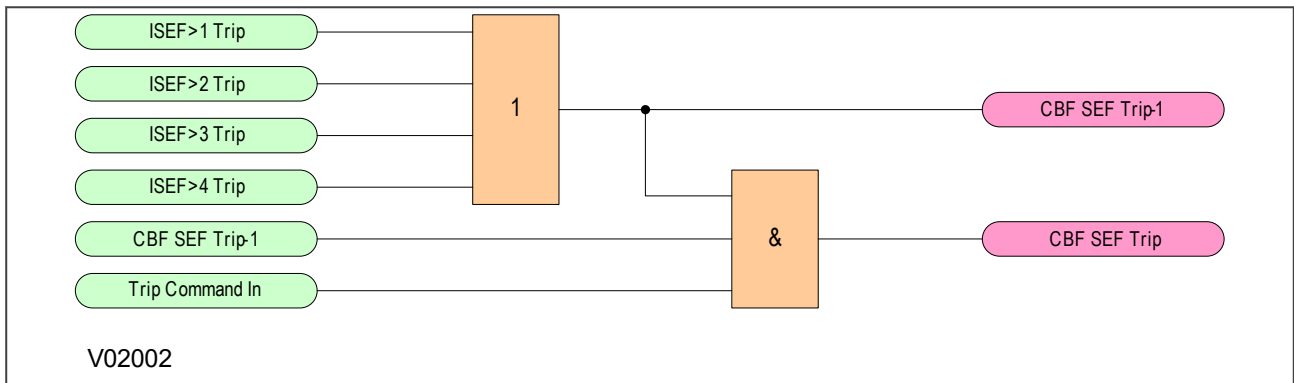


**Figure 65: CB Fail SEF Protection Logic**

# 7      CB FAIL NON CURRENT PROTECTION LOGIC
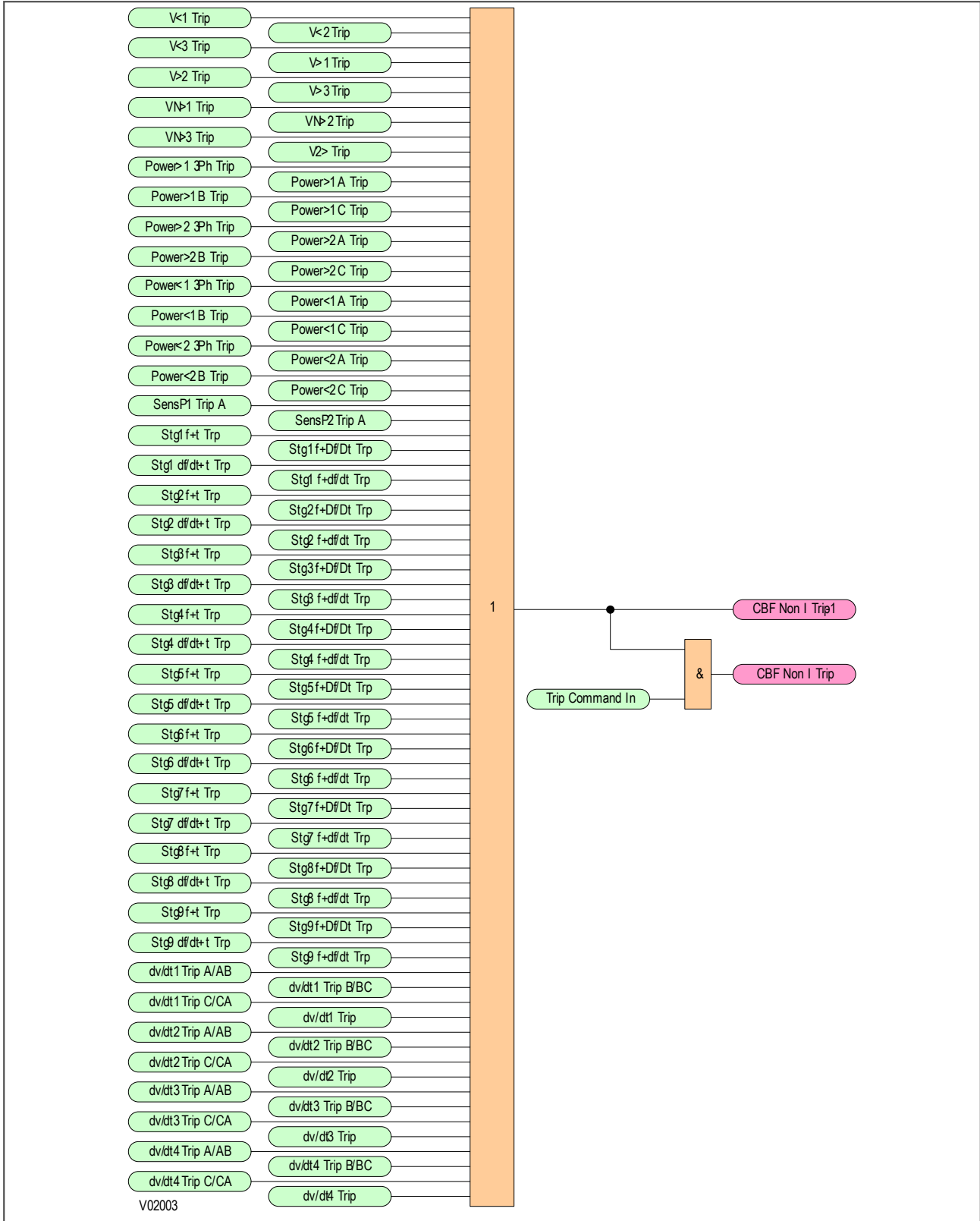


**Figure 66: CB Fail Non Current Protection Logic**

# 8        CIRCUIT BREAKER MAPPING

CB Closed 3 ph ———————————— CB in Service

V02026
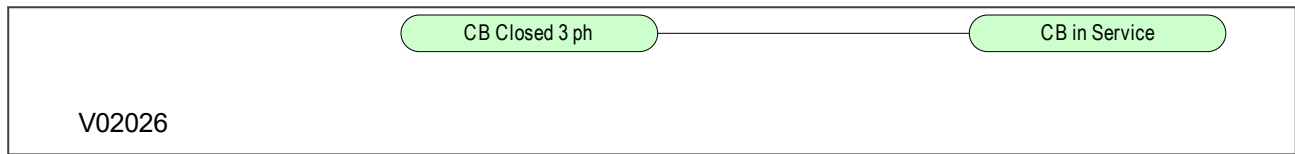
**Figure 67: Circuit Breaker mapping**

# 9          APPLICATION NOTES

## 9.1          RESET MECHANISMS FOR CB FAIL TIMERS

It is common practise to use low set undercurrent elements to indicate that circuit breaker poles have interrupted the fault or load current. This covers the following situations:

- Where circuit breaker auxiliary contacts are defective, or cannot be relied on to definitely indicate that the breaker has tripped.
- Where a circuit breaker has started to open but has become jammed. This may result in continued arcing at the primary contacts, with an additional arcing resistance in the fault current path. Should this resistance severely limit fault current, the initiating protection element may reset. Therefore, reset of the element may not give a reliable indication that the circuit breaker has opened fully.

For any protection function requiring current to operate, the device uses operation of undercurrent elements to detect that the necessary circuit breaker poles have tripped and reset the CB fail timers. However, the undercurrent elements may not be reliable methods of resetting CBF in all applications. For example:

- Where non-current operated protection, such as under/overvoltage or under/overfrequency, derives measurements from a line connected voltage transformer. Here, I< only gives a reliable reset method if the protected circuit would always have load current flowing. In this case, detecting drop-off of the initiating protection element might be a more reliable method.
- Where non-current operated protection, such as under/overvoltage or under/overfrequency, derives measurements from a busbar connected voltage transformer. Again using I< would rely on the feeder normally being loaded. Also, tripping the circuit breaker may not remove the initiating condition from the busbar, and so drop-off of the protection element may not occur. In such cases, the position of the circuit breaker auxiliary contacts may give the best reset method.

## 9.2          SETTING GUIDELINES (CB FAIL TIMER)

The following timing chart shows the CB Fail timing during normal and CB Fail operation. The maximum clearing time should be less than the critical clearing time which is determined by a stability study. The CB Fail back-up trip time delay considers the maximum CB clearing time, the CB Fail reset time plus a safety margin. Typical CB clearing times are 1.5 or 3 cycles. The CB Fail reset time should be short enough to avoid CB Fail back-trip during normal operation. Phase and ground undercurrent elements must be asserted for the CB Fail to reset. The assertion of the undercurrent elements might be delayed due to the subsidence current that might be flowing through the secondary AC circuit.
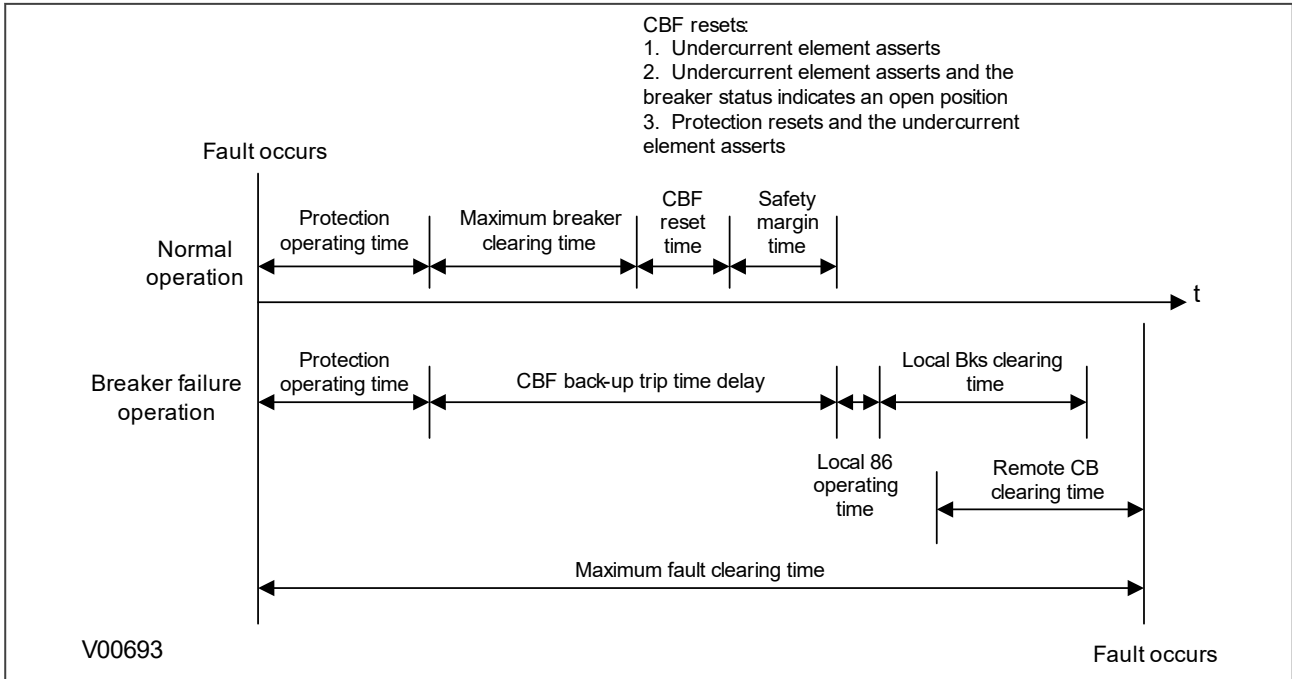
**Figure 68: CB Fail timing**

The following examples consider direct tripping of a 2-cycle circuit breaker. Typical timer settings to use are as follows:

| CB Fail Reset Mechanism | tBF Time Delay | Typical Delay For 2 Cycle Circuit Breaker |
|---|---|---|
| Initiating element reset | CB interrupting time + element reset time (max.) + error in tBF timer + safety margin | 50 + 50 + 10 + 50 = 160 ms |
| CB open | CB auxiliary contacts opening/ closing time (max.) + error in tBF timer + safety margin | 50 + 10 + 50 = 110 ms |
| Undercurrent elements | CB interrupting time + undercurrent element (max.) + safety margin operating time | 50 + 25 + 50 = 125 ms |

*Note:*
*All CB Fail resetting involves the operation of the undercurrent elements. Where element resetting or CB open resetting is used, the undercurrent time setting should still be used if this proves to be the worst case.*
*Where auxiliary tripping relays are used, an additional 10-15 ms must be added to allow for trip relay operation.*

## 9.3    SETTING GUIDELINES (UNDERCURRENT)

The phase undercurrent settings (I<) must be set less than load current to ensure that I< operation correctly indicates that the circuit breaker pole is open. A typical setting for overhead line or cable circuits is 20%In. Settings of 5% of In are common for generator CB Fail.

The earth fault undercurrent elements must be set less than the respective trip. For example:

$IN< = (IN> trip)/2$

# CHAPTER 9

# CURRENT TRANSFORMER REQUIREMENTS

# 1          CHAPTER OVERVIEW

This chapter contains the following sections:

## 2    CT REQUIREMENTS

The current transformer requirements are based on a maximum fault current of 50 times the rated current (In) with the device having an instantaneous overcurrent setting of 25 times the rated current. The current transformer requirements are designed to provide operation of all protection elements.

Where the criteria for a specific application are in excess of this, or the lead resistance exceeds the limiting lead resistance shown in the following table, the CT requirements may need to be modified according to the formulae in the subsequent sections:

| Nominal Rating | Nominal Output | Accuracy Class | Accuracy Limited Factor | Limiting Lead Resistance |
|---|---|---|---|---|
| 1A | 2.5 VA | 10P | 20 | 1.3 ohms |
| 5A | 7.5 VA | 10P | 20 | 0.11 ohms |

The formula subscripts used in the subsequent sections are as follows:

$K$ = A constant affected by the dynamic response of the relay

$I_{cn}$ = Maximum prospective secondary earth fault current or 30 times I> setting (whichever is lower) (amps)

$I_{cp}$ = Maximum prospective secondary phase fault current or 30 times I> setting (whichever is lower) (amps)

$I_f$ = Maximum through-fault current level (amps)

$I_{fn}$ = Maximum prospective secondary earth fault current (amps)

$I_{fp}$ = Maximum prospective secondary phase fault current (amps)

$I_n$ = Rated secondary current (amps)

$I_s$ = Current setting of REF elements (amps)

$I_{sn}$ = Stage 3 & 4 earth fault setting (amps)

$I_{sp}$ = Stage 3, 4, 5 and 6 setting (amps)

$I_{st}$ = Motor start up current referred to CT secondary side (amps)

$R_{CT}$ = Resistance of current transformer secondary winding (ohms)

$R_L$ = Resistance of a single lead from relay to current transformer (ohms)

$R_n$ = Impedance of the neutral current input at 30In (ohms)

$R_p$ = Impedance of the phase current input at 30In (ohms)

$R_{st}$ = Value of stabilising resistor for REF applications (ohms)

$V_K$ = Required CT knee-point voltage (volts)

$V_S$ = Required stability voltage

### 2.1    PHASE OVERCURRENT PROTECTION

#### 2.1.1    DIRECTIONAL ELEMENTS

**Time-delayed phase overcurrent elements**

$$V_K = \frac{I_{cp}}{2}(R_{CT} + R_L + R_p)$$

Instantaneous phase overcurrent elements

$$V_K = \frac{I_{fp}}{2}(R_{CT} + R_L + R_p)$$

## 2.1.2        NON-DIRECTIONAL ELEMENTS

Time-delayed phase overcurrent elements

$$V_K = \frac{I_{cp}}{2}(R_{CT} + R_L + R_p)$$

Instantaneous phase overcurrent elements

$$V_K = I_{sp}(R_{CT} + R_L + R_p)$$

## 2.2        EARTH FAULT PROTECTION

## 2.2.1        DIRECTIONAL ELEMENTS

Instantaneous earth fault overcurrent elements

$$V_K = \frac{I_{fn}}{2}(R_{CT} + 2R_L + R_p + Rn)$$

## 2.2.2        NON-DIRECTIONAL ELEMENTS

Time-delayed earth fault overcurrent elements

$$V_K = \frac{I_{cn}}{2}(R_{CT} + 2R_L + R_p + R_n)$$

Instantaneous earth fault overcurrent elements

$$V_K = I_{sn}(R_{CT} + 2R_L + R_p + R_n)$$

## 2.3        SEF PROTECTION (RESIDUALLY CONNECTED)

## 2.3.1        DIRECTIONAL ELEMENTS

Time delayed SEF protection

$$V_K \geq \frac{I_{cn}}{2}(R_{CT} + 2R_L + R_p + Rn)$$

Instantaneous SEF protection

$$V_K \geq \frac{I_{fn}}{2}(R_{CT} + 2R_L + R_p + Rn)$$

### 2.3.2        NON-DIRECTIONAL ELEMENTS

**Time delayed SEF protection**

$$V_K \geq \frac{I_{cn}}{2}(R_{CT} + 2R_L + R_p + Rn)$$

**Instantaneous SEF protection**

$$V_K \geq \frac{I_{sn}}{2}(R_{CT} + 2R_L + R_p + Rn)$$

## 2.4        SEF PROTECTION (CORE-BALANCED CT)

### 2.4.1        DIRECTIONAL ELEMENTS

**Instantaneous element**

$$V_K \geq \frac{I_{fn}}{2}(R_{CT} + 2R_L + Rn)$$

> *Note:*
> *Ensure that the phase error of the applied core balance current transformer is less than 90 minutes at 10% of rated current and less than 150 minutes at 1% of rated current.*

### 2.4.2        NON-DIRECTIONAL ELEMENTS

**Time delayed element**

$$V_K \geq \frac{I_{cn}}{2}(R_{CT} + 2R_L + Rn)$$

**Instantaneous element**

$$V_K \geq I_{sn}(R_{CT} + 2R_L + Rn)$$

> *Note:*
> *Ensure that the phase error of the applied core balance current transformer is less than 90 minutes at 10% of rated current and less than 150 minutes at 1% of rated current.*

## 2.5        LOW IMPEDANCE REF PROTECTION

**For X/R < 40 and $I_f < 15I_n$**

$$V_K \geq 24I_n(R_{CT} + 2R_L)$$

**For 40 < X/R < 120 and $15I_n < If < 40I_n$**

$$V_K \geq 48I_n(R_{CT} + 2R_L)$$

> *Note:*
> *Class x or Class 5P CTs should be used for low impedance REF applications.*

## 2.6 HIGH IMPEDANCE REF PROTECTION

The high impedance REF element will maintain stability for through-faults and operate in less than 40ms for internal faults, provided the following equations are met:

$$R_{st} = \frac{I_f (R_{CT} + 2R_L)}{I_s}$$

$$V_K \geq 4 I_s R_{st}$$

> *Note:*
> *Class x CTs should be used for high impedance REF applications.*

## 2.7 HIGH IMPEDANCE BUSBAR PROTECTION

The high impedance bus bar protection element will maintain stability for through faults and operate for internal faults. You should select Vk/Vs based on the X/R of the system. The equation is:

$$V_S = K * I_f * (R_{CT} + R_L)$$

**For X/R <= 40**

$$V_k / V_S >= 2$$

*Typical operating time = 25 ms*

**For X/R > 40**

$$V_k / V_S >= 4$$

*Typical operating time = 30 ms*

> *Note:*
> *K is a constant affected by the dynamic response of the device. K is always equal to 1.*

## 2.8 USE OF METROSIL NON-LINEAR RESISTORS

Current transformers can develop high peak voltages under internal fault conditions. Metrosils are used to limit these peak voltages to a value below the maximum withstand voltage (usually 3 kV).

You can use the following formulae to estimate the peak transient voltage that could be produced for an internal fault. The peak voltage produced during an internal fault is a function of the current transformer kneepoint voltage and the prospective voltage that would be produced for an internal fault if current transformer saturation did not occur.

$$Vp = 2 \sqrt{2 V K (V_F - V_K)}$$

$$Vf = I'f (R_{CT} + 2_{RL} + R_{ST})$$

where:

- Vp = Peak voltage developed by the CT under internal fault conditions
- Vk = Current transformer kneepoint voltage
- Vf = Maximum voltage that would be produced if CT saturation did not occur
- I'f = Maximum internal secondary fault current
- $R_{CT}$ = Current transformer secondary winding resistance
- $R_L$ = Maximum lead burden from current transformer to relay
- $R_{ST}$ = Relay stabilising resistor

You should always use Metrosils when the calculated values are greater than 3000 V. Metrosils are connected across the circuit to shunt the secondary current output of the current transformer from the device to prevent very high secondary voltages.

Metrosils are externally mounted and take the form of annular discs. Their operating characteristics follow the expression:

$$V = CI^{0.25}$$

where:

- V = Instantaneous voltage applied to the Metrosil
- C = Constant of the Metrosil
- I = Instantaneous current through the Metrosil

With a sinusoidal voltage applied across the Metrosil, the RMS current would be approximately 0.52 × the peak current. This current value can be calculated as follows:

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

where:

- $V_{S(RMS)}$ = RMS value of the sinusoidal voltage applied across the metrosil.

This is due to the fact that the current waveform through the Metrosil is not sinusoidal but appreciably distorted.

The Metrosil characteristic should be such that it complies with the following requirements:

- The Metrosil current should be as low as possible, and no greater than 30 mA RMS for 1 A current transformers or 100 mA RMS for 5 A current transformers.
- At the maximum secondary current, the Metrosil should limit the voltage to 1500 V RMS or 2120 V peak for 0.25 second. At higher device voltages it is not always possible to limit the fault voltage to 1500 V rms, so higher fault voltages may have to be tolerated.

The following tables show the typical Metrosil types that will be required, depending on relay current rating, REF voltage setting etc.

### Metrosils for devices with a 1 Amp CT

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

- The Metrosil current should be less than 30 mA rms.
- At the maximum secondary internal fault current the Metrosil should limit the voltage to 1500 V rms if possible.

The Metrosil units normally recommended for use with 1Amp CTs are as shown in the following table:

| | Nominal Characteristic | | Recommended Metrosil Type | |
|---|---|---|---|---|
| Device Voltage Setting | C | β | Single Pole Relay | Triple Pole Relay |
| Up to 125 V RMS | 450 | 0.25 | 600A/S1/S256 | 600A/S3/1/S802 |
| 125 to 300 V RMS | 900 | 0.25 | 600A/S1/S1088 | 600A/S3/1/S1195 |

> *Note:*
> *Single pole Metrosil units are normally supplied without mounting brackets unless otherwise specified by the customer.*

### Metrosils for devices with a 5 Amp CT

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

- The Metrosil current should be less than 100 mA rms (the actual maximum currents passed by the devices shown below their type description.
- At the maximum secondary internal fault current the Metrosil should limit the voltage to 1500 V rms for 0.25secs. At the higher relay settings, it is not possible to limit the fault voltage to 1500 V rms so higher fault voltages have to be tolerated.

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

| Secondary Internal Fault Current | Recommended Metrosil types for various voltage settings | | | |
|---|---|---|---|---|
| Amps RMS | Up to 200 V RMS | 250 V RMS | 275 V RMS | 300 V RMS |
| 50A | 600A/S1/S1213<br>C = 540/640<br>35 mA RMS | 600A/S1/S1214<br>C = 670/800<br>40 mA RMS | 600A/S1/S1214<br>C =670/800<br>50 mA RMS | 600A/S1/S1223<br>C = 740/870<br>50 mA RMS |
| 100A | 600A/S2/P/S1217<br>C = 470/540<br>70 mA RMS | 600A/S2/P/S1215<br>C = 570/670<br>75 mA RMS | 600A/S2/P/S1215<br>C =570/670<br>100 mA RMS | 600A/S2/P/S1196<br>C =620/740<br>100 mA RMS |
| 150A | 600A/S3/P/S1219<br>C = 430/500<br>100 mA RMS | 600A/S3/P/S1220<br>C = 520/620<br>100 mA RMS | 600A/S3/P/S1221<br>C = 570/670<br>100 mA RMS | 600A/S3/P/S1222<br>C =620/740<br>100 mA RMS |

In some situations single disc assemblies may be acceptable, contact GE for detailed applications.

> *Note:*
> *The Metrosils recommended for use with 5 Amp CTs can also be used with triple pole devices and consist of three single pole units mounted on the same central stud but electrically insulated from each other. To order these units please specify "Triple pole Metrosil type", followed by the single pole type reference. Metrosil for higher voltage settings and fault currents are available if required.*

## 2.9    USE OF ANSI C-CLASS CTS

Where American/IEEE standards are used to specify CTs, the C class voltage rating can be used to determine the equivalent knee point voltage according to IEC. The equivalence formula is:

$$V_K = 1.05(C\ rating\ in\ volts) + 100R_{CT}$$

# CHAPTER 10

# AUTORECLOSE

# 1          CHAPTER OVERVIEW

Selected models of this product provide sophisticated Autoreclose (AR) functionality. The purpose of this chapter is to describe the operation of this functionality including the principles, logic diagrams and applications.

This chapter contains the following sections:

## 2          INTRODUCTION TO 3-PHASE AUTORECLOSE

It is known that approximately 80 - 90% of faults are transient in nature. This means that most faults do not last long and are self-clearing. A common example of a transient fault is an insulator flashover, which may be caused for example by lightning, clashing conductors or wind-blown debris.

A transient fault, such as an insulator flashover, is a self-clearing 'non-damage' fault. The flashover will cause one or more circuit breakers to trip, but it may also have the effect of clearing the fault. If the fault clears itself, the fault does not recur when the line is re-energised.

The remaining 10 – 20% of faults are either semi-permanent or permanent. A small tree branch falling on the line could cause a semi-permanent fault. Here the cause of the fault would not be removed by the immediate tripping of the circuit, but could be burnt away during a time-delayed trip. Permanent faults could be broken conductors, transformer faults, cable faults or machine faults, which must be located and repaired before the supply can be restored.

In the majority of fault incidents, if the faulty line is immediately tripped out, and time is allowed for the fault arc to deionise, reclosure of the circuit breakers will result in the line being successfully re-energised.

Autoreclose schemes are used to automatically reclose a circuit breaker a set time after it has been opened due to operation of a protection element.

On HV/MV distribution networks, autoreclosing is applied mainly to radial feeders, where system stability problems do not generally arise. The main advantages of using Autoreclose are:

- Minimal interruption in supply to the consumer
- Reduction of operating costs - fewer man hours in repairing fault damage and the possibility of running unattended substations
- With Autoreclose, instantaneous protection can be used which means shorter fault durations. This in turn means less fault damage and fewer permanent faults

Autoreclosing provides an important benefit on circuits using time-graded protection, in that it allows the use of instantaneous protection to provide a high speed first trip. With fast tripping, the duration of the power arc resulting from an overhead line fault is reduced to a minimum. This lessens the chance of damage to the line, which might otherwise cause a transient fault to develop into a permanent fault. Using instantaneous protection also prevents blowing of fuses in teed feeders, as well as reducing circuit breaker maintenance by eliminating pre-arc heating.

When instantaneous protection is used with autoreclosing, the scheme is normally arranged to block the instantaneous protection after the first trip. Therefore, if the fault persists after re-closure, the time-graded protection will provide discriminative tripping resulting in the isolation of the faulted section. However, for certain applications, where the majority of the faults are likely to be transient, it is common practise to allow more than one instantaneous trip before the instantaneous protection is blocked.

Some schemes allow a number of re-closures and time-graded trips after the first instantaneous trip, which may result in the burning out and clearance of semi-permanent faults. Such a scheme may also be used to allow fuses to operate in teed feeders where the fault current is low.

When considering feeders that are partly overhead line and partly underground cable, any decision to install auto-reclosing should be subject to analysis of the data (knowledge of the frequency of transient faults). This is because this type of arrangement probably has a greater proportion of semi-permanent and permanent faults than for purely overhead feeders. In this case, the advantages of autoreclosing are small. It can even be disadvantageous because re-closing on to a faulty cable is likely to exacerbate the damage.

## 3          IMPLEMENTATION

Autoreclose functionality is a software option, which is selected when ordering the device, so this description only applies to models with this option.

Autoreclose works for phase overcurrent (POC) earth fault (EF) and sensitive earth fault (SEF) protection. It is implemented in the *AUTORECLOSE* column of the relevant settings group. In addition to the settings contained in this column, you will also need to make some settings in the blocking cells of the relevant protection columns.

The Autoreclose function can be set to perform a single-shot, two-shot, three-shot or four-shot cycle. You select this by the **Number of Shots** cell in the *AUTORECLOSE* column. You can also initiate a separate Autoreclose cycle for the SEF protection, with a different number of shots, selected by the **Number SEF Shots** cell. Dead times for all shots can be adjusted independently.

An Autoreclose cycle can be initiated internally by operation of a protection element, or externally by a separate protection device. The dead time starts in one of two cases; when the circuit breaker has tripped, or when the protection has reset. You select this using the **Start Dead t On** cell.

At the end of the relevant dead time, a **CB Closed 3 ph** signal is given, providing it is safe for the circuit breaker to close. This is determined by checking that certain system conditions are met as specified by the **System Checks** functionality.

It is safe to close the circuit breaker providing that:

- only one side of the circuit breaker is live (either dead line / live bus, or live line / dead bus), or
- if both bus and line sides of the circuit breaker are live, the system voltages are synchronised.

In addition, the energy source powering the circuit breaker (for example the closing spring) must be fully charged. This is indicated from the **CB Healthy** DDB input.

When the CB has closed, the reclaim time starts. If the circuit breaker does not trip again, the Autoreclose function resets at the end of the set reclaim time. If the protection operates during the reclaim time the device either advances to the next shot in the Autoreclose cycle, or if all reclose attempts have been made, goes to lockout.

CB Status signals must also be available, so the default setting for **CB Status Input** should be modified according to the application. The default PSL requires 52A, 52B and CB Healthy logic inputs, so a setting of both **52A and 52B** would be required for the **CB Status Input** if used with the default PSL.

# 4 AUTORECLOSE FUNCTION INPUTS

The Autoreclose function has several logic inputs, which can be mapped to any of the opto-inputs or to one or more of the DDB output signals generated by the PSL. The functions of these inputs are described below.

## 4.1 CB HEALTHY

It is necessary to establish if there is sufficient energy in the circuit breaker (spring charged, gas pressure healthy, etc.) before the CB can be closed. This **CB Healthy** input is used to ensure this before initiating a **CB closed 3ph** command. If on completion of the dead time, the **CB Healthy** input is low, and remains low for a period given by the **CB Healthy Time** timer, lockout will result and the circuit breaker will remain open.

The majority of circuit breakers are only capable of providing a single trip-close-trip cycle, in which case the **CB Healthy** signal would stay low after one Autoreclose shot, resulting in lockout.

This check can be disabled by not allocating an opto-input for the **CB Healthy** signal, whereby the signal defaults to a High state.

## 4.2 BLOCK AR

The **Block AR** input blocks the Autoreclose function and causes a lockout. It can be used when protection operation without Autoreclose is required. A typical example is on a transformer feeder, where Autoreclose may be initiated by the feeder protection but blocked by the transformer protection.

## 4.3 RESET LOCKOUT

The **Reset Lockout** input can be used to reset the Autoreclose function following lockout. It also resets any Autoreclose alarms, provided that the signals that initiated the lockout have been removed.

## 4.4 AR AUTO MODE

The **AR Auto Mode** input is used to select the Auto operating mode. In this mode, the Autoreclose function is in service.

## 4.5 AR LIVELINE MODE

The **AR LiveLine Mode** input is used to select the Live Line operating mode when Autoreclose is out of service and all blocking of instantaneous protection by Autoreclose is disabled. This operating mode takes precedence over all other operating modes for safety reasons, as it indicates that utility personnel are working near live equipment.

## 4.6 TELECONTROL MODE

The **Telecontrol** input is used to select the Telecontrol operating mode so that the Auto and Non-auto modes of operation can be selected remotely.

## 4.7 LIVE/DEAD CCTS OK (LIVE/DEAD CIRCUITS OK)

The **LiveDead Ccts OK** signal is a signal indicating the status of the Live Line / Dead Bus or Live Bus / Dead Line system conditions (High = OK, Low = Not OK). The logic required can be derived in the PSL from the Live Line, Dead Line, Live Bus and Dead Bus signals in the System Check logic (if applicable), or it can come from an external source depending on the application.

## 4.8 AR SYS CHECKS (AR SYSTEM CHECKS)

The **AR Sys Checks** signal can be mapped from the system checks output **SysChks Inactive**, to enable auto-reclosing without any system checks, providing the **System Checks** setting in the *CONFIGURATION* column is

disabled. This mapping is not essential, because the **No System Checks** setting in the *AUTORECLOSE* column can be enabled to achieve the same effect.

This DDB can also be mapped to an opto-input, to allow the IED to receive a signal from an external system monitoring device, indicating that the system conditions are suitable for CB closing. This should not normally be necessary, since the IED has comprehensive built in system check functionality.

## 4.9 EXT AR PROT TRIP (EXTERNAL AR PROTECTION TRIP)

The **Ext AR Prot Trip** signal allows Autoreclose initiation by a Trip from a separate protection device.

## 4.10 EXT AR PROT START (EXTERNAL AR PROTECTION START)

The **Ext AR Prot Strt** signal allows Autoreclose initiation by a Start from a separate protection device.

## 4.11 DAR COMPLETE (DELAYED AUTORECLOSE COMPLETE)

Some utilities require Delayed Autoreclose (DAR) functionality.

The **DAR Complete** signal can, if required, be mapped in PSL to provide a short pulse when a CB Close command is given at the end of the dead time. If **DAR Complete** is activated during an Autoreclose cycle, the output signal **DAR in Progress** resets, even though the reclaim time may still be running, and **AR in Progress** remains set until the end of the reclaim time.

For most applications, **DAR complete** can be ignored (not mapped in PSL). In such cases, **DAR in Progress** operates and resets in parallel with **AR in Progress**.

## 4.12 CB IN SERVICE (CIRCUIT BREAKER IN SERVICE)

The **CB In Service** signal must remain asserted when protection operates if autoreclose is to be initiated. For most applications, it can be mapped to **CB Closed 3ph**. More complex PSL mapping can be programmed if required, for example where it is necessary to confirm not only that the CB is closed but also that the line and/or bus VT is actually live up to the instant of protection operation.

## 4.13 AR RESTART

In some applications, it is sometimes necessary to initiate an Autoreclose cycle by means of connecting an external signal to an opto-input. This would be when the normal interlock conditions are not all satisfied, i.e. when the CB is open and the associated feeder is dead. If the **AR Restart** input is mapped to an opto-input, activation of that opto-input will initiate an Autoreclose cycle irrespective of the status of the **CB in Service** input, provided the other interlock conditions, are still satisfied.

## 4.14 DT OK TO START (DEAD TIME OK TO START)

This is an optional extra interlock in the dead time initiation logic. In addition to the CB being open and the protection reset, **DT OK To Start** has to be set high to allow the dead time function to be primed after an AR cycle has started. Once the dead time function is primed, this signal has no further affect – the dead time function stays primed even if the signal subsequently goes low. A typical PSL mapping for this input is from the **Dead Line** signal from the System Check logic. This would enable dead time priming only when the feeder has gone dead after CB tripping. If this extra dead time priming interlock is not required, **DT OK To Start** can be left unmapped, and it will default to a high state.

## 4.15 DEADTIME ENABLED

This is an optional interlock in the dead time logic. This signal has to be high to allow the dead time to run. If this signal goes low, the dead time stops and resets, but stays primed, and will restart from zero when it goes high again. A typical PSL mapping is from the **CB Healthy** input or from selected signals from the System Check logic. It

could also be mapped to an opto-input to provide a 'hold off' function for the follower CB in a 'master/follower' application with 2 CBs. If this optional interlock is not required, **DeadTime Enabled** can be left unmapped, and it will default to a high state.

## 4.16       AR INIT TRIPTEST (INITIATE TRIP TEST)

If **AR Init TripTest** is mapped to an opto-input, and that input is activated momentarily, the IED generates a CB trip output via **AR Trip Test**. The default PSL then maps this to output to the trip output relay and initiates an Autoreclose cycle.

## 4.17       AR SKIP SHOT 1

If **AR Skip Shot 1** is mapped to an opto-input, and that input is activated momentarily, the IED logic will cause the Autoreclose sequence counter to increment by 1. This will decrease the available number of reclose shots and will lockout the re-closer.

## 4.18       INH RECLAIM TIME (INHIBIT RECLAIM TIME)

If **Inh Reclaim Time** is mapped to an opto-input, and that input is active at the start of the reclaim time, the IED logic will cause the reclaim timers to be blocked.

# 5          AUTORECLOSE FUNCTION OUTPUTS

The Autoreclose function has several logic outputs, which can be assigned to output relay contacts, monitor bits in the *COMMISSION TESTS* column, or the PSL. The functions of these outputs are described below.

## 5.1          AR IN PROGRESS

This signal is present during the complete re-close cycle from the start of protection to the end of the reclaim time or lockout.

## 5.2          DAR IN PROGRESS

This operates together with the *AR In Progress* signal at the start of Autoreclose. If *DAR Complete* does not operate, *DAR in Progress* remains operated until *AR In Progress* resets at the end of the cycle. If *DAR Complete* goes high during the Autoreclose cycle, *DAR in Progress* resets.

## 5.3          SEQUENCE COUNTER STATUS DDB SIGNALS

During each Autoreclose cycle a sequence Counter increments by 1 after each fault trip and resets to zero at the end of the cycle.

- *AR SeqCounter 0* is set when the counter is at zero
- *AR SeqCounter 1* is set when the counter is at 1
- *AR SeqCounter 2* is set when the counter is at 2
- *AR SeqCounter 3* is set when the counter is at 3
- *AR SeqCounter 4* is set when the counter is at 4

## 5.4          SUCCESSFUL CLOSE

The *Successful Close* output indicates that an Autoreclose cycle has been successfully completed. A successful Autoreclose signal is given after the protection has tripped the CB and it has reclosed successfully. The successful Autoreclose output is reset at the next CB trip or from one of the reset lockout methods.

## 5.5          AR IN SERVICE

The *AR In Service* output indicates whether the Autoreclose is in or out of service. Autoreclose is In Service when the device is in *Auto* mode and Out of Service when in the *Non Auto* and *Live Line* modes.

## 5.6          AR BLK MAIN PROT (BLOCK MAIN PROTECTION)

The *AR Blk Main Prot* signal blocks the DT-only stages (instantaneous stages) of the main current protection elements. These are *I>3, I>4, I>6, IN1>3, IN1>4, IN2>3,* and *IN2>4.* You block the instantaneous stages for each trip of the Autoreclose cycle using the Overcurrent and Earth Fault 1 and 2 settings, *I> Blocking, IN1> Blocking, IN2> Blocking* and the *Trip 1 Main, Trip 2 Main, Trip 3 Main, Trip 4 Main* and *Trip 5 Main* settings.

## 5.7          AR BLK SEF PROT (BLOCK SEF PROTECTION)

The *AR Blk SEF Prot* signal blocks the DT-only stages (instantaneous stages) of the SEF protection elements. These are *ISEF>3*, and *ISEF>4*. You block the instantaneous SEF stages for each trip of the Autoreclose cycle using the *SEF PROTECTION* setting *ISEF> Blocking*, and the *Trip 1 SEF*, *Trip 2 SEF*, *Trip 3 SEF*, *Trip 4 SEF* and *Trip 5 SEF* settings.

## 5.8      RECLOSE CHECKS

The *Reclose Checks* output indicates that the AR System Checks are in progress.

## 5.9      DEADTIME IN PROG

The *DeadTime in Prog* output indicates that the dead time is in progress. This signal is set when *Reclose Checks* is set AND input *Dead TimeEnabled* is high. This may be useful during commissioning to check the operation of the Autoreclose cycle.

## 5.10     DT COMPLETE (DEAD TIME COMPLETE)

DT *Complete* (Dead time complete) operates at the end of the set dead time, and remains operated until either the scheme resets at the end of the reclaim time or a further protection operation or Autoreclose initiation occurs. It can be applied purely as an indication, or included in PSL mapping to logic input *DAR Complete*.

## 5.11     AR SYNC CHECK (AR SYNCHRONISATION CHECK)

*AR Sync Check* indicates that the Autoreclose Synchronism checks are satisfactory. This is when either of the synchronisation check modules (CS1 or CS2), confirms an In-Synchronism condition.

## 5.12     AR SYSCHECKS OK (AR SYSTEM CHECKS OK)

*AR SysChecks OK* indicates that the Autoreclose System checks are satisfactory. This is when any selected system check condition (synchronism check, live bus/dead line etc.) is confirmed.

This DDB signal ihas the number 463 and is an output from the Autoreclose function (i.e. a PSL input). It should not be confused with DDB signal 403, which is an input to the Autoreclose function (i.e. a PSL output).

## 5.13     AUTO CLOSE

The *Auto Close* output indicates that the Autoreclose logic has issued a `Close` signal to the CB. This output feeds a signal to the control close pulse timer and remains on until the CB has closed. This signal may be useful during commissioning to check the operation of the Autoreclose cycle.

## 5.14     PROTECTION LOCKT (PROTECTION LOCKOUT)

*Protection Lockt* (Protection Lockout) operates if *AR lockout* is triggered by protection operation either during the inhibit period following a manual CB close or when the device is in *Non-auto* or *Live Line* mode.

## 5.15     RESET LCKOUT ALM (RESET LOCKOUT ALARM)

*Reset Lckout Alm* operates when the device is in *Non-auto mode*, if the *Reset Lockout* setting is set to `Select Non Auto`.

## 5.16     RECLAIM IN PROG

*Reclaim in Prog* output indicates that a reclaim timer is in progress and will drop-off once the reclaim timer resets.

## 5.17     RECLAIM COMPLETE

*Reclaim Complete* operates at the end of the set reclaim time and is a fast reset. To maintain the output indication a dwell timer has to be implemented in PSL.

# 6        AUTORECLOSE FUNCTION ALARMS

The following DDB signals will produce an alarm. These are described below.

## 6.1        AR NO SYS CHECK

The **AR No Sys Check** alarm indicates that the system voltages are not suitable for autoreclosing at the end of the system check time (setting **Sys Check Time**), leading to a lockout condition. This alarm is latched and must be reset manually.

## 6.2        AR CB UNHEALTHY

The **AR CB Unhealthy** alarm indicates that the **CB Healthy** input was not energised at the end of the `CB Healthy Time`, leading to a lockout condition. This alarm is latched and must be reset manually.

## 6.3        AR LOCKOUT

The **AR Lockout** alarm indicates that the device is in a lockout status and that further re-close attempts will not be made. This alarm can configured to reset automatically (self-reset) or manually as determined by the setting **Reset Lockout by** in the *CB CONTROL* column.

## 7          AUTORECLOSE OPERATION

The Autoreclose function is a complex function consisting of several modules interacting with one another. This is described in terms of separate logic diagrams, which link together by means of Internal signals (depicted by the pink-coloured boxes. To help you with the analysis of the various Autoreclose modules, the following table describes how these internal signals link up in the various logic diagrams. Each internal signal is allocated with an ID, and the diagrams on which they appear are also identified.

| Internal signal ID | Input to AR function | Appearing in diagrams | Output from AR function | Appearing in diagrams |
|---|---|---|---|---|
| 1 | Autoreclose Disabled | V00505, V00507 | Autoreclose Disabled | V00501 |
| 2 | Live Line Mode | V00505, V00507, V00514 | Live Line Mode | V00501 |
| 3 | Non Auto Mode | V00505, V00507, V00514 | Non Auto Mode | V00501 |
| 4 | Auto Mode (int) | V00505, V00507, V00512 | Auto Mode (int) | V00501 |
| 5 | Main Protection Start | V00504, V00505, V00507, V00511, V00512 | Main Protection Start | V00502 |
| 6 | SEF Protection Start | V00504, V00505, V00511, V00512 | SEF Protection Start | V00502 |
| 7 | Main Protection Trip | V00505, V00513, V00514 | Main Protection Trip | V00503 |
| 8 | SEF Protection Trip | V00505, V00507, V00513, V00514 | SEF Protection Trip | V00503 |
| 9 | Block Autoreclose | V00513 | Block Autoreclose | V00515 |
| 10 | SC Count >= Main Shots | V00504 | SC Count >= Main Shots | V00505 |
| 11 | SC Count >= SEF Shots | V00504 | SC Count >= SEF Shots | V00505 |
| 12 | Main High Shots | V00505, V00513 | Main High Shots | V00504 |
| 13 | SEF High Shots | V00505, V00513 | SEF High Shots | V00504 |
| 14 | Autoreclose Inhibit | V00505, V00507, V00514 | Autoreclose Inhibit | V00512 |
| 15 | Autoreclose Start | V00508, V00509, V00511, V00513 | Autoreclose Start | V00505 |
| 16 | Autoreclose Initiate | V00508, V00513 | Autoreclose Initiate | V00505 |
| 17 | SC Count > 4 | V00506 | SC Count > 4 | V00505 |
| 18 | Block Main Prot Trips | V00507 | Block Main Prot Trips | V00506 |
| 19 | Block SEF Prot Trips | V00507 | Block SEF Prot Trips | V00506 |
| 20 | Hold Reclaim Output | V00511 | Hold Reclaim Output | V00509 |

### 7.1          OPERATING MODES

The Autoreclose function has three operating modes:

- Auto Mode: Autoreclose is in service
- Non-auto Mode: Autoreclose is out of service AND the chosen protection functions are blocked if setting **AR Deselected** = `Block Inst Prot.`
- Live Line Mode: Autoreclose is out of service, but protection functions are NOT blocked, even if setting **AR Deselected** = `Block Inst Prot.`

> *Note:*
> *Live Line Mode provides extra security for live line working on the protected feeder.*

The Autoreclose function must first be enabled in the *CONFIGURATION* column. You can then select the operating mode according to application requirements. The basic method of mode selection is determined by the setting **AR Mode Select** in the *AUTORECLOSE* column, as summarised in the following table:

| AR Mode Select Setting | Description |
|---|---|
| Command Mode | Auto or Non-auto mode selection is determined by the command cell *Autoreclose Mode* in the *CB CONTROL* column. |
| Opto Set Mode | Auto or Non-auto mode selection is determined by an opto-input mapped to *AR Auto Mode*<br>If the *AR Auto Mode* input is high, Auto operating mode is selected. If the *AR Auto Mode* input is low, Non-Auto operating mode is selected. |
| User Set Mode | Auto or Non-auto mode selection is controlled by the *Telecontrol Mode* input. If the *Telecontrol Mode* input is high, the setting *Autoreclose Mode* in the *CB CONTROL* column is used to select Auto or Non Auto operating mode. If the *Telecontrol Mode* input is low, it behaves as for the `Opto Set Mode` setting. |
| Pulse Set Mode | Auto or Non-auto mode selection is determined by the falling edge of *AR Auto Mode* signal. If the Telecontrol input is high, the operating mode is toggled between Auto and Non Auto Mode on the falling edge of the *AR Auto Mode* signal as it goes low. The Auto Mode pulses are produced by the SCADA system. If the Telecontrol input is low, it behaves as for the *Opto Set Mode* setting. |

The Live Line Mode is controlled by *AR LiveLine Mode*. If this is high, the scheme is forced into Live Line Mode irrespective of the other signals.

### 7.1.1      FOUR-POSITION SELECTOR SWITCH IMPLEMENTATION

It is quite common for some utilities to apply a four position selector switch to control the mode of operation. This application can be implemented using the DDB signals *AR LiveLine Mode*, *AR Auto Mode* and *Telecontrol Mode*. This is demonstrated in the following diagram.
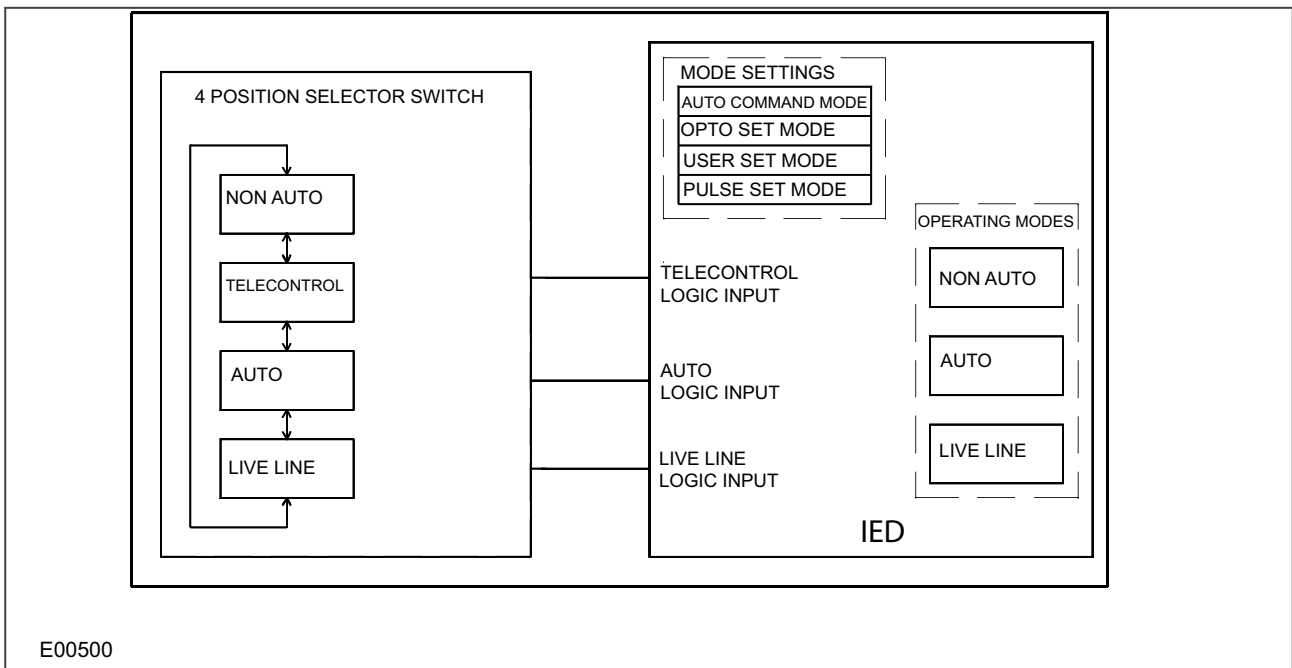


**Figure 69: Four-position selector switch implementation**

The required logic truth table for this arrangement is as follows:

| Switch position | AR Auto Mode | Telecontrol Mode | AR Live Line Mode |
|---|---|---|---|
| Non-auto | 0 | 0 | 0 |
| Telecontrol | 0 or SCADA pulse | 1 | 0 |
| Auto | 1 | 0 | 0 |
| Live Line | 0 | 0 | 1 |

### 7.1.2    OPERATING MODE SELECTION LOGIC
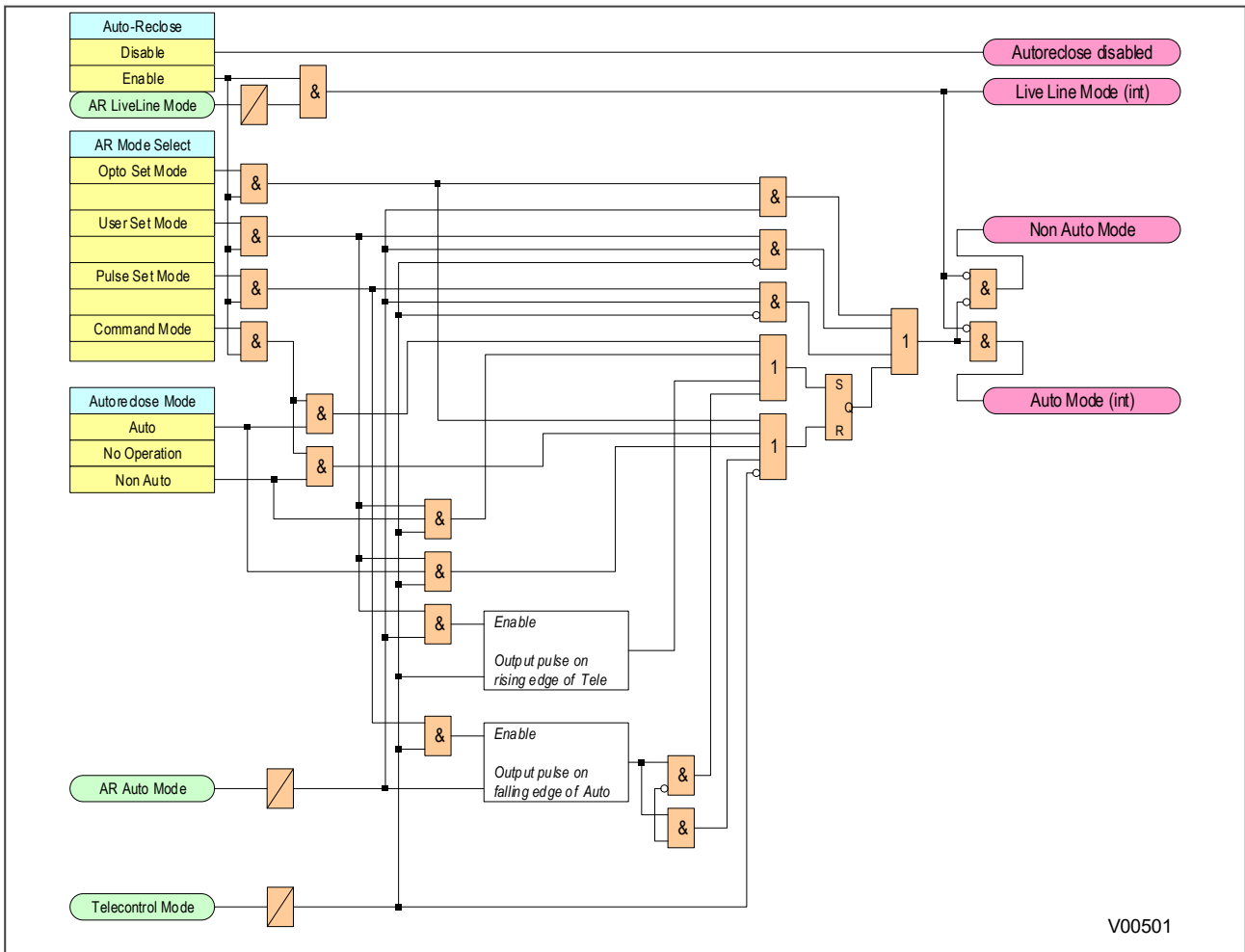


**Figure 70: Autoreclose mode select logic**

The mode selection logic includes a 100 ms delay for **Auto Mode**, **Telecontrol** and **Live Line** logic inputs, to ensure a predictable change of operating modes. This is of particular importance for the case when the four position switch does not have 'make-before-break' contacts. The logic also ensures that when the switch is moved from Auto or Non-Auto position to Telecontrol, the scheme remains in the previously selected mode (Auto or Non-Auto) until a different mode is selected by remote control.

For applications where live line operating mode and remote selection of Auto/Non-auto modes are not required, a simple two position switch can be arranged to activate **Auto Mode** input. In this case, the **Live Line** and **Telecontrol** inputs would be unused.

## 7.2    AUTORECLOSE INITIATION

Autoreclose is usually initiated from the IED's internal protection function. Different stages of phase overcurrent and earth fault protection can be programmed to initiate or block the main Autoreclose function. The stages of sensitive earth fault protection can also be programmed to initiate or block both the Main Autoreclose function or the SEF Autoreclose function.

The associated settings are found in the *AUTORECLOSE* column under the sub-heading *AR INITIATION*.

For example:

If **I>1 AR** is set to `Initiate Main AR`, operation of the **I>1** protection stage will initiate Autoreclose

If **ISEF>1 AR** is set to `No Action`, operation of the **ISEF>1** protection stage will lead to a CB trip but no reclose. Otherwise it can be used to initiate Main autoreclose or SEF autoreclose.

> *Note:*
> *A selection must be made for each protection stage that is enabled.*

A separate protection device may also initiate Autoreclose. The Autoreclose can be initiated from a protection Trip, or when sequence coordination is required from a protection Start. If external triggering of Autoreclose is required, the following DDB signals should be mapped to opto-inputs:

- **Ext AR Prot Trip**
- **Ext AR Prot Strt** (if applicable)

In addition, the setting **Ext Prot** should be set to `Initiate Main AR`.

Although a protection start and a protection trip can initiate an AR cycle, several checks still have to be performed before the initialisation signal is given. Some of the checks are listed below:

- **Auto Mode** has been selected
- **Live line mode** is disabled
- The number of main protection and SEF shots have not been reached
- Sequence co-ordination is enabled (for protection start to initiate AR. This is not necessary if a protection trip is doing the initiating)
- The **CB Ops Lockout** DDB signal is not set
- The **CB in Service** DDB signal is high

> *Note:*
> *The relevant protection trip must be mapped to the **Trip Command In** DDB.*

### 7.2.1    START SIGNAL LOGIC



V00502

Note: This diagram does not show all stages. Other stages follow similar principles.
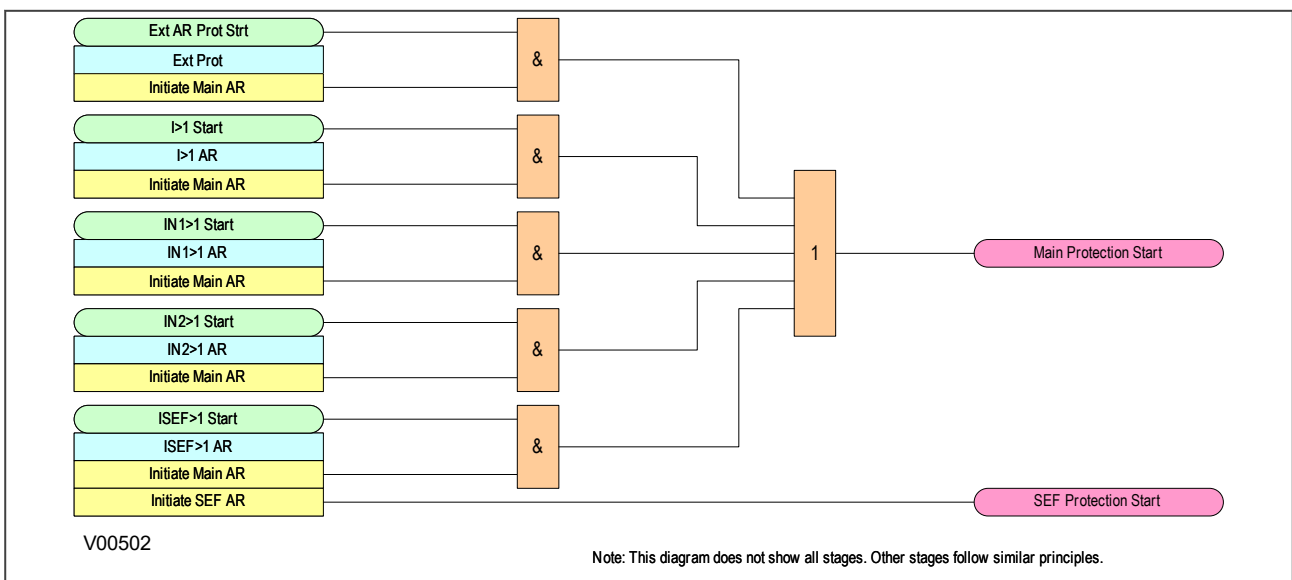
**Figure 71: Start signal logic**

## 7.2.2      TRIP SIGNAL LOGIC
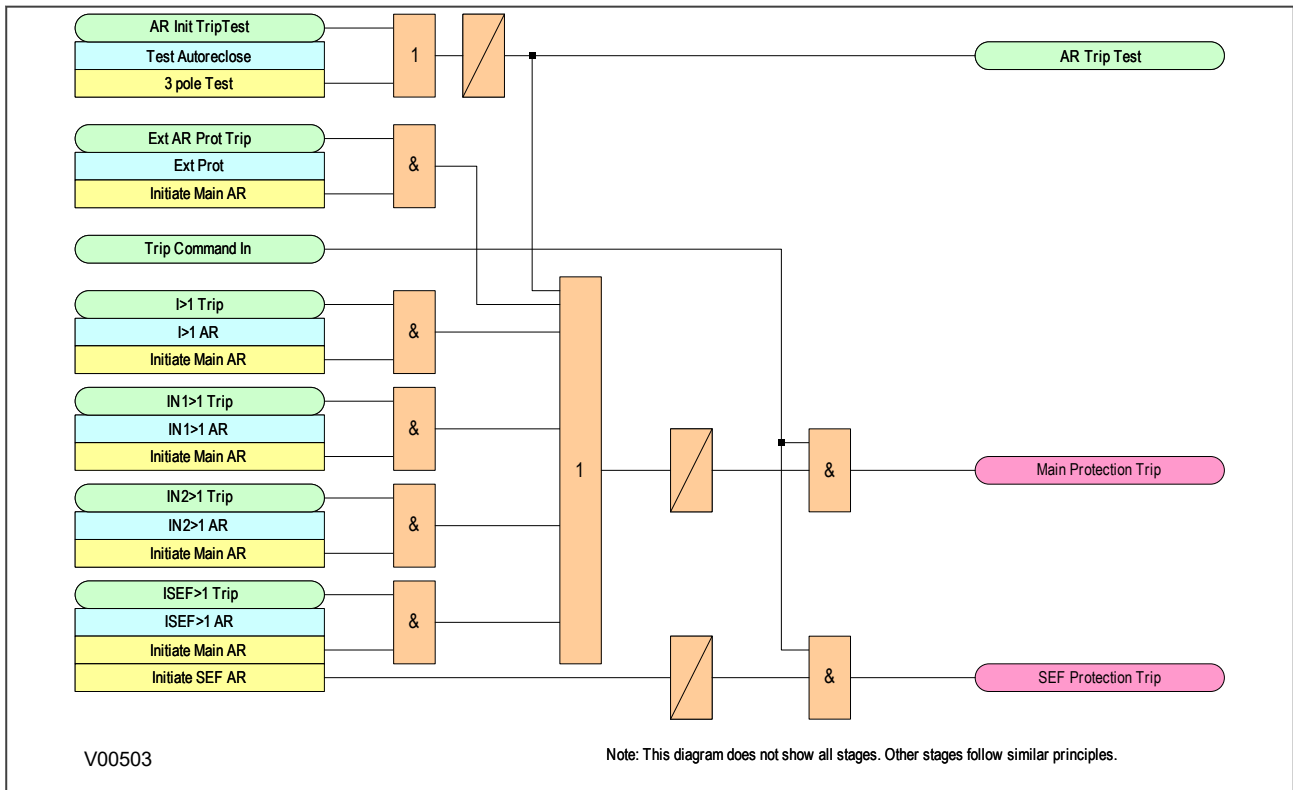


**Figure 72: Trip signal logic**

## 7.2.3    BLOCKING SIGNAL LOGIC
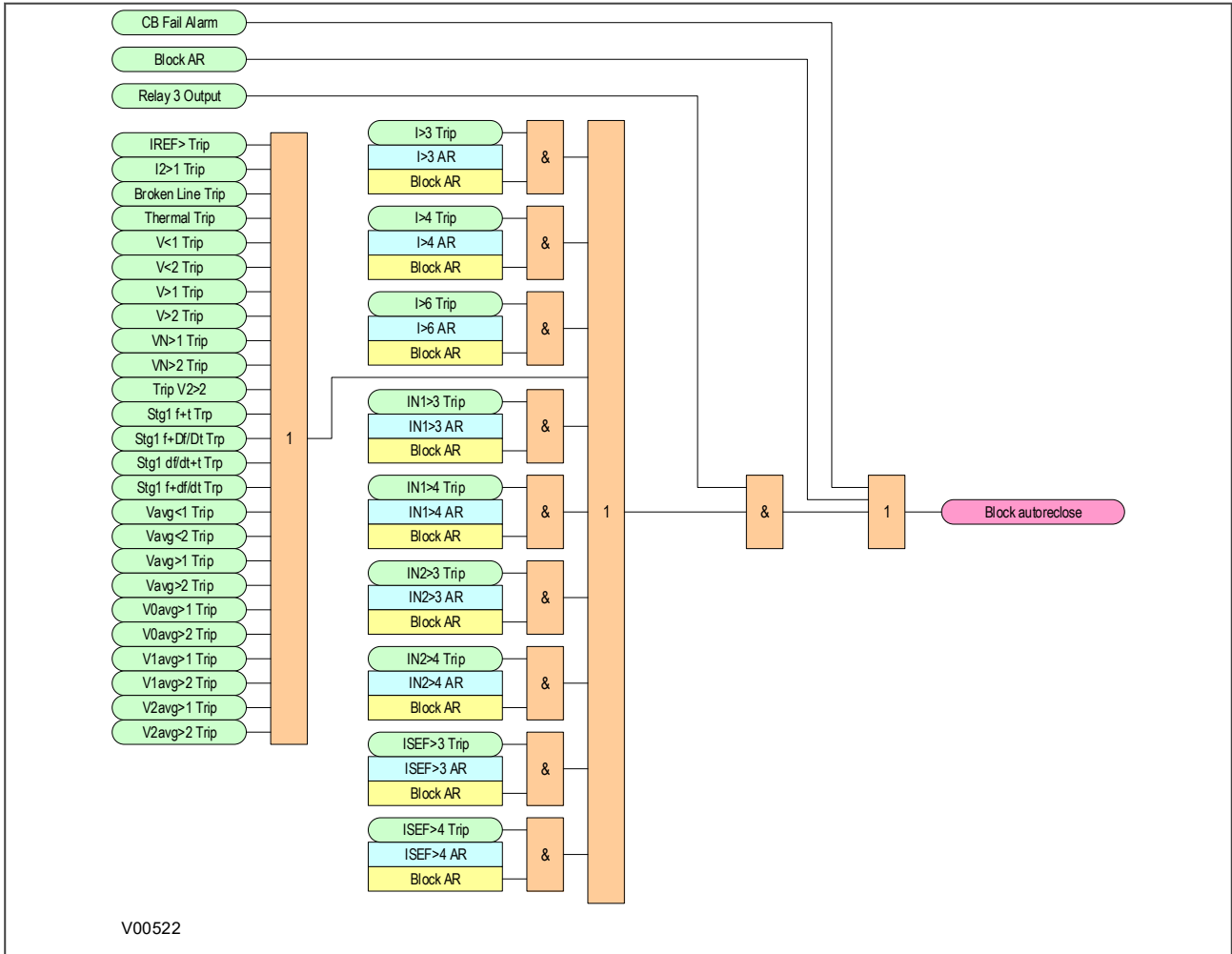


**Figure 73: Blocking signal logic**

## 7.2.4    SHOTS EXCEEDED LOGIC
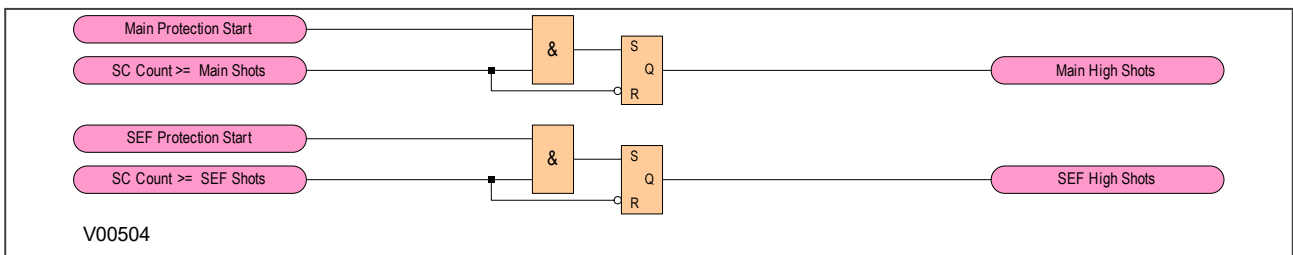


**Figure 74: Shots Exceeded logic**

### 7.2.5 AR INITIATION LOGIC
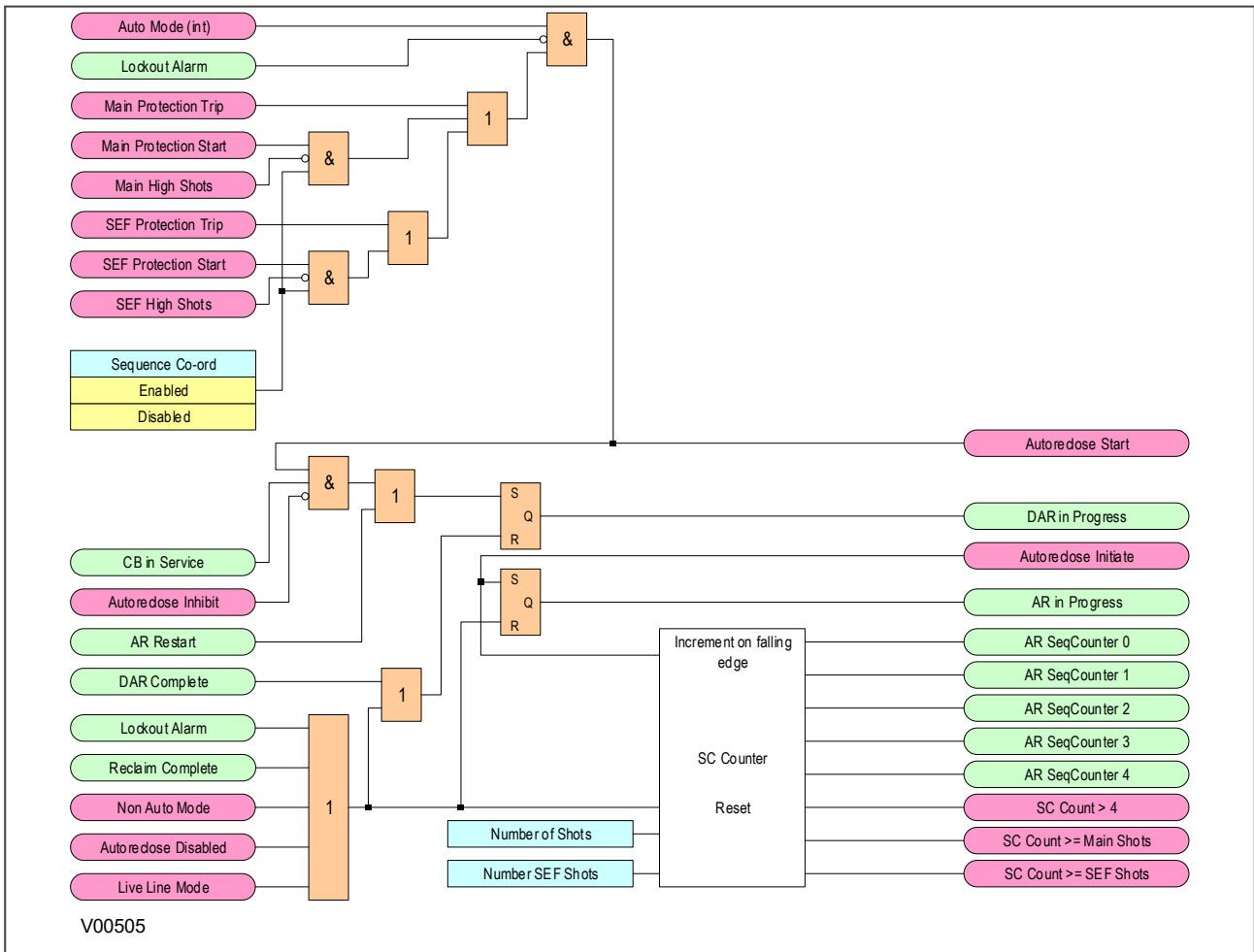


**Figure 75: AR initiation logic**

## 7.3 BLOCKING INSTANTANEOUS PROTECTION FOR SELECTED TRIPS

Instantaneous protection may be blocked or not blocked for each trip in an Autoreclose cycle. This is selected using the **Trip (n) Main** and **Trip (n) SEF** settings, where n is the number of the trip in the autoreclose cycle. These allow the instantaneous elements of phase, earth fault and SEF protection to be selectively blocked for a CB trip sequence. For example, if **Trip 1 Main** is set to `No Block` and **Trip 2 Main** is set to `Block Inst Prot`, the instantaneous elements of the phase and earth fault protection will be available for the first trip but blocked afterwards for the second trip during the Autoreclose cycle. The logic for this is shown below.
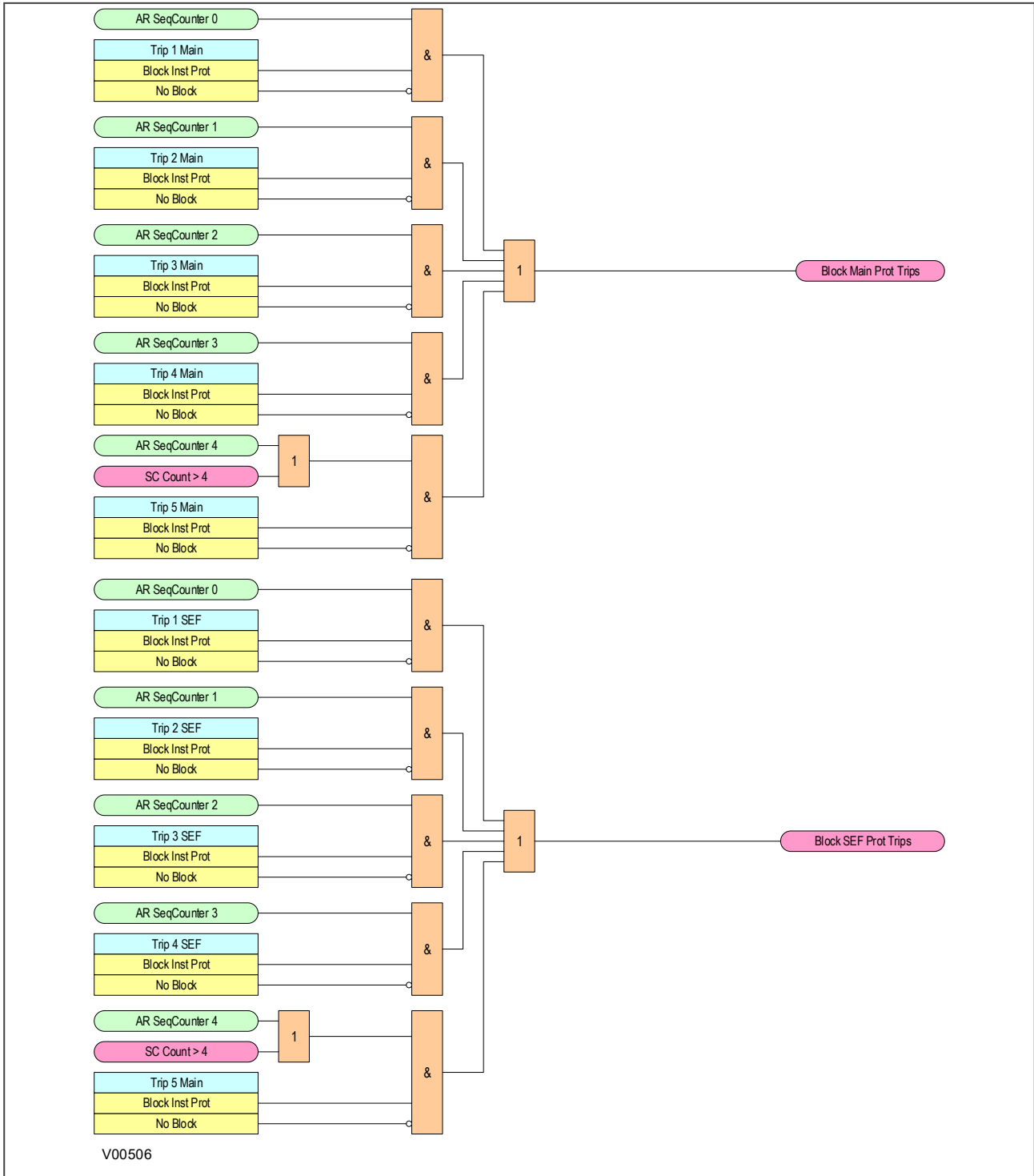
**Figure 76: Blocking instantaneous protection for selected trips**

## 7.4    BLOCKING INSTANTANEOUS PROTECTION FOR LOCKOUTS

Instantaneous protection can also be blocked for certain lockout conditions:

It is blocked when the CB maintenance lockout counter or excessive fault frequency lockout has reached its penultimate value.

For example, if the setting **No. CB Ops Lock** in the *CB MONITOR SETUP* column is set to 100 and the **No. CB Ops Maint** = '99', the instantaneous protection can be blocked to ensure that the last CB trip before lockout will be due

to discriminative protection operation. This is controlled using the **EFF Maint Lock** setting (Excessive Fault Frequency maintenance lockout). If this is set to `Block Inst Prot`, the instantaneous protection will be blocked for the last CB Trip before lockout occurs.

Instantaneous protection can also be blocked when the IED is locked out, using the **AR Lockout** setting. It can also be blocked after a manual close using the **Manual Close** setting. When the IED is in the Non-auto mode it can be blocked by using the **AR Deselected** setting. The logic for these features is shown below.
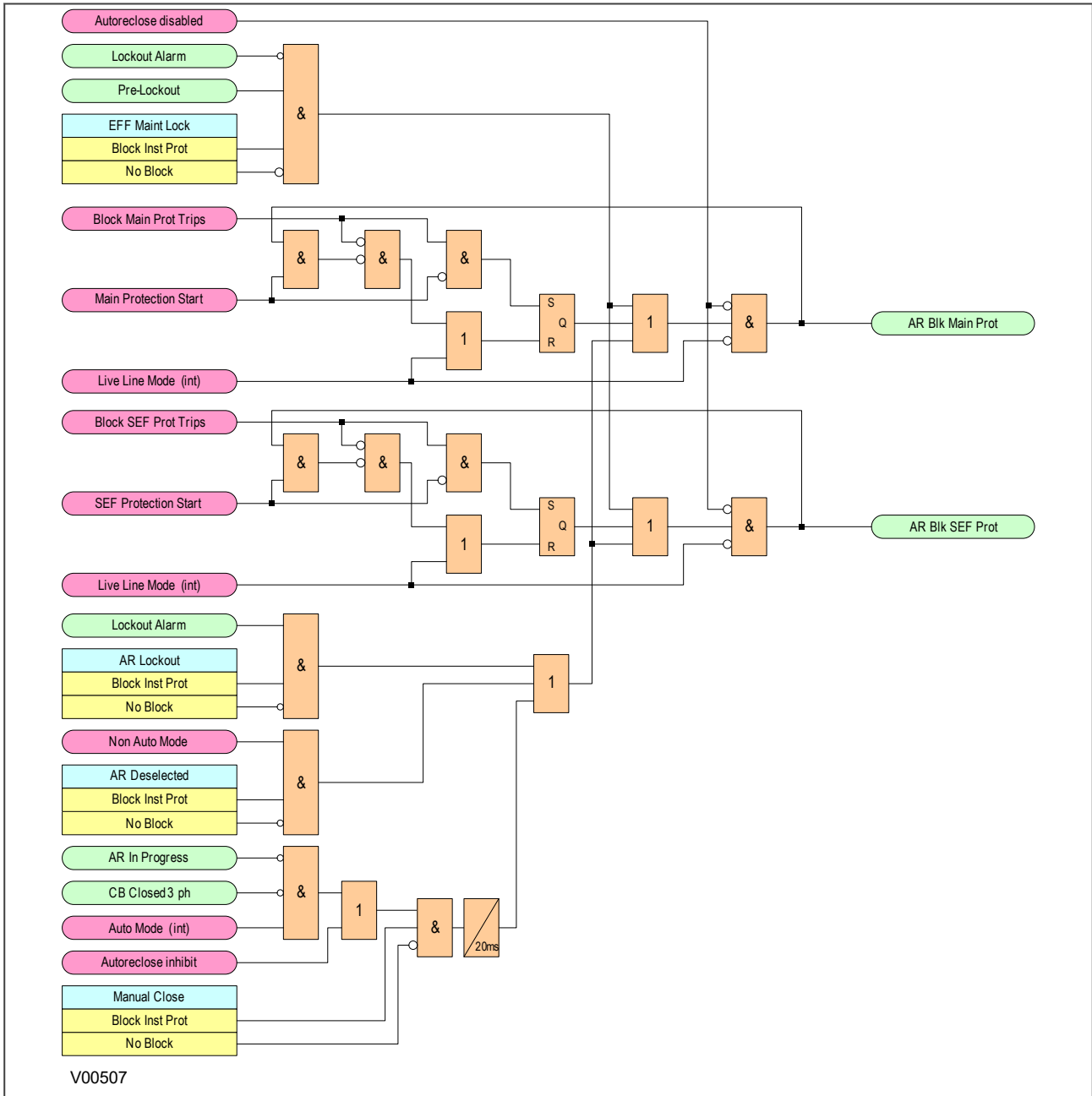


**Figure 77: Blocking instantaneous protection for lockouts**

## 7.5 DEAD TIME CONTROL

When the setting **CS AR Immediate** is enabled, immediate re-closure of the circuit breaker is allowed providing that both sides of the circuit breaker are live and in synchronism at any time after the dead time has started. This allows for quicker load restoration, as it is not necessary to wait for the full dead time to expire.

If **CS AR Immediate** is disabled, or neither Line nor Bus are live, the dead timer will continue to run, if the **DeadTime Enabled** signal is high. The **DeadTime Enabled** function could be mapped to an opto-input to indicate that the circuit breaker is healthy. Mapping the **DeadTime Enabled** function in PSL increases the flexibility by allowing it to be triggered by other conditions such as Live Line/Dead Bus. If **DeadTime Enabled** is not mapped in PSL, it defaults to high, so the dead time can run.

The dead time control logic is shown below.
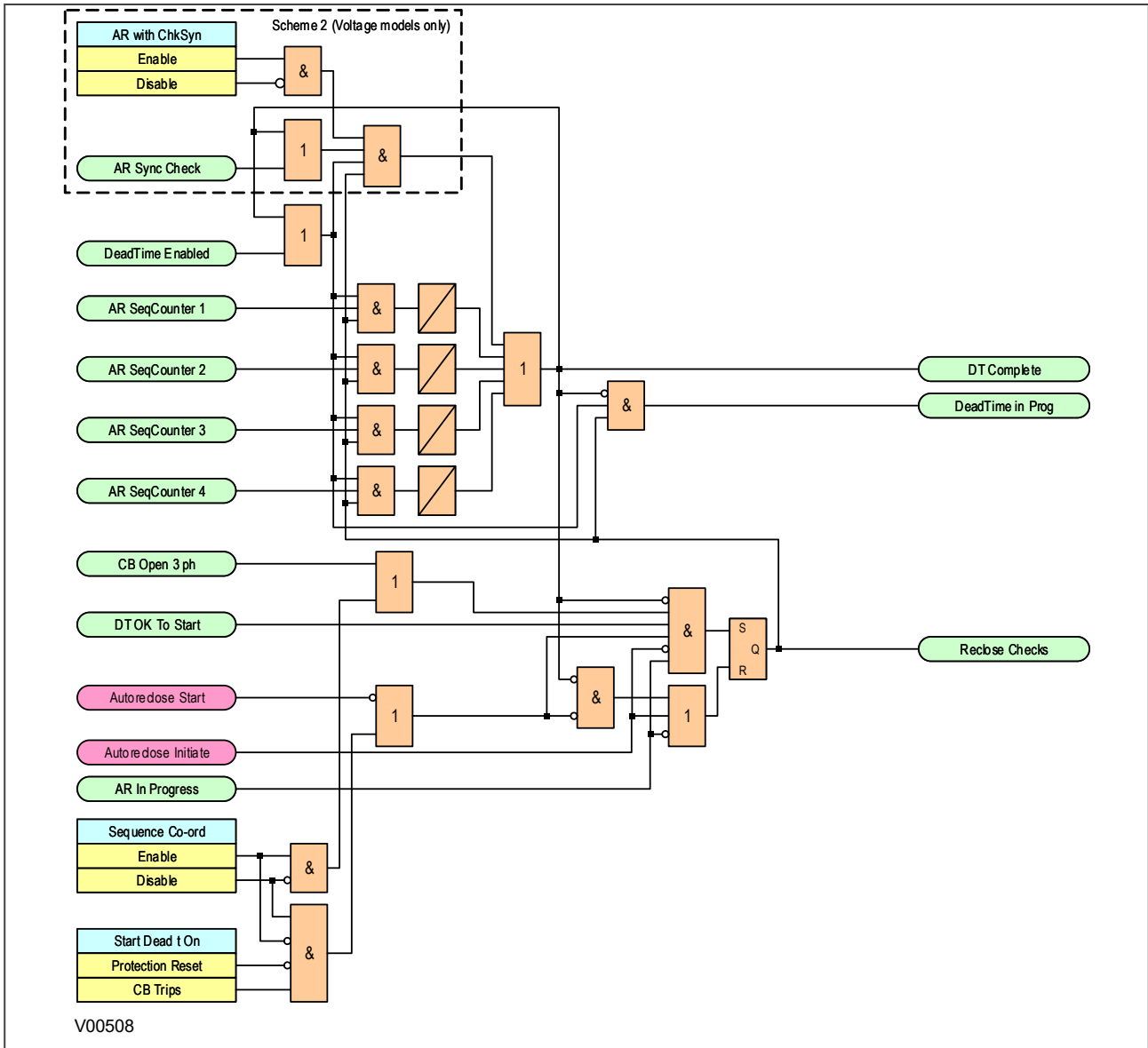


**Figure 78: Dead Time Control logic**

### 7.5.1      AR CB CLOSE CONTROL

Once the dead time is completed or a synchronism check is confirmed, the **Auto Close** signal is given, provided both the **CB Healthy** and the **System Checks** are satisfied. The **Auto Close** signal triggers a CB Close command via the CB Control functionality.

The AR CB Close Control Logic is as follows:
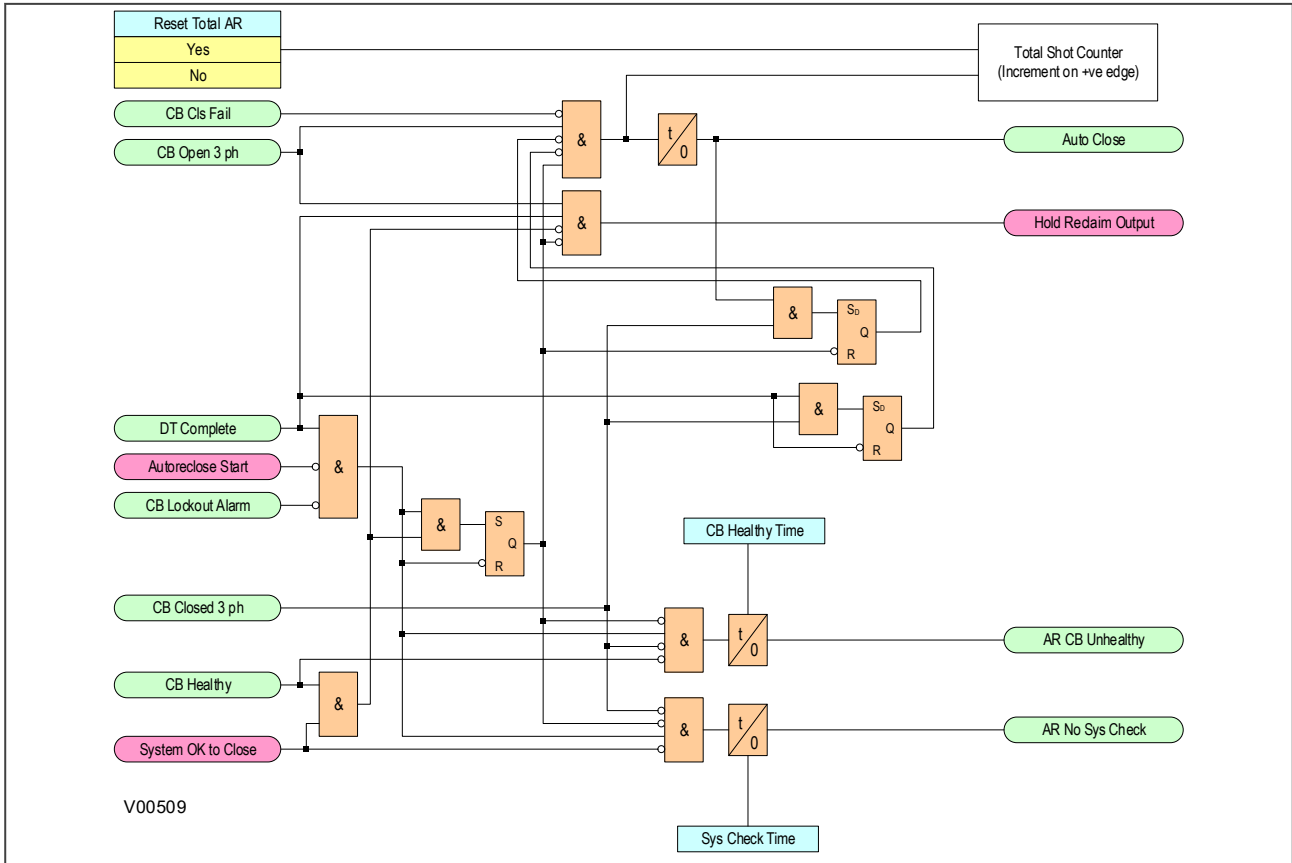
**Figure 79: AR CB Close Control logic**

## 7.6      AR SYSTEM CHECKS

The permission to initiate an Autoreclose depends on the following AR system check settings. These are found in the *AUTORECLOSE* column under the *AR SYSTEM CHECKS* sub-heading and are not to be confused with the main system check settings in the *SYSTEM CHECKS* column.

The *AR SYSTEM CHECKS* are as follows:

- **Live/Dead Ccts**: When enabled this setting will give an **AR Check OK** signal when the **LiveDead Ccts OK** signal is high. This logic input DDB would normally be mapped in PSL to appropriate combinations of Line Live, Line Dead, Bus Live and Bus Dead DDB signals.

- **No System Checks**: When enabled this setting completely disables system checks thus allowing Autoreclose initiation under any system conditions.

- **SysChk on Shot 1**: Can be used to disable system checks on the first AR shot.

- **AR with ChkSyn**: Only allows Autoreclose when the system satisfies the Check Sync Stage 1 (CS1) settings in the main *SYSTEM CHECKS* menu.

- **AR with SysSyn**: Only allows Autoreclose when the system satisfies the Check Sync Stage 2 (CS2) settings in the main *SYSTEM CHECKS* menu.

The AR System Check logic is as follows:
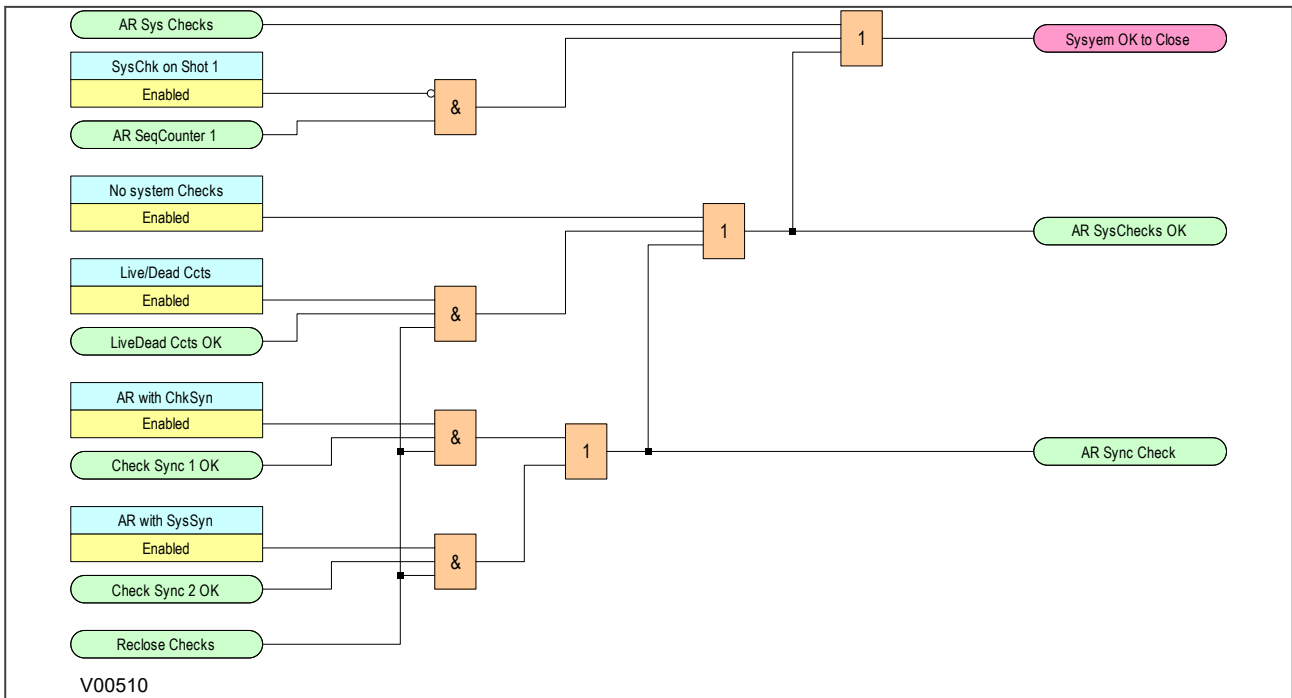
**Figure 80: AR System Check logic**

## 7.7 RECLAIM TIMER INITIATION

The ***tReclaim Extend*** setting allows you to control whether the timer is suspended from the protection start contacts or not. When a setting of `No Operation` is used, the reclaim timer operates from the instant the CB is closed and will continue until the timer expires. The ***Reclaim Time*** must therefore be set in excess of the time-delayed protection operating time, to ensure that the protection can operate before the Autoreclose function is reset.

For certain applications it is advantageous to set ***tReclaim Extend*** to `On Prot Start`. This facility allows the operation of the reclaim timer to be suspended after CB re-closure by a signal from the main protection start or SEF protection start signals. This feature ensures that the reclaim time cannot time out and reset the Autoreclose before the time delayed protection has operated.

Since the reclaim timer will be suspended, it is unnecessary to use a timer setting in excess of the protection operating time, therefore a short reclaim time can be used. Short reclaim time settings can help to prevent unnecessary lockout for a succession of transient faults in a short period, for example during a thunderstorm.
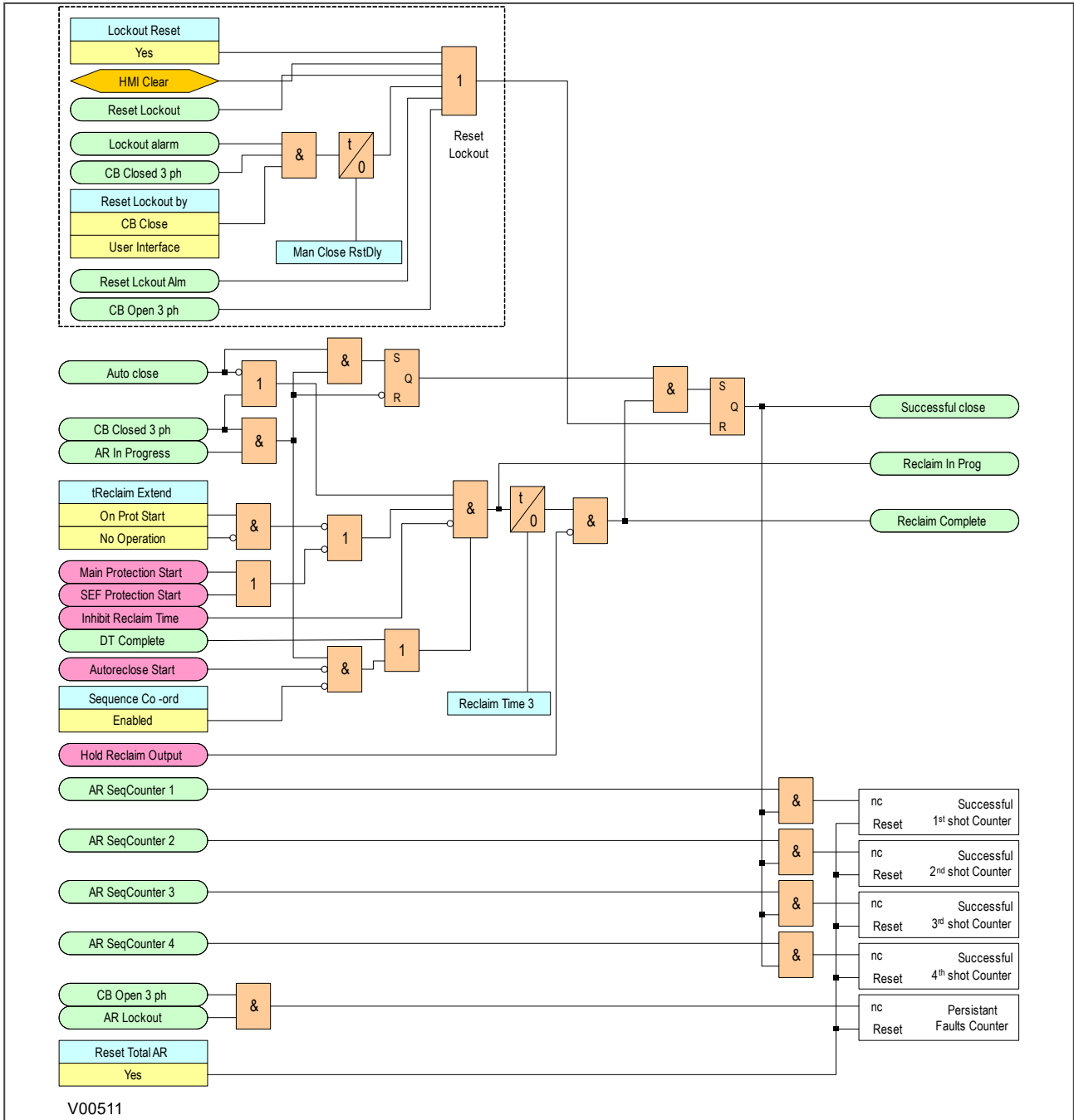
**Figure 81: Reclaim Time logic**

## 7.8    AUTORECLOSE INHIBIT

To ensure that autoreclosing is not initiated for a manual CB closure on to a pre-existing fault (switch on to fault), the *AR on Man Close* setting can be set to Inhibited. With this setting, Autoreclose initiation is inhibited for a period equal to setting *AR Inhibit Time* following a manual CB closure. The logic for AR Inhibit is as follows:
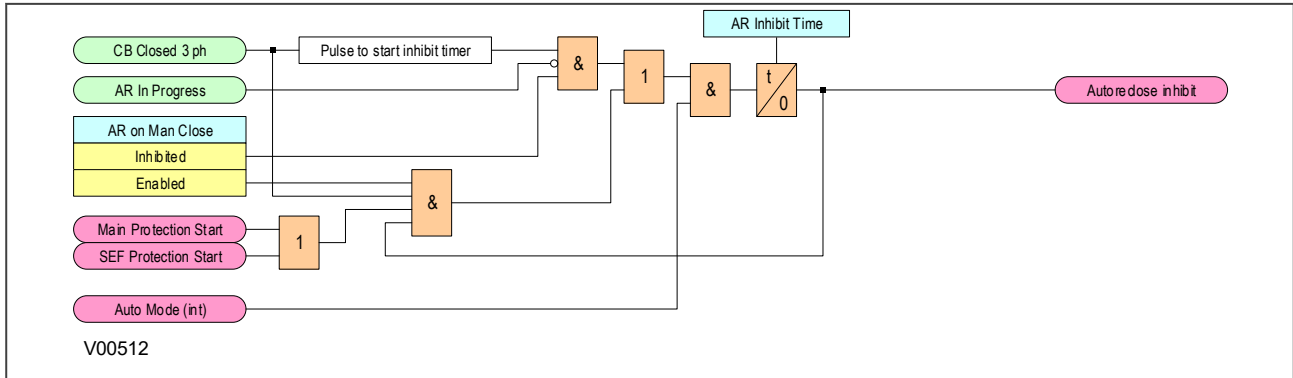
**Figure 82: AR Initiation inhibit**

If a protection operation occurs during the inhibit period, Autoreclose is not initiated. A further option is provided by setting **Man Close on Flt**. If this is set to `Lockout`, Autoreclose is locked out (**AR Lockout**) for a fault during the inhibit period following manual CB closure. If **Man Close on Flt** is set to `No Lockout`, the CB trips without reclosure, but Autoreclose is not locked out.

You may need to block selected fast non-discriminating protection in order to obtain fully discriminative tripping during the AR initiation inhibit period following CB manual close. You can do this by setting **Manual Close** to `Block Inst Prot`. A `No Block` setting will enable all protection elements immediately on CB closure.

If setting **AR on Man Close** is set to `Enabled`, Autoreclose can be initiated immediately on CB closure, and settings **AR Inhibit Time**, **Man Close on Flt** and **Manual Close** are irrelevant.

## 7.9      AUTORECLOSE LOCKOUT

If protection operates during the reclaim time following the final reclose attempt, the IED is driven to lockout and the Autoreclose function is disabled until the lockout condition is reset. This produces the alarm, **AR Lockout**. The **Block AR** input blocks Autoreclose and causes a lockout if Autoreclose is in progress.

Autoreclose lockout can also be caused by the CB failing to close due to an unhealthy circuit breaker (CB springs not charged or low gas pressure) or if there is no synchronisation between the system voltages. These two conditions are indicated by the alarms **CB Unhealthy** and **AR No Sys Check** This is shown in the AR Lockout logic diagram as follows:
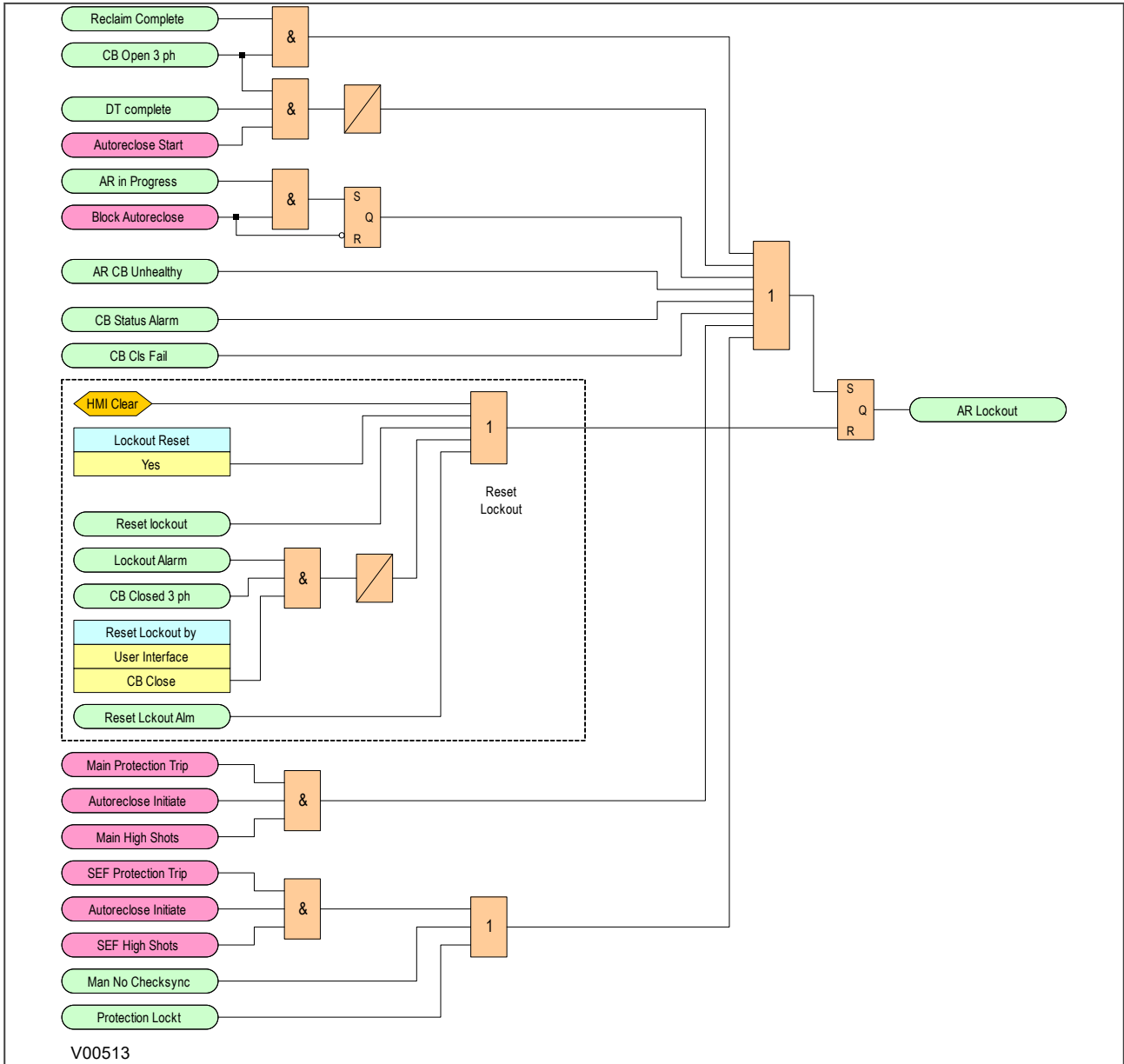
**Figure 83: Overall Lockout logic**

AR lockout may also be due to a protection operation when the IED is in the Live Line or Non-auto modes when the setting **Trip AR Inactive** is set to `Lockout`. Autoreclose lockout can also be caused by a protection operation after manual closing during the **AR Inhibit Time** when the **Man Close on Flt** setting is set to `Lockout`. This is shown as follows:
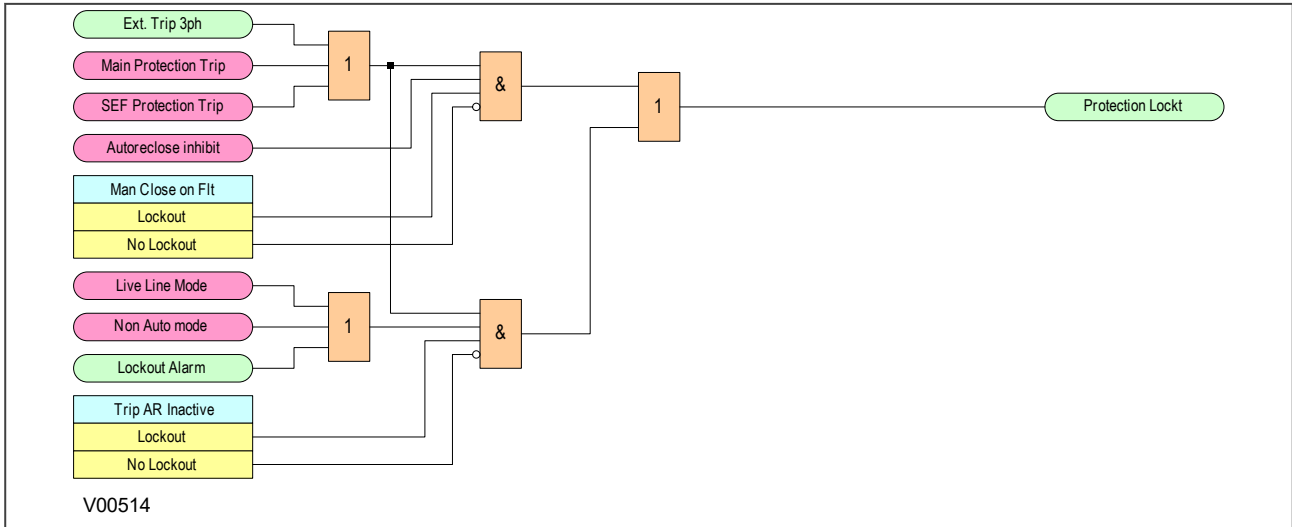
**Figure 84: Lockout for protection trip when AR is not available**

> *Note:*
> *Lockout can also be caused by the CB condition monitoring functions in the CB MONITOR SETUP column.*

The **Reset Lockout** input can be used to reset the Autoreclose function following lockout and reset any Autoreclose alarms, provided that the signals that initiated the lockout have been removed. Lockout can also be reset from the clear key or the command **Lockout Reset** from the *CB CONTROL* column.

There are two different **Reset Lockout by** settings. One in the *CB CONTROL* column and one in the *AUTORECLOSE* column.

The **Reset Lockout by** setting in the *CB CONTROL* column is used to enable or disable reset of lockout automatically from a manual close after the manual close time **Man Close RstDly**.

The **Reset Lockout by** setting in the *AUTORECLOSE* column is used to enable/disable the resetting of lockout when the IED is in the Non-auto operating mode. The reset lockout methods are summarised in the following table:

| Reset Lockout Method | When Available? |
|---|---|
| User Interface via the Clear key.<br>Note: This will also reset all other protection flags | Always |
| User interface via *CB CONTROL* command Lockout Reset | Always |
| Opto-input Reset lockout | Always |
| Following a successful manual close if *CB CONTROL* setting Reset Lockout by is set to `CB Close` | Only when set |
| By selecting Non-Auto mode, provided *AUTORECLOSE* setting Reset Lockout by is set to `Select NonAuto` | Only when set |

## 7.10      SEQUENCE CO-ORDINATION

The **Sequence Co-ord** setting in the *AUTORECLOSE* menu allows sequence co-ordination with other protection devices, such as downstream pole-mounted reclosers.

The main protection start or SEF protection start signals indicate when fault current is present, advance the sequence count by one and start the dead time, whether the CB is open or closed. When the dead time is complete and the protection start inputs are low, the reclaim timer is initiated.

You should program both the upstream and downstream Autoreclose IEDs with the same number of shots to lockout and number of instantaneous trips before instantaneous protection is blocked. This will ensure that for a persistent downstream fault, both Autoreclose IEDs will be on the same sequence count and will block

instantaneous protection at the same time. When sequence co-ordination is disabled, the circuit breaker has to be tripped to start the dead time, and the sequence count is advanced by one.

When using sequence co-ordination for some applications such as downstream pole-mounted reclosers, it may be desirable to re-enable instantaneous protection when the recloser has locked out. When the downstream recloser has locked out there is no need for discrimination. This allows you to have instantaneous, then IDMT, then instantaneous trips again during an Autoreclose cycle. Instantaneous protection may be blocked or not blocked for each trip in an Autoreclose cycle using the **Trip (n) Main** and **Trip (n) SEF** settings, where n is the number of the trip in the autoreclose cycle.

## 7.11     SYSTEM CHECKS FOR FIRST RECLOSE

The **SysChk on Shot 1** setting in the *SYSTEM CHECKS* sub menu of the *AUTORECLOSE* column is used to enable or disable system checks for the first reclose attempt in an Autoreclose cycle. This may be preferred when high speed Autoreclose is applied, to avoid the extra time for a synchronism check. Subsequent reclose attempts in a multi-shot cycle will, however, still require a synchronism check.

# 8          SETTING GUIDELINES

## 8.1          NUMBER OF SHOTS

There are no clear cut rules for defining the number of shots for a particular application. Generally medium voltage systems use only two or three shot Autoreclose schemes. However, in certain countries, for specific applications, a four-shot scheme is used. A four-shot scheme has the advantage that the final dead time can be set sufficiently long to allow any thunderstorms to pass before reclosing for the final time. This arrangement prevents unnecessary lockout for consecutive transient faults.

Typically, the first trip, and sometimes the second, will result from instantaneous protection. Since most faults are transient, the subsequent trips will be time delayed, all with increasing dead times to clear semi-permanent faults.

An important consideration is the ability of the circuit breaker to perform several trip-close operations in quick succession and the affect of these operations on the circuit maintenance period.

On EHV transmission circuits with high fault levels, only one re-closure is normally applied, because of the damage that could be caused by multiple re-closures.

## 8.2          DEAD TIMER SETTING

The choice of dead time is dependent on the system. The main factors that can influence the choice of dead time are:

- Stability and synchronism requirements
- Operational convenience
- Load
- The type of circuit breaker
- Fault deionising time
- The protection reset time

### 8.2.1          STABILITY AND SYNCHRONISM REQUIREMENTS

It may be that the power transfer level on a specific feeder is such that the systems at either end of the feeder could quickly fall out of synchronism if the feeder is opened. If this is the case, it is usually necessary to reclose the feeder as quickly as possible to prevent loss of synchronism. This is called high speed autoreclosing (HSAR). In this situation, the dead time setting should be adjusted to the minimum time necessary. This time setting should comply with the minimum dead time limitations imposed by the circuit breaker and associated protection, which should be enough to allow complete deionisation of the fault path and restoration of the full voltage withstand level. Typical HSAR dead time values are between 0.3 and 0.5 seconds.

On a closely interconnected transmission system, where alternative power transfer paths usually hold the overall system in synchronism even when a specific feeder opens, or on a radial supply system where there are no stability implications, it is often preferred to leave a feeder open for a few seconds after fault clearance. This allows the system to stabilise, and reduces the shock to the system on re-closure. This is called slow or delayed auto-reclosing (DAR). The dead time setting for DAR is usually selected for operational convenience.

### 8.2.2          OPERATIONAL CONVENIENCE

When HSAR is not required, the dead time chosen for the first re-closure following a fault trip is not critical. It should be long enough to allow any resulting transients resulting to decay, but not so long as to cause major inconvenience to consumers who are affected by the loss of the feeder. The setting chosen often depends on service experience with the specific feeder.

Typical first shot dead time settings on 11 kV distribution systems are 5 to 10 seconds. In situations where two parallel circuits from one substation are carried on the same towers, it is often arranged for the dead times on the

two circuits to be staggered, e.g. one at 5 seconds and the other at 10 seconds, so that the two circuit breakers do not reclose simultaneously following a fault affecting both circuits.

For multi-shot Autoreclose cycles, the second shot and subsequent shot dead times are usually longer than the first shot, to allow time for semi-permanent faults to burn clear, and for the CB to recharge. Typical second and third shot dead time settings are 30 seconds and 60 seconds respectively.

### 8.2.3    LOAD REQUIREMENTS

Some types of electrical load might have specific requirements for minimum and/or maximum dead time, to prevent damage and minimise disruption. For example, synchronous motors are only capable of tolerating extremely short supply interruptions without losing synchronism. In practise it is desirable to disconnect the motor from the supply in the event of a fault; the dead time would normally be sufficient to allow a controlled shutdown. Induction motors, on the other hand, can withstand supply interruptions up to typically 0.5 seconds and re-accelerate successfully.

### 8.2.4    CIRCUIT BREAKER

For HSAR, the minimum dead time of the power system will depend on the minimum time delays imposed by the circuit breaker during a tripping and reclose operation.

After tripping, time must be allowed for the mechanism to reset before applying a closing pulse, otherwise the circuit breaker might fail to close correctly. This resetting time will vary depending on the circuit breaker, but is typically 0.1 seconds.

Once the mechanism has reset, a CB Close signal can be applied. The time interval between energising the closing mechanism and making the contacts is called the closing time. A solenoid closing mechanism may take up to 0.3 seconds. A spring-operated breaker, on the other hand, can close in less than 0.1 seconds.

Where HSAR is required, for the majority of medium voltage applications, the circuit breaker mechanism reset time itself dictates the minimum dead time. This would be the mechanism reset time plus the CB closing time. A solenoid mechanism is not suitable for high speed Autoreclose as the closing time is generally too long.

For most circuit breakers, after one reclosure, it is necessary to recharge the closing mechanism energy source before a further reclosure can take place. Therefore the dead time for second and subsequent shots in a multi-shot sequence must be set longer than the spring or gas pressure recharge time.

### 8.2.5    FAULT DE-IONISATION TIME

For HSAR, the fault deionising time may be the most important factor when considering the dead time. This is the time required for ionised air to disperse around the fault position so that the insulation level of the air is restored. You cannot accurately predict this, but you can obtain an approximation from the following formula:

Deionising time = (10.5 + ((system voltage in kV)/34.5))/frequency

Examples:

At 66 kV 50 Hz, the deionising time is approximately 0.25 s

At 132 kV 60 Hz, the deionising time is approximately 0.29 s

### 8.2.6    PROTECTION RESET TIME

It is essential that any time-graded protection fully resets during the dead time, so that correct time discrimination will be maintained after reclosing on to a fault. For HSAR, instantaneous reset of protection is required. However at distribution level, where the protection is predominantly made up of overcurrent and earth fault devices, the protection reset time may not be instantaneous. In the event that the circuit breaker recloses on to a fault and the protection has not fully reset, discrimination may be lost with the downstream protection. To avoid this condition the dead time must be set in excess of the slowest reset time of either the local device or any downstream protection.

Typical 11/33 kV dead time settings are as follows:

1st dead time = 5 - 10 seconds

2nd dead time = 30 seconds

3rd dead time = 60 - 180 seconds

4th dead time = 1 - 30 minutes

## 8.3      RECLAIM TIMER SETTING

A number of factors influence the choice of the reclaim timer:

- Supply continuity: Large reclaim times can result in unnecessary lockout for transient faults.
- Fault incidence/Past experience: Small reclaim times may be required where there is a high incidence of lightning strikes to prevent unnecessary lockout for transient faults.
- Spring charging time: For HSAR the reclaim time may be set longer than the spring charging time to ensure there is sufficient energy in the circuit breaker to perform a trip-close-trip cycle. For delayed Autoreclose there is no need as the dead time can be extended by an extra CB healthy check window time if there is insufficient energy in the CB. If there is insufficient energy after the check window time the IED will lockout.
- Switchgear maintenance: Excessive operation resulting from short reclaim times can mean shorter maintenance periods. A minimum reclaim time of more than 5 seconds may be needed to allow the circuit breaker time to recover after a trip and close before it can perform another trip-close-trip cycle. This time will depend on the circuit breaker's duty rating.

The reclaim time must be long enough to allow any time-delayed protection initiating Autoreclose to operate. Failure to do so would result in premature resetting of the Autoreclose scheme and re-enabling of instantaneous protection. If this condition arose, a permanent fault would effectively look like a number of transient faults, resulting in continuous autoreclosing, unless additional measures are taken such as excessive fault frequency lockout protection.

Sensitive earth fault protection is applied to detect high resistance earth faults and usually has a long time delay, typically 10 - 15 seconds. This longer time may have to be taken into consideration, if autoreclosing from SEF protection. High resistance earth faults are rarely transient and may be a danger to the public. It is therefore common practise to block Autoreclose by operation of sensitive earth fault protection and lockout the circuit breaker.

A typical 11/33 kV reclaim time is 5 - 10 seconds. This prevents unnecessary lockout during thunderstorms. However, reclaim times of up to 60 - 180 seconds may be used elsewhere in the world.

# CHAPTER 11

# MONITORING AND CONTROL

# 1        CHAPTER OVERVIEW

As well as providing a range of protection functions, the product includes comprehensive monitoring and control functionality.

This chapter contains the following sections:

## 2          EVENT RECORDS

GE devices record events in an event log. This allows you to establish the sequence of events that led up to a particular situation. For example, a change in a digital input signal or protection element output signal would cause an event record to be created and stored in the event log. This could be used to analyse how a particular power system condition was caused. These events are stored in the IED's non-volatile memory. Each event is time tagged.

The event records can be displayed on an IED's front panel but it is easier to view them through the settings application software. This can extract the events log from the device and store it as a single .evt file for analysis on a PC.

The event records are detailed in the *VIEW RECORDS* column. The first event (0) is always the latest event. After selecting the required event, you can scroll through the menus to obtain further details.

If viewing the event with the settings application software, simply open the extracted event file. All the events are displayed chronologically. Each event is summarised with a time stamp obtained from the ***Time & Date*** cell) and a short description relating to the event obtained from the ***Event Text*** cell). You can expand the details of the event by clicking on the **+** icon to the left of the time stamp.

The following table shows the correlation between the fields in the setting application software's event viewer and the cells in the menu database.

| Field in Event Viewer | Equivalent cell in menu DB | Cell reference | User settable? |
|---|---|---|---|
| Left hand column header | VIEW RECORDS → Time & Date | 01 03 | No |
| Right hand column header | VIEW RECORDS → Event Text | 01 04 | No |
| Description | SYSTEM DATA → Description | 00 04 | Yes |
| Plant reference | SYSTEM DATA → Plant Reference | 00 05 | Yes |
| Model number | SYSTEM DATA → Model Number | 00 06 | No |
| Address | Displays the Courier address relating to the event | N/A | No |
| Event type | VIEW RECORDS → Menu Cell Ref | 01 02 | No |
| Event Value | VIEW RECORDS → Event Value | 01 05 | No |
| Evt Unique Id | VIEW RECORDS → Evt Unique ID | 01 FE | No |

## 2.1        EVENT TYPES

There are several different types of event:

- Opto-input events (Change of state of opto-input)
- Contact events (Change of state of output relay contact)
- Alarm events
- Fault record events
- Standard events
- Security events

Standard events are further sub-categorised internally to include different pieces of information. These are:

- Protection events (starts and trips)
- Maintenance record events
- Platform events

> *Note:*
> *The first event in the list (event 0) is the most recent event to have occurred.*

### 2.1.1 OPTO-INPUT EVENTS

If one or more of the opto-inputs has changed state since the last time the protection algorithm ran (which runs at several times per cycle), a new event is created, which logs the logic states of all opto-inputs. You can tell which opto-input has changed state by comparing the new event with the previous one.

The description of this event type, as shown in the **Event Text** cell is always `Logic Inputs #` where # is the batch number of the opto-inputs. This is '1', for the first batch of opto-inputs and '2' for the second batch of opto-inputs (if applicable).

The event value shown in the **Event Value** cell for this type of event is a binary string. This shows the logical states of the opto-inputs, where the Least Significant Bit (LSB), on the right corresponds to the first opto-input `Input L1`.

The same information is also shown in the **Opto I/P Status** cell in the *SYSTEM DATA* column. This information is updated continuously, whereas the information in the event log is a snapshot at the time when the event was created.

### 2.1.2 CONTACT EVENTS

If one or more of the output relays (also known as output contacts) has changed state since the last time the protection algorithm ran (which runs at several times per cycle), a new event is created, which logs the logic states of all output relays. You can tell which output relay has changed state by comparing the new event with the previous one.

The description of this event type, as shown in the **Event Text** cell is always `Output Contacts #` where # is the batch number of the output relay contacts. This is '1', for the first batch of output contacts and '2' for the second batch of output contacts (if applicable).

The event value shown in the **Event Value** cell for this type of event is a binary string. This shows the logical states of the output relays, where the LSB (on the right) corresponds to the first output contact `Output R1`.

The same information is also shown in the **Relay O/P Status** cell in the *SYSTEM DATA* column. This information is updated continuously, whereas the information in the event log is a snapshot at the time when the event was created.

### 2.1.3 ALARM EVENTS

The IED monitors itself on power up and continually thereafter. If it notices any problems, it will register an alarm event.

The description of this event type, as shown in the **Event Text** cell is cell dependent on the type of alarm and will be one of those shown in the following tables, followed by `OFF` or `ON`.

The event value shown in the **Event Value** cell for this type of event is a 32 bit binary string. There are one or more banks 32 bit registers, depending on the device model. These contain all the alarm types and their logic states (`ON` or `OFF`).

The same information is also shown in the **Alarm Status (n)** cells in the *SYSTEM DATA* column. This information is updated continuously, whereas the information in the event log is a snapshot at the time when the event was created.

**Alarm Status 1**

| Bit No. | Bit Mask<br>2nd register, 1st register | Alarm Description |
|---------|----------------------------------------|-------------------|
| Bit 0 | 0x0000, 0x0001 | Thermal Lockout |
| Bit 1 | 0x0000, 0x0002 | HIF Alarm |
| Bit 2 | 0x0000, 0x0004 | SG-opto Invalid ON/OFF |
| Bit 3 | 0x0000, 0x0008 | Prot'n Disabled ON/OFF |
| Bit 4 | 0x0000, 0x0010 | F out of Range ON/OFF |

| Bit No. | Bit Mask<br>2nd register, 1st register | Alarm Description |
|---------|-----------------------------------------|-------------------|
| Bit 5   | 0x0000, 0x0020 | VT Fail Alarm ON/OFF |
| Bit 6   | 0x0000, 0x0040 | CT Fail Alarm ON/OFF |
| Bit 7   | 0x0000, 0x0080 | CB Fail Alarm ON/OFF |
| Bit 8   | 0x0000, 0x0100 | I^ Maint Alarm ON/OFF |
| Bit 9   | 0x0000, 0x0200 | I^ Lockout Alarm ON/OFF |
| Bit 10  | 0x0000, 0x0400 | CB Ops Maint ON/OFF |
| Bit 11  | 0x0000, 0x0800 | CB Ops Lockout ON/OFF |
| Bit 12  | 0x0000, 0x1000 | CB Op Time Maint ON/OFF |
| Bit 13  | 0x0000, 0x2000 | CB Op Time Lock ON/OFF |
| Bit 14  | 0x0000, 0x4000 | Fault Freq Lock ON/OFF |
| Bit15   | 0x0000, 0x8000 | CB Status Alarm ON/OFF |
| Bit 16  | 0x0001, 0x0000 | Man CB Trip Fail ON/OFF |
| Bit17   | 0x0002, 0x0000 | Man CB Cls Fail ON/OFF |
| Bit 18  | 0x0004, 0x0000 | Man CB Unhealthy ON/OFF |
| Bit 19  | 0x0008, 0x0000 | Man No Checksync ON/OFF |
| Bit 20  | 0x0010, 0x0000 | A/R Lockout ON/OFF |
| Bit 21  | 0x0020, 0x0000 | A/R CB Unhealthy ON/OFF |
| Bit 22  | 0x0040, 0x0000 | A/R No Checksync ON/OFF |
| Bit 23  | 0x0080, 0x0000 | System Split ON/OFF |
| Bit 24  | 0x0100, 0x0000 | UV Block ON/OFF |
| Bit 25  | 0x0200, 0x0000 | User Alarm 1 ON/OFF |
| Bit 26  | 0x0400, 0x0000 | User Alarm 2 ON/OFF |
| Bit 27  | 0x0800, 0x0000 | User Alarm 3 ON/OFF |
| Bit 28  | 0x1000, 0x0000 | User Alarm 4 ON/OFF |
| Bit 29  | 0x2000, 0x0000 | User Alarm 5 ON/OFF |
| Bit 30  | 0x4000, 0x0000 | User Alarm 6 ON/OFF |
| Bit 31  | 0x8000, 0x0000 | User Alarm 7 ON/OFF |

### Alarm Status 2

| Bit No. | Bit Mask<br>2nd register, 1st register | Alarm Description |
|---------|-----------------------------------------|-------------------|
| Bit 1 | 0x0000, 0x0001 | Time Betwe Start (motor protection models only) |
| Bit 2 | 0x0000, 0x0002 | Hot Start Nb. (motor protection models only) |
| Bit 3 | 0x0000, 0x0004 | Cold Start Nb. (motor protection models only) |
| Bit 4 | 0x0000, 0x0008 | Antibkspin Alarm (motor protection models only) |
| Bit 5 | 0x0000, 0x0010 | User Alarm 8 |
| Bit 6 | 0x0000, 0x0020 | User Alarm 9 |
| Bit 7 | 0x0000, 0x0040 | User Alarm 10 |
| Bit 8 | 0x0000, 0x0080 | User Alarm 11 |
| Bit 9 | 0x0000, 0x0100 | User Alarm 12 |

| Bit No. | Bit Mask 2nd register, 1st register | Alarm Description |
|---------|-------------------------------------|-------------------|
| Bit 10 | 0x0000, 0x0200 | User Alarm 13 |
| Bit 11 | 0x0000, 0x0400 | User Alarm 14 |
| Bit 12 | 0x0000, 0x0800 | User Alarm 15 |
| Bit 13 | 0x0000, 0x1000 | User Alarm 16 |
| Bit 14 | 0x0000, 0x2000 | User Alarm 17 |
| Bit 15 | 0x0000, 0x4000 | User Alarm 18 |
| Bit 16 | 0x0000, 0x8000 | User Alarm 19 |
| Bit 17 | 0x0001, 0x0000 | User Alarm 20 |
| Bit 18 | 0x0002, 0x0000 | User Alarm 21 |
| Bit 19 | 0x0004, 0x0000 | User Alarm 22 |
| Bit 20 | 0x0008, 0x0000 | User Alarm 23 |
| Bit 21 | 0x0010, 0x0000 | User Alarm 24 |
| Bit 22 | 0x0020, 0x0000 | User Alarm 25 |
| Bit 23 | 0x0040, 0x0000 | User Alarm 26 |
| Bit 24 | 0x0080, 0x0000 | User Alarm 27 |
| Bit 25 | 0x0100, 0x0000 | User Alarm 28 |
| Bit 26 | 0x0200, 0x0000 | User Alarm 29 |
| Bit 27 | 0x0400, 0x0000 | User Alarm 30 |
| Bit 28 | 0x0800, 0x0000 | User Alarm 31 |
| Bit 29 | 0x1000, 0x0000 | User Alarm 32 |
| Bit 30 | 0x2000, 0x0000 | MR User Alarm 33 |
| Bit 31 | 0x4000, 0x0000 | MR User Alarm 34 |
| Bit 32 | 0x8000, 0x0000 | MR User Alarm 35 |

## Alarm Status 3

| Bit No. | Bit Mask 2nd register, 1st register | Alarm Description |
|---------|-------------------------------------|-------------------|
| Bit 1 | 0x00000001 | DC Supply Fail |
| Bit 2 | 0x00000002 | Unused |
| Bit 3 | 0x00000004 | Unused |
| Bit 4 | 0x00000008 | GOOSE IED Absent |
| Bit 5 | 0x00000010 | NIC Not Fitted |
| Bit 6 | 0x00000020 | NIC No Response |
| Bit 7 | 0x00000040 | NIC Fatal Error |
| Bit 8 | 0x00000080 | Unused |
| Bit 9 | 0x00000100 | Bad TCP/IP Cfg. |
| Bit 10 | 0x00000200 | Unused |
| Bit 11 | 0x00000400 | NIC Link Fail |
| Bit 12 | 0x00000800 | NIC SW Mis-Match |

| Bit No. | Bit Mask 2nd register, 1st register | Alarm Description |
|---------|-------------------------------------|-------------------|
| Bit 13 | 0x00001000 | IP Addr Conflict |
| Bit 14 | 0x00002000 | Unused |
| Bit 15 | 0x00004000 | Unused |
| Bit 16 | 0x00008000 | Unused |
| Bit 17 | 0x00010000 | Unused |
| Bit 18 | 0x00020000 | Unused |
| Bit 19 | 0x00040000 | Bad DNP Settings |
| Bit 20 | 0x00080000 | Unused |
| Bit 21 | 0x00100000 | Unused |
| Bit 22 | 0x00200000 | Unused |
| Bit 23 | 0x00400000 | Unused |
| Bit 24 | 0x00800000 | Unused |
| Bit 25 | 0x01000000 | Unused |
| Bit 26 | 0x02000000 | Unused |
| Bit 27 | 0x04000000 | Unused |
| Bit 28 | 0x08000000 | Unused |
| Bit 29 | 0x10000000 | Unused |
| Bit 30 | 0x20000000 | Unused |
| Bit 31 | 0x40000000 | Unused |
| Bit 32 | 0x80000000 | Unused |

## Alarm Status 4

*Alarm Status 4* setting values are reserved.

## User Alarms

| Bit No. | Bit Mask 2nd register, 1st register | Alarm Description |
|---------|-------------------------------------|-------------------|
| Bit 1 | 0x0000,0x0001 | User Alarm 1 (0=Self-reset, 1=Manual reset) |
| Bit 2 | 0x0000,0x0002 | User Alarm 2 (0=Self-reset, 1=Manual reset) |
| Bit 3 | 0x0000,0x0004 | User Alarm 3 (0=Self-reset, 1=Manual reset) |
| Bit 4 | 0x0000,0x0008 | User Alarm 4 (0=Self-reset, 1=Manual reset) |
| Bit 5 | 0x0000,0x0010 | User Alarm 5 (0=Self-reset, 1=Manual reset) |
| Bit 6 | 0x0000,0x0020 | User Alarm 6 (0=Self-reset, 1=Manual reset) |
| Bit 7 | 0x0000,0x0040 | User Alarm 7 (0=Self-reset, 1=Manual reset) |
| Bit 8 | 0x0000,0x0080 | User Alarm 8 (0=Self-reset, 1=Manual reset) |
| Bit 9 | 0x0000,0x0100 | User Alarm 9 (0=Self-reset, 1=Manual reset) |
| Bit 10 | 0x0000,0x0200 | User Alarm 10 (0=Self-reset, 1=Manual reset) |
| Bit 11 | 0x0000,0x0400 | User Alarm 11 (0=Self-reset, 1=Manual reset) |
| Bit 12 | 0x0000,0x0800 | User Alarm 12 (0=Self-reset, 1=Manual reset) |

| Bit No. | Bit Mask<br>2nd register, 1st register | Alarm Description |
|---------|----------------------------------------|-------------------|
| Bit 13 | 0x0000,0x1000 | User Alarm 13 (0=Self-reset, 1=Manual reset) |
| Bit 14 | 0x0000,0x2000 | User Alarm 14 (0=Self-reset, 1=Manual reset) |
| Bit 15 | 0x0000,0x4000 | User Alarm 15 (0=Self-reset, 1=Manual reset) |
| Bit 16 | 0x0000,0x8000 | User Alarm 16 (0=Self-reset, 1=Manual reset) |
| Bit 17 | 0x0001,0x0000 | User Alarm 17 (0=Self-reset, 1=Manual reset) |
| Bit 18 | 0x0002,0x0000 | User Alarm 18 (0=Self-reset, 1=Manual reset) |
| Bit 19 | 0x0004,0x0000 | User Alarm 19 (0=Self-reset, 1=Manual reset) |
| Bit 20 | 0x0008,0x0000 | User Alarm 20 (0=Self-reset, 1=Manual reset) |
| Bit 21 | 0x0010,0x0000 | User Alarm 21 (0=Self-reset, 1=Manual reset) |
| Bit 22 | 0x0020,0x0000 | User Alarm 22 (0=Self-reset, 1=Manual reset) |
| Bit 23 | 0x0040,0x0000 | User Alarm 23 (0=Self-reset, 1=Manual reset) |
| Bit 24 | 0x0080,0x0000 | User Alarm 24 (0=Self-reset, 1=Manual reset) |
| Bit 25 | 0x0100,0x0000 | User Alarm 25 (0=Self-reset, 1=Manual reset) |
| Bit 26 | 0x0200,0x0000 | User Alarm 26 (0=Self-reset, 1=Manual reset) |
| Bit 27 | 0x0400,0x0000 | User Alarm 27 (0=Self-reset, 1=Manual reset) |
| Bit 28 | 0x0800,0x0000 | User Alarm 28 (0=Self-reset, 1=Manual reset) |
| Bit 29 | 0x1000,0x0000 | User Alarm 29 (0=Self-reset, 1=Manual reset) |
| Bit 30 | 0x2000,0x0000 | User Alarm 30 (0=Self-reset, 1=Manual reset) |
| Bit 31 | 0x4000,0x0000 | User Alarm 31 (0=Self-reset, 1=Manual reset) |
| Bit 32 | 0x8000,0x0000 | User Alarm 32 (0=Self-reset, 1=Manual reset) |

*Note:*
*User Alarms 1 to 32 are fully settable in the USER ALARMS column:*

*Note:*
*Alarm texts can be changed via menu*

*Note:*
*Alarm types can changed via menu (Self-reset or Manual reset*

### 2.1.4    FAULT RECORD EVENTS

An event record is created for every fault the IED detects. This is also known as a fault record.

The event type description shown in the **Event Text** cell for this type of event is always `Fault Recorded`.

The IED contains a separate register containing the latest fault records. This provides a convenient way of viewing the latest fault records and saves searching through the event log. You access these fault records using the **Select Fault** setting, where fault number 0 is the latest fault.

A fault record is triggered by the **Fault REC TRIG** signal DDB, which is assigned in the PSL. The fault recorder records the values of all parameters associated with the fault for the duration of the fault. These parameters are stored in separate Courier cells, which become visible depending on the type of fault.

The fault recorder stops recording only when:

The Start signal is reset AND the undercurrent is ON OR the Trip signal is reset, as shown below:
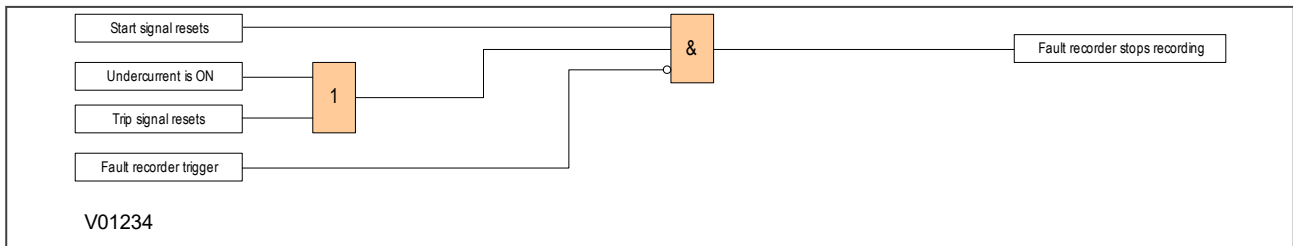


**Figure 85: Fault recorder stop conditions**

The event is logged as soon as the fault recorder stops. The time stamp assigned to the fault corresponds to the start of the fault. The timestamp assigned to the fault record event corresponds to the time when the fault recorder stops.

> *Note:*
> *We recommend that you do not set the triggering contact to latching. This is because if you use a latching contact, the fault record would not be generated until the contact has been fully reset.*

### 2.1.5    MAINTENANCE EVENTS

Internal failures detected by the self-test procedures are logged as maintenance records. Maintenance records are special types of standard events.

The event type description shown in the **Event Text** cell for this type of event is always `Maint Recorded`.

The **Event Value** cell also provides a unique binary code.

The IED contains a separate register containing the latest maintenance records. This provides a convenient way of viewing the latest maintenance records and saves searching through the event log. You access these fault records using the **Select Maint** setting.

The maintenance record has a number of extra menu cells relating to the maintenance event. These parameters are **Maint Text**, **Maint Type** and **Maint Data**. They contain details about the maintenance event selected with the **Select Maint** cell.

### 2.1.6    PROTECTION EVENTS

The IED logs protection starts and trips as individual events. Protection events are special types of standard events.

The event type description shown in the **Event Text** cell for this type of event is dependent on the protection event that occurred. Each time a protection event occurs, a DDB signal changes state. It is the name of this DDB signal followed by 'ON' or 'OFF' that appears in the **Event Text** cell.

The **Event Value** cell for this type of event is a 32 bit binary string representing the state of the relevant DDB signals. These binary strings can also be viewed in the *COMMISSION TESTS* column in the relevant DDB batch cells.

Not all DDB signals can generate an event. Those that can are listed in the *RECORD CONTROL* column. In this column, you can set which DDBs generate events.

### 2.1.7    SECURITY EVENTS

An event record is generated each time a setting that requires an access level is executed.

The event type description shown in the **Event Text** cell displays the type of change.

### 2.1.8    PLATFORM EVENTS

Platform events are special types of standard events.

The event type description shown in the **Event Text** cell displays the type of change.

# 3         DISTURBANCE RECORDER

The disturbance recorder feature allows you to record selected current and voltage inputs to the protection elements, together with selected digital signals. The digital signals may be inputs, outputs, or internal DDB signals. The disturbance records can be extracted using the disturbance record viewer in the settings application software. The disturbance record file can also be stored in the COMTRADE format. This allows the use of other packages to view the recorded data.

The integral disturbance recorder has an area of memory specifically set aside for storing disturbance records. The number of records that can be stored is dependent on the recording duration. The minimum duration is 0.1 s and the maximum duration is 10.5 s.

When the available memory is exhausted, the oldest records are overwritten by the newest ones.

Each disturbance record consists of a number of analogue data channels and digital data channels. The relevant CT and VT ratios for the analogue channels are also extracted to enable scaling to primary quantities.

The fault recording times are set by a combination of the **Duration** and **Trigger Position** cells. The **Duration** cell sets the overall recording time and the **Trigger Position** cell sets the trigger point as a percentage of the duration. For example, the default settings show that the overall recording time is set to 1.5 s with the trigger point being at 33.3% of this, giving 0.5 s pre-fault and 1 s post fault recording times.

With the **Trigger Mode** set to $Single$, if further triggers occurs whilst a recording is taking place, the recorder will ignore the trigger. However, with the **Trigger Mode** set to $Extended$, the post trigger timer will be reset to zero, extending the recording time.

You can select any of the IED's analogue inputs as analogue channels to be recorded. You can also map any of the opto-inputs output contacts to the digital channels. In addition, you may also map a number of DDB signals such as Starts and LEDs to digital channels.

You may choose any of the digital channels to trigger the disturbance recorder on either a low to high or a high to low transition, via the **Input Trigger** cell. The default settings are such that any dedicated trip output contacts will trigger the recorder.

It is not possible to view the disturbance records locally via the front panel LCD. You must extract these using suitable setting application software such as MiCOM S1 Agile.

# 4          MEASUREMENTS

## 4.1        MEASURED QUANTITIES

The device measures directly and calculates a number of system quantities, which are updated every second. You can view these values in the relevant MEASUREMENT columns or with the Measurement Viewer in the settings application software. Depending on the model, the device may measure and display some or more of the following quantities:

- Measured and calculated analogue current and voltage values
- Power and energy quantities
- Peak, fixed and rolling demand values
- Frequency measurements
- Thermal measurements

### 4.1.1        MEASURED AND CALCULATED CURRENTS

The device measures phase-to-phase and phase-to-neutral current values. The values are produced by sampling the analogue input quantities, converting them to digital quantities to present the magnitude and phase values. Sequence quantities are produced by processing the measured values. These are also displayed as magnitude and phase angle values.

These measurements are contained in the *MEASUREMENTS 1* column.

### 4.1.2        OTHER MEASUREMENTS

Depending on the model, the device produces a range of other measurements such as thermal measurements.

These measurements are contained in the *MEASUREMENTS 3* column.

## 4.2        MEASUREMENT SETUP

You can define the way measurements are set up and displayed using the *MEASURE'T SETUP* column and the measurements are shown in the relevant MEASUREMENTS tables.

## 4.3        OPTO-INPUT TIME STAMPING

Each opto-input sample is time stamped within a tolerance of +/- 1 ms with respect to the Real Time Clock. These time stamps are used for the opto event logs and for the disturbance recording. The device needs to be synchronised accurately to an external clock source such as an IRIG-B signal or a master clock signal provided in the relevant data protocol.

For both the filtered and unfiltered opto-inputs, the time stamp of an opto-input change event is the sampling time at which the change of state occurred. If multiple opto-inputs change state at the same sampling interval, these state changes are reported as a single event.

# 5          CB CONDITION MONITORING

The device records various statistics related to each circuit breaker trip operation, allowing an accurate assessment of the circuit breaker condition to be determined. The circuit breaker condition monitoring counters are incremented every time the device issues a trip command.

These statistics are available in the *CB CONDITION* column. The menu cells are counter values only, and cannot be set directly. The counters may be reset, however, during maintenance. This is achieved with the setting **Reset CB Data.**

> *Note:*
> *When in Commissioning test mode the CB condition monitoring counters are not updated.*

## 5.1        APPLICATION NOTES

### 5.1.1      SETTING THE THRESHOLDS FOR THE TOTAL BROKEN CURRENT

Where power lines use oil circuit breakers (OCBs), changing of the oil accounts for a significant proportion of the switchgear maintenance costs. Often, oil changes are performed after a fixed number of CB fault operations. However, this may result in premature maintenance where fault currents tend to be low, because oil degradation may be slower than would normally be expected. The Total Current Accumulator (I^ counter) cumulatively stores the total value of the current broken by the circuit breaker providing a more accurate assessment of the circuit breaker condition.

The dielectric withstand of the oil generally decreases as a function of $I^2t$, where 'I' is the broken fault current and 't' is the arcing time within the interrupter tank. The arcing time cannot be determined accurately, but is generally dependent on the type of circuit breaker being used. Instead, you set a factor (**Broken I^**) with a value between 1 and 2, depending on the circuit breaker.

Most circuit breakers would have this value set to '2', but for some types of circuit breaker, especially those operating on higher voltage systems, a value of 2 may be too high. In such applications **Broken I^** may be set lower, typically 1.4 or 1.5.

The setting range for **Broken I^** is variable between 1.0 and 2.0 in 0.1 steps.

> *Note:*
> *Any maintenance program must be fully compliant with the switchgear manufacturer's instructions.*

### 5.1.2      SETTING THE THRESHOLDS FOR THE NUMBER OF OPERATIONS

Every circuit breaker operation results in some degree of wear for its components. Therefore routine maintenance, such as oiling of mechanisms, may be based on the number of operations. Suitable setting of the maintenance threshold will allow an alarm to be raised, indicating when preventative maintenance is due. Should maintenance not be carried out, the device can be set to lockout the autoreclose function on reaching a second operations threshold (**No. CB ops Lock**). This prevents further reclosure when the circuit breaker has not been maintained to the standard demanded by the switchgear manufacturer's maintenance instructions.

Some circuit breakers, such as oil circuit breakers (OCBs) can only perform a certain number of fault interruptions before requiring maintenance attention. This is because each fault interruption causes carbonising of the oil, degrading its dielectric properties. The maintenance alarm threshold (setting **No. CB Ops Maint**) may be set to indicate the requirement for oil dielectric testing, or for more comprehensive maintenance. Again, the lockout threshold **No. CB Ops Lock** may be set to disable autoreclosure when repeated further fault interruptions could not be guaranteed. This minimises the risk of oil fires or explosion.

### 5.1.3          SETTING THE THRESHOLDS FOR THE OPERATING TIME

Slow CB operation indicates the need for mechanism maintenance. Alarm and lockout thresholds (*CB Time Maint* and *CB Time Lockout*) are provided to enforce this. They can be set in the range of 5 to 500 ms. This time relates to the interrupting time of the circuit breaker.

### 5.1.4          SETTING THE THRESHOLDS FOR EXCESSSIVE FAULT FREQUENCY

Persistent faults will generally cause autoreclose lockout, with subsequent maintenance attention. Intermittent faults such as clashing vegetation may repeat outside of any reclaim time, and the common cause might never be investigated. For this reason it is possible to set a frequent operations counter, which allows the number of operations *Fault Freq Count* over a set time period *Fault Freq Time* to be monitored. A separate alarm and lockout threshold can be set.

# 6        CB STATE MONITORING

CB State monitoring is used to verify the open or closed state of a circuit breaker. Most circuit breakers have auxiliary contacts through which they transmit their status (open or closed) to control equipment such as IEDs. These auxiliary contacts are known as:

- 52A for contacts that follow the state of the CB
- 52B for contacts that are in opposition to the state of the CB

This device can be set to monitor both of these types of circuit breaker state indication. If the state is unknown for some reason, an alarm can be raised.

Some CBs provide both sets of contacts. If this is the case, these contacts will normally be in opposite states. Should both sets of contacts be open, this would indicate one of the following conditions:

- Auxiliary contacts/wiring defective
- Circuit Breaker (CB) is defective
- CB is in isolated position

Should both sets of contacts be closed, only one of the following two conditions would apply:

- Auxiliary contacts/wiring defective
- Circuit Breaker (CB) is defective

If any of the above conditions exist, an alarm will be issued after a 5 s time delay. An output contact can be assigned to this function via the programmable scheme logic (PSL). The time delay is set to avoid unwanted operation during normal switching duties.

In the CB CONTROL column there is a setting called **CB Status Input**. This cell can be set at one of the following four options:

- None
- 52A
- 52B
- Both 52A and 52B

Where *None* is selected no CB status is available. Where only 52A is used on its own then the device will assume a 52B signal opposite to the 52A signal. Circuit breaker status information will be available in this case but no discrepancy alarm will be available. The above is also true where only a 52B is used. If both 52A and 52B are used then status information will be available and in addition a discrepancy alarm will be possible, according to the following table:

| Auxiliary Contact Position | | CB State Detected | Action |
|---|---|---|---|
| 52A | 52B | | |
| Open | Closed | Breaker open | Circuit breaker healthy |
| Closed | Open | Breaker closed | Circuit breaker healthy |
| Closed | Closed | CB failure | Alarm raised if the condition persists for greater than 5 s |
| Open | Open | State unknown | Alarm raised if the condition persists for greater than 5 s |

## 6.1      CB STATE MONITORING LOGIC
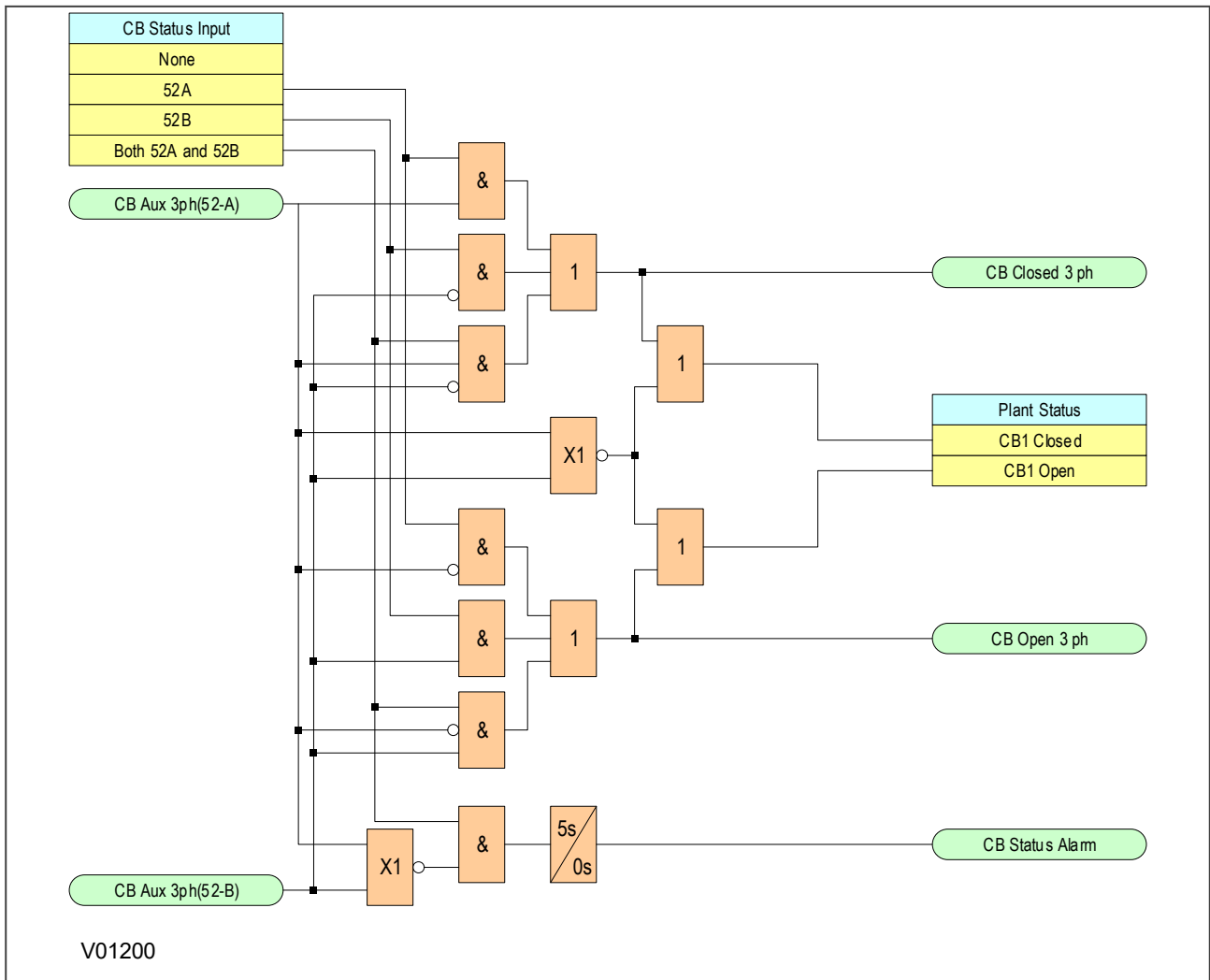


**Figure 86: CB State Monitoring logic**

# 7          CIRCUIT BREAKER CONTROL

Although some circuit breakers do not provide auxiliary contacts, most provide auxiliary contacts to reflect the state of the circuit breaker. These are:

- CBs with 52A contacts (where the auxiliary contact follows the state of the CB)
- CBs with 52B contacts (where the auxiliary contact is in the opposite state from the state of the CB)
- CBs with both 52A and 52B contacts

Circuit Breaker control is only possible if the circuit breaker in question provides auxiliary contacts. The **CB Status Input** cell in the *CB CONTROL* column must be set to the type of circuit breaker. If no CB auxiliary contacts are available then this cell should be set to `None`, and no CB control will be possible.

For local control, the **CB control by** cell should be set accordingly.

The output contact can be set to operate following a time delay defined by the setting **Man Close Delay**. One reason for this delay is to give personnel time to safely move away from the circuit breaker following a CB close command.

The control close cycle can be cancelled at any time before the output contact operates by any appropriate trip signal, or by activating the **Reset Close Dly** DDB signal.

The length of the trip and close control pulses can be set via the **Trip Pulse Time** and **Close Pulse Time** settings respectively. These should be set long enough to ensure the breaker has completed its open or close cycle before the pulse has elapsed.

If an attempt to close the breaker is being made, and a protection trip signal is generated, the protection trip command overrides the close command.

The **Reset Lockout by** setting is used to enable or disable the resetting of lockout automatically from a manual close after the time set by **Man Close RstDly**.

If the CB fails to respond to the control command (indicated by no change in the state of CB Status inputs) an alarm is generated after the relevant trip or close pulses have expired. These alarms can be viewed on the LCD display, remotely, or can be assigned to output contacts using the programmable scheme logic (PSL).

> *Note:*
> *The **CB Healthy Time** and **Sys Check time** set under this menu section are applicable to manual circuit breaker operations only. These settings are duplicated in the AUTORECLOSE menu for autoreclose applications.*

The **Lockout Reset** and **Reset Lockout by** settings are applicable to CB Lockouts associated with manual circuit breaker closure, CB Condition monitoring (Number of circuit breaker operations, for example) and autoreclose lockouts.

The device includes the following options for control of a single circuit breaker:

- The IED menu (local control)
- The Hotkeys (local control)
- The function keys (local control)
- The opto-inputs (local control)
- SCADA communication (remote control)

## 7.1          CB CONTROL USING THE IED MENU

You can control manual trips and closes with the **CB Trip/Close** command in the *SYSTEM DATA* column. This can be set to `No Operation`, `Trip`, or `Close` accordingly.

For this to work you have to set the **CB control by** cell to option 1 *Local*, option 3 *Local + Remote*, option 5 *Opto+Local*, or option 7 *Opto+Local+Remote* in the *CB CONTROL* column.

## 7.2 CB CONTROL USING THE HOTKEYS

The hotkeys allow you to manually trip and close the CB without the need to enter the *SYSTEM DATA* column. For this to work you have to set the **CB control by** cell to option 1 *Local*, option 3 *Local+Remote*, option 5 *Opto+Local*, or option 7 *Opto+Local+Remote* in the *CB CONTROL* column.

CB control using the hotkey is achieved by pressing the right-hand button directly below LCD screen. This button is only enabled if:

- The **CB Control by** setting is set to one of the options where local control is possible (option 1,3,5, or 7)
- The **CB Status Input** is set to '52A', '52B', or 'Both 52A and 52B'

If the CB is currently closed, the command text on the bottom right of the LCD screen will read *Trip*. Conversely, if the CB is currently open, the command text will read *Close*.

If you execute a *Trip*, a screen with the CB status will be displayed once the command has been completed. If you execute a *Close*, a screen with a timing bar will appear while the command is being executed. This screen also gives you the option to cancel or restart the close procedure. The time delay is determined by the **Man Close Delay** setting in the *CB CONTROL* menu. When the command has been executed, a screen confirming the present status of the circuit breaker is displayed. You are then prompted to select the next appropriate command or exit.

If no keys are pressed for a period of 5 seconds while waiting for the command confirmation, the device will revert to showing the CB Status. If no key presses are made for a period of 25 seconds while displaying the CB status screen, the device will revert to the default screen.

To avoid accidental operation of the trip and close functionality, the hotkey CB control commands are disabled for 10 seconds after exiting the hotkey menu.

The hotkey functionality is summarised graphically below:
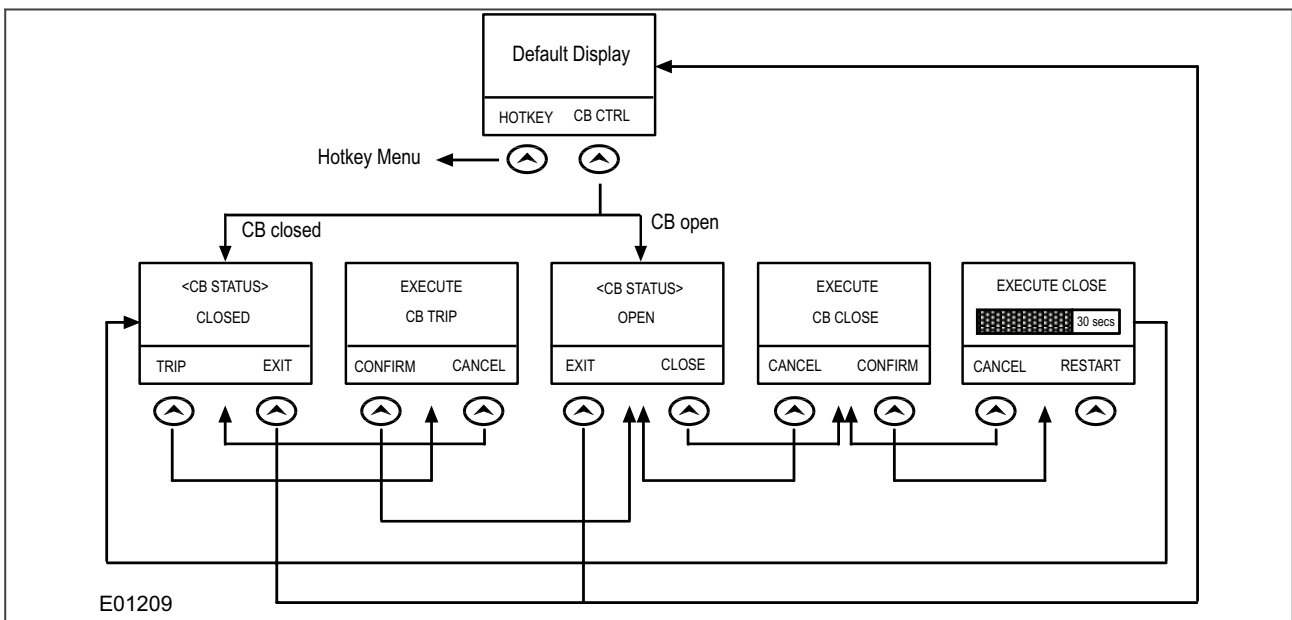


**Figure 87: Hotkey menu navigation**

## 7.3 CB CONTROL USING THE FUNCTION KEYS

For most models, you can also use the function keys to allow direct control of the circuit breaker. This has the advantage over hotkeys, that the LEDs associated with the function keys can indicate the status of the CB. The

default PSL is set up such that Function key 2 initiates a trip and Function key 3 initiates a close. For this to work you have to set the CB control by cell to option 5 *Opto+Local*, or option 7 *Opto+Local+Remote* in the *CB CONTROL* column.

As shown below, function keys 2 and 3 have already been assigned to CB control in the default PSL.
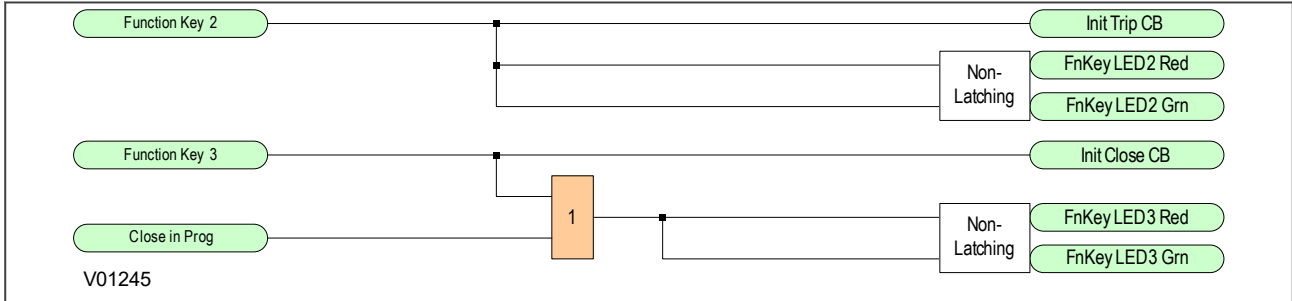


**Figure 88: Default function key PSL**

The programmable function key LEDs have been mapped such that they will indicate yellow whilst the keys are activated.

*Note:*
*Not all models provide function keys.*

## 7.4      CB CONTROL USING THE OPTO-INPUTS

Certain applications may require the use of push buttons or other external signals to control the various CB control operations. It is possible to connect such push buttons and signals to opto-inputs and map these to the relevant DDB signals.

For this to work, you have to set the **CB control by** cell to option 4 *opto*, option 5 *Opto+Local*, option 6 *Opto +Remote*, or option 7 *Opto+Local+Remote* in the *CB CONTROL* column.

## 7.5      REMOTE CB CONTROL

Remote CB control can be achieved by setting the **CB Trip/Close** cell in the *SYSTEM DATA* column to trip or close by using a command over a communication link.

For this to work, you have to set the **CB control by** cell to option 2 *Remote*, option 3 *Local+Remote*, option 6 *Opto+remote*, or option 7 *Opto+Local+Remote* in the *CB CONTROL* column.

We recommend that you allocate separate relay output contacts for remote CB control and protection tripping. This allows you to select the control outputs using a simple local/remote selector switch as shown below. Where this feature is not required the same output contact(s) can be used for both protection and remote tripping.
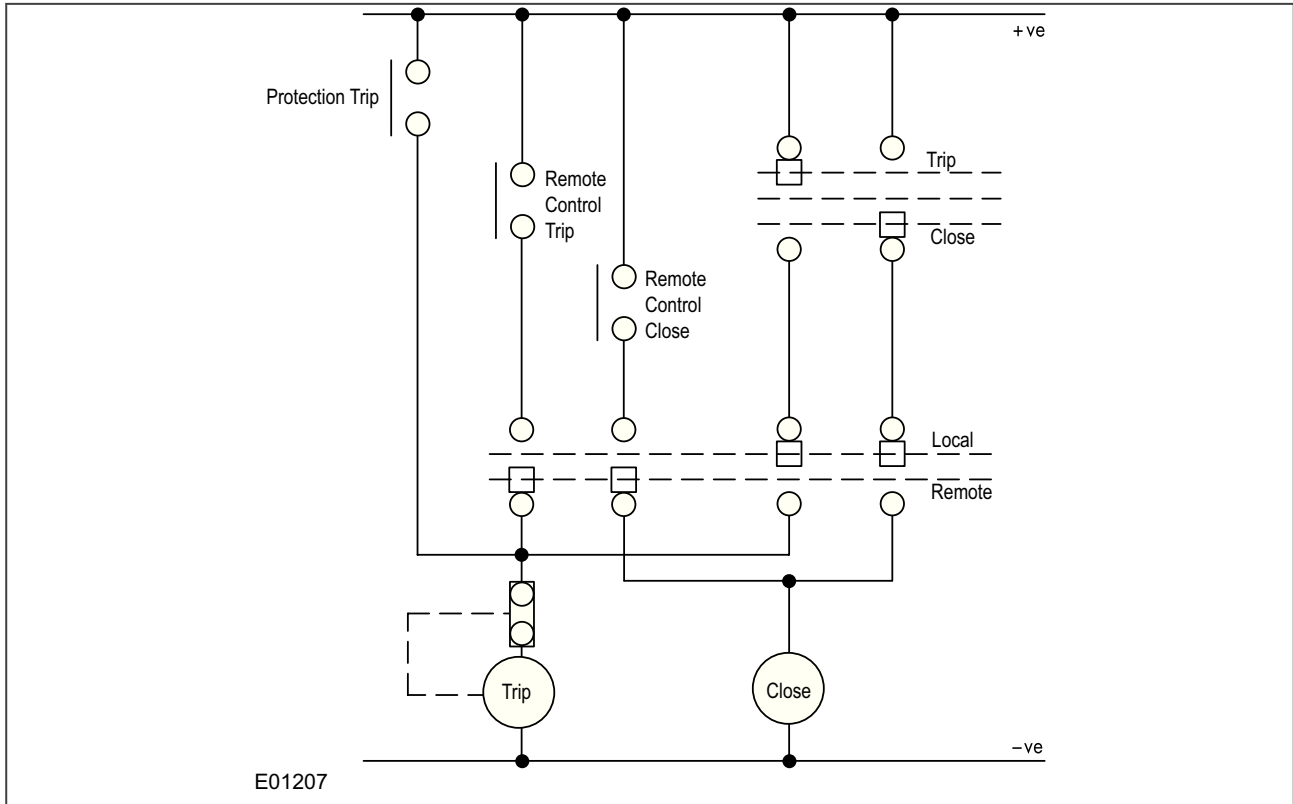
**Figure 89: Remote Control of Circuit Breaker**

## 7.6    CB HEALTHY CHECK

A CB Healthy check is available if required. This facility accepts an input to one of the opto-inputs to indicate that the breaker is capable of closing (e.g. that it is fully charged). A time delay can be set with the setting *CB Healthy Time*. If the CB does not indicate a healthy condition within the time period following a Close command, the device will lockout and alarm.

## 7.7 CB CONTROL LOGIC
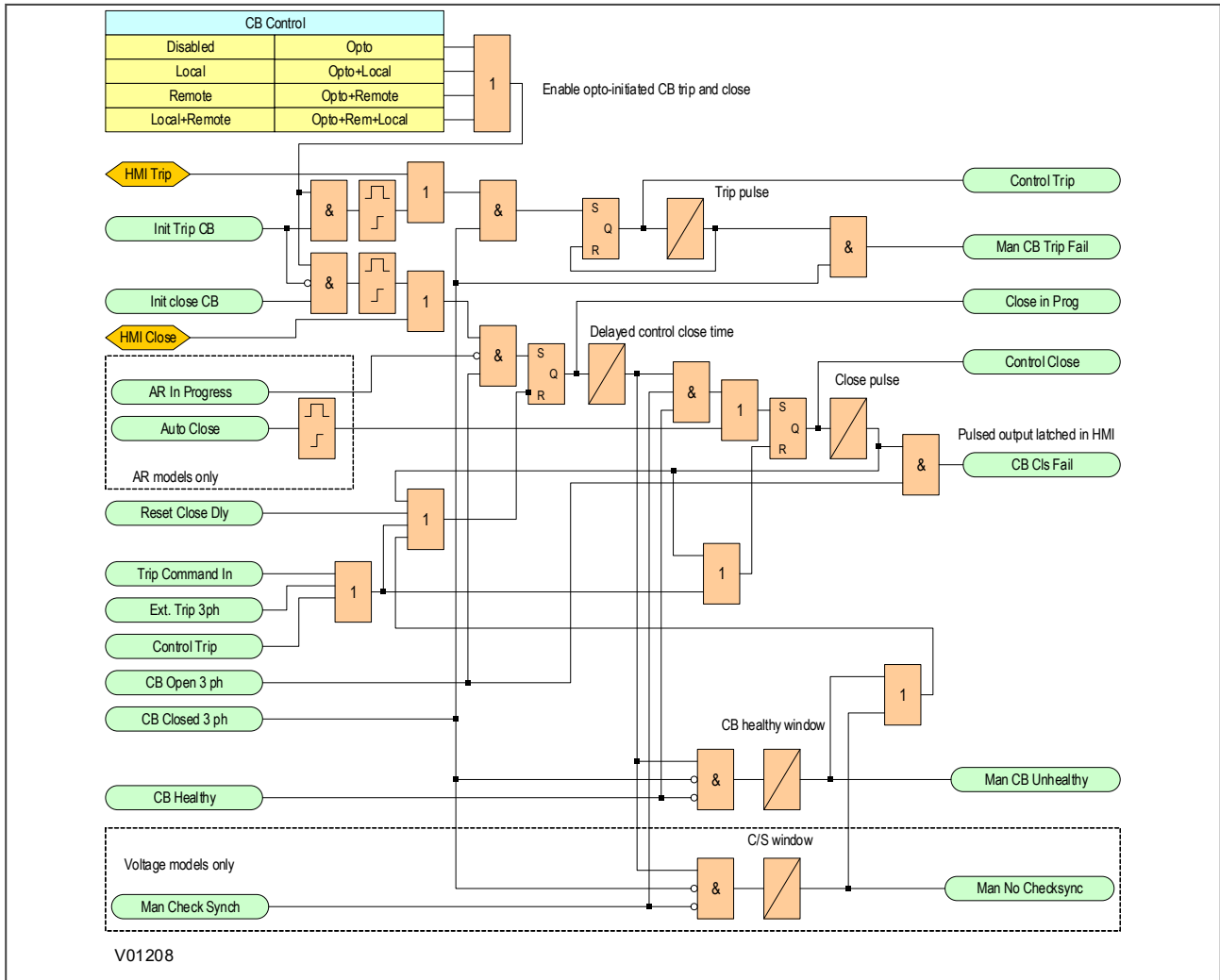


**Figure 90: CB Control logic**

## 8          POLE DEAD FUNCTION

The Pole Dead Logic is used to determine and indicate that one or more phases of the line are not energised. A Pole Dead condition is determined either by measuring:

- the line currents and/or voltages, or
- by monitoring the status of the circuit breaker auxiliary contacts, as shown by dedicated DDB signals.

It can also be used to block operation of underfrequency and undervoltage elements where applicable.

### 8.1        POLE DEAD LOGIC
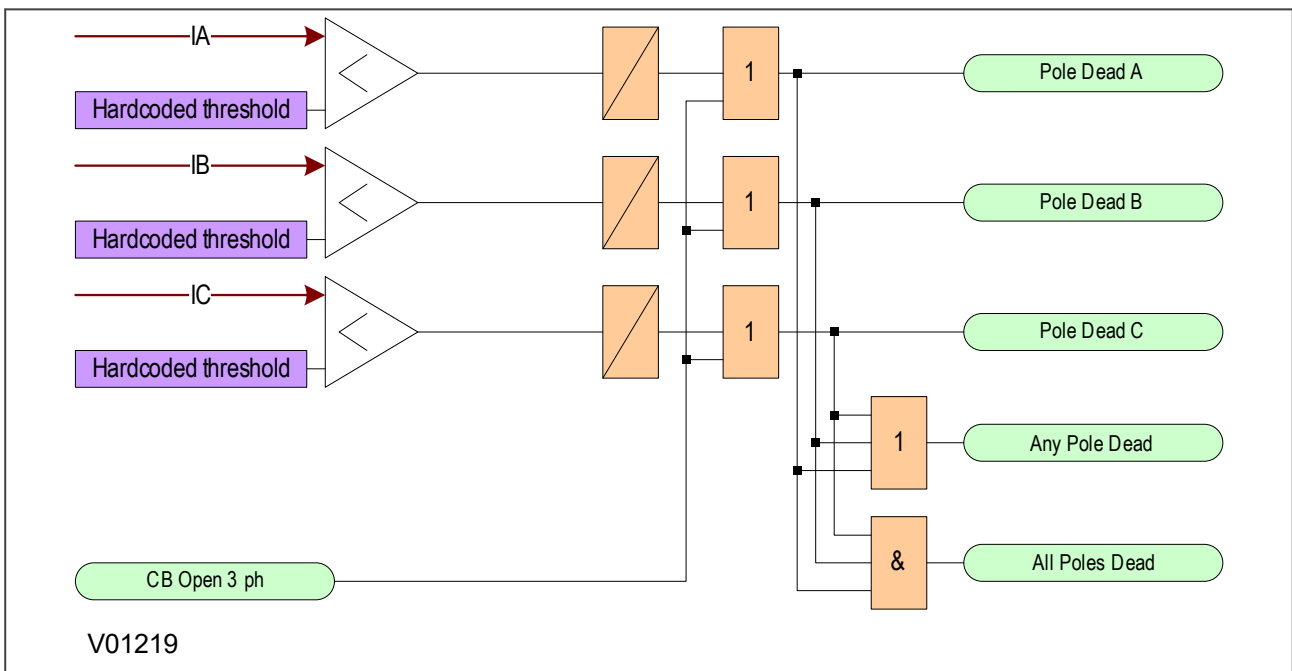
**Figure 91: Pole Dead logic**

If the line current falls below a certain threshold the device initiates a Pole Dead condition. The undercurrent (I<) threshold is hardcoded internally.

If one or more poles are dead, the device will indicate which phase is dead and will also assert the **Any Pole Dead** DDB signal. If all phases are dead the **Any Pole Dead** signal would be accompanied by the **All Poles Dead** signal.

A **CB Open 3ph** signal automatically initiates a Pole Dead condition regardless of the current measurement.

# 9 SWITCH STATUS AND CONTROL

All P40 Agile products support Switch Status and Control for up to 8 switchgear elements in an IEC61850 substation. The device is able to monitor the status of and control up to eight switches. The types of switch that can be controlled are:

- Load Break switch
- Disconnector
- Earthing Switch
- High Speed Earthing Switch

Consider the following feeder bay:
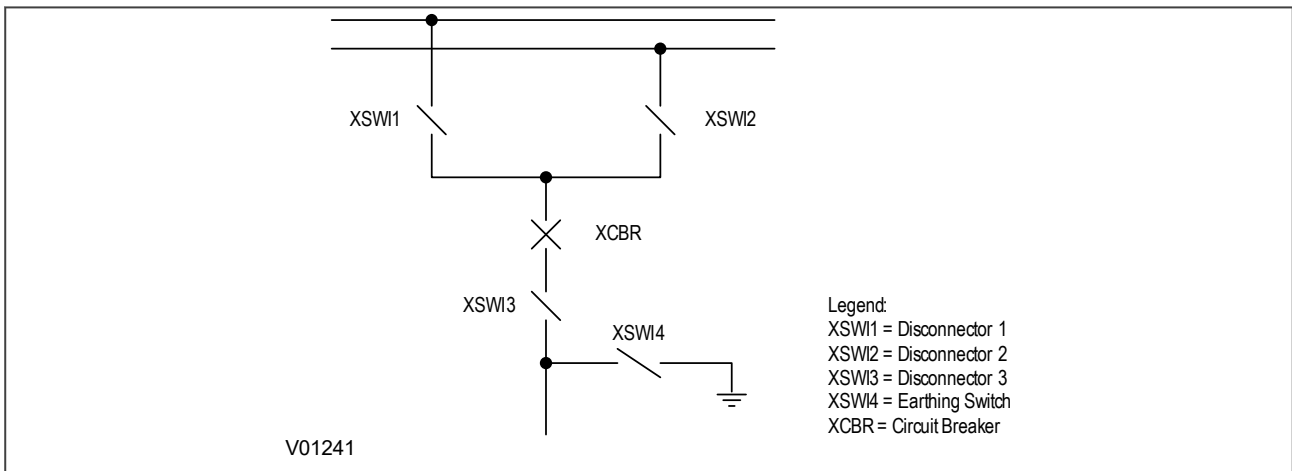


**Figure 92: Representation of typical feeder bay**

This bay shows four switches of the type LN XSWI and one circuit breaker of type LN XCBR. In this example, the switches XSWI1 – XSWI3 are disconnectors and XCSWI4 is an earthing switch.

For the device to be able to control the switches, the switches must provide auxiliary contacts to indicate the switch status. For convenience, the device settings refer to the auxiliary contacts as 52A and 52B, even though they are not circuit breakers.

There are eight sets of settings in the *SWITCH CONTROL* column, which allow you to set up the Switch control, one set for each switch. These settings are as follows:

### SWITCH1 Type

This setting defines the type of switch. It can be a load breaking switch, a disconnector, an earthing switch or a high speed earthing switch.

### SWI1 Status Inpt

This setting defines the type of auxiliary contacts that will be used for the control logic. For convenience, the device settings refer to the auxiliary contacts as 52A and 52B, even though they are not circuit breakers. "A" contacts match the status of the primary contacts, whilst "B" contacts are of the opposite polarity.

### SWI1 Control by

This setting determines how the switch is to be controlled. This can be Local (using the device directly) remote (using a communications link), or both.

### SWI1 Trip/Close

This is a command to directly trip or close the switch.

### SWI1 Trp Puls T and SWI1 Cls Puls T

These settings allow you to control the width of the open and close pulses.

*SWI1 Sta Alrm T*

This setting allows you to define the duration of wait timer before the relay raises a status alarm.

*SWI1 Trp Alrm T* and *SWI1 Cls Alrm T*

These settings allow you to control the delay of the open and close alarms when the final switch status is not in line with expected status.

*SWI1 Operations*

This is a data cell, which displays the number of switch operations that have taken place. It is an accumulator, which you can reset using the **Reset SWI1 Data** setting

*Reset SWI1 Data*

This setting resets the switch monitoring data.

> *Note:*
> *Settings for switch 1 are shown, but settings for all other switch elements are the same.*

## 9.1     SWITCH STATUS LOGIC
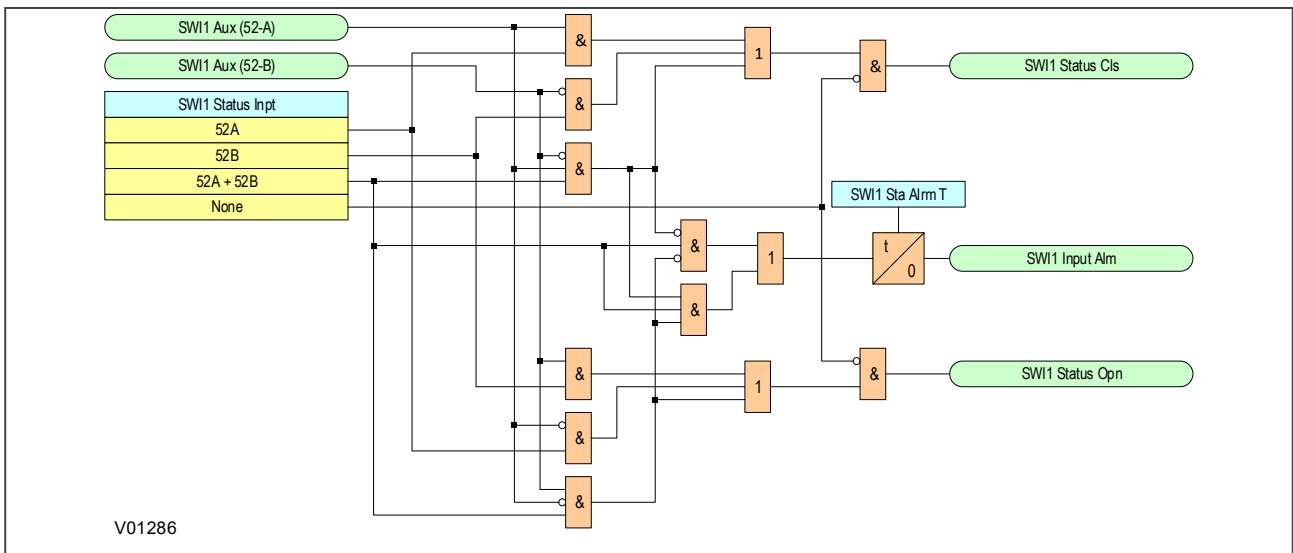


**Figure 93: Switch Status logic**

## 9.2    SWITCH CONTROL LOGIC
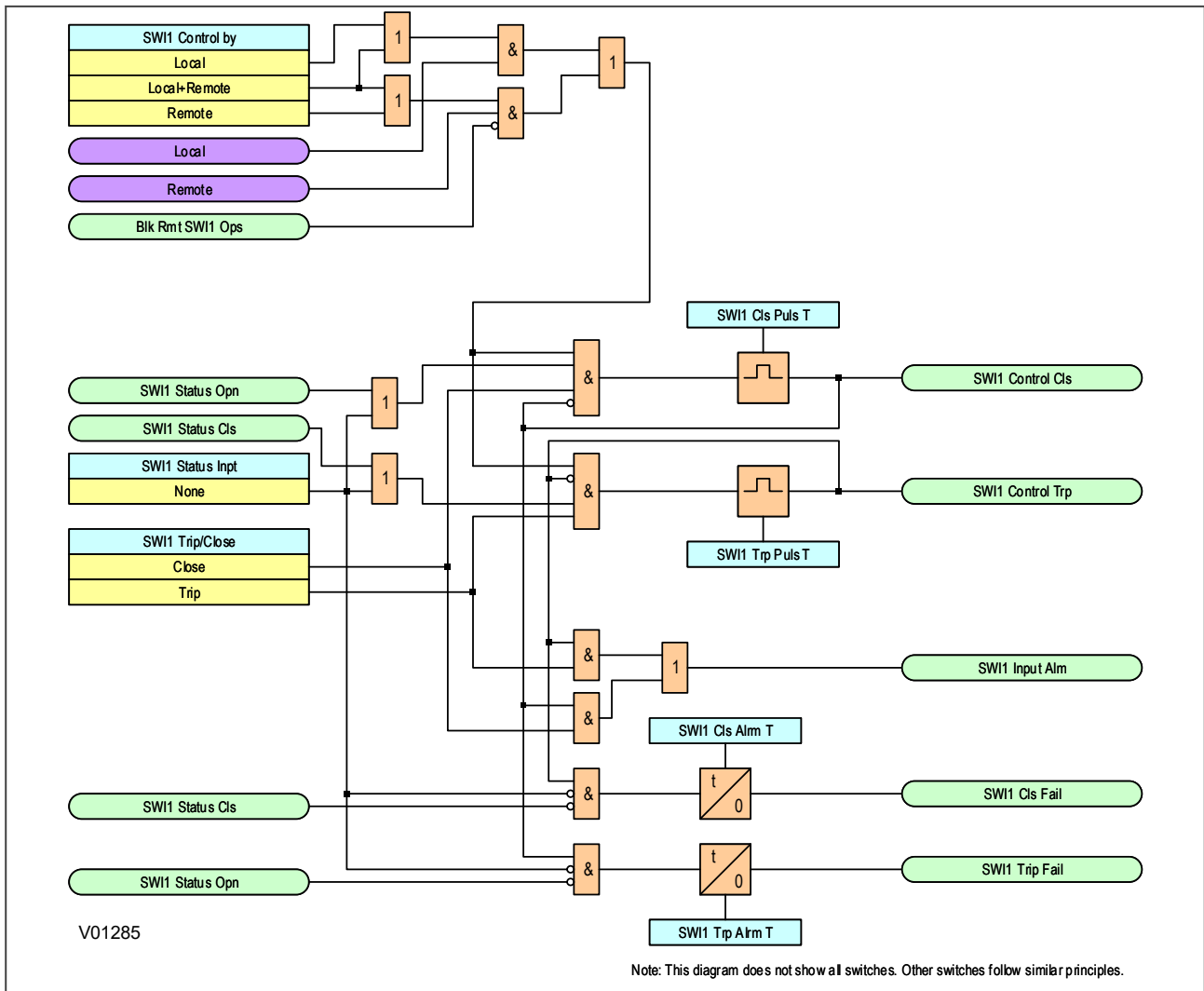


**Figure 94: Switch Control logic**

# CHAPTER 12

# SUPERVISION

# 1         CHAPTER OVERVIEW

This chapter describes the supervison functions.

This chapter contains the following sections:

## 2          DC SUPPLY MONITOR

This product can be powered using either a DC or AC supply. As a DC supply is normally used, a DC Supply Monitoring feature is included to indicate the DC supply status. The nominal DC Station supply is 48 V DC, which is provided by a bank of batteries. It is sometimes possible for this nominal supply to fall below or rise above acceptable operational limits. If the voltage is too high, it may indicate overcharging. If the voltage is too low, it may indicate a failing battery.

In such cases it is very useful to have DC supply monitoring functionality. The P40 Agile products provide such functionality by measuring the auxiliary DC supply fed into the device and processing this information using settings to define certain limits. In addition, the DC Auxiliary Supply value can be displayed on the front panel LCD to a resolution of 0.1 V DC. The measuring range is from 19 V DC to 300 V DC.

### 2.1        DC SUPPLY MONITOR IMPLEMENTATION

The P40Agile products provide three DC supply monitoring zones; zone 1, zone 2, and zone 3. This allows you to have multiple monitoring criteria. Each zone must be configured to correspond to either an overvoltage condition or an undervoltage condition. A single zone cannot be configured to provide an alarm for both undervoltage and overvoltage conditions. Typically, you would configure zones 1 and 2 for undervoltage conditions, whereby the lowest limit is set very low, and zone 3 for an overvoltage condition whereby the upper limit is very high.

This is best illustrated diagrammatically:
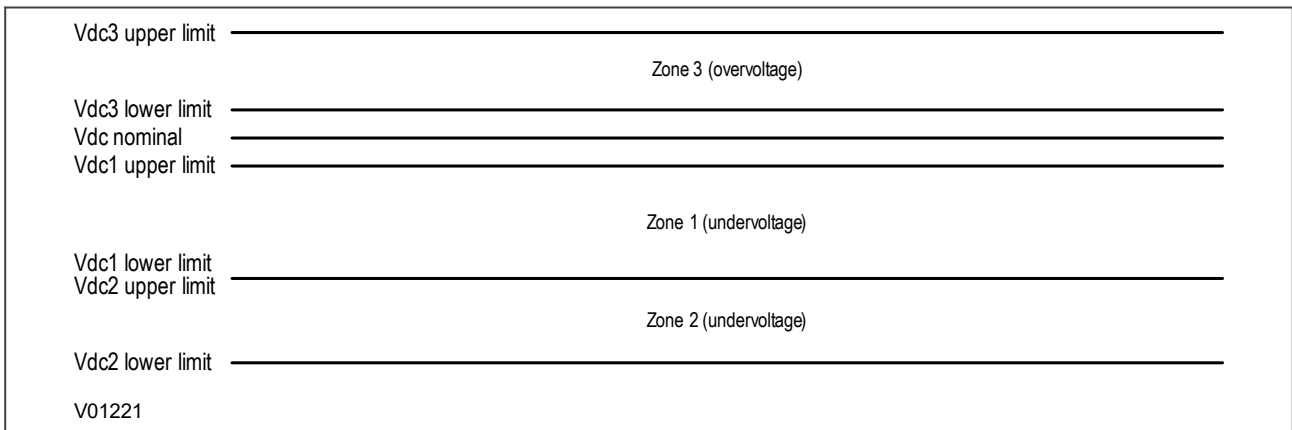


**Figure 95: DC Supply Monitor zones**

It is possible to have overlapping zones whereby zone 2 upper limit is lower than zone 1 lower limit in the above example.

The DC Supply Monitoring function is implemented using settings in the *DC SUP. MONITOR* column. There are three sets of settings; one for each of the zones. The settings allow you to:

- Enable or disable the function for each zone
- Set a lower voltage limit for each zone
- Set an upper voltage limit for each zone
- Set a time delay for each zone

## 2.2          DC SUPPLY MONITOR LOGIC
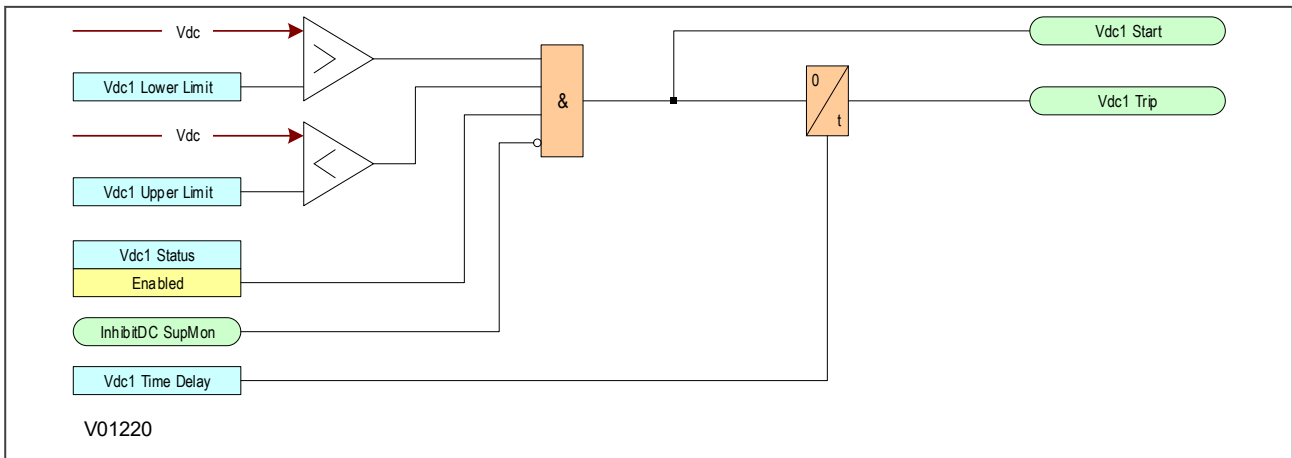


**Figure 96: DC Supply Monitor logic**

The diagram above shows the DC supply monitoring logic for stage 1 only. Stages 2 and 3 are identical in principle.

The logic function will work when the **Vdc1 status** setting cell is `Enabled` and the DC Supply Monitoring inhibit signal (**InhibitDC SupMon**) is low.

If the auxiliary supply voltage (Vdc) exceeds the lower limit AND falls below the upper limit, the voltage is in the healthy zone and a Start signal is generated.

The Vdc(n) Trip signals from all stages are OR'd together to produce an alarm signal **DC Supply Fail**.

> *Note:*
> *The device's supercapacitor uses Vdc to provide charge and so may cause the voltage to dip below the Vdc lower limit (19.2 V) during a system power-up sequence if fully discharged. This will trigger a lockout error. In this case, it will be necessary to allow the supercapacitor to charge before attempting another power-up sequence. The supercapacitor may take several minutes to become fully charged, depending on the AC/DC supply specification. With the supercapacitor charged, the next relay power cycle will clear the lockout and the relay will boot and operate normally.*

# 3        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.

## 3.1        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.*
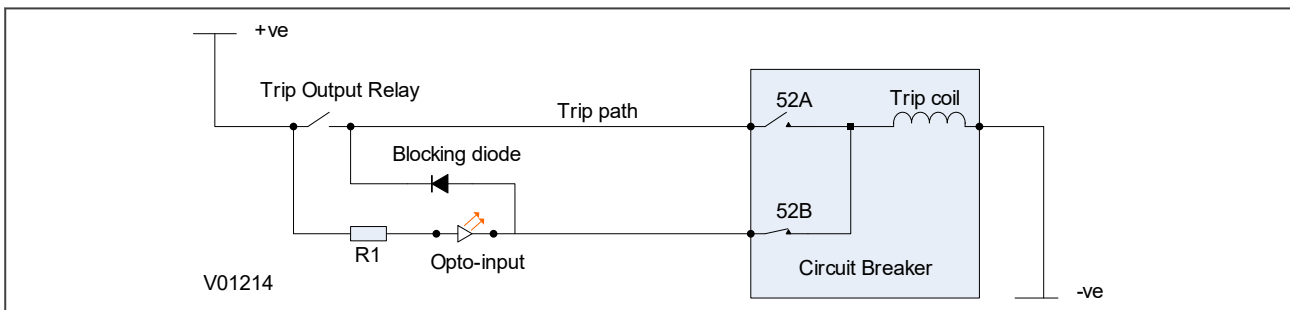


**Figure 97: TCS Scheme 1**

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.

### 3.1.1        RESISTOR VALUES

The supervision current is a lot less than the current required by the trip coil to trip a CB. The TCS opto-input limits this supervision current to less than 10 mA. If the TCS 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 TCS opto-input. This limits the current to less than 60 mA. The table below shows the appropriate resistor value and voltage setting for this scheme.

| Trip Circuit Voltage | Resistor R1 |
|---|---|
| 24/27 | 620 Ohms at 2 Watts |
| 30/34 | 820 Ohms at 2 Watts |
| 48/54 | 1.2 kOhms at 5 Watts |
| 110/125 | 2.7 kOhms at 10 Watts |
| 220/250 | 5.2 kOhms at 15 Watts |

⚠ **Warning:**
**If your IED has Opto Mode settings available in the *OPTO CONFIG* column, these MUST be set to *TCS* for any corresponding Opto Inputs(s) used for Trip Circuit Supervision.**

### 3.1.2    PSL FOR TCS SCHEME 1
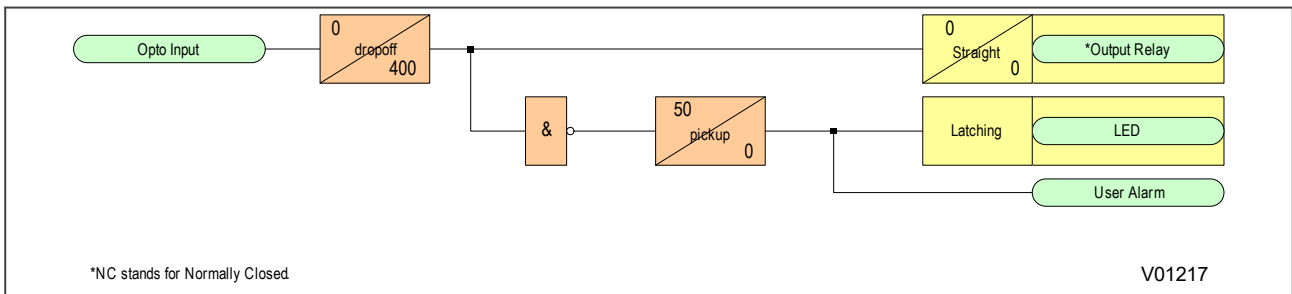


**Figure 98: PSL for TCS Scheme 1**

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.

## 3.2    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.
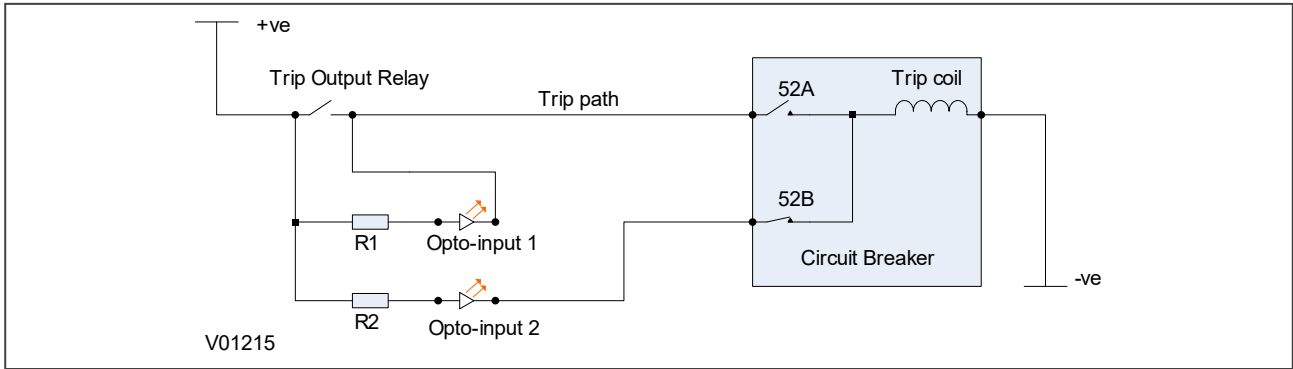
**Figure 99: TCS Scheme 2**

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.

### 3.2.1 RESISTOR VALUES

As with scheme 1, optional resistors R1 and R2 can be added to prevent tripping of the CB if either TCS opto-input is shorted. The table below shows the appropriate resistor value and voltage setting for this scheme.

| Trip Circuit Voltage | Resistor R1 and R2 |
| --- | --- |
| 24/27 | 620 Ohms at 2 Watts |
| 30/34 | 820 Ohms at 2 Watts |
| 48/54 | 1.2 kOhms at 5 Watts |
| 110/125 | 2.7 kOhms at 10 Watts |
| 220/250 | 5.2 kOhms at 15 Watts |

⚠️ **Warning:**
**If your IED has Opto Mode settings available in the *OPTO CONFIG* column, these MUST be set to `TCS` for any corresponding Opto Inputs(s) used for Trip Circuit Supervision.**

### 3.2.2 PSL FOR TCS SCHEME 2
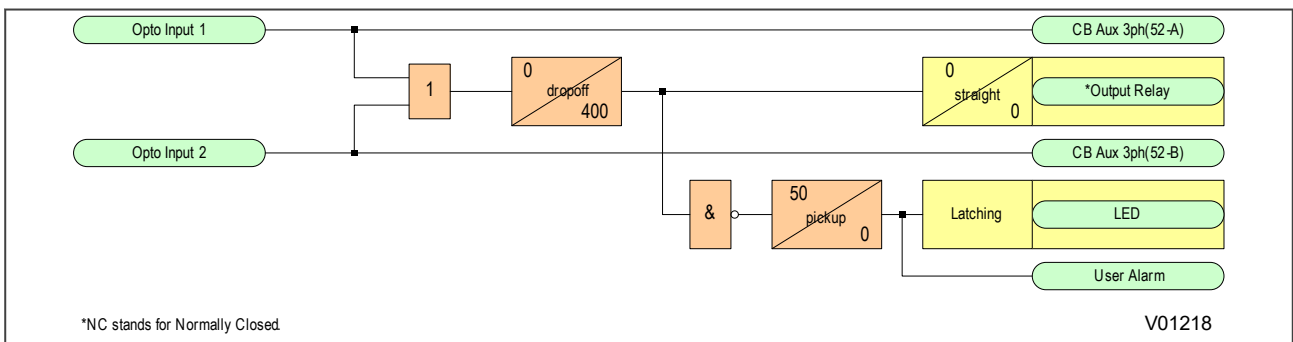


**Figure 100: PSL for TCS Scheme 2**

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

## 3.3        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.
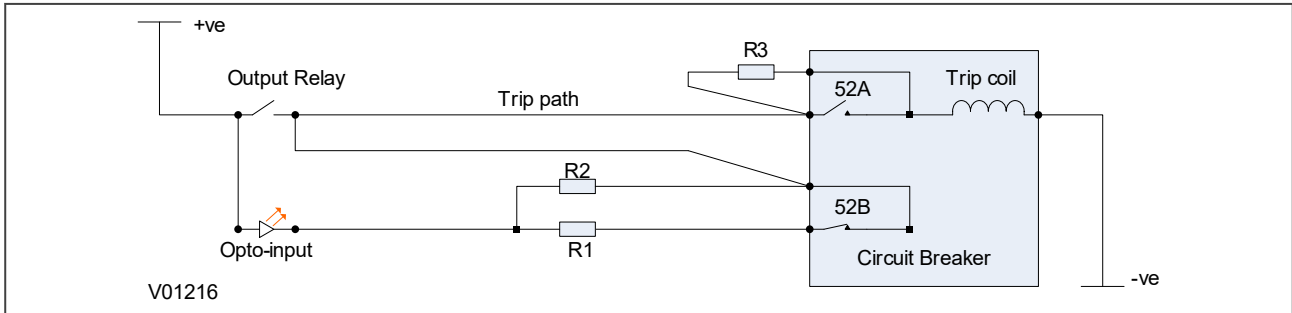


**Figure 101: TCS Scheme 3**

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.

### 3.3.1        RESISTOR VALUES

As with TCS schemes 1 and 2, resistors R1 and R2 are used to prevent false tripping, if the TCS opto-input is accidentally shorted. However, unlike the other two schemes, this scheme is dependent on 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 | Resistor R1 and R2 | Resistor R3 |
|---|---|---|
| 24/27 | 620 Ohms at 2 Watts | 330 Ohms at 5 Watts |
| 30/34 | 820 Ohms at 2 Watts | 430 Ohms at 5 Watts |
| 48/54 | 1.2 kOhms at 5 Watts | 620 Ohms at 10 Watts |
| 110/125 | 2.7 kOhms at 10 Watts | 1.5 k Ohms at 15 Watts |
| 220/250 | 5.2 kOhms at 15 Watts | 2.7 k Ohms at 25 Watts |

⚠ **Warning:**
**If your IED has Opto Mode settings available in the *OPTO CONFIG* column, these MUST be set to *TCS* for any corresponding Opto Inputs(s) used for Trip Circuit Supervision.**

### 3.3.2       PSL FOR TCS SCHEME 3
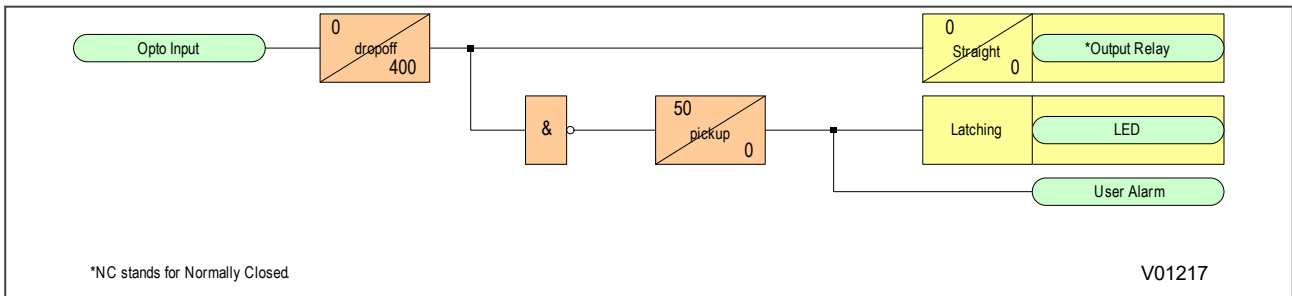


**Figure 102: PSL for TCS Scheme 3**

## 3.4       TRIP CIRCUIT SUPERVISION SCHEME 4

Scheme 4 is identical to that offered by MVAX31 (a Trip Circuit Supervision relay) and consequently is fully compliant with ENA Specification H7. To achieve this compliance, there are eight settings in the *OPTO CONFIG* column. Two of these settings (**Opto 1 Mode** to **Opto 11 Mode**--dependant on I/O option chosen) must be set to *TCS* before the scheme can be used, with any remaining opto-input set to *Normal* as required.

In the diagram below, Opto-input 1 and Opto-input 2 would correlate to one of the above-mentioned opto-inputs.
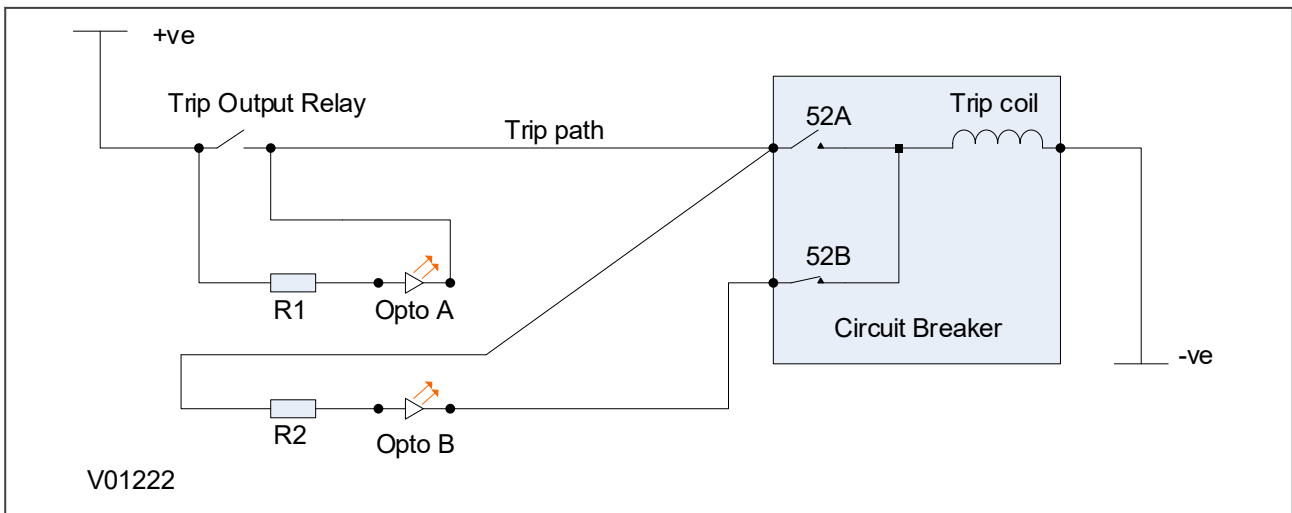


**Figure 103: TCS Scheme 4**

Under normal non-fault conditions, a current of 2 mA flows through one of the following paths:

a) Post Close Supervision: When the CB is in a closed state, the current flows through R1, Opto A, Contact 52A and the trip coil.

b) Pre-close Supervision: When the CB is in an open state, the current flows through R1, Opto A, Contact 52B, Opto B and the trip coil.

c) Momentary Tripping with Self-reset Contact: When a self-reset trip contact is in a closed state, the current flows through the trip contact, contact 52A and the trip coil.

d) Tripping with Latched Contact: When a latched trip contact is used and when it is in a closed state, the current flows through the trip contact, Contact 52A, the trip coil, then changing to the path trip contact, R2, Contact 52B, Opto B and the trip coil.

A current of 2 mA through the Trip Coil is insufficient to cause operation of the Trip Contact, but large enough to energise the opto-inputs. Under this condition both of the opto-inputs will output logic 1, so the output relay (TCS health) will be closed and the User Alarm will be off. If a break occurs in the trip circuit, the current ceases to flow, resulting in both opto-inputs outputting logic 0. This will open the output relay and energise the user alarm.

**Recommended Scheme Opto Connections and Settings**

| I/O option G or J | | I/O Option F | | | I/O Option C | | |
|---|---|---|---|---|---|---|---|
| Opto Input 1 (Mode Setting) | Opto Input 2 (Mode Setting) | Opto Input 4 (Mode Setting) | Opto Input 5 (Mode Setting) | Opto Input 6 (Mode Setting) | Opto Input 9 (Mode Setting) | Opto Input 10 (Mode Setting) | Opto Input 11 (Mode Setting) |
| Opto A (TCS) | Opto B (TCS) | Opto A (TCS) | Opto B (TCS) | - (NORMAL) | Opto A (TCS) | Opto B (TCS) | - (NORMAL) |
| | | | | | I/O Option H | | |

## 3.4.1 RESISTOR VALUES

The TCS opto-inputs sink a constant current of 2 mA. The values of external resistors R1 and R2 are chosen to limit the current to a maximum of 60 mA in the event that a TCS opto-input becomes shorted. The values of these resistors depend on the trip circuit voltage.

| Trip Circuit Voltage | Resistor R1 and R2 (ohms) |
|---|---|
| 24/27 | 620 Ohms at 2 Watts |
| 30/34 | 820 Ohms at 2 Watts |
| 48/54 | 1.2 kOhms at 5 Watts |
| 110/125 | 2.7 kOhms at 10 Watts |
| 220/250 | 5.2 kOhms at 15 Watts |

For the momentary tripping condition, none of the opto-inputs are energised. To tide over this normal CB operation, a dropoff time delay of about 400 ms is added in the PSL.

> ⚠️ **Warning:**
> If your IED has Opto Mode settings available in the *OPTO CONFIG* column, these **MUST be set to** *TCS* **for any corresponding Opto Inputs(s) used for Trip Circuit Supervision.**

## 3.4.2 PSL FOR TCS SCHEME 4
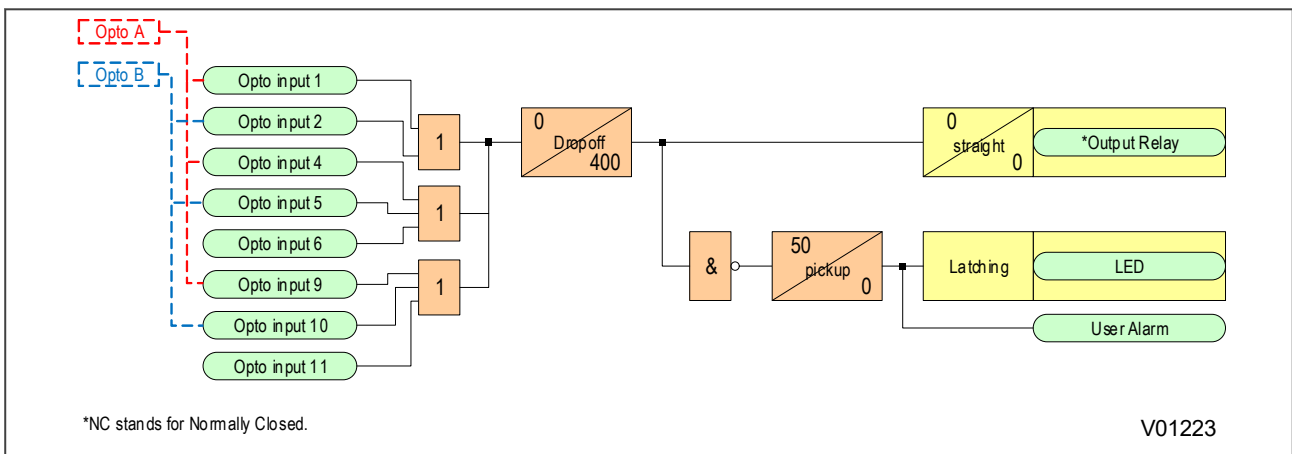


Figure 104: PSL for TCS Scheme 4

# CHAPTER 13

# DIGITAL I/O AND PSL CONFIGURATION

# 1 CHAPTER OVERVIEW

This chapter introduces the PSL (Programmable Scheme Logic) Editor, and describes the configuration of the digital inputs and outputs. It provides an outline of scheme logic concepts and the PSL Editor. This is followed by details about allocation of the digital inputs and outputs, which require the use of the PSL Editor. A separate "Settings Application Software" document is available that gives a comprehensive description of the PSL, but enough information is provided in this chapter to allow you to allocate the principal digital inputs and outputs.

This chapter contains the following sections:

## 2          CONFIGURING DIGITAL INPUTS AND OUTPUTS

Configuration of the digital inputs and outputs in this product is very flexible. You can use a combination of settings and programmable logic to customise them to your application. You can access some of the settings using the keypad on the front panel, but you will need a computer running the settings application software to fully interrogate and configure the properties of the digital inputs and outputs.

The settings application software includes an application called the PSL Editor (Programmable Scheme Logic Editor). The PSL Editor lets you allocate inputs and outputs according to your specific application. It also allows you to apply attributes to some of the signals such as a drop-off delay for an output contact.

In this product, digital inputs and outputs that are configurable are:

- Optically isolated digital inputs (opto-inputs). These can be used to monitor the status of associated plant.
- Output relays. These can be used for purposes such as initiating the tripping of circuit breakers, providing alarm signals, etc..
- Programmable LEDs. The number and colour of the programmable LEDs varies according to the particular product being applied.
- Function keys and associated LED indications. These are not provided on all products, but where they are, each function key has an associated tri-colour LED.
- IEC 61850 GOOSE inputs and outputs. These are only provided on products that have been specified for connection to an IEC61850 system, and the details of the GOOSE are presented in the documentation on IEC61850.

# 3        SCHEME LOGIC

The product is supplied with pre-loaded Fixed Scheme Logic (FSL) and Programmable Scheme Logic (PSL).

The Scheme Logic is a functional module within the IED, through which all mapping of inputs to outputs is handled. The scheme logic can be split into two parts; the Fixed Scheme Logic (FSL) and the Programmable Scheme Logic (PSL). It is built around a concept called the digital data bus (DDB). The DDB encompasses all of the digital signals (DDBs) which are used in the FSL and PSL. The DDBs included digital inputs, outputs, and internal signals.

The FSL is logic that has been hard-coded in the product. It is fundamental to correct interaction between various protection and/or control elements. It is fixed and cannot be changed.

The PSL gives you a facility to develop custom schemes to suit your application if the factory-programmed default PSL schemes do not meet your needs. Default PSL schemes are programmed before the product leaves the factory. These default PSL schemes have been designed to suit typical applications and if these schemes suit your requirements, you do not need to take any action. However, if you want to change the input-output mappings, or to implement custom scheme logic, you can change these, or create new PSL schemes using the PSL editor.

The PSL consists of components such as logic gates and timers, which combine and condition DDB signals.

The logic gates can be programmed to perform a range of different logic functions. The number of inputs to a logic gate are not limited. The timers can be used either to create a programmable delay or to condition the logic outputs. Output contacts and programmable LEDs have dedicated conditioners.

The PSL logic is event driven. Only the part of the PSL logic that is affected by the particular input change that has occurred is processed. This minimises the amount of processing time used by the PSL ensuring industry leading performance.

The following diagram shows how the scheme logic interacts with the rest of the IED.
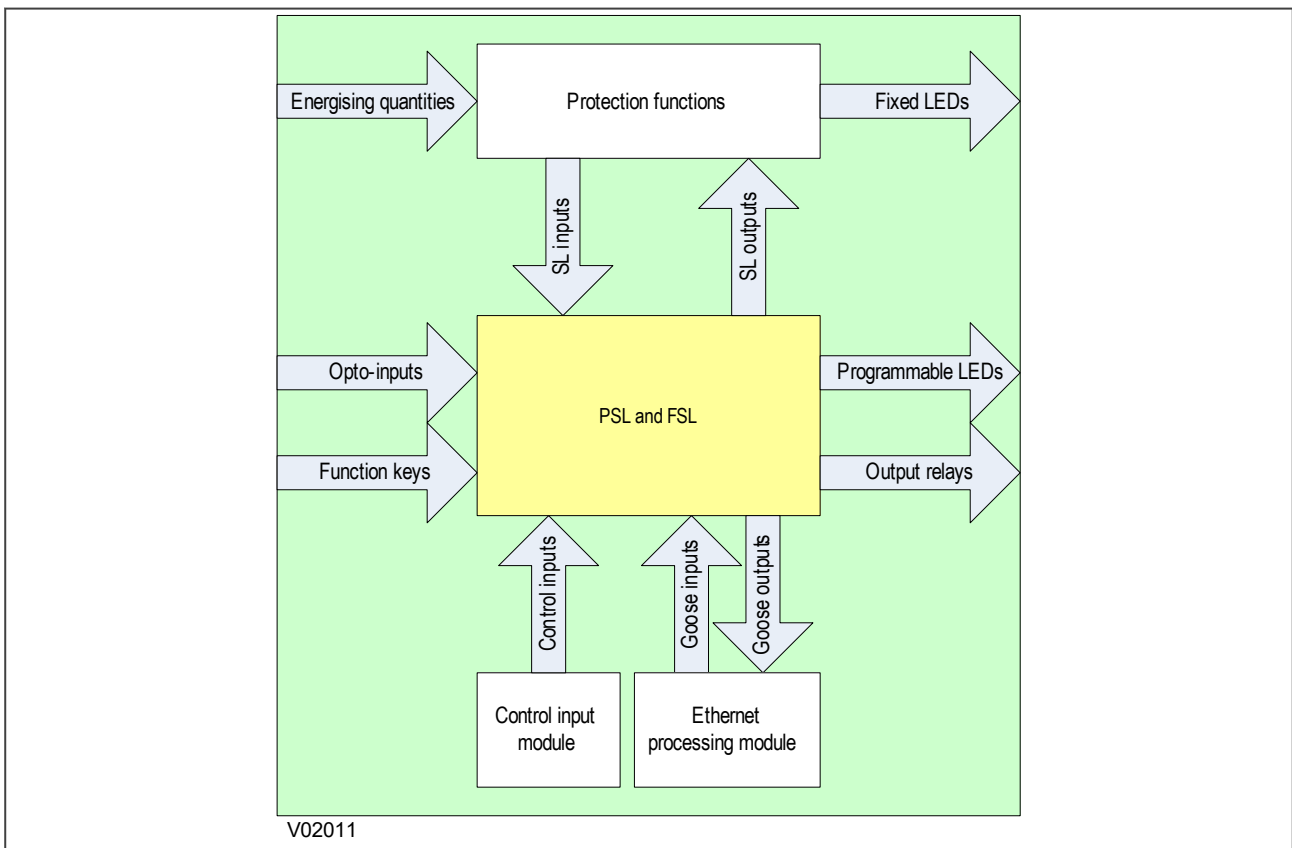


**Figure 105: Scheme Logic Interfaces**

## 3.1        PSL EDITOR

The Programmable Scheme Logic (PSL) is a module of programmable logic gates and timers in the IED, which can be used to create customised logic to qualify how the product manages its response to system conditions. The IED's digital inputs are combined with internally generated digital signals using logic gates, timers, and conditioners. The resultant signals are then mapped to digital outputs signals including output relays and LEDs.

The PSL Editor is a tool in the settings application software that allows you to create and edit scheme logic diagrams. You can use the default scheme logic which has been designed to suit most applications, but if it does not suit your application you can change it. If you create a different scheme logic with the software, you need to upload it to the device to apply it.

## 3.2        PSL SCHEMES

Your product is shipped with default scheme files. These can be used without modification for most applications, or you can choose to use them as a starting point to design your own scheme. You can also create a new scheme from scratch. To create a new scheme, or to modify an existing scheme, you will need to launch the settings application software. You then need to open an existing PSL file, or create a new one, for the particular product that you are using, and then open a PSL file. If you want to create a new PSL file, you should select **File** then **New** then **Blank scheme...** This action opens a default file appropriate for the device in question, but deletes the diagram components from the default file to leave an empty diagram with configuration information loaded. To open an existing file, or a default file, simply double-click on it.

## 3.3        PSL SCHEME VERSION CONTROL

To help you keep track of the PSL loaded into products, a version control feature is included. The user interface contains a *PSL DATA* column, which can be used to track PSL modifications. A total of 12 cells are contained in the *PSL DATA* column; 3 for each setting group.

*Grp(n) PSL Ref*: When downloading a PSL scheme to an IED, you will be prompted to enter the relevant group number and a reference identifier. The first 32 characters of the reference identifier are displayed in this cell. The horizontal cursor keys can scroll through the 32 characters as the LCD display only displays 16 characters.

**Example:**

```
Grp(n)  PSL Ref
```

*Date/time*: This cell displays the date and time when the PSL scheme was downloaded to the IED.

**Example:**

```
18 Nov 2002
08:59:32.047
```

*Grp(n) PSL ID*: This cell displays a unique ID number for the downloaded PSL scheme.

**Example:**

```
Grp(n)  PSL ID
ID - 2062813232
```

# 4 CONFIGURING THE OPTO-INPUTS

The number of optically isolated status inputs (opto-inputs) depends on the specific model supplied. The use of the inputs will depend on the application, and their allocation is defined in the programmable scheme logic (PSL). In addition to the PSL assignment, you also need to specify the expected input voltage. Generally, all opto-inputs will share the same input voltage range, but if different voltage ranges are being used, this device can accommodate them.

In the *OPTO CONFIG* column there is a global nominal voltage setting. If all opto-inputs are going to be energised from the same voltage range, you select the appropriate value with this setting. If you select `Custom` in the setting, then the cells **Opto Input 1**, **Opto Input 2**, etc. become visible. You use these cells to set the voltage ranges for each individual opto-input.

If you are using the recommended settings application software (MiCOM S1 Agile), the product's DC supply monitoring function detects the DC supply voltage and provides some automation for setting for the global nominal voltage. This feature is found by right clicking on **Device**, then selecting **Supervise Device → Auto-setup of Opto Voltage**. This automatic detection only works for DC inputs.

Within the *OPTO CONFIG* column there are also settings to control the filtering applied to the inputs, as well as the pick-up/drop-off characteristic.

The filter control setting provides a bit string with a bit associated with all opto-inputs. Setting the bit to '1' means that a half-cycle filter is applied to the inputs. This helps to prevent incorrect operation in the event of power system frequency interference on the wiring. Setting the field to '0' removes the filter and provides for faster operation. You should note that removing the filter reduces the AC immunity. that means it is less effective at filtering out-of-band interference.

The **Characteristic** setting is a single setting that applies to all the opto-inputs. It is used to set the pick-up/drop-off ratios of the input signals.

By default the drop-off is 60% of the maximum DC input value and the pick-up threshold is 80% of the minimum DC input value. You can change this to other available thresholds if required. Other available thresholds are 50% - 70% and 58% - 75%.

# 5          ASSIGNING THE OUTPUT RELAYS

Relay contact action is controlled using the PSL. DDB signals are mapped in the PSL and drive the output relays. The driving of an output relay is controlled by means of a relay output conditioner. Several choices are available for how output relay contacts are conditioned. For example, you can choose whether operation of an output relay contact is latched, has delay on pick-up, or has a delay on drop-off. You make this choice in the **Contact Properties** window associated with the output relay conditioner.

To map an output relay in the PSL you should use the Contact Conditioner button in the toolbar to import it. You then condition it according to your needs. The output of the conditioner respects the attributes you have assigned.

The toolbar button for a Contact Conditioner looks like this:



The PSL contribution that it delivers looks like this:
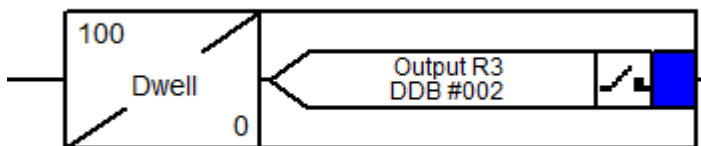


*Note:*
*Contact Conditioners are only available if they have not all been used. In some default PSL schemes, all Contact Conditioners might have been used. If that is the case, and you want to use them for something else, you will need to re-assign them.*

On the toolbar there is another button associated with the relay outputs. The button looks like this:



This is the "Contact Signal" button. It allows you to put replica instances of a conditioned output relay into the PSL, preventing you having to make cross-page connections which might detract from the clarity of the scheme.

# 6          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.

## 6.1         TRIP LED LOGIC

When a trip occurs, the trip LED is illuminated. It is possible to reset this with a number of ways:

- Directly with a reset command (by pressing the Clear Key)
- With a reset logic input
- With self-resetting logic

You enable the automatic self-resetting with the **Sys Fn Links** cell in the *SYSTEM DATA* column. A '0' disables self resetting and a '1' enables self resetting.

The reset occurs when the circuit is reclosed and the **Any Pole Dead** signal has been reset for three seconds providing the **Any Start** signal is inactive. The reset is prevented if the **Any Start** signal is active after the breaker closes.

The Trip LED logic is as follows:
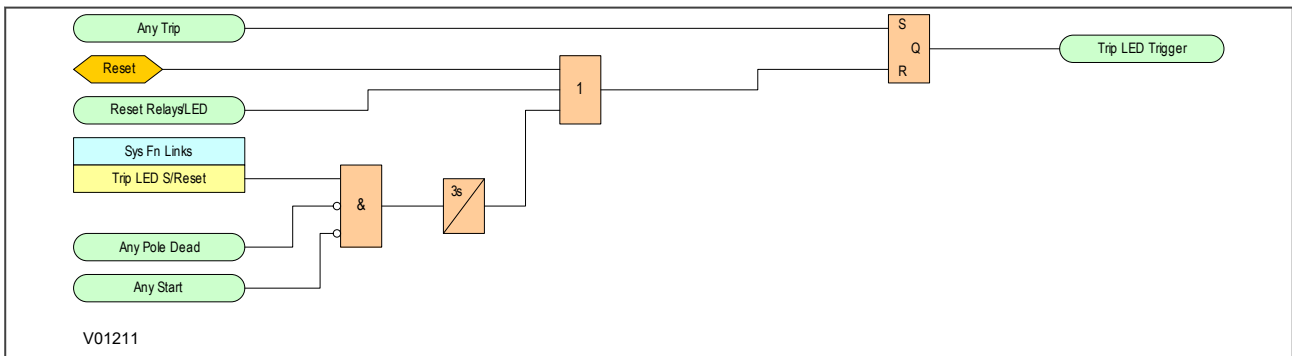


**Figure 106: Trip LED logic**

# 7          CONFIGURING PROGRAMMABLE LEDS

There are three types of programmable LED signals which vary according to the model being used. These are:

- Single-colour programmable LED. These are red when illuminated.
- Tri-colour programmable LED. These can be illuminated red, green, or amber.
- Tri-colour programmable LED associated with a Function Key. These can be illuminated red, green, or amber.

DDB signals are mapped in the PSL and used to illuminate the LEDs. For single-coloured programmable LEDs there is one DDB signal per LED. For tri-coloured LEDs there are two DDB signals associated with the LED. Asserting **LED # Grn** will illuminate the LED green. Asserting **LED # Red** will illuminate the LED red. Asserting both DDB signals will illuminate the LED amber.

The illumination of an LED is controlled by means of a conditioner. Using the conditioner, you can decide whether the LEDs reflect the real-time state of the DDB signals, or whether illumination is latched pending user intervention.

To map an LED in the PSL you should use the LED Conditioner button in the toolbar to import it. You then condition it according to your needs. The output(s) of the conditioner respect the attribute you have assigned.

The toolbar button for a tri-colour LED looks like this:



The PSL contribution that it delivers looks like this:
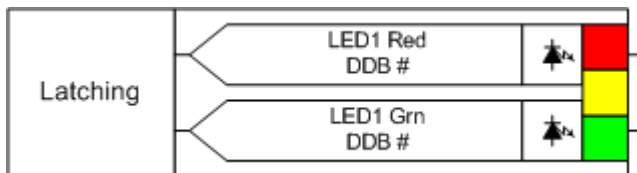


The toolbar button for a single-colour LED looks like this:



The PSL contribution that it delivers looks like this.
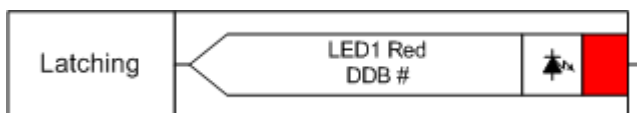


*Note:*
*LED Conditioners are only available if they have not all been used up, and in some default PSL schemes they might be. If that is the case and you want to use them for something else, you will need to re-assign them.*

On the toolbar there is another button associated with the LEDs. For a tri-coloured LED the button looks like this:



For a single-colour LED it looks like this:



It is the "LED Signal" button. It allows you to put replica instances of a conditioned LED into the PSL, preventing you having to make cross-page connections which might detract from the clarity of the scheme.

*Note:*
*All LED DDB signals are always shown in the PSL Editor. However, the actual number of LEDs depends on the device hardware. For example, if a small 20TE device has only 4 programmable LEDs, LEDs 5-8 will not take effect even if they are mapped in the PSL.*

# 8      FUNCTION KEYS

For most models, a number of programmable function keys are available. This allows you to assign function keys to control functionality via the programmable scheme logic (PSL). Each function key is associated with a programmable tri-colour LED, which you can program to give the desired indication on activation of the function key.

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 found in the *FUNCTION KEYS* column.

Each function key is associated with a DDB signal as shown in the DDB table. You can map these DDB signals to any function available in the PSL.

The ***Fn Key Status*** cell displays the status (energised or de-energised) of the function keys by means of a binary string, where each bit represents a function key starting with bit 0 for function key 1.

Each function key has three settings associated with it, as shown:

- ***Fn Key (n)***, which enables or disables the function key
- ***Fn Key (n) Mode***, which allows you to configure the key as toggled or normal
- ***Fn Key (n) label***, which allows you to define the function key text that is displayed

The ***Fn Key (n)*** cell is used to enable (unlock) or disable (unlock) the function key signals in PSL. The Lock setting has been provided to prevent further activation on subsequent key presses. This allows function keys that are set to `Toggled` mode and their DDB signal active 'high', to be locked in their active state therefore 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.

When the ***Fn Key (n) Mode*** cell is set to `Toggle`, the function key DDB signal output will remain in the set state until a reset command is given. In the `Normal` mode, the function key DDB signal will remain energised for as long as the function key is pressed and will then reset automatically. In this mode, a minimum pulse duration can be programmed by adding a minimum pulse timer to the function key DDB output signal.

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

The status of all function keys are recorded in non-volatile memory. In case of auxiliary supply interruption their status will be maintained.

> *Note:*
> *All function key DDB signals are always shown in the PSL Editor. However, the actual number of function keys depends on the device hardware. For example, if a small 20TE device has no function keys, the function key DDBs mapped in the PSL will not take effect.*

## 9        CONTROL INPUTS

The control inputs are software switches, which can be set or reset locally or remotely. These inputs can be used to trigger any PSL function to which they are connected. There are three setting columns associated with the control inputs: *CONTROL INPUTS*, *CTRL I/P CONFIG* and *CTRL I/P LABELS*. These are listed in the Settings and Records appendix at the end of this manual.

## 10       INTER-PSL INPUTS AND OUTPUTS

To make the design of PSL schemes easier, P40 Agile provides a range of DDB signals for conncting PSL Inputs to PSL Outputs. these are called Inter-PSL inputs and outputs. This facility allows you to map many PSL input signals to a single Inter-PSL output signal, many PSL output signals to a single Inter-PSL input signal, and to join the Inter-PSL input signal to an Inter-PSL output signal. The Inter-PSL input signals can also be used to directly trigger the Disturbance Recorder.

# CHAPTER 14

# COMMUNICATIONS

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# 1          CHAPTER OVERVIEW

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This product supports Substation Automation System (SAS), and Supervisory Control and Data Acquisition (SCADA) communication. It embraces the evolution of communications technologies, since microprocessor technologies were introduced into protection, control, and monitoring devices - now known as Intelligent Electronic Devices for the substation (IEDs).

All products support rugged serial communications for SCADA and SAS applications. Optionally, any product can support Ethernet communications for more advanced SCADA and SAS applications.

This chapter contains the following sections:

## 2        COMMUNICATION INTERFACES

The MiCOM P40 Agile 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 | Local settings<br>Firmware download | Courier |
| Rear serial port 1 | Standard | RS485 / K-Bus | SCADA<br>Remote settings<br>IRIG-B | Courier, MODBUS, IEC 60870-5-103, DNP3.0 |
| Rear serial port 2 (order option) | Optional | RS485 | SCADA<br>Remote settings<br>IRIG-B | Courier |
| Rear Ethernet port | Optional | Ethernet/copper | SCADA<br>Remote settings | Courier, DNP3.0 over Ethernet, IEC 61850 (order option) |
| Rear Ethernet port | Optional | Ethernet/fibre | SCADA<br>Remote settings | Courier or DNP3.0 over Ethernet (order option) |

> *Note:*
> *Optional communication boards are always fitted into slot C and only slot C.*
> *It is only possible to fit one optional communications board, therefore Serial and Ethernet communications are mutually exclusive.*

## 3          SERIAL COMMUNICATION

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

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

USB is a relatively new standard, which replaces EIA(RS232) 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 and GE's K-Bus interface guide reference R6509.

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

### 3.1        UNIVERSAL SERIAL BUS

The USB port is used for connecting computers locally for the purposes of transferring settings, measurements and records to/from the computer to the IED and to download firmware updates from a local computer to 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.*
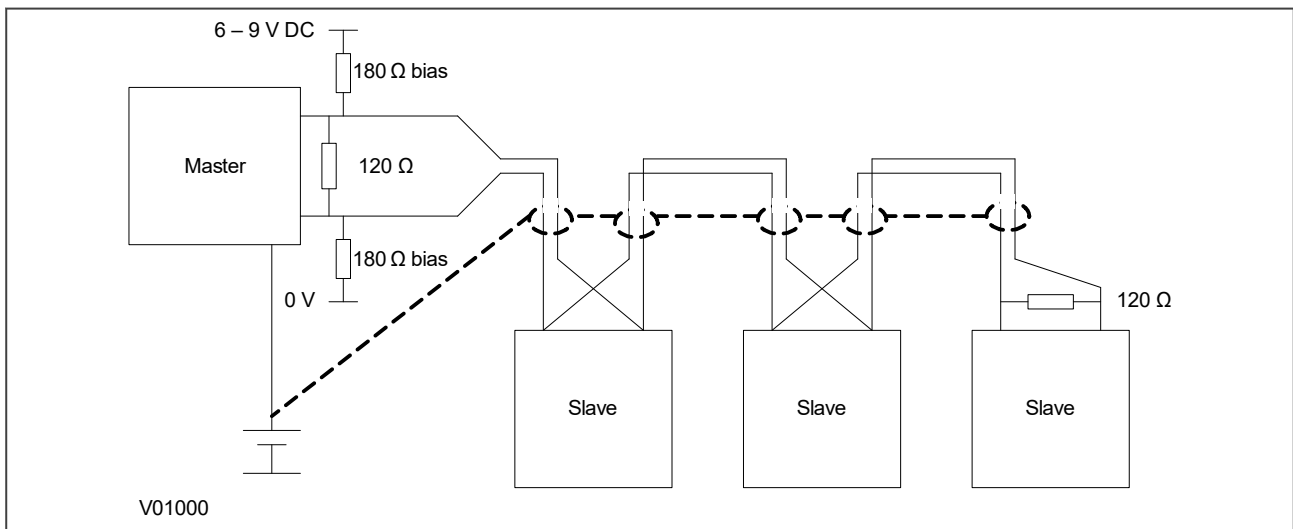


**Figure 107: RS485 biasing circuit**

⚠ **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 or KITZ102, 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.
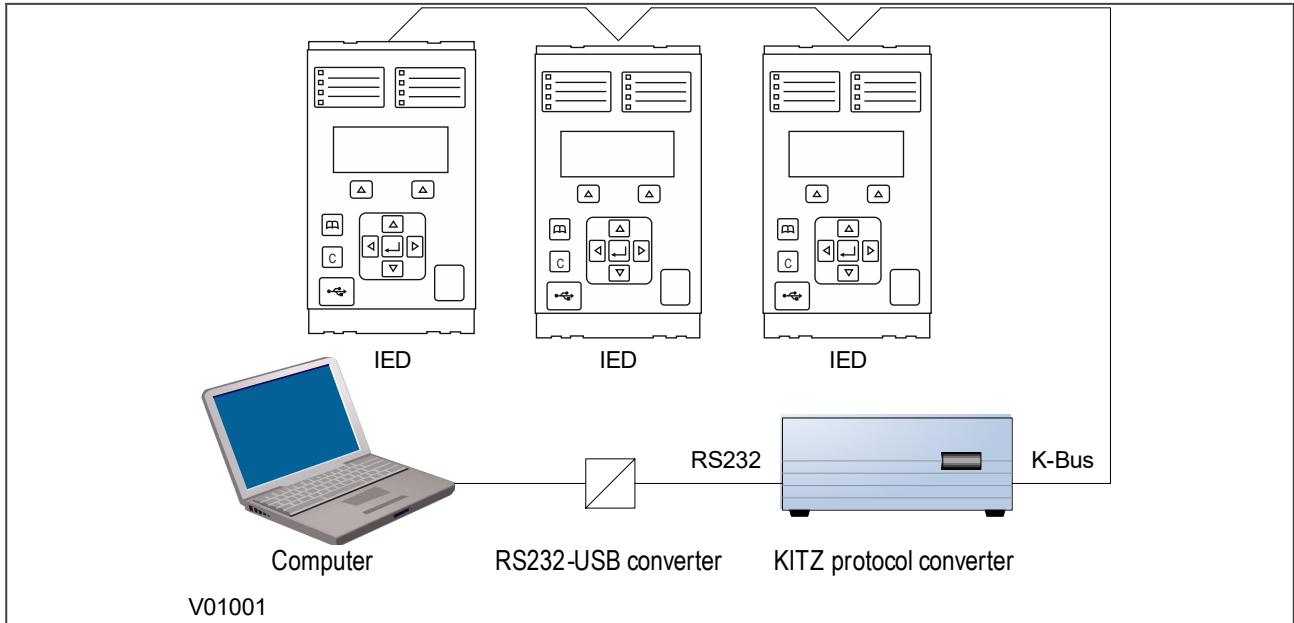
**Figure 108: Remote communication using K-Bus**

> *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 Ethernet interface is required for either IEC 61850 and/or DNP3 over Ethernet (protocol must be selected at time of order). With either of these protocols, the Ethernet interface also offers communication with MiCOM S1 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 LC connectors.

The device can also be connected to either a 10Base-T or a 100Base-TX Ethernet hub or switch using the RJ45 port. The port automatically senses which type of hub is connected. Due to noise and interference reasons, this connection type is only recommended for short-term connections over a short distance.

The pins on the RJ45connector are 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 |

# 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 facility. This is an in-built Network Interface Card (NIC), which incorporates an integrated Ethernet switch. The interface provides two Ethernet transmitter/receiver pairs, both of which are for the same physical medium (two copper, or two fibre). In addition to the two Ethernet transmitter/receiver pairs, the REB provides link activity indication.

Both industry standard PRP (Parallel Redundancy Protocol) and HSR (High-availability Seamless Redundancy) protocols are available by ordering option.

## 5.1        SUPPORTED PROTOCOLS

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.

P40Agile version 56 onwards supports redundant Ethernet. Variants for each of the following protocols are available:

- PRP (Parallel Redundancy Protocol)
- HSR (High-availability Seamless Redundancy)

PRP and HSR are open standards, so their implementation is compatible with any standard PRP or HSR device respectively. PRP provides "bumpless" redundancy.

## 5.2        PARALLEL REDUNDANCY PROTOCOL

PRP (Parallel Redundancy 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.
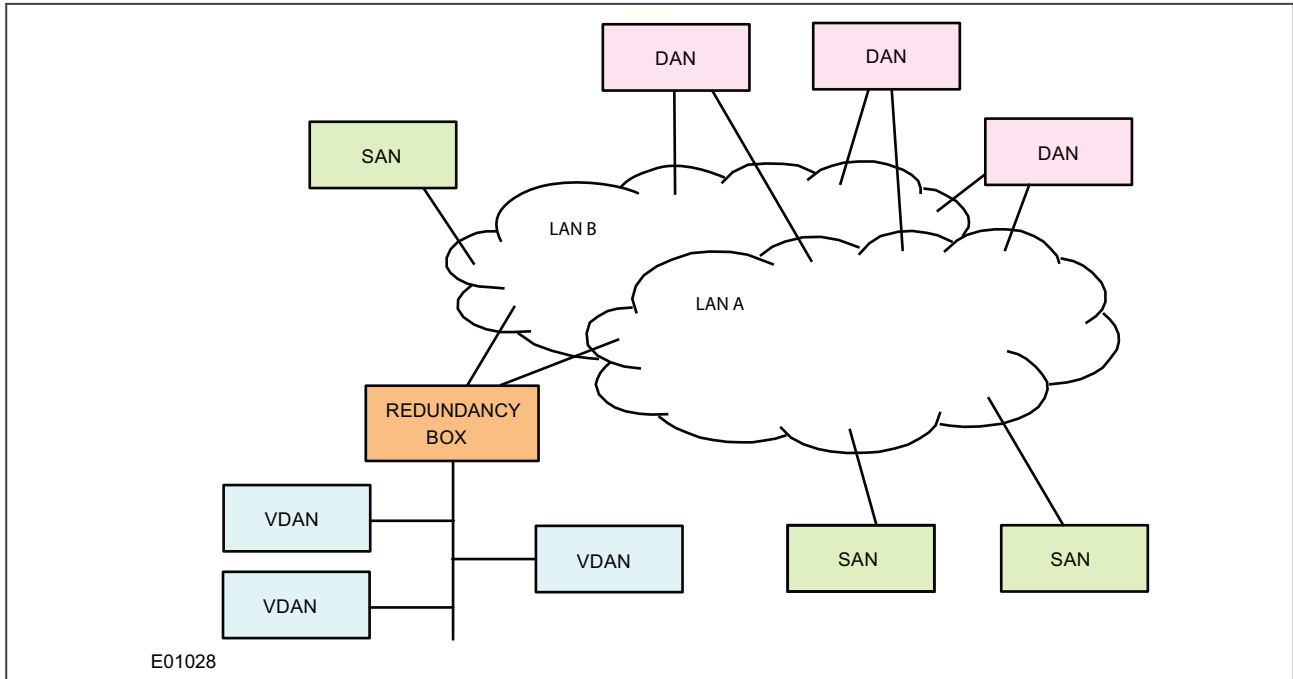
**Figure 109: IED attached to separate LANs**

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.
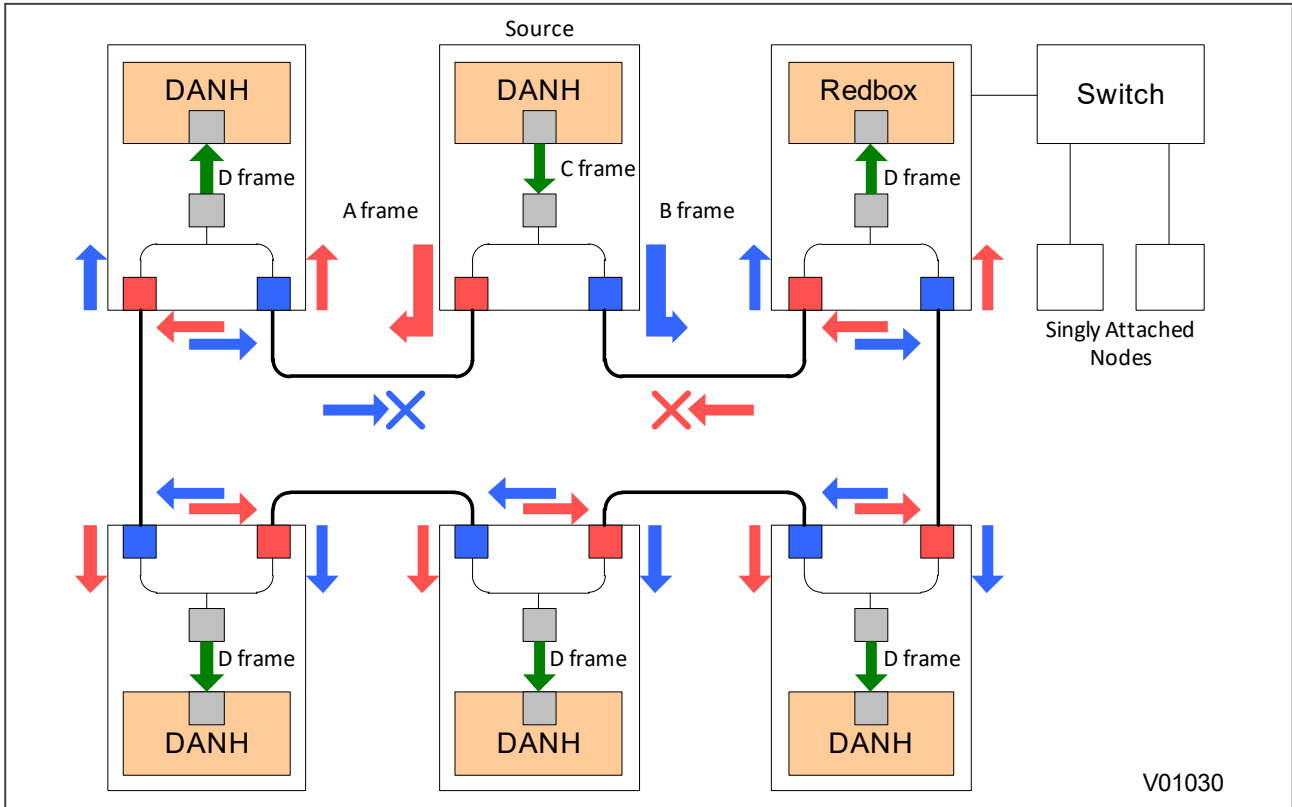
**Figure 110: HSR multicast topology**

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.
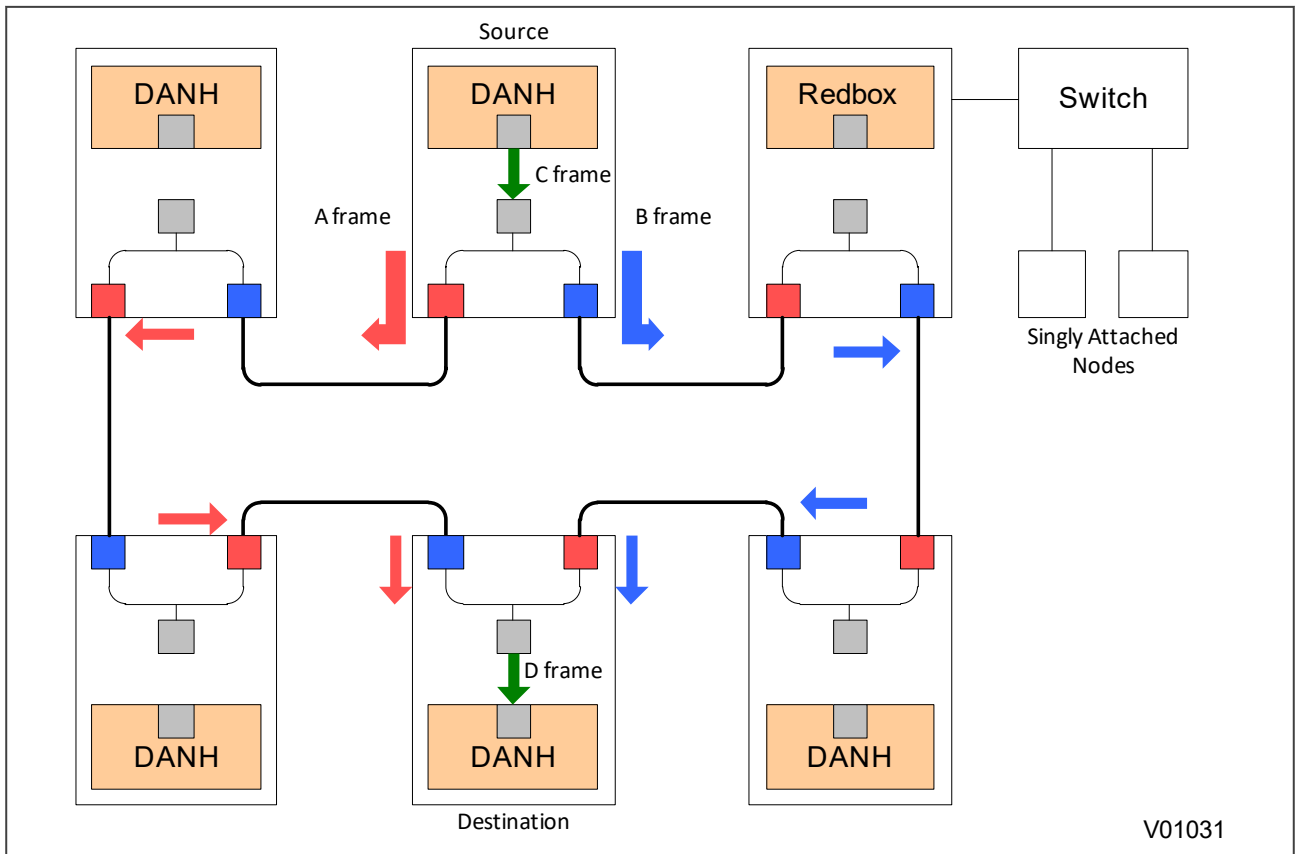
**Figure 111: HSR unicast topology**

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
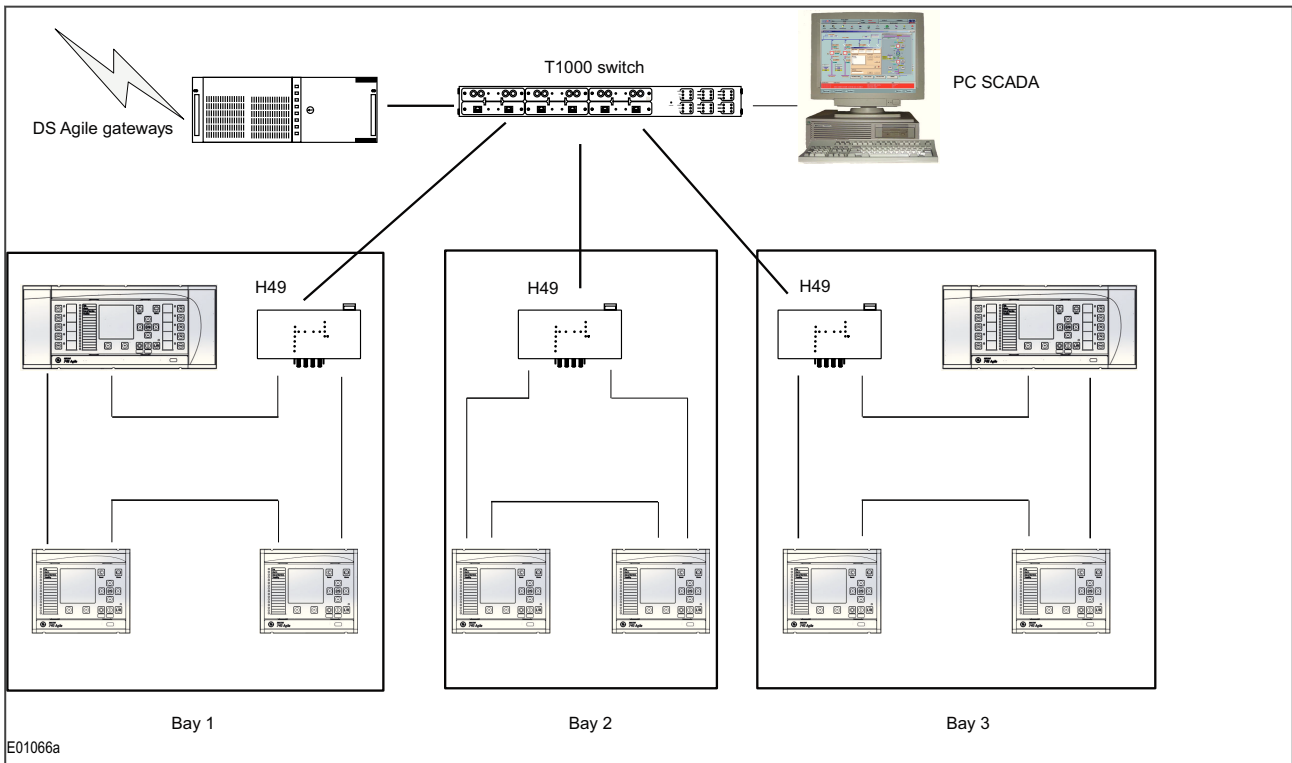


**Figure 112: HSR application in the substation**

## 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.
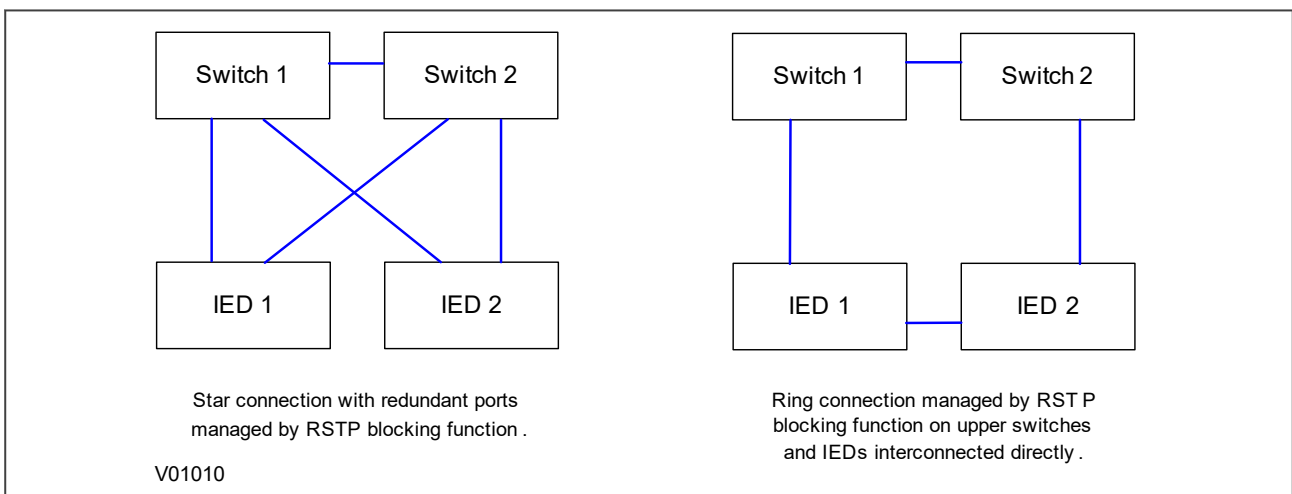


**Figure 113: IED attached to redundant Ethernet star or ring circuit**

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 oepration of the protocol.

## 5.5        CONFIGURING IP ADDRESS

The redundant Ethernet facility does not have any special IP address configuration requirements. There is just one IP address for the device, which can be configured using the IEC61850 configurator as for a standard Ethernet device.

The IED configurator will automatically display the PRP/HSR configuration parameters.

# 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 | K-Bus, RS485, Ethernet, USB | 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, Ethernet | Standard for SCADA communications developed by Harris. Used mainly in North America. |
| 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 DNP3.0 Courier | Courier | Courier |
|---|---|---|---|---|
| **Data Link Layer** | EIA(RS)485 | Ethernet | USB | K-Bus |
| **Physical Layer** | Copper or Optical Fibre | | | |

## 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 a 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

In the P40 Agile products, Courier can be used with three physical layer protocols: K-Bus, EIA(RS)485 and USB.

Three connection options are available for Courier:

- The front USB port - for connection to Settings application software on, for example, a laptop
- Rear serial port 1 - for permanent SCADA connection via RS485 or K-Bus
- The optional rear serial port 2 - for permanent SCADA connection via RS485 or K-Bus

The IED address and baud rate can be selected using the front panel menu or by a suitable application such as MiCOM S1 Agile.

### 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 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

There is just one option for IEC 60870-5-103:

- Rear serial port 1- for permanent SCADA connection via RS485

The IED address and baud rate can be selected using the front panel menu or by a suitable application such as MiCOM S1 Agile.

## 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 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.

## 6.2.5 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.

## 6.2.6 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 with maximum value of 2.4 times the rated value of the measurement.

## 6.2.7 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'.

## 6.2.8 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'.

### 6.2.9 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.*

### 6.2.10 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

### 6.2.11 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**). Set this to the table 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      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).

### 6.3.1      PHYSICAL CONNECTION AND LINK LAYER

DNP 3.0 can be used with two physical layer protocols: EIA(RS)485, or Ethernet.

Several connection options are available for DNP 3.0

- Rear serial port 1 - for permanent SCADA connection via RS485
- The rear Ethernet RJ45 port on the optional Ethernet board - for permanent SCADA Ethernet connection
- The rear Ethernet fibre port on the optional Ethernet board - for permanent SCADA Ethernet connection

With DNP3 Over Ethernet, a maximum of 10 Clients can be configured. They are configured using the DNP3 Configurator

The IED address and baud rate can be selected using the front panel menu or by a suitable application such as MiCOM Agile.

When using a serial interface, the data format is: 1 start bit, 8 data bits, 1 stop bit and optional configurable parity bit.

### 6.3.2     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.

> *Note:*
> *For the DNP Events to be transmitted it is mandatory to have the corresponding DDBs of the Configured Point Index to be included in the Courier Event Record. The RECORD CONTROL Menu lists all the DDBs, and the mask settings control their inclusion/exclusion as a Courier Event.*

### 6.3.3     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.
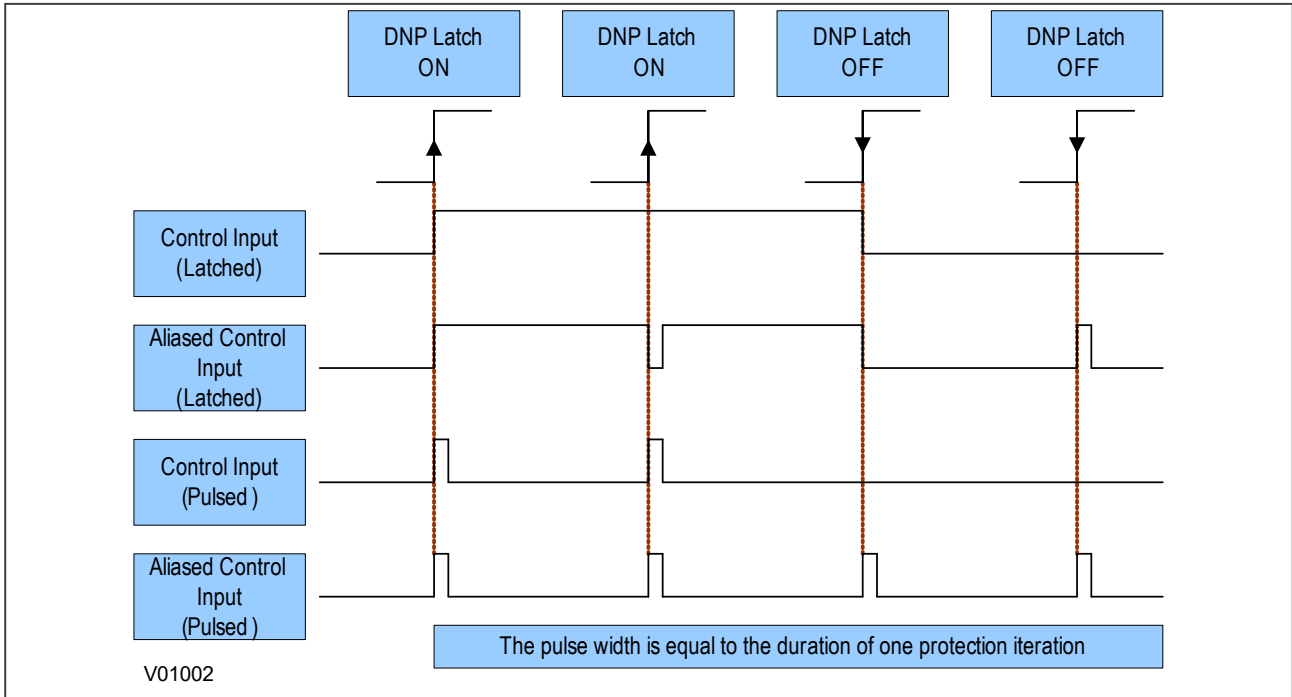
**Figure 114: Control input behaviour**

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

### 6.3.4    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.

### 6.3.5    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).

### 6.3.6 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.

### 6.3.7 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.

### 6.3.8 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.

#### 6.3.8.1 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 |

| DNP 3.0 Device Profile Document | |
|---|---|
| Highest DNP Level Supported*: <br> *This is the highest DNP level FULLY supported. Parts of level 3 are also supported | For Requests: Level 2 <br> 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): <br> 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)) <br> Static object requests sent with qualifiers 00, 01, 06, 07, or 08 will be responded with qualifiers 00 or 01 <br> Static object requests sent with qualifiers 17 or 28 will be responded with qualifiers 17 or 28 <br> For change-event object requests, qualifiers 17 or 28 are always responded <br> 16-bit and 32-bit analogue change events with time may be requested <br> The read function code for Object 50 (time and date) variation 1 is supported <br> Analogue Input Deadbands, Object 34, variations 1 through 3, are supported <br> Floating Point Analogue Output Status and Output Block Objects 40 and 41 are supported <br> Sequential file transfer, Object 70, variations 2 through 7, are supported <br> Device Attribute Object 0 is supported | |
| Maximum Data Link Frame Size (octets): | Transmitted: 292 <br> Received: 292 |
| Maximum Application Fragment Size (octets) | Transmitted: Configurable (100 to 2048). Default 2048 <br> 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) <br> 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. |
| 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 |

| DNP 3.0 Device Profile Document | |
|---|---|
| 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<br>No other options are permitted |
| Default Counter Object/Variation: | Configurable, Point-by-point list attached<br>Default object: 20<br>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 |

### 6.3.8.2    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<br>22 | (read)<br>(assign class) | 00, 01<br>06<br>07, 08<br>17, 27, 28 | (start-stop)<br>(no range, or all)<br>(limited qty)<br>(index) | | | | |
| 1 | 1<br>(default - see note 1) | Binary Input | 1 | (read) | 00, 01<br>06<br>07, 08<br>17, 27, 28 | (start-stop)<br>(no range, or all)<br>(limited qty)<br>(index) | 129 | response | 00, 01<br>17, 28 | (start-stop)<br>(index - see note 2) |
| 1 | 2 | Binary Input with Flag | 1 | (read) | 00, 01<br>06<br>07, 08<br>17, 28 | (start-stop)<br>(no range, or all)<br>(limited qty)<br>(index) | 129 | response | 00, 01<br>17, 28 | (start-stop)<br>(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) | |
| 2 | 0 | Binary Input Change - Any Variation | 1 | (read) | 06<br>07, 08 | (no range, or all)<br>(limited qty) | | | | |
| 2 | 1 | Binary Input Change without Time | 1 | (read) | 06<br>07, 08 | (no range, or all)<br>(limited qty) | 129 | response | 17, 28 | (index) |
| 2 | 2 | Binary Input Change with Time | 1 | (read) | 06<br>07, 08 | (no range, or all)<br>(limited qty) | 129 | response | 17, 28 | (index) |
| 10 | 0 | Binary Output Status - Any Variation | 1 | (read) | 00, 01<br>06<br>07, 08<br>17, 27, 28 | (start-stop)<br>(no range, or all)<br>(limited qty)<br>(index) | | | | |
| 10 | 2 (default - see note 1) | Binary Output Status | 1 | (read) | 00, 01<br>06<br>07, 08<br>17, 28 | (start-stop)<br>(no range, or all)<br>(limited qty)<br>(index) | 129 | response | 00, 01<br>17, 28 | (start-stop)<br>(index - see note 2) |
| 12 | 1 | Control Relay Output Block | 3<br>4<br>5<br>6 | (select)<br>(operate)<br>(direct op)<br>(dir. op, noack) | 17, 28 | (index) | 129 | response | | echo of request |
| 20 | 0 | Binary Counter - Any Variation | 1<br>22 | (read)<br>(assign class) | 00, 01<br>06<br>07, 08<br>17, 27, 28 | (start-stop)<br>(no range, or all)<br>(limited qty)<br>(index) | | | | |
| | | | 7<br>8<br>9<br>10 | (freeze)<br>(freeze noack)<br>(freeze clear)<br>(frz. cl. Noack) | 00, 01<br>06<br>07, 08 | (start-stop)<br>(no range, or all)<br>(limited qty) | | | | |
| 20 | 1 | 32-Bit Binary Counter with Flag | 1 | (read) | 00, 01<br>06<br>07, 08<br>17, 27, 28 | (start-stop)<br>(no range, or all)<br>(limited qty)<br>(index) | 129 | response | 00, 01<br>17, 28 | (start-stop)<br>(index - see note 2) |
| 20 | 2 | 16-Bit Binary Counter with Flag | 1 | (read) | 00, 01<br>06<br>07, 08<br>17, 27, 28 | (start-stop)<br>(no range, or all)<br>(limited qty)<br>(index) | 129 | response | 00, 01<br>17, 28 | (start-stop)<br>(index - see note 2) |
| 20 | 5 (default - see note 1) | 32-Bit Binary Counter without Flag | 1 | (read) | 00, 01<br>06<br>07, 08<br>17, 27, 28 | (start-stop)<br>(no range, or all)<br>(limited qty)<br>(index) | 129 | response | 00, 01<br>17, 28 | (start-stop)<br>(index - see note 2) |
| 20 | 6 | 16-Bit Binary Counter without Flag | 1 | (read) | 00, 01<br>06<br>07, 08<br>17, 27, 28 | (start-stop)<br>(no range, or all)<br>(limited qty)<br>(index) | 129 | response | 00, 01<br>17, 28 | (start-stop)<br>(index - see note 2) |
| 21 | 0 | Frozen Counter - Any Variation | 1 | (read) | 00, 01<br>06<br>07, 08<br>17, 27, 28 | (start-stop)<br>(no range, or all)<br>(limited qty)<br>(index) | | | | |
| 21 | 1 | 32-Bit Frozen Counter with Flag | 1 | (read) | 00, 01<br>06<br>07, 08<br>17, 27, 28 | (start-stop)<br>(no range, or all)<br>(limited qty)<br>(index) | 129 | response | 00, 01<br>17, 28 | (start-stop)<br>(index - see note 2) |
| 21 | 2 | 16-Bit Frozen Counter with Flag | 1 | (read) | 00, 01<br>06<br>07, 08<br>17, 27, 28 | (start-stop)<br>(no range, or all)<br>(limited qty)<br>(index) | 129 | response | 00, 01<br>17, 28 | (start-stop)<br>(index - see note 2) |
| 21 | 5 | 32-Bit Frozen Counter with Time of Freeze | 1 | (read) | 00, 01<br>06<br>07, 08<br>17, 27, 28 | (start-stop)<br>(no range, or all)<br>(limited qty)<br>(index) | 129 | response | 00, 01<br>17, 28 | (start-stop)<br>(index - see note 1) |
| 21 | 6 | 16-Bit Frozen Counter with Time of Freeze | 1 | (read) | 00, 01<br>06<br>07, 08<br>17, 27, 28 | (start-stop)<br>(no range, or all)<br>(limited qty)<br>(index) | 129 | response | 00, 01<br>17, 28 | (start-stop)<br>17, 28 (index - see note 1) |
| 21 | 9 (default - see note 1) | 32-Bit Frozen Counter without Flag | 1 | (read) | 00, 01<br>06<br>07, 08<br>17, 27, 28 | (start-stop)<br>(no range, or all)<br>(limited qty)<br>(index) | 129 | response | 00, 01<br>17, 28 | (start-stop)<br>(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 | 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) |
| 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) |

| 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) |
| 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 |
| 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) | | | |

| 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) | |
| | | | 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.

### 6.3.8.3    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 |

| Bit | Indication | Description | Supported |
|-----|-----------|-------------|-----------|
| 1 | Class 1 data available | Set when data that has been configured as Class 1 data is ready to be sent to the master.<br>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.<br>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.<br>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).<br>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.<br>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.<br>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 |
| 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. | |

### 6.3.8.4    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.<br>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.*

### 6.3.9  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
```

### 6.3.9.1    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**.

### 6.3.10    DNP3 UNSOLICITED REPORTING

In previous versions, DNP3 only supports data transmission based on poll requests from the master station. From this version onwards, a new mode of transmission called Unsolicited Reporting is supported. This is a mode of operation where the outstation spontaneously transmits a response without having received a specific request for data. This mode is useful when the system has many outstations and the master requires notification as soon as possible after a change occurs. Rather than waiting for a master station polling cycle, the outstation transmits the change immediately. It is thus event driven rather than poll driven.

This feature requires a new group of settings, which are found under the DNP SETTINGS column (Courier cell range 1B). These can be found in the settings tables available as an interactive PDF at the back of the manual.

> *Note:*
> *We advise you not to enable Unsolicited Reporting on a serial multi-drop line. This is due the fact that collisions may result from multiple IEDs reporting concurrent events. If Unsolicited Reporting is enabled on a serial line, we recommend connecting only one IED per master link. This restriction is not applicable if DNP3 Over Ethernet is used.*

## 6.4        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).

### 6.4.1      PHYSICAL CONNECTION AND LINK LAYER

Only one option is available for connecting MODBUS

- Rear serial port 1 - for permanent SCADA connection via EIA(RS)485

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 a suitable application such as MiCOM Agile.

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).

### 6.4.2      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)

### 6.4.3      RESPONSE CODES

| MCode | MODBUS Description | MiCOM Interpretation |
|-------|--------------------|----------------------|
| 01 | Illegal Function Code | The function code transmitted is not supported by the slave. |

| MCode | MODBUS Description | MiCOM Interpretation |
|-------|-------------------|----------------------|
| 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.<br>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. |

### 6.4.4    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.*

### 6.4.5    EVENT EXTRACTION

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

#### 6.4.5.1    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.

### 6.4.5.2    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.

### 6.4.5.3    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. |
| MODBUS Address | 30110 | 1 | This indicates the MODBUS register address where the change occurred.<br>Alarm 30011<br>Relays 30723<br>Optos 30725<br>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.<br>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.<br>1 means fault record data can be read from 30113 to 30199 (number of registers depends on the product).<br>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.

### 6.4.6    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:<br>b0: Out of service<br>b1: Minor self test failure<br>b2: Event<br>b3: Time synchronization<br>b4: Disturbance<br>b5: Fault<br>b6: Trip<br>b7: Alarm<br>b8 to b15: Unused<br>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. |
| 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:<br>b0: Select next event<br>b1: Accept event<br>b2: Select next disturbance record<br>b3: Accept disturbance record<br>b4: Select next page of disturbance data<br>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. |

### 6.4.6.1    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.
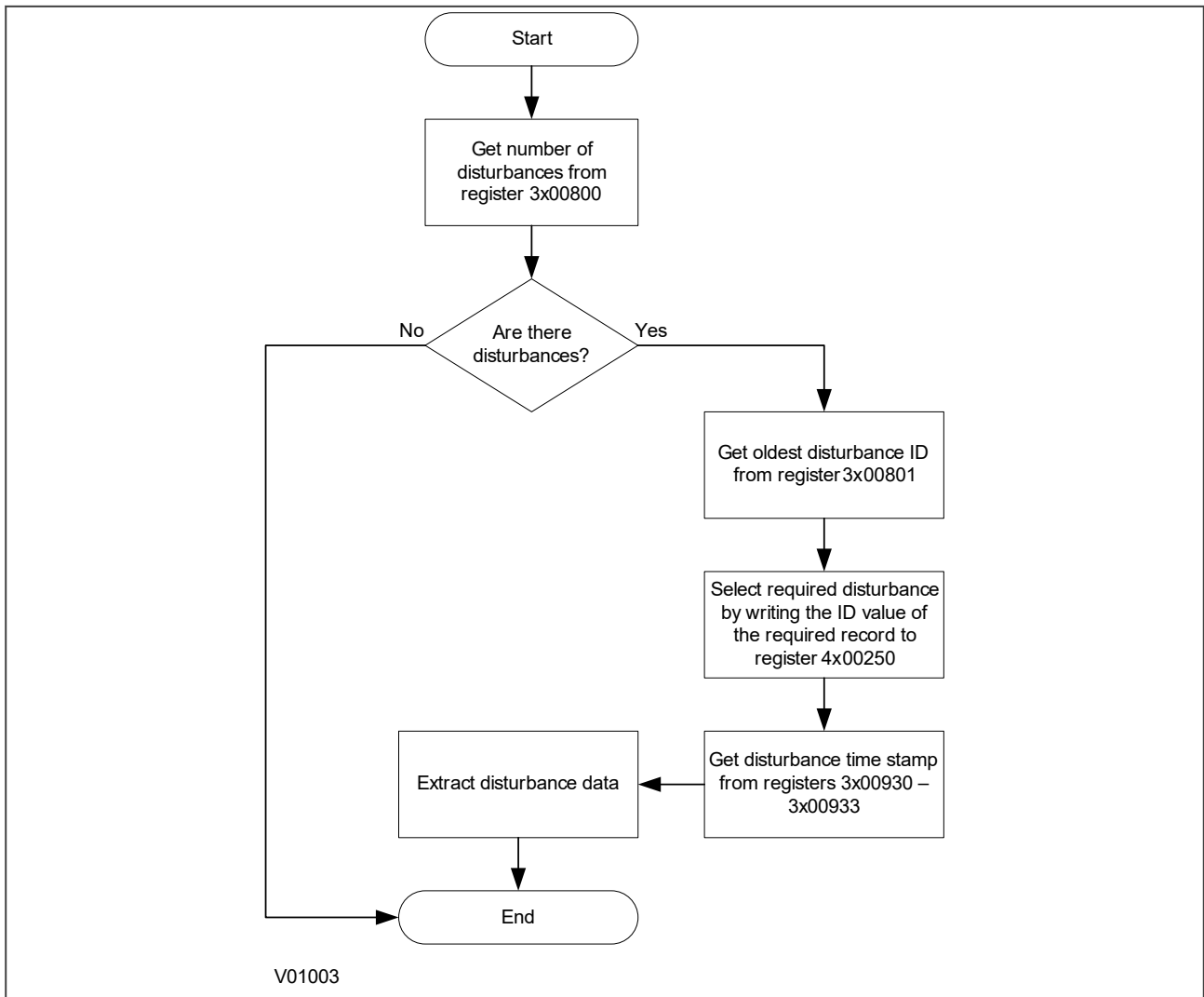
**Figure 115: Manual selection of a disturbance record**

#### 6.4.6.2    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).
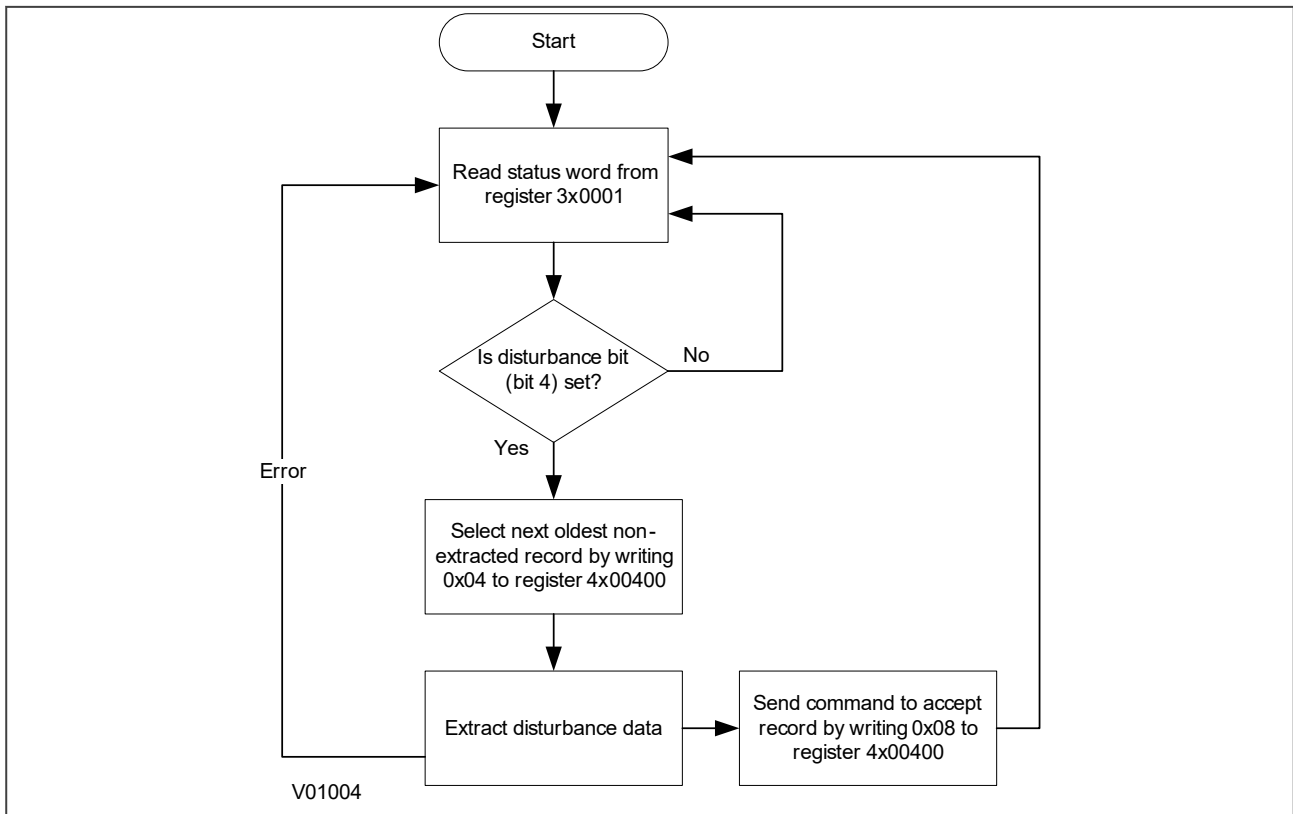
**Figure 116: Automatic selection of disturbance record - method 1**

## 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.
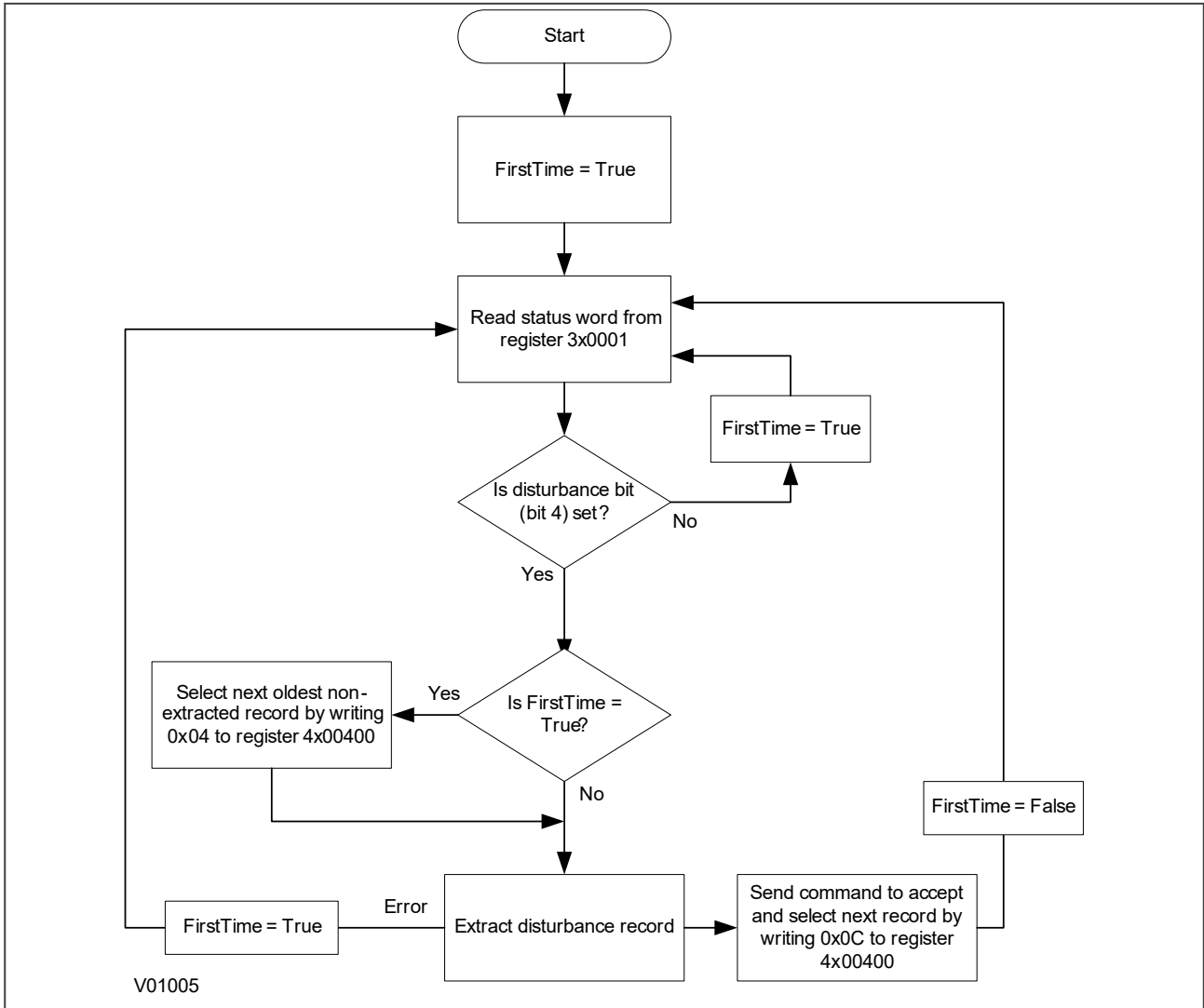
**Figure 117: Automatic selection of disturbance record - method 2**

### 6.4.6.3   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 <u>must</u> be extracted first, followed by the data file:

**Extracting the Comtrade configuration file**
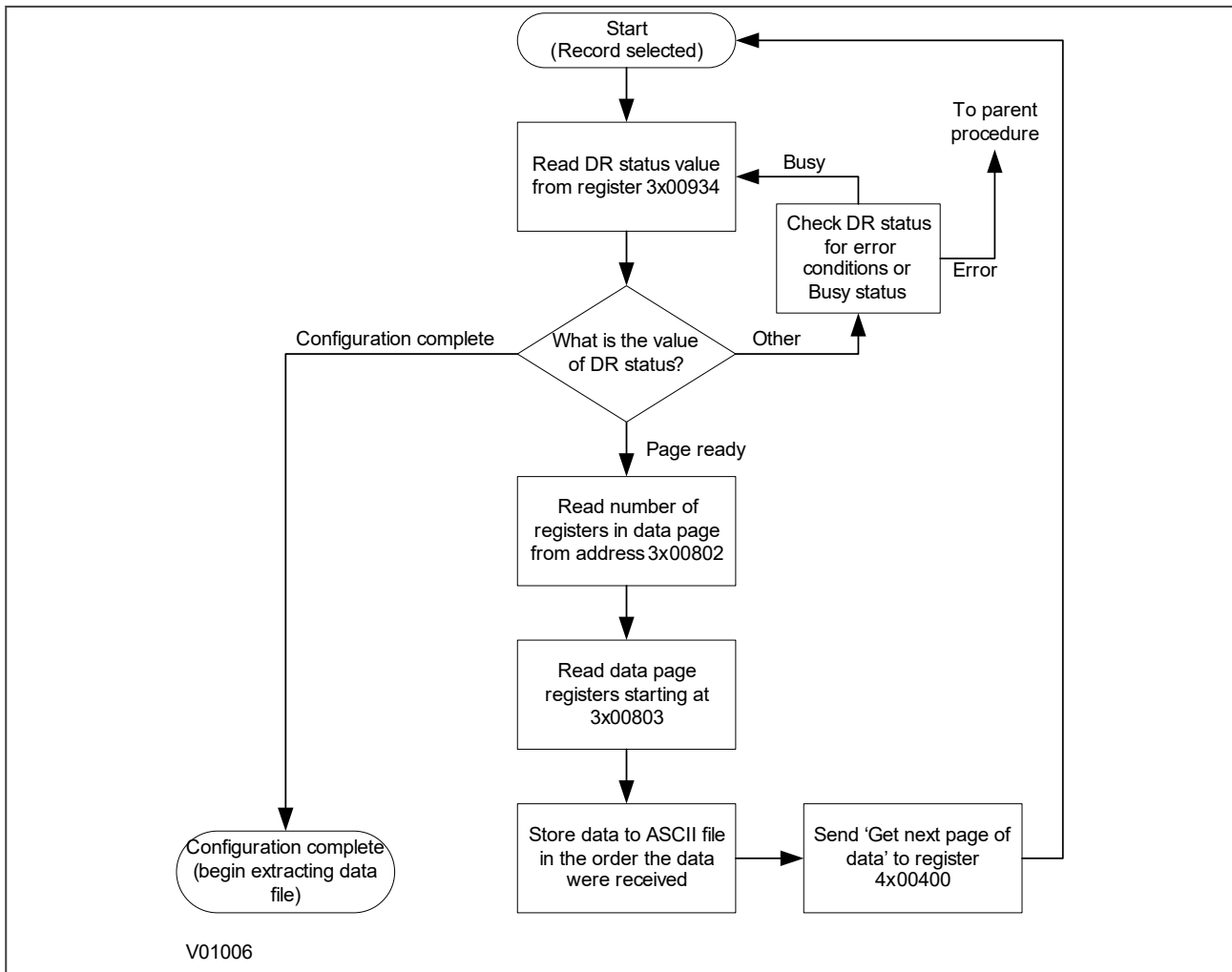


Figure 118: Configuration file extraction

**Extracting the comtrade data file**
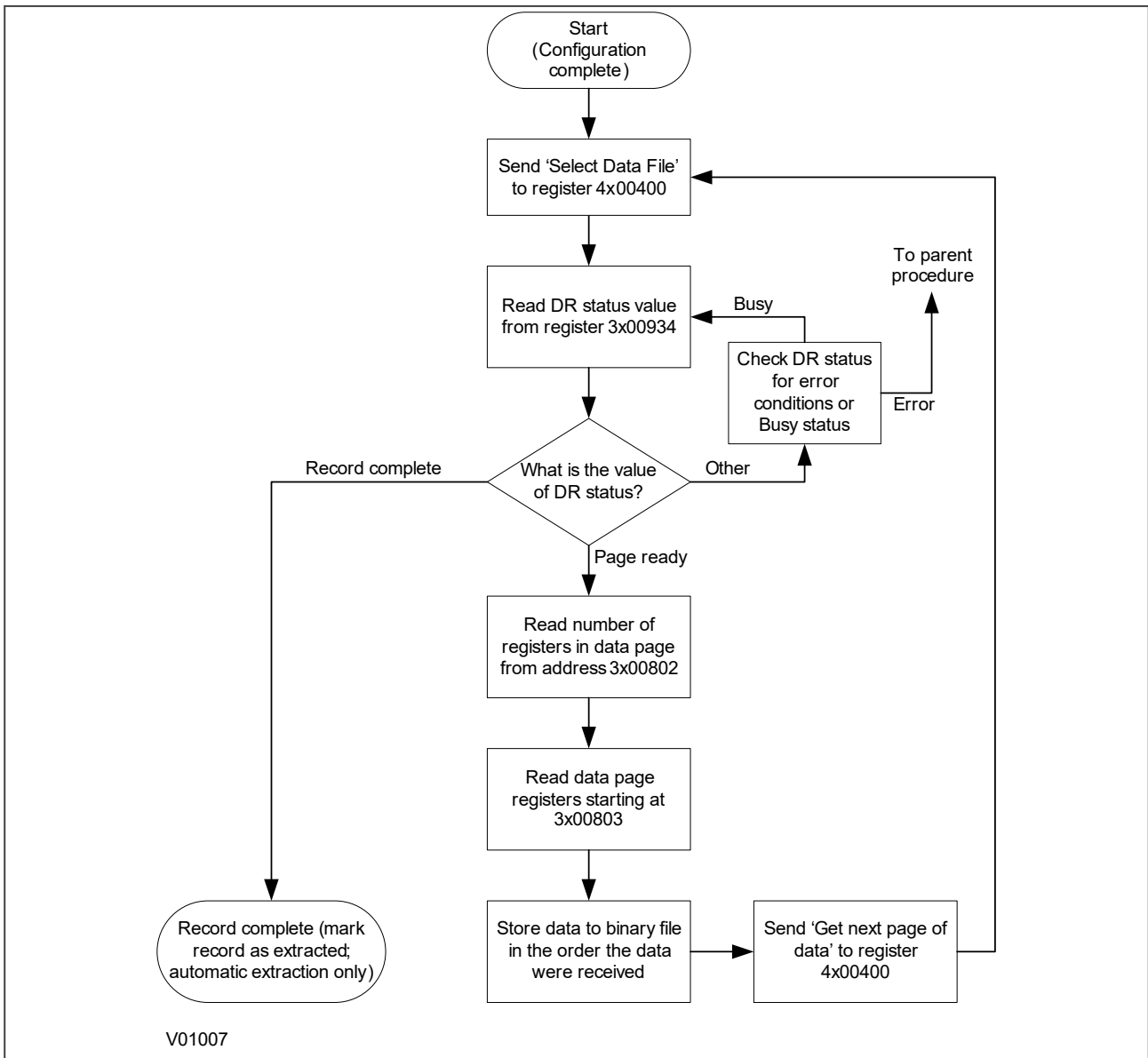


Figure 119: Data file extraction

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. |

### 6.4.7 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.

### 6.4.8 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 |

### 6.4.9 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.

## 6.4.10   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

| Byte | Bit Position | | | | | | | |
|------|------|------|------|------|------|------|------|------|
|      | 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).

### 6.4.11      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 × 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.

## 6.4.12    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
```

## 6.5      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.

Software Version 70 onwards provides an IEC 61850 Edition 2 compatible implementation.

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.
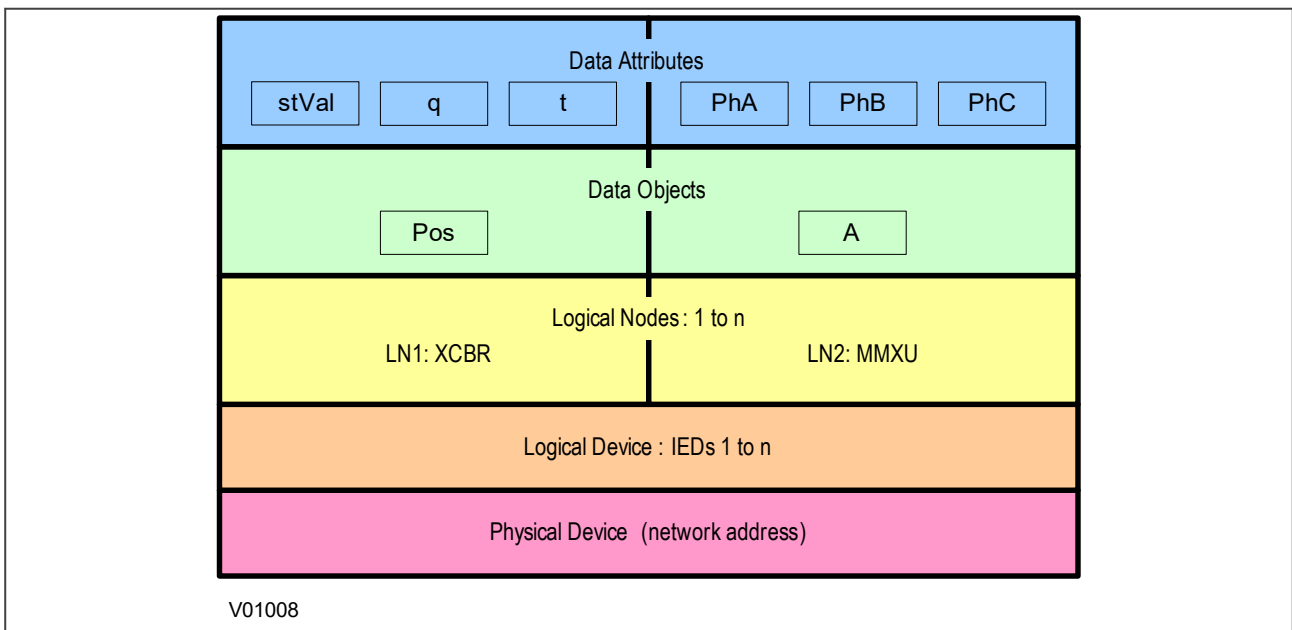


**Figure 120: Data model layers in IEC 61850**

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. |

| Layer | Description |
|---|---|
| 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.<br>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 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

#### 6.5.8.1 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.

### 6.5.9 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.

#### 6.5.9.1 ETHERNET DISCONNECTION

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.

### 6.5.9.2    LOSS OF POWER

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.

### 6.5.10    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.*

### 6.5.10.1    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.

### 6.5.10.2    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.

## 6.5.11       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.

### 6.5.11.1      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:
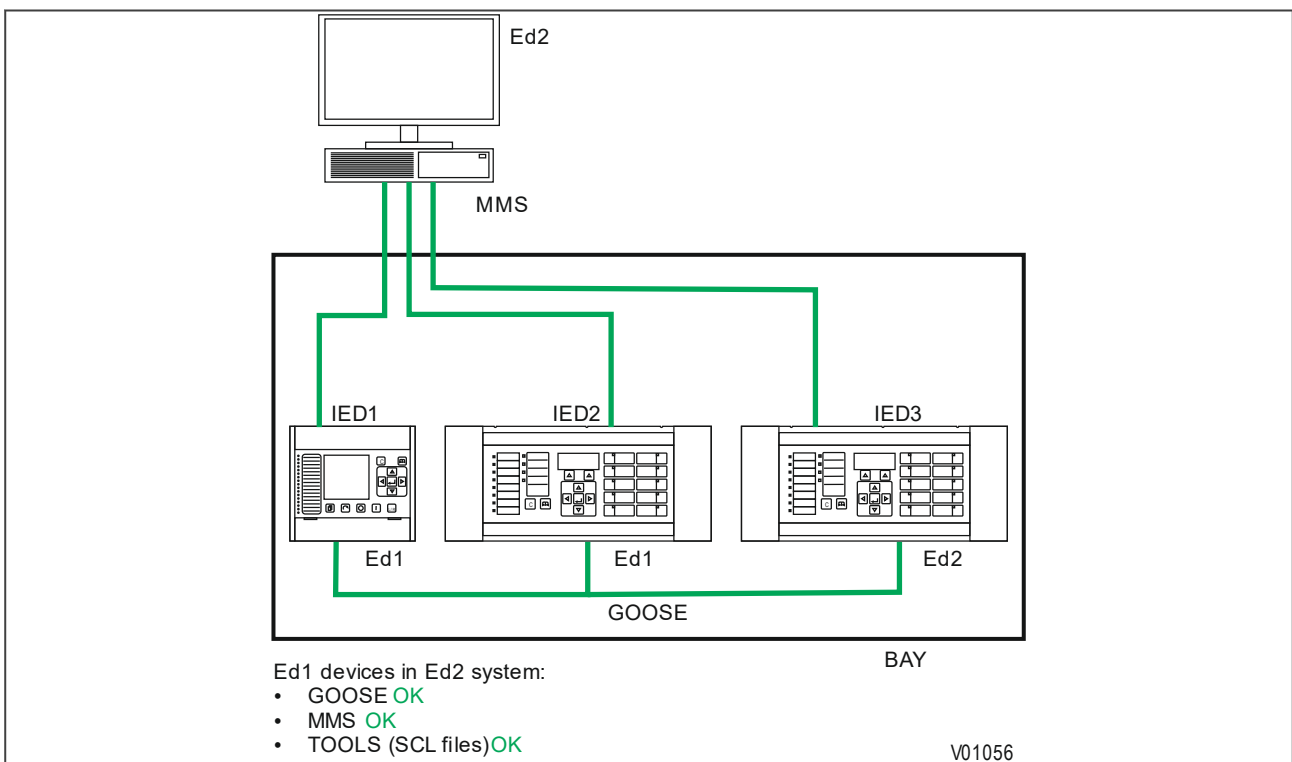


**Figure 121: Edition 2 system - backward compatibility**

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.
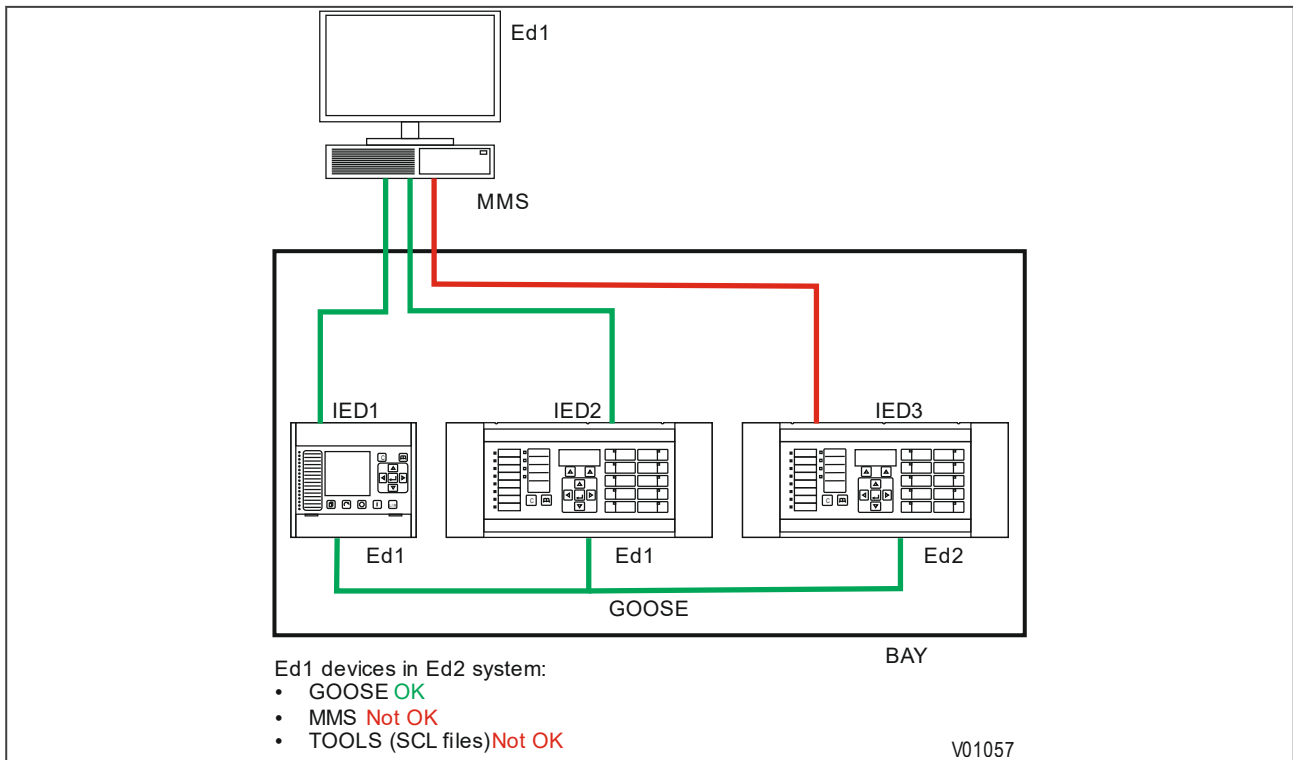
**Figure 122: Edition 1 system - forward compatibility issues**

### 6.5.11.2    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.

## 6.6        CONCURRENT IEC 61850 AND DNP3.0 OPERATION

**No Redundancy**

Simultaneous IEC 61850 and DNP3.0 operation may be achieved using single or dual IP addresses.

Where concurrent IEC61850 & DNP3 uses a dual IP address configuration (defined via ordering option), Port A is dedicated to IEC 61850 (configured with or without SNTP), and Port B is dedicated to DNP3.0. Configuration settings are applied via IED Configurator Communications and DNP Over Ethernet Settings respectively. In this case, no Redundancy option is available.

> *Note:*
> *SNTP may only be configured via the IED Configurator tool.*

> *Note:*
> *When concurrent IEC61850 & DNP3 uses a dual IP address configuration, the Redundancy list in the IED Configurator tool is visible but ineffective.*

Where concurrent IEC61850 & DNP3 uses a single IP address setup with no redundancy required, configuration settings are applied via the IED Configurator and DNP3 settings respectively, with Redundancy set to NONE.

### With Redundancy

Simultaneous IEC 61850 and DNP3.0 with FAILOVER, RSTP, PRP or HSP Redundancy is only possible where concurrent IEC61850 & DNP3 uses a single IP address. With Redundancy set to FAILOVER, either Port A or B may be selected, but when set to RSTP, PRP or HSR redundancy protocols, IEC 61850 and DNP3.0 communications (configured with or without SNTP) no port is specified.

> *Note:*
> *Redundancy and SNTP may only be configured via the IED Configurator tool.*

> *Note:*
> *The IP address, Subnet and Gateway may be set with either configuration tool, (IED Configurator Communications or DNP3 Over Ethernet settings), but only the last values sent will be configured, as only one IP address/Subnet/Gateway is used in a single IP Address setup. It is therefore recommended that the same IP address is entered into both configuration tools.*

To confirm the network interface protocol is set to concurrent IEC 61850 and DNP3, navigate to the device's *COMMUNICATIONS* column and check that **NIC Protocol** is set to `IEC61850 & DNP3`:

```
COMMUNICATIONS
NIC Protocol
IEC61850 & DNP3
```

To confirm the IP address setting for IEC 61850, navigate to the Device's *IEC61850 CONFIG.* column and check the **IP Address** setting:

```
IEC61850 CONFIG.
IP Address
192.168.1.1
```

To confirm the IP address setting for DNP, navigate to the Device's *DNP SETTINGS* column and check the **IP Address** setting:

```
DNP SETTINGS
IP Address
192.168.1.1
```

*Note:*
*It is recommended that a maximum of two communication protocols are configured to operate concurrently.*

## 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 + DNP3 OE)
- 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.
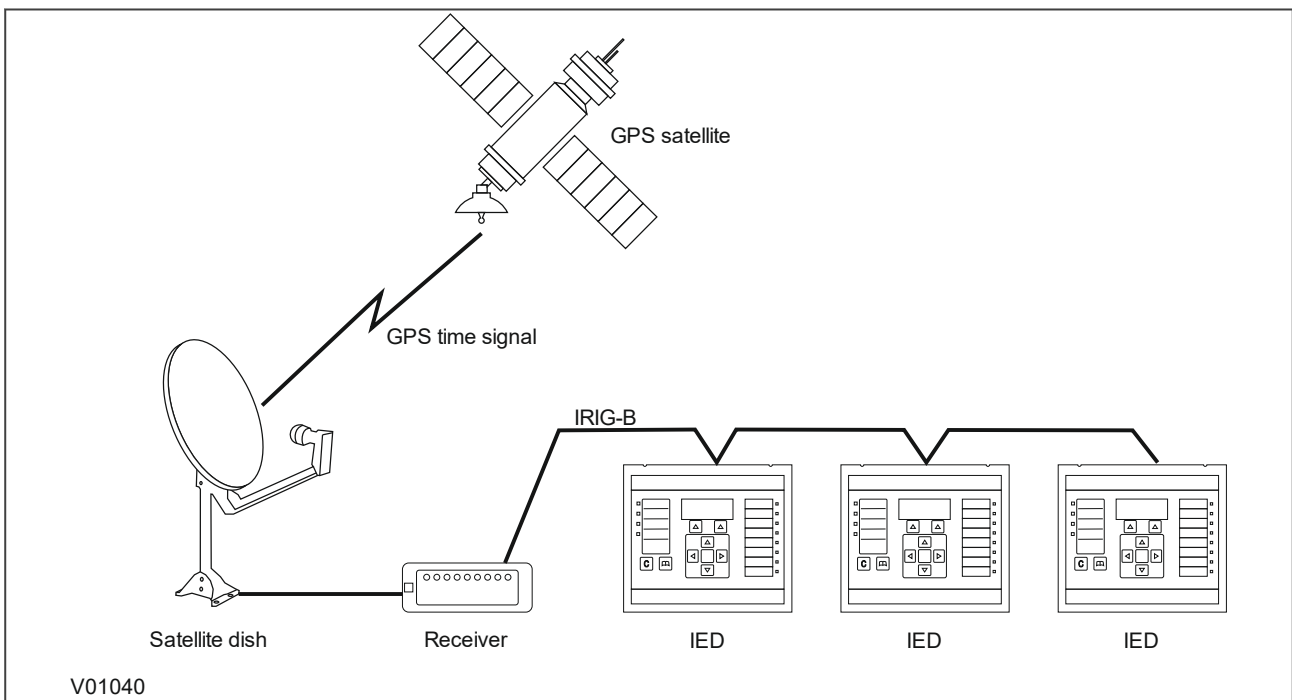


**Figure 123: GPS Satellite timing signal**

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    DEMODULATED IRIG-B IMPLEMENTATION

All models have the option of accepting a demodulated IRIG-B input. This is a hardware option and it uses the same terminals as the RP1 (or RP2 if applicable) inputs. You cannot have IRIG-B and a serial port in the same slot. This means 20Te models cannot have both IRIG-B time synchronisation and serial communications capability. For 30TE and 40TE models however, it is possible to have IRIG-B in one slot and a serial port in another, provided this option is ordered.

To set the device to use IRIG-B, use the setting **IRIG-B Sync** cell in the *DATE AND TIME* column. This can be set to `None` (for no IRIG-B), `RP1` (for the option where IRIG-B uses terminals 54 and 56) and `RP2` (for the option where IRIG-B uses terminals 82 and 84)

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.

### 8.2.1    LOSS OF SNTP SERVER SIGNAL ALARM

This function issues an alarm when there is a loss of time synchronization on the SNTP server. It is issued when the SNTP sever has not detected a valid time synchronisation response within its 5 second window. This is because there is no response or no valid clock. The alarm is mapped to IEC 61850.

## 8.3    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 15

# CYBER-SECURITY

# 1        DISCLAIMER

GE Grid Automation products are digital devices designed to be installed and operated in utility substations & industrial plant environments and connected to secure private networks.  GE IEDs should not be connected to the public internet.

GE strongly recommends that users protect their digital devices using a defense-in-depth strategy which will protect their products, their network, their systems and interfaces against cyber security threats.  This includes, but is not limited to, placing digital devices inside the control system network security perimeter, deploying and maintaining access controls, monitoring and intrusion detection, security awareness training, security policies, network segmentation and firewalls installation, strong and active password management, data encryption, antivirus and other mitigating applicable technologies.

GE IEDs are available with standard features, and in some products additional optional software options, which provide cyber security mechanisms to help users protect against cyber security intrusion.  GE strongly recommends using all available cyber security options.

For additional details and recommendations on how to protect the GE IEDs, please see Cyber Security sections of the manuals.  GE Grid Solutions may also provide additional instructions and recommendations to users from time to time relating to IED and cyber security threats or vulnerabilities.

It is the users' sole responsibility to make sure that all GE Grid Automation IEDs are installed and operated considering its cyber security capabilities, security context, and the instructions and recommendations provided to the user relating to GE IEDs. Users assume all risks and liability associated with damages or losses incurred in connection with any and all cyber security incidences.

**IT IS THE SOLE RESPONSIBILITY OF THE USER TO SECURE THEIR NETWORK AND ASSOCIATED DEVICES AGAINST CYBER SECURITY INTRUSIONS OR ATTACKS. GE GRID AUTOMATION AND ITS AFFILIATES ARE NOT LIABLE FOR ANY DAMAGES AND/OR LOSSES ARISING FROM OR RELATED TO SUCH SECURITY INTRUSION OR ATTACKS.**

## 2          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).

However, note that these are not recognised defences against attackers.

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:

## 3          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.

# 4        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 |

## 4.1        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 |

### 4.1.1        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 |

### 4.1.2        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. |

### 4.1.3        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 |

### 4.1.4        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 |

### 4.1.5        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. |

## 4.1.6      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 |

## 4.1.7      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. |

## 4.1.8      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 |

## 4.2      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.

# 5          CYBER-SECURITY IMPLEMENTATION

The GE 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.

This section describes the current implementation of cyber-security. This is valid for the release of platform software to which this manual pertains. This current cyber-security implementation is known as Cyber-security Phase 1.

At the IED level, these cyber-security measures have been implemented:

- NERC-compliant default display
- Four-level access
- Enhanced password security
- Password recovery procedure
- Disabling of unused physical and logical ports
- Inactivity timer
- Security events management
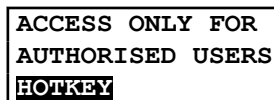
External to the IEDs, the following cyber-security measures have been implemented:

- Antivirus
- Security patch management
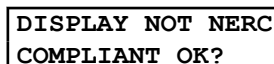
## 5.1          NERC-COMPLIANT DISPLAY

For the device to be NERC-compliant, it must provide the option for a NERC-compliant default display. The default display that is implemented in our cyber-security concept contains a warning that the IED can be accessed by authorised users. You can change this if required with the **User Banner** setting in the *SECURITY CONFIG* column.

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

If you try to change the default display from the NERC-compliant one, a further warning is displayed:

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

The default display navigation map shows how NERC-compliance is achieved with the product's default display concept.
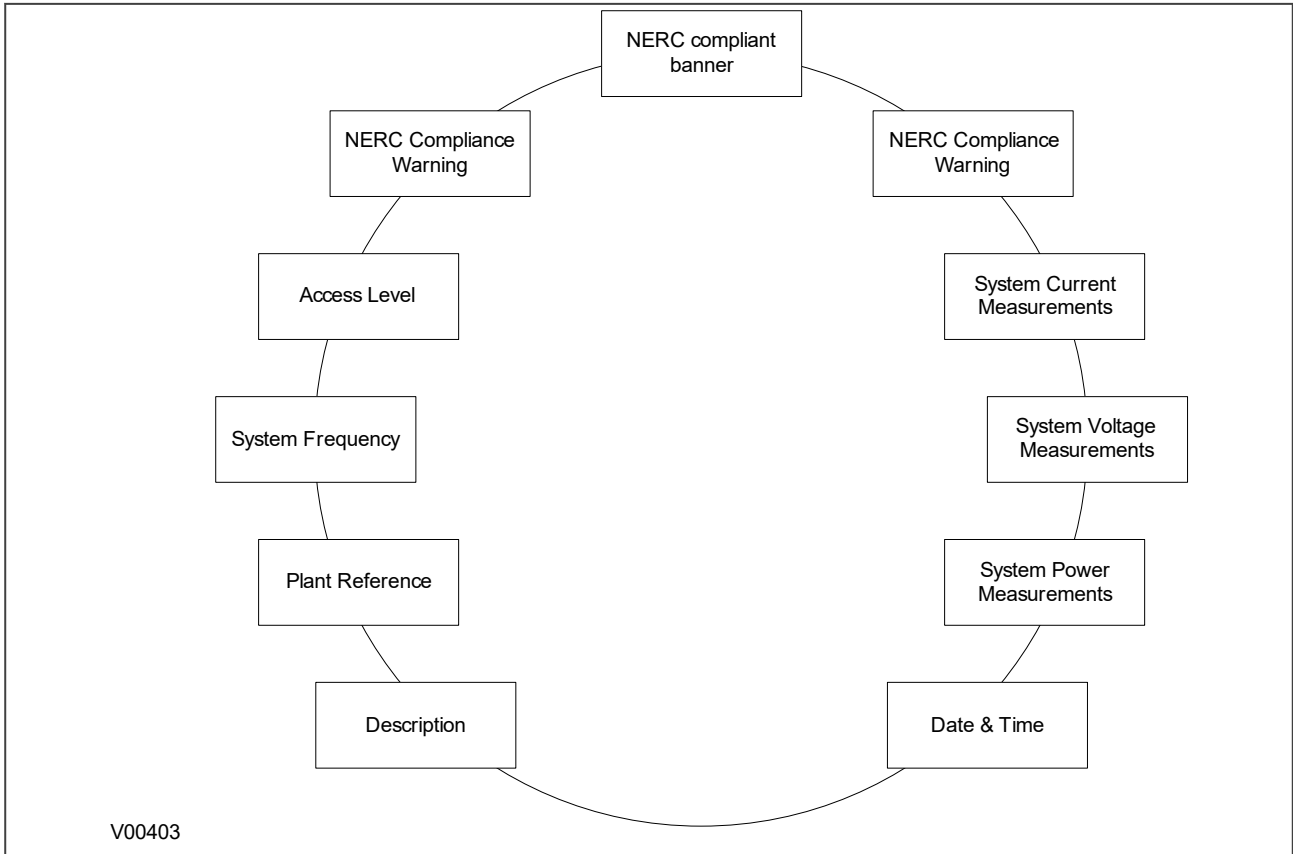
**Figure 124: Default display navigation**

## 5.2         FOUR-LEVEL ACCESS

The menu structure contains four levels of access, three of which are password protected.

**Password levels**

| Level | Meaning | Read Operation | Write Operation |
|-------|---------|----------------|-----------------|
| 0 | Read Some<br>Write Minimal | SYSTEM DATA column:<br>Description<br>Plant Reference<br>Model Number<br>Serial Number<br>S/W Ref.<br>Access Level<br>Security Feature<br><br>SECURITY CONFIG column:<br>User Banner<br>Attempts Remain<br>Blk Time Remain<br>Fallback PW level<br>Security Code (UI only) | Password Entry<br>LCD Contrast (UI only) |
| 1 | Read All<br>Write Few | All data and settings are readable.<br>Poll Measurements | All items writeable at level 0.<br>Level 1 Password setting<br>Extract Disturbance Record<br>Select Event, Main and Fault (upload)<br>Extract Events (e.g. via MiCOM S1 Studio) |

| Level | Meaning | Read Operation | Write Operation |
|-------|---------|----------------|-----------------|
| 2 | Read All<br>Write Some | All data and settings are readable.<br>Poll Measurements | All items writeable at level 1.<br>Setting Cells that change visibility (Visible/Invisible).<br>Setting Values (Primary/Secondary) selector<br>Commands:<br>Reset Indication<br>Reset Demand<br>Reset Statistics<br>Reset CB Data / counters<br>Level 2 Password setting |
| 3 | Read All<br>Write All | All data and settings are readable.<br>Poll Measurements | All items writeable at level 2.<br>Change all Setting cells<br>Operations:<br>Extract and download Setting file.<br>Extract and download PSL<br>Extract and download MCL61850 (IEC61850 CONFIG)<br>Auto-extraction of Disturbance Recorder<br>Courier/Modbus Accept Event (auto event extraction, e.g. via A2R)<br>Commands:<br>Change Active Group setting<br>Close / Open CB<br>Change Comms device address.<br>Set Date & Time<br>Switch MCL banks / Switch Conf. Bank in UI (IEC61850 CONFIG)<br>Enable / Disable Device ports (in SECURITY CONFIG column)<br>Level 3 password setting |

## 5.2.1 BLANK PASSWORDS

A blank password is effectively a zero-length password. Through the front panel it is entered by confirming the password entry without actually entering any password characters. Through a communications port the Courier and Modbus protocols each have a means of writing a blank password to the IED. A blank password disables the need for a password at the level that this password is applied.

Blank passwords have a slightly different validation procedure. If a blank password is entered through the front panel, the following text is displayed, after which the procedure is the same as already described:

```
BLANK PASSWORD
ENTERED CONFIRM
```

Blank passwords cannot be configured if the lower level password is not blank.

Blank passwords affect the fall back level after inactivity timeout or logout.

The 'fallback level' is the password level adopted by the IED after an inactivity timeout, or after the user logs out. This will be either the level of the highest-level password that is blank, or level 0 if no passwords are blank.

## 5.2.2 PASSWORD RULES

- Default passwords are blank for Level 1 and are AAAA for Levels 2 and 3
- Passwords may be any length between 0 and 8 characters long
- Passwords may or may not be NERC compliant
- Passwords may contain any ASCII character in the range ASCII code 33 (21 Hex) to ASCII code 122 (7A Hex) inclusive
- Only one password is required for all the IED interfaces

### 5.2.3    ACCESS LEVEL DDBS

In addition to having the 'Access level' cell in the 'System data' column (address 00D0), the current level of access for each interface is also available for use in the Programming Scheme Logic (PSL) by mapping to these Digital Data Bus (DDB) signals:

- *HMI Access Lvl 1*
- *HMI Access Lvl 2*
- *HMI Access Lvl 3*
- *FPort AccessLvl1*
- *FPort AccessLvl2*
- *FPort AccessLvl3*
- *RPrt1 AccessLvl1*
- *RPrt1 AccessLvl2*
- *RPrt1 AccessLvl3*
- *RPrt2 AccessLvl1*
- *RPrt2 AccessLvl2*
- *RPrt2 AccessLvl3*

**Key:**

HMI = Human Machine Interface

FPort = Front Port

RPrt = Rear Port

Lvl = Level

## 5.3    ENHANCED PASSWORD SECURITY

Cyber-security requires strong passwords and validation for NERC compliance.

### 5.3.1    PASSWORD STRENGTHENING

NERC compliant passwords have the following requirements:

- At least one upper-case alpha character
- At least one lower-case alpha character
- At least one numeric character
- At least one special character (%,$...)
- At least six characters long

### 5.3.2    PASSWORD VALIDATION

The IED checks for NERC compliance. If the password is entered through the front panel, this is briefly displayed on the LCD.

If the entered password is NERC compliant, the following text is displayed.

```
NERC COMPLIANT
P/WORD WAS SAVED
```

If the password entered is not NERC-compliant, the user is required to actively confirm this, in which case the non-compliance is logged.

If the entered password is not NERC compliant, the following text is displayed:

```
┌─────────────────────────┐
│ NERC COMPLIANCE         │
│ NOT MET CONFIRM?        │
│                         │
│                         │
└─────────────────────────┘
```

On confirmation, the non-compliant password is stored and the following acknowledgement message is displayed for 2 seconds.

```
┌─────────────────────────┐
│ NON-NERC P/WORD         │
│ SAVED OK                │
│                         │
│                         │
└─────────────────────────┘
```

If the action is cancelled, the password is rejected and the following message is displayed for 2 seconds.

```
┌─────────────────────────┐
│ NON-NERC P/WORD         │
│ NOT SAVE                │
│                         │
│                         │
└─────────────────────────┘
```

If the password is entered through a communications port using Courier or Modbus protocols, the device will store the password, irrespective of whether it is NERC-compliant or not. It then uses appropriate response codes to inform the client of the NERC-compliancy status. You can then choose to enter a new NERC-compliant password or accept the non-NERC compliant password just entered.

### 5.3.3    PASSWORD BLOCKING

You are locked out temporarily, after a defined number of failed password entry attempts. Each invalid password entry attempt decrements the 'Attempts Remain' data cell by 1. When the maximum number of attempts has been reached, access is blocked. If the attempts timer expires, or the correct password is entered *before* the 'attempt count' reaches the maximum number, then the 'attempts count' is reset to 0.

An attempt is only counted if the attempted password uses only characters in the valid range, but the attempted password is not correct (does not match the corresponding password in the IED). Any attempt where one or more characters of the attempted password are not in the valid range will not be counted.

Once the password entry is blocked, a 'blocking timer' is started. Attempts to access the interface while the 'blocking timer' is running results in an error message, irrespective of whether the correct password is entered or not. Once the 'blocking timer' has expired, access to the interface is unblocked and the attempts counter is reset to zero.

If you try to enter the password while the interface is blocked, the following message is displayed for 2 seconds.

```
┌─────────────────────────┐
│ NOT ACCEPTED            │
│ ENTRY IS BLOCKED        │
│                         │
│                         │
└─────────────────────────┘
```

A similar response occurs if you try to enter the password through a communications port.

The parameters can then be configured using the *Attempts Limit*, *Attempts Timer* and *Blocking Timer* settings in the *SECURITY CONFIG* column.

### Password blocking configuration

| Setting | Cell col row | Units | Default Setting | Available Setting |
|---------|--------------|-------|-----------------|-------------------|
| Attempts Limit | 25 02 | | 3 | 0 to 3 step 1 |

| Setting | Cell col row | Units | Default Setting | Available Setting |
|---------|--------------|-------|-----------------|-------------------|
| Attempts Timer | 25 03 | Minutes | 2 | 1 to 3 step 1 |
| Blocking Timer | 25 04 | Minutes | 5 | 1 to 30 step 1 |

## 5.4      PASSWORD RECOVERY

If you mislay a device's password, they can be recovered. To obtain the recovery password you must contact the Contact Centre and supply the Serial Number and its Security Code. The Contact Centre will use these items to generate a Recovery Password.

The security code is a 16-character string of upper case 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

As soon as the security code is displayed on the LCD, 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.

To prevent accidental reading of the IED security code, the cell will initially display a warning message:

```
PRESS ENTER TO
READ SEC. CODE
```

The security code is displayed on confirmation. The validity timer is then started. The security code can only be read from the front panel.

### 5.4.1      ENTRY OF THE RECOVERY PASSWORD

The recovery password is intended for recovery only. It is not a replacement password that can be used continually. It can only be used once – for password recovery.

Entry of the recovery password causes the IED to reset all passwords back to default. This is all it is designed to do. After the passwords have been set back to default, it is up to the user to enter new passwords. Each password should be appropriate for its intended function, ensuring NERC compliance, if required.

On this action, the following message is displayed:

```
PASSWORDS HAVE
BEEN SET TO
DEFAULT
```

The recovery password can be applied through any interface, local or remote. It will achieve the same result irrespective of which interface it is applied through.

### 5.4.2      PASSWORD ENCRYPTION

The IED supports encryption for passwords entered remotely. The encryption key can be read from the IED through a specific cell available only through communication interfaces, not the front panel. Each time the key is read the IED generates a new key that is valid only for the next password encryption write. Once used, the key is invalidated

and a new key must be read for the next encrypted password write. The encryption mechanism is otherwise transparent to the user.

## 5.5     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** setting)

*Note:*
*It is not possible to disable a port from which the disabling port command originates.*

*Note:*
*We do not generally advise disabling the physical Ethernet port.*

## 5.6     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 (**IEC61850** setting)
- DNP3 Over Ethernet (**DNP3 OE** setting)
- Courier Tunnelling (**Courier Tunnel** setting)

*Note:*
*If any of these protocols are enabled or disabled, the Ethernet card will reboot.*

## 5.7     SECURITY EVENTS MANAGEMENT

To implement NERC-compliant cyber-security, a range of Event records need to be generated. These log security issues such as the entry of a non-NERC-compliant password, or the selection of a non-NERC-compliant default display.

## Security event values

| Event Value | Display |
|---|---|
| PASSWORD LEVEL UNLOCKED | USER LOGGED IN<br>ON {int} LEVEL {n} |
| PASSWORD LEVEL RESET | USER LOGGED OUT<br>ON {int} LEVEL {n} |
| PASSWORD SET BLANK | P/WORD SET BLANK<br>BY {int} LEVEL {p} |
| PASSWORD SET NON-COMPLIANT | P/WORD NOT-NERC<br>BY {int} LEVEL {p} |
| PASSWORD MODIFIED | PASSWORD CHANGED<br>BY {int} LEVEL {p} |
| PASSWORD ENTRY BLOCKED | PASSWORD BLOCKED<br>ON {int} |
| PASSWORD ENTRY UNBLOCKED | P/WORD UNBLOCKED<br>ON {int} |
| INVALID PASSWORD ENTERED | INV P/W ENTERED<br>ON <int} |
| PASSWORD EXPIRED | P/WORD EXPIRED<br>ON {int} |
| PASSWORD ENTERED WHILE BLOCKED | P/W ENT WHEN BLK<br>ON {int} |
| RECOVERY PASSWORD ENTERED | RCVY P/W ENTERED<br>ON {int} |
| IED SECURITY CODE READ | IED SEC CODE RD<br>ON {int} |
| IED SECURITY CODE TIMER EXPIRED | IED SEC CODE EXP<br>- |
| PORT DISABLED | PORT DISABLED<br>BY {int} PORT {prt} |
| PORT ENABLED | PORT ENABLED<br>BY {int} PORT {prt} |
| DEF. DISPLAY NOT NERC COMPLIANT | DEF DSP NOT-NERC |
| PSL SETTINGS DOWNLOADED | PSL STNG D/LOAD<br>BY {int} GROUP {grp} |
| DNP SETTINGS DOWNLOADED | DNP STNG D/LOAD<br>BY {int} |
| TRACE DATA DOWNLOADED | TRACE DAT D/LOAD<br>BY {int} |
| IEC61850 CONFIG DOWNLOADED | IED CONFG D/LOAD<br>BY {int} |
| USER CURVES DOWNLOADED | USER CRV D/LOAD<br>BY {int} GROUP {crv} |
| PSL CONFIG DOWNLOADED | PSL CONFG D/LOAD<br>BY {int} GROUP {grp} |
| SETTINGS DOWNLOADED | SETTINGS D/LOAD<br>BY {int} GROUP {grp} |
| PSL SETTINGS UPLOADED | PSL STNG UPLOAD<br>BY {int} GROUP {grp} |

| Event Value | Display |
|---|---|
| DNP SETTINGS UPLOADED | DNP STNG UPLOAD<br>BY {int} |
| TRACE DATA UPLOADED | TRACE DAT UPLOAD<br>BY {int} |
| IEC61850 CONFIG UPLOADED | IED CONFG UPLOAD<br>BY {int} |
| USER CURVES UPLOADED | USER CRV UPLOAD<br>BY {int} GROUP {crv} |
| PSL CONFIG UPLOADED | PSL CONFG UPLOAD<br>BY {int} GROUP {grp} |
| SETTINGS UPLOADED | SETTINGS UPLOAD<br>BY {int} GROUP {grp} |
| EVENTS HAVE BEEN EXTRACTED | EVENTS EXTRACTED<br>BY {int} {nov} EVNTS |
| ACTIVE GROUP CHANGED | ACTIVE GRP CHNGE<br>BY {int} GROUP {grp} |
| CS SETTINGS CHANGED | C & S CHANGED<br>BY {int} |
| DR SETTINGS CHANGED | DR CHANGED<br>BY {int} |
| SETTING GROUP CHANGED | SETTINGS CHANGED<br>BY {int} GROUP {grp} |
| POWER ON | POWER ON<br>- |
| SOFTWARE_DOWNLOADED | S/W DOWNLOADED<br>- |

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.*

## 5.8    LOGGING OUT

If you have been configuring the IED, you should 'log out'. Do this by going 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:

```
DO YOU WANT TO
LOG OUT?
```

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

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

```
LOGGED OUT
Access Level #
```

Where # is the current fallback level.

If you decide not to log out, the following message is displayed for 2 seconds.

```
LOGOUT CANCELLED
Access Level #
```

where # is the current access level.

# CHAPTER 16

# 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 +70ºC for unlimited periods or between -40°C to + 85°C for up to 96 hours (see technical specifications).

## 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 available in the following forms

- For flush panel and rack mounting
- For retrofitting K-series models
- Software only (for upgrades)

### 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.**

### 3.1.1      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.
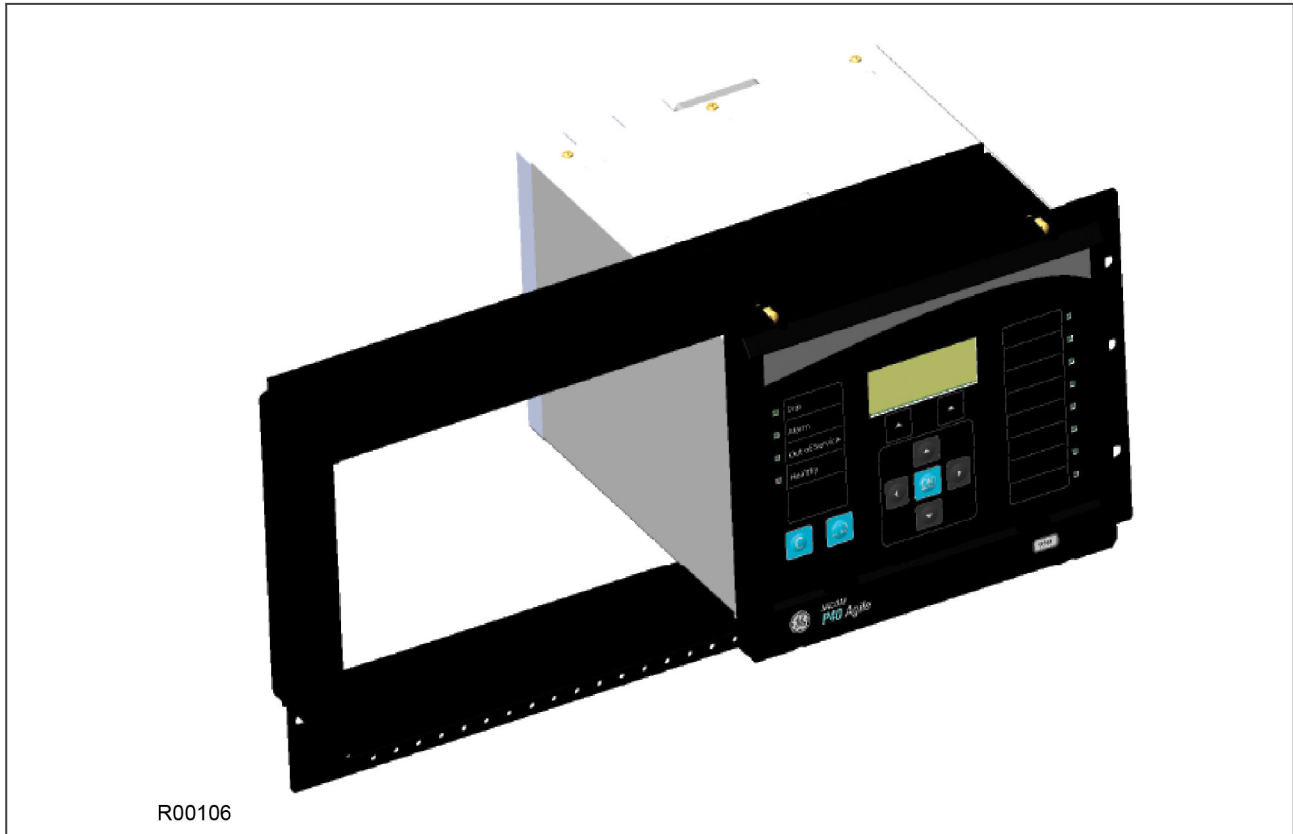
**Figure 125: Rack mounting of products**

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 |

## 3.2 K-SERIES RETROFIT

A major advantage of the P40 Agile platform is its backward compatibility with the K-series products. The P40 Agile products have been designed such that the case, back panel terminal layout and pin-outs are identical to their K-series predecessors and can be retrofitted without the usual overhead associated with replacing and rewiring

devices. This allows easy upgrade of the protection system with minimum impact and minimum shutdown time of the feeder.

The equivalencies of the models are as follows:

| Case width (TE) | Case width (mm) | Equivalent K series | Products |
|---|---|---|---|
| 20TE | 102.4 mm (4 inches) | KCGG140/142 | P14N |
| 30TE | 154.2 mm (6 inches) | KCEG140/142 | P14D |

The old K-series products can be removed by sliding the cradle out of the case. The new P40 Agile cradle can then be inserted into the old case as shown below:



R00103
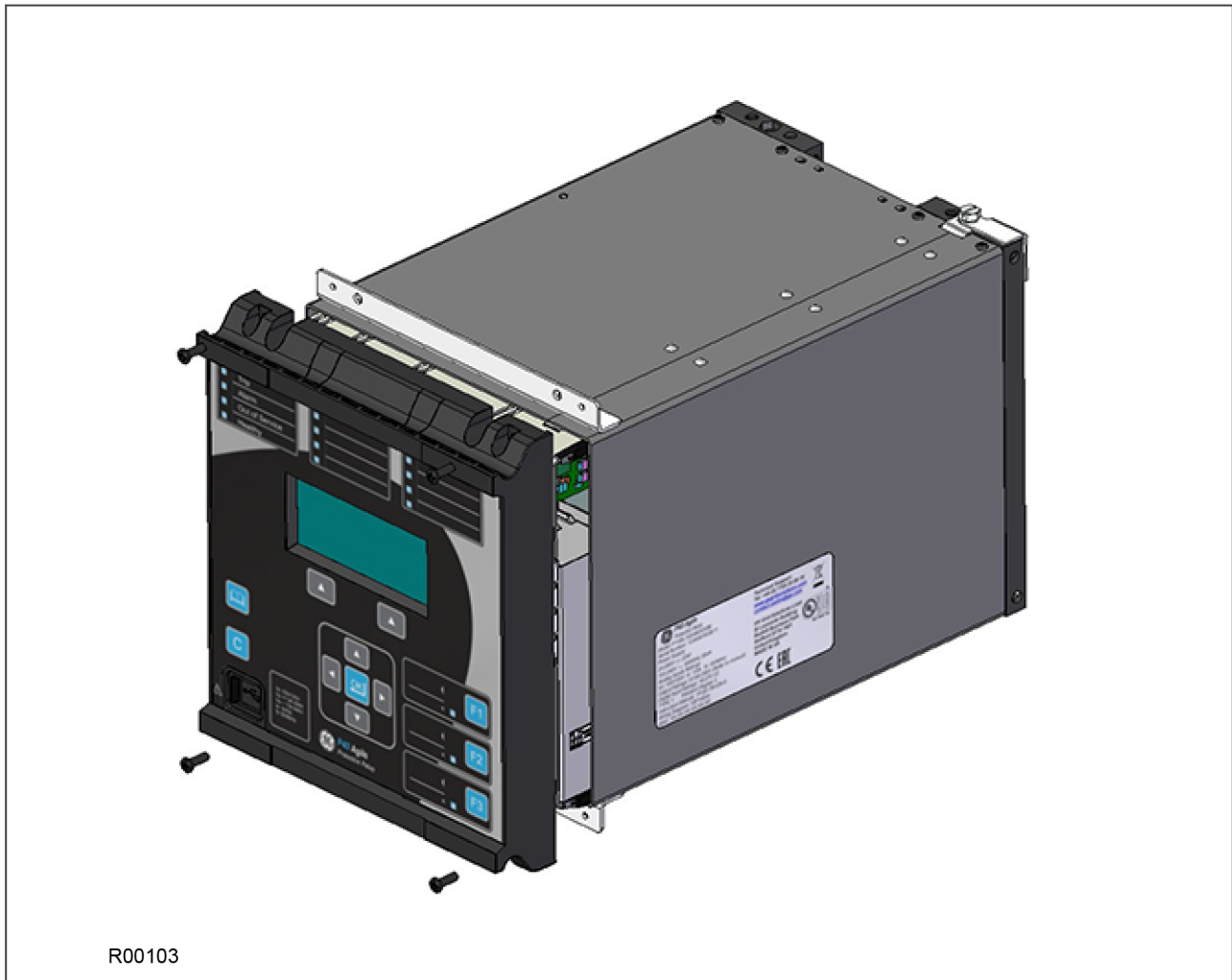
**Figure 126: Inserting cradle into case**

Both K-series products and P40 Agile products are equipped with CT shorting links. Depending on the model, your device may or may not be equipped with CTs. If there are CTs present, spring-loaded shorting contacts (see below) ensure that the terminals into which the CTs connect are shorted before the CT contacts are broken, when withdrawing the cradle from the case. This ensures that no voltage is developed between the two terminals on breaking the CT connections.

If no CTs are present, the CT terminals are permanently shorted internally.

E01407
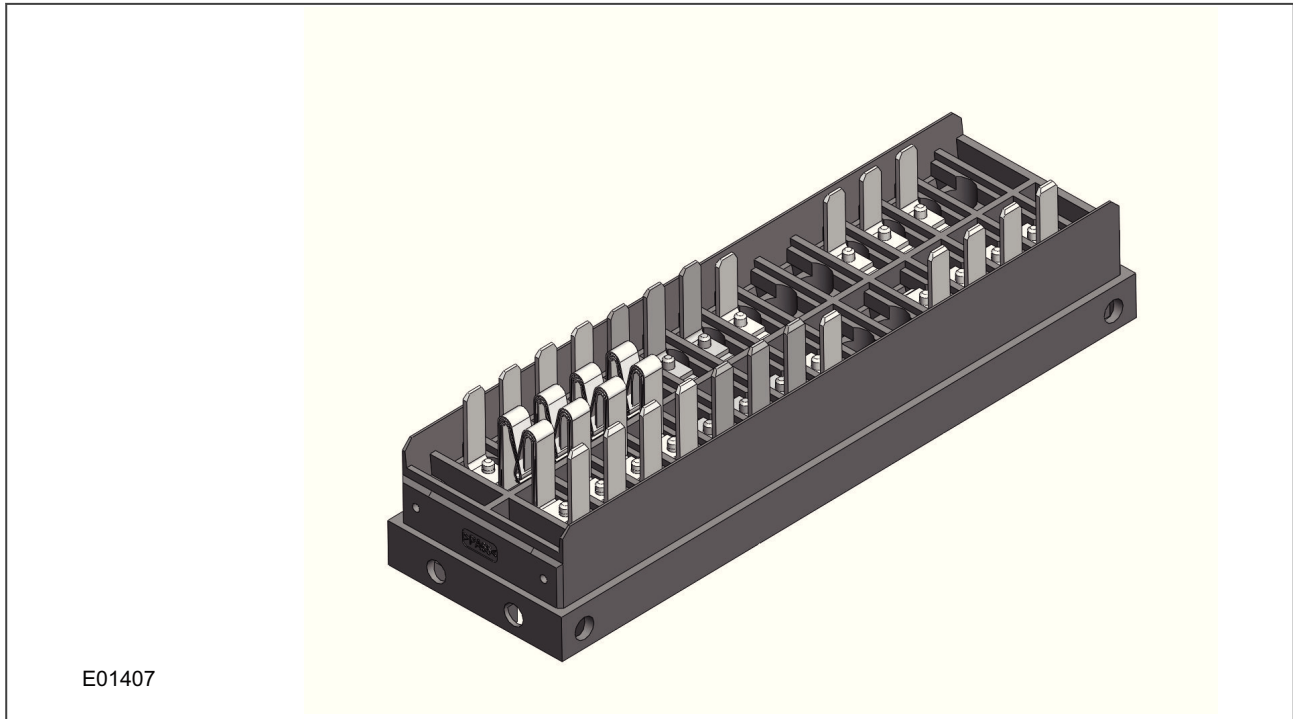
**Figure 127: Spring-loaded CT shorting contacts**

Before withdrawing the cradle it is important to:

- Check the existing case for any damage
- Check the wiring is in good condition, especially the earth wiring
- Check the continuity of the earth connection to the cublicle earthing bar.

If there is any doubt as to the integrity of any of these aspects, contact your local representative.

⚠️ **Caution:**
**After removing the K-series product from its case, refit it into the case that came with your device, for storage or reuse in another location.**

The difference between a standard device and a K-series retrofit device is that the retrofit device has internal links between terminals 7 and 13, and terminals 8 and 14 respectively. This is so that equipment driven by the K-series field voltage conected to terminals 7 and 8, will continue to be driven indirectly via terminals 13 and 14 when replaced by P40 Agile products.

A K-series device provides a 48 V DC field voltage between terminals 7 and 8. This field voltage is intended for driving auxiliary equipment such as opto-inputs. P40 Agile devices DO NOT provide this field voltage. For this reason, P40 Agile retrofit devices have internal shorting links between terminals 7 and 13, and terminals 8 and 14 respectively. The intention of this is to provide the auxiliary supply voltage to terminals 7 and 8 in lieue of the field voltage.

⚠️ **Caution:**
**The voltage on terminals 7 and 8 mirrors that of the auxiliary supply voltage. If the auxiliary supply voltage on terminals 13 and 14 is not 48 V DC, then the voltage on terminals 7 and 8 is also not 48 V DC.**

⚠️ **Caution:**
**When retrofitting a K-series device, ensure the load on terminals 7 and 8 is limited to a maximum of 5A. A jumplead with a 5A ceramic timelag fuse is fitted internally.**

### 3.2.1 CONVENTIONS

The P40 Agile products have different conventions from the K-series products when it comes to numbering some hardware components. It is very important that you are aware of this. This is just a matter of convention and does not affect the terminal compatibility.

The equivalencies are as follows:

| Component | P40 Agile products | K-series products |
|---|---|---|
| Output relay | RL1 | RL0 |
| Output relay | RL2 | RL1 |
| Output relay | RL3 | RL2 |
| Output relay | RL4 | RL3 |
| Output relay | RL5 | RL4 |
| Output relay | RL6 | RL5 |
| Output relay | RL7 | RL6 |
| Output relay | RL8 | RL7 |
| Opto-input | L1 | L0 |
| Opto-input | L2 | L1 |
| Opto-input | L3 | L2 |
| Opto-input | L4 | L3 |
| Opto-input | L5 | L4 |
| Opto-input | L6 | L5 |
| Opto-input | L7 | L6 |
| Opto-input | L8 | L7 |

## 3.3 SOFTWARE ONLY

It is possible to upgrade an existing device by purchasing software only (providing the device is already fitted with the requisite hardware).

There are two options for software-only products:

- Your device is sent back to the GE factory for upgrade.
- The software is sent to you for upgrade. Please contact your local representative if you wish to procure the services of a commissioning engineer to help you with your device upgrade.

*Note:*
*Software-only products are licensed for use with devices with specific serial numbers.*

⚠️ **Caution:**
**Do not attempt to upgrade an existing device if the software has not been licensed for that speciific device.**

# 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 uses MiDOS terminal blocks as shown below.



R01401

**Figure 128: MiDOS terminal block**

The MiDOS terminal block consists of up to 28 x M4 screw terminals. The wires should be terminated with rings using 90° ring terminals, with no more than two rings per terminal. The products are supplied with sufficient M4 screws.

M4 90° crimp ring terminals are available in three different sizes depending on the 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 |

## 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.

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

To guarantee the performance specifications, you must ensure continuity of the screen, when daisy chaining the connections. The device is supplied with an earth link pack (part number ZA0005092) consisting of an earth link and a self-tapping screw to facilitate this requirement.

The earth link is fastened to the Midos block just below terminal number 56 as shown:



E01402
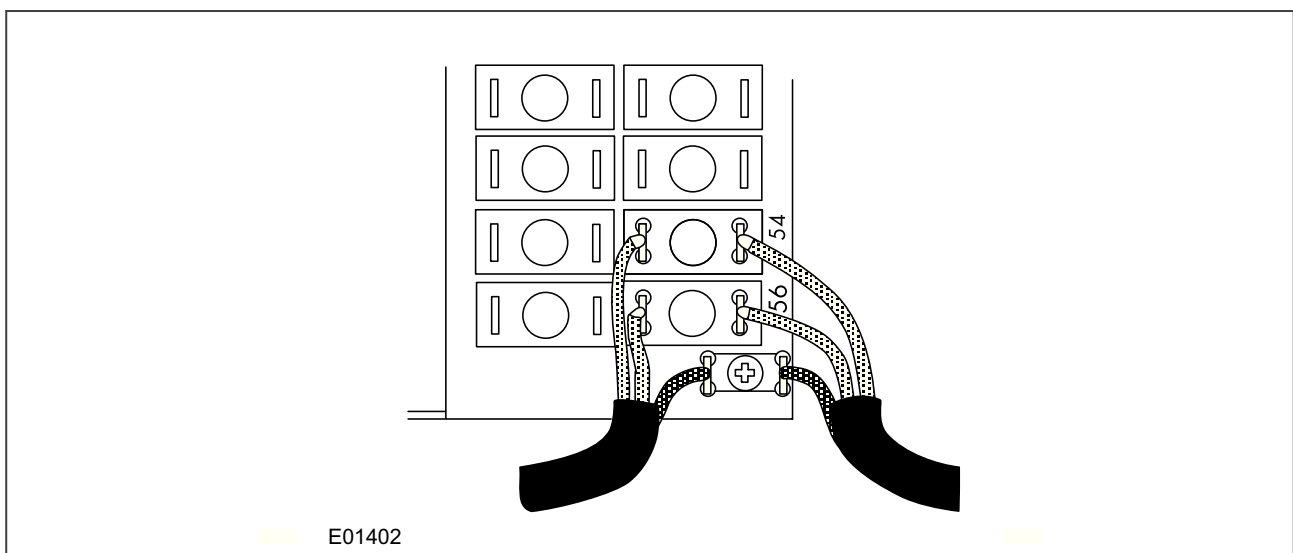
**Figure 129: Earth link for cable screen**

There is no electrical connection of the cable screen to the device. The link is provided purely to link together the two cable screens.

## 4.8      IRIG-B CONNECTION

The optional IRIG-B input uses the same terminals as the EIA(RS)485 port RP1. It is therefore apparent that RS485 communications and IRIG-B input are mutually exclusive.

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

## 4.9      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 is based on the 100BaseFX standard and uses type LC connectors. They are compatible with 50/125 µm or 62.5/125 µm multimode fibres at 1300 nm wavelength.

## 4.13     USB CONNECTION

The IED has a type B USB socket on the front panel. 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.

# 5        CASE DIMENSIONS



A = Clearance holes
B = Mounting holes

99.0mm
10.5mm   78.0mm
A  B       B  A
159.0mm  168.0mm
A  B       B  A
23.5mm   52.0mm      8 holes ⌀ 3.4mm

243.1mm

213.1mm
177.0mm
102.4mm

E01403
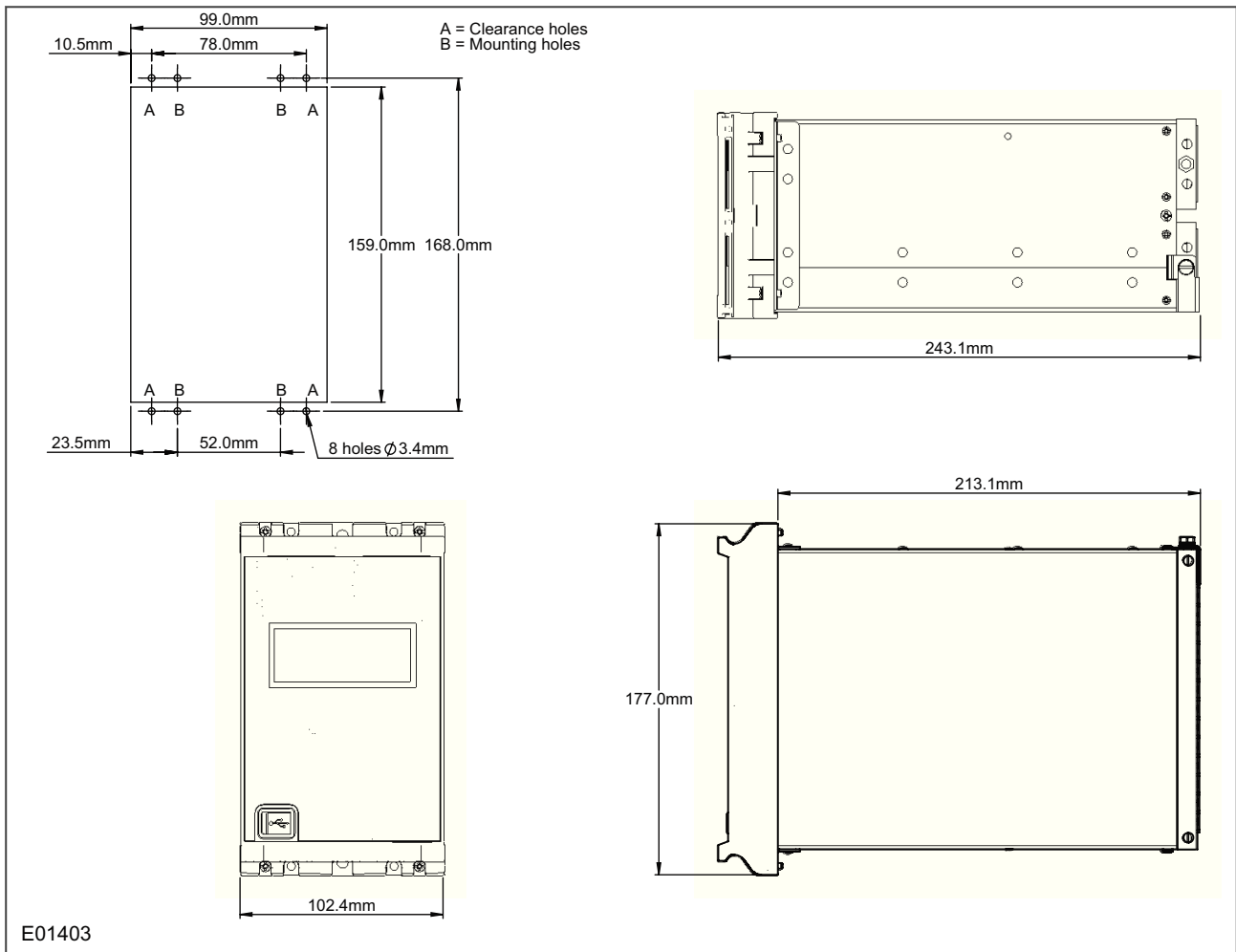
**Figure 130: 20TE case dimensions**
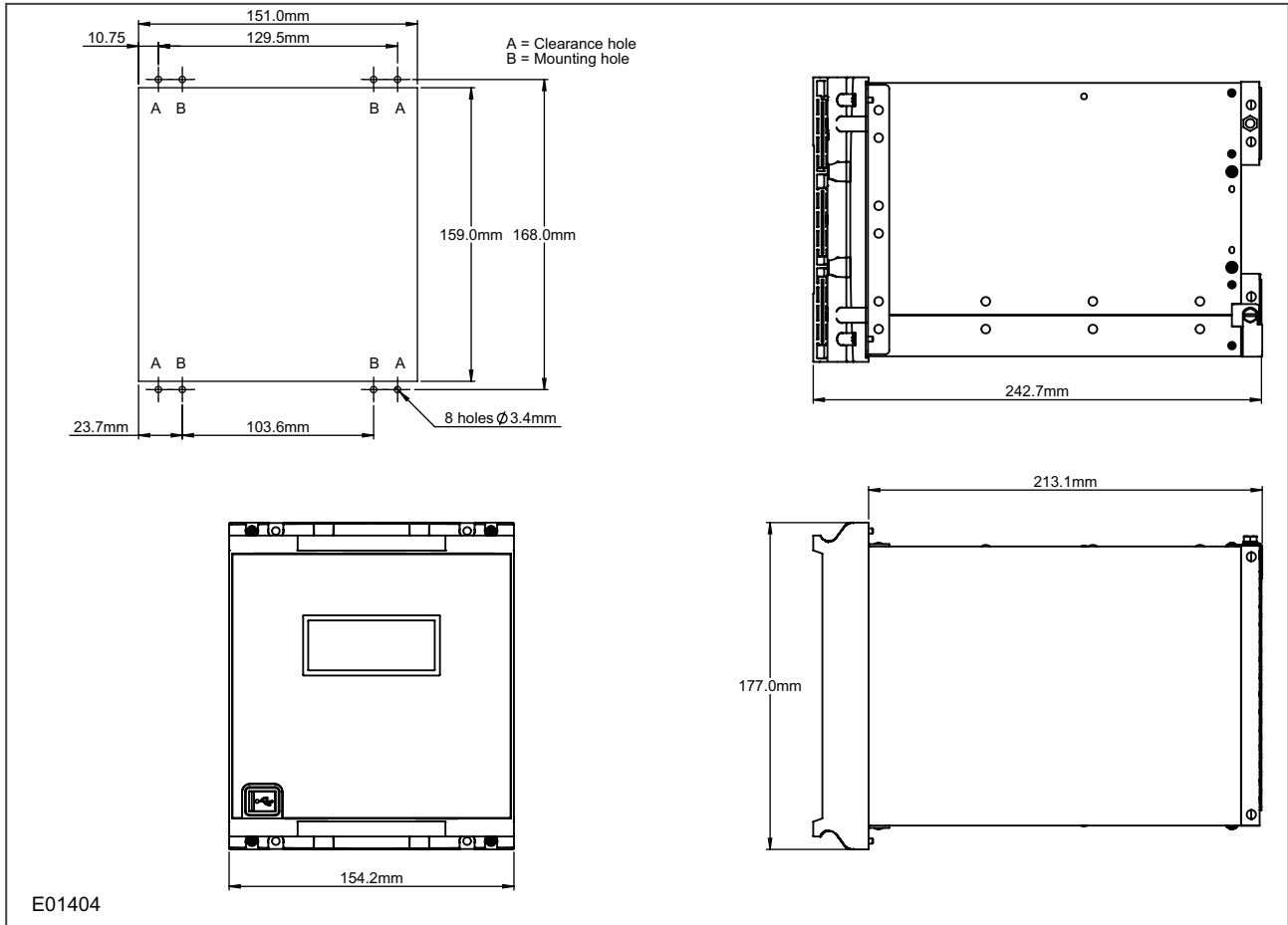
**Figure 131: 30TE case dimensions**
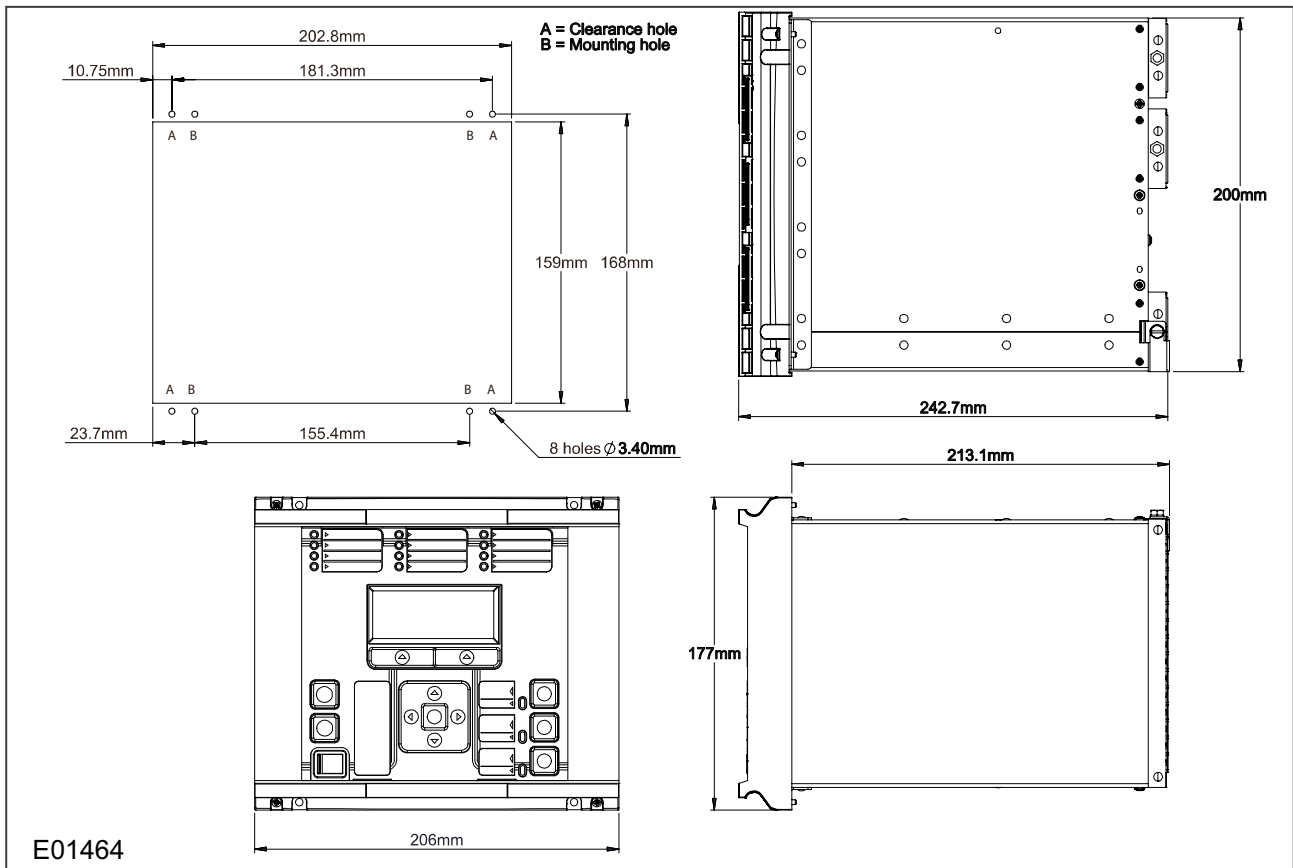
**Figure 132: 40TE case dimensions**

# CHAPTER 17

# 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:**<br>**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:**<br>**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 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).

## 3.4 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.

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.

## 3.5 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.*

## 3.6     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.

## 3.7     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.*

## 3.8     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**.

## 3.9     TEST AUTORECLOSE CELL

Where the IED provides an auto-reclose function, this cell will be available for testing the sequence of circuit breaker trip and auto-reclose cycles.

The `3 Pole Test` command causes the device to perform the first three phase trip/reclose cycle so that associated output contacts can be checked for operation at the correct times during the cycle. Once the trip output has operated the command text will revert to `No Operation` whilst the rest of the auto-reclose cycle is performed. To test subsequent three-phase autoreclose cycles, you repeat the `3 Pole Test` command.

*Note:*
*The default settings for the programmable scheme logic has the `AR Trip Test` signals mapped to the `Trip Input` signals. If the programmable scheme logic has been changed, it is essential that these signals retain this mapping for the `Test Autoreclose` facility to work.*

## 3.10     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.*

# 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

**Caution:**
**Check the rating information provided with the device. Check that the IED being tested is correct for the line or circuit.**

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.

Check that the current transformer shorting switches in the case are wired into the correct circuit. Ensure that, during withdrawal, they are closed by checking with a continuity tester. The shorting switches are between terminals 21 and 22, 23 and 24, 25 and 26, and 27 and 28.

### 5.1.2    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.

### 5.1.3    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.**

The auxiliary DC voltage supply uses terminals 13 (supply positive) and 14 (supply negative). Unlike the K-series products, the P40Agile series does not provide a field voltage supply. For K-series retrofit applications where pin-to-pin compatibility is required, the equivalent P40 Agile products emulate the field voltage supply by having internal links between pins 7 and 13, and pins 8 and 14, respectively.

### 5.1.4    WATCHDOG CONTACTS

Using a continuity tester, check that the Watchdog contacts are in the following states:

| Terminals | De-energised contact |
|---|---|
| 3 - 5 | Closed |
| 4 - 6 | Open |

### 5.1.5    POWER SUPPLY

The IED can accept a nominal DC voltage from 24 V DC to 250 V DC, or a nominal AC voltage from 110 V AC to 240 V AC at 50 Hz or 60 Hz. Ensure that the power supply is within this operating range. The power supply must be rated at 12 Watts or more.

⚡ **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:

| Terminals | Energised contact |
|-----------|-------------------|
| 3 - 5     | Open              |
| 4 - 6     | 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 non-volatile memory. If the values are not already correct, set them to the correct values. The method of setting will depend on whether accuracy is being maintained by the IRIG-B port or by the IED's internal clock.

When using IRIG-B to maintain the clock, the IED must first be connected to the satellite clock equipment (usually an 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    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.

### 5.2.10.1    CHECK PHYSICAL CONNECTIVITY

The rear communication port RP1 is presented on terminals 54 and 56. Screened twisted pair cable is used to make a connection to the port. The cable screen should be connected to the earth link just below pin 56:



E01402
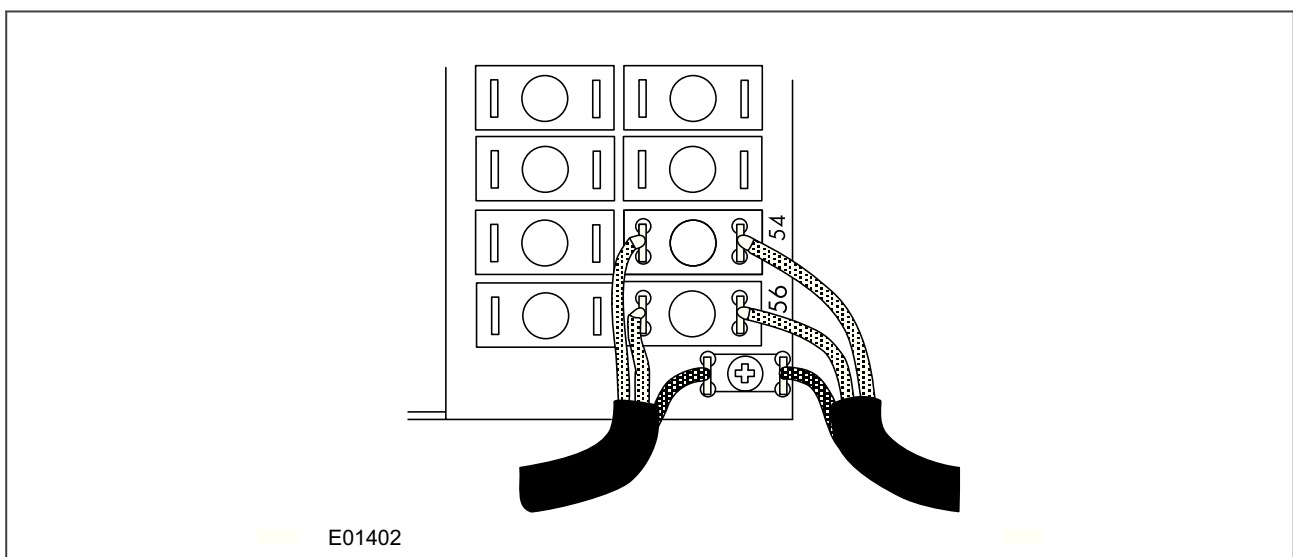
**Figure 133: RP1 physical connection**

For K-Bus applications, pins 54 and 56 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 54 is positive, pin 56 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.
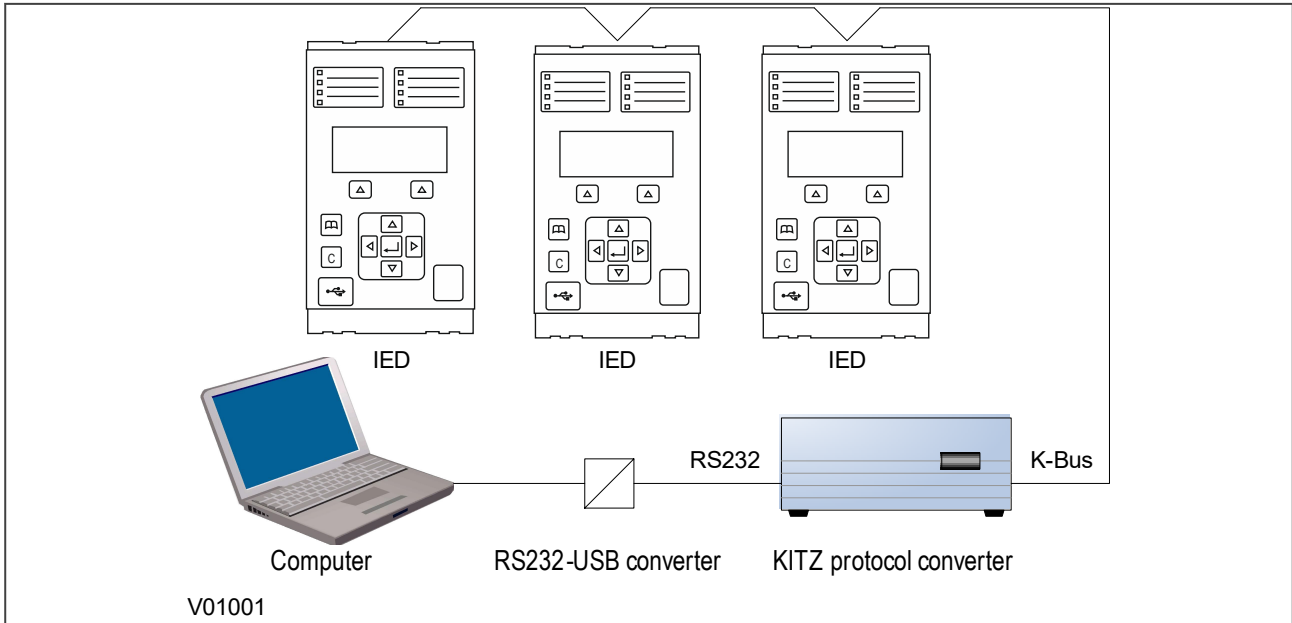
**Figure 134: Remote communication using K-bus**

### 5.2.10.2    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.

## 5.2.11    TEST SERIAL COMMUNICATION PORT RP2

RP2 is only available on selected models. If applicable, this test is the same as for RP1 only the relevant terminals are 82 and 84.

## 5.2.12    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).

## 5.2.13    TEST CURRENT INPUTS

This test verifies that the current measurement inputs are configured correctly.

All devices leave the factory set for operation at a system frequency of 50 Hz. If operation at 60 Hz is required then this must be set in the Frequency cell in the *SYSTEM DATA* column.

1.  Apply current equal to the line current transformer secondary winding rating to each current transformer input in turn.
2.  Check its magnitude using a multi-meter or test set readout. The corresponding reading can then be checked in the *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), as shown below. 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.

| Cell in MEASUREMENTS 1 | Corresponding CT ratio (in CT AND VT RATIOS column) |
|---|---|
| IA magnitude<br>IB magnitude<br>IC magnitude | Phase CT Primary / Phase CT Sec'y |
| IN measured mag | E/F CT Primary / E/F CT Secondary |
| IN measured RMS | E/F CT Primary / E/F CT Secondary |
| ISEF magnitude | SEF CT Primary / SEF CT Secondary |

# 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.**

# 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

IEC 61850 Edition 2 defines how the IED responds to test messages in the IED test modes, and whether the relay output contacts are activated or not.

You can select the mode of operation of the P40 IED by:

- Using the front panel HMI, with the setting **IED Test Mode** under the *COMMISSION TESTS* column.
- Using an IEC 61850 MMS control service to **System/LLN0.Mod**
- Using an opto-input via PSL with the signal **Block Contacts**

The following table summarises the P40 IED behaviour under the different modes:

| IED Test Mode Setting | IEC 61850 Mod | Result |
|---|---|---|
| *Disabled* | on | - Normal IED behaviour<br>- IED only responds to incoming GOOSE and SV messages with quality q.test = false |
| *Test* | test | - Protection remains enabled<br>- IED responds to incoming GOOSE and SV messages with both quality q.test = true and q.test = false<br>- Relay output contacts are still active<br>- IEC 61850 message outputs have 'quality' q.test = true<br>- IED responds to incoming IEC 61850 MMS messages with only quality q.test = true |
| *Contacts Blocked* | test/blocked | - Protection remains enabled<br>- IED responds to incoming GOOSE and SV messages with both quality q.test = true and q.test = false<br>- Relay output contacts are disabled<br>- IEC 61850 message outputs have quality q.test = true<br>- IED responds to incoming IEC 61850 MMS messages with only quality q.test = true |

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.

## 7.2    SIMULATED INPUT BEHAVIOUR

Simulated GOOSE messages 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:
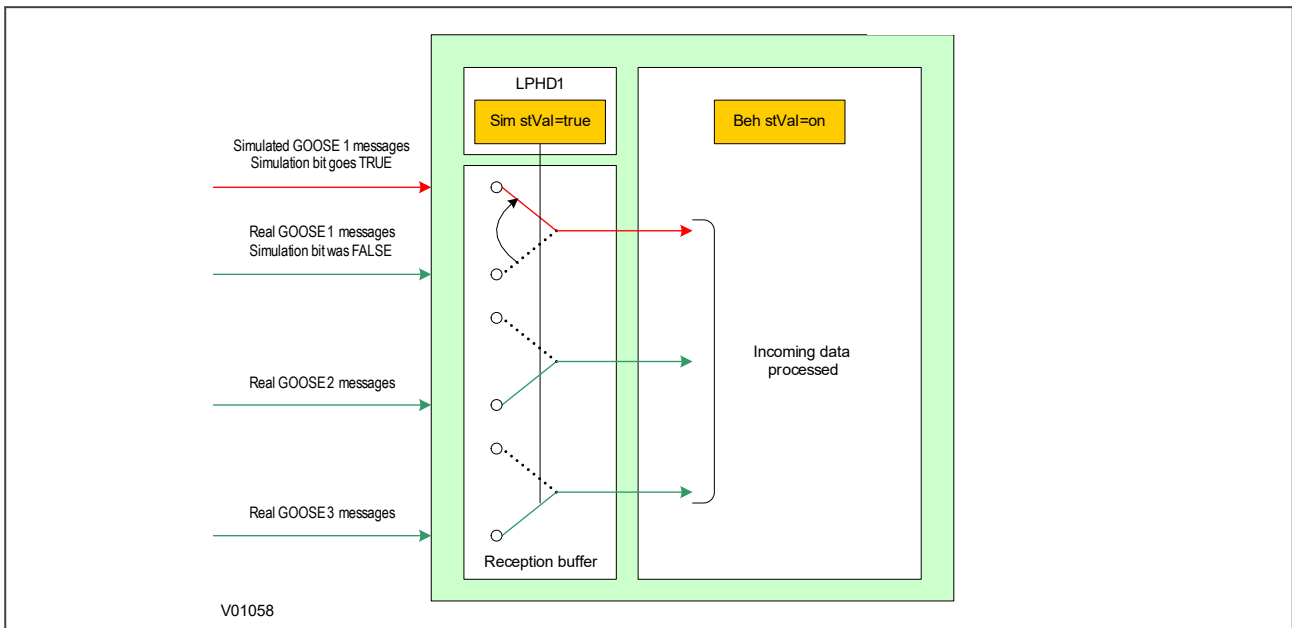


**Figure 135: Simulated input behaviour**

## 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.    Ensure the device Simulation Listening Mode is disabled

      Select *COMMISSION TESTS* → **Subscriber Sim** = `Disabled`

4.    Inject real GOOSE signals using a test device. The device will continue to listen to 'real' GOOSE messages
      and ignore simulated messages received.

5.    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
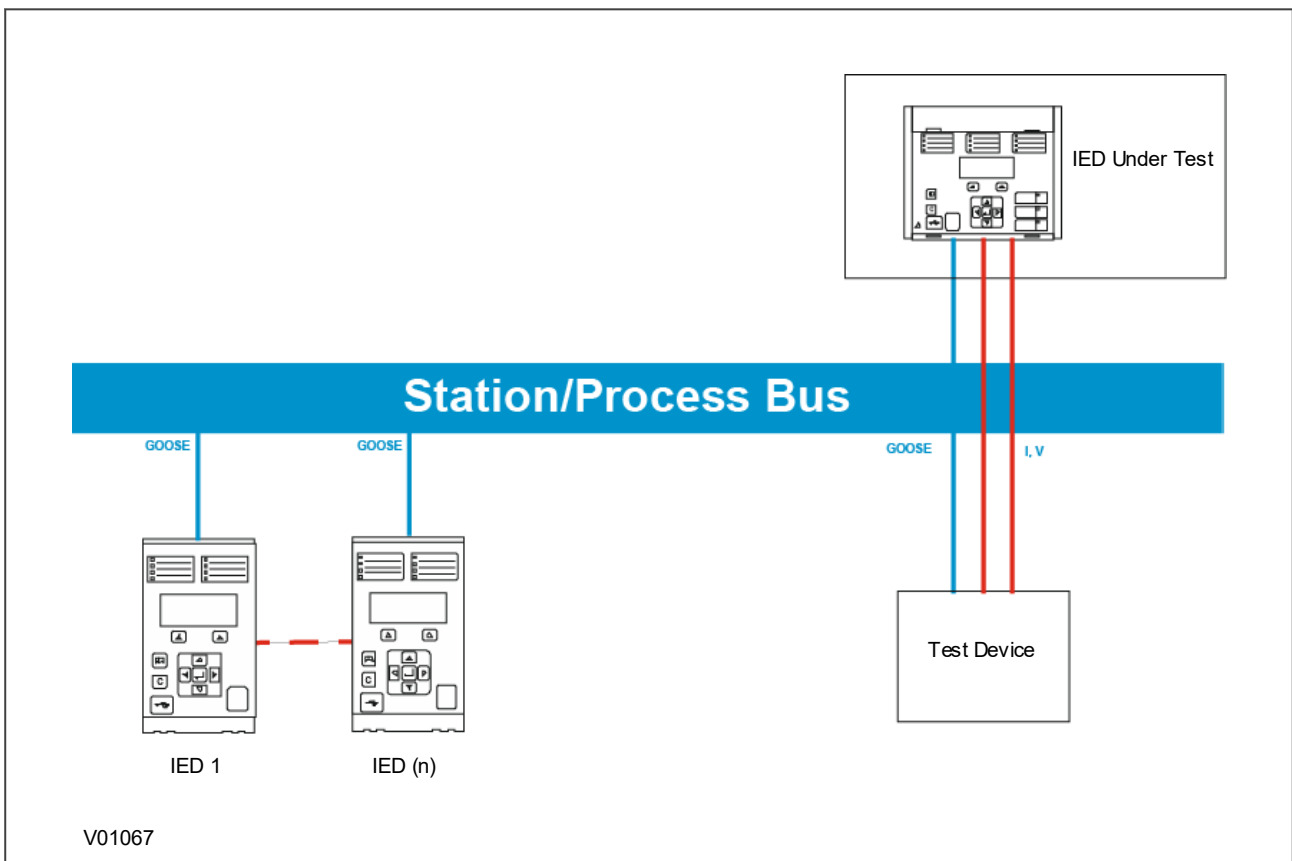


**Figure 136: Test example 1**

### 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.  Inject simulated GOOSE 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.

5.  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
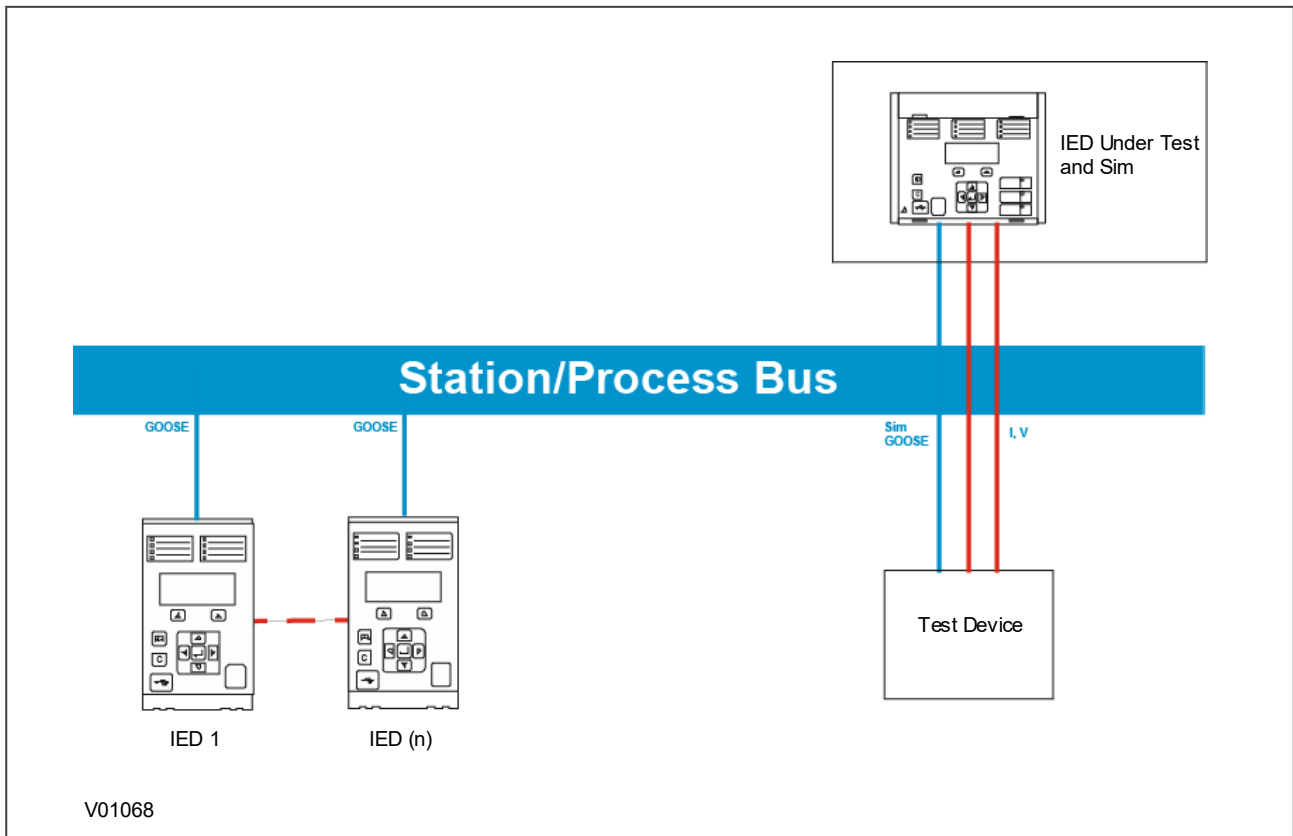


**Figure 137: Test example 2**

### 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.  Inject simulated GOOSE 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.

5.  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:
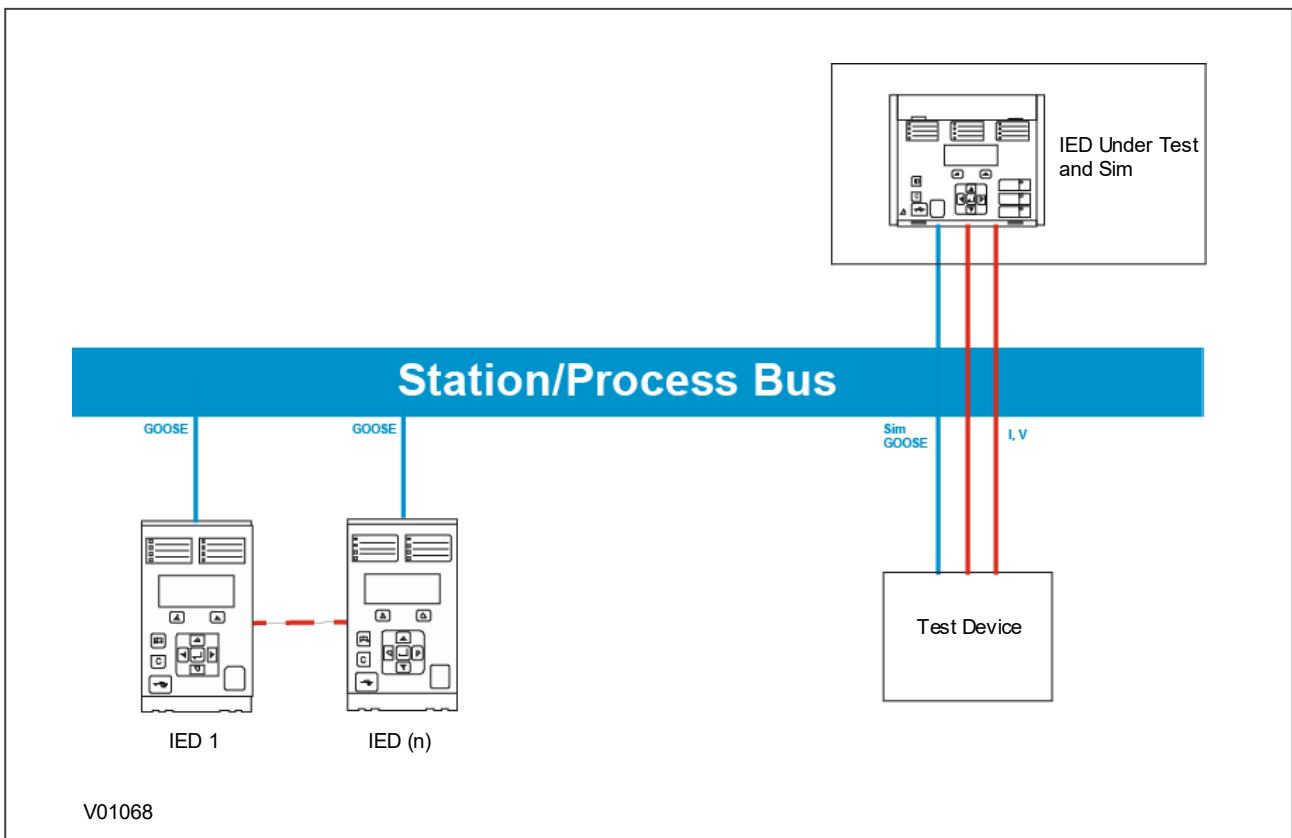


**Figure 138: Test example 3**

### 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          PROTECTION TIMING CHECKS

There is no need to check every protection function. Only one protection function needs to be checked as the purpose is to verify the timing on the processor is functioning correctly.

## 8.1          OVERCURRENT CHECK

If the overcurrent protection function is being used, test the overcurrent protection for stage 1.

1.    Check for any possible dependency conditions and simulate as appropriate.
2.    In the *CONFIGURATION* column, disable all protection elements other than the one being tested.
3.    Make a note of which elements need to be re-enabled after testing.
4.    Connect the test circuit.
5.    Perform the test.
6.    Check the operating time.

## 8.2          CONNECTING THE TEST CIRCUIT

1.    Use the PSL to determine which output relay will operate when an overcurrent trip occurs.
2.    Use the output relay assigned to **Trip Output A**.
3.    Use the PSL to map the protection stage under test directly to an output relay.

> *Note:*
> *If the default PSL is used, output relay 3 can be used as this is already mapped to the DDB signal **Trip Command Out**.*

4.    Connect the output relay so that its operation will trip the test set and stop the timer.
5.    Connect the current output of the test set to the A-phase current transformer input.
6.    Ensure that the timer starts when the current is applied.

## 8.3          PERFORMING THE TEST

1.    Ensure that the timer is reset.
2.    Apply a current of twice the setting shown in the **I>1 Current Set** cell in the *OVERCURRENT* column.
3.    Note the time displayed when the timer stops.
4.    Check that the red trip LED has illuminated.

## 8.4          CHECK THE OPERATING TIME

Check that the operating time recorded by the timer is within the range shown below.

For all characteristics, allowance must be made for the accuracy of the test equipment being used.

| Characteristic | Operating time at twice current setting and time multiplier/ time dial setting of 1.0 | |
|---|---|---|
| | Nominal (seconds) | Range (seconds) |
| DT | I>1 Time Delay setting | Setting ±2% |
| IEC S Inverse | 10.03 | 9.53 - 10.53 |
| IEC V Inverse | 13.50 | 12.83 - 14.18 |
| IEC E Inverse | 26.67 | 24.67 - 28.67 |
| UK LT Inverse | 120.00 | 114.00 - 126.00 |
| IEEE M Inverse | 3.8 | 3.61 - 4.0 |

| Characteristic | Operating time at twice current setting and time multiplier/ time dial setting of 1.0 | |
| --- | --- | --- |
| | Nominal (seconds) | Range (seconds) |
| IEEE V Inverse | 7.03 | 6.68 - 7.38 |
| IEEE E Inverse | 9.50 | 9.02 - 9.97 |
| US Inverse | 2.16 | 2.05 - 2.27 |
| US ST Inverse | 12.12 | 11.51 - 12.73 |

*Note:*
*With the exception of the definite time characteristic, the operating times given are for a Time Multiplier Setting (TMS) or Time Dial Setting (TDS) of 1. For other values of TMS or TDS, the values need to be modified accordingly.*

*Note:*
*For definite time and inverse characteristics there is an additional delay of up to 0.02 second and 0.08 second respectively. You may need to add this the IED's acceptable range of operating times.*

⚠ **Caution:**
**On completion of the tests, you must restore all settings to customer specifications.**

# 9       ONLOAD CHECKS

The objectives of the on-load checks are to:

- Confirm the external wiring to the current and voltage inputs is correct
- Check the polarity of the line current transformers
- Check the magnitudes and phase angles of the phase currents

These checks can only be carried out if there are no restrictions preventing the energization 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.**

## 9.1      CONFIRM CURRENT CONNECTIONS

1. Measure the current transformer secondary values for each input using a multimeter connected in series with the corresponding current input.
2. Ensure the current flowing in the neutral circuit of the current transformers is negligible.
3. Compare the values of the secondary phase currents and phase angle with the measured values, which can be found in the *MEASUREMENTS 1* column.

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.

## 10      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.*

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# CHAPTER 18

# 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 UNIT

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 should normally replace the cradle which slides easily out of the case. This can be done without disturbing the scheme wiring.

In the unlikely event that the problem lies with the wiring and/or terminals, then you must replace the complete device, rewire and re-commission the device.

| ⚠ | **Caution:** <br> **If the repair is not performed by an approved service centre, the warranty will be invalidated.** |
|---|---|
| ⚠ | **Caution:** <br> **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:** <br> **Before working at the rear of the unit, isolate all voltage and current supplying it.** |

*Note:*
*The GE products have integral current transformer shorting switches which will close, for safety reasons, when the terminal block is removed.*

To replace the cradle without disturbing the case and wiring:

1.      Remove the faceplate.
2.      Carefully withdraw the cradle from the front.
3.      To reinstall the unit, follow the above instructions in reverse, ensuring that each terminal block is relocated in the correct position and all connections are replaced. The terminal blocks are labelled alphabetically with 'A' on the left hand side when viewed from the rear.

Once the unit has been reinstalled, it should be re-commissioned as set out in the Commissioning chapter.

## 2.3        CLEANING

| ⚡ | **Warning:** <br> **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 checks 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 voltage on terminals 13 and 14. Verify the voltage level and polarity against the rating label | 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 on terminals 4 and 6 to see if they close. | If the LEDs and LCD backlight switch on, or the Watchdog contacts close and no error code is displayed, the error is probably on the main processor board. If the LEDs and LCD backlight do not switch on and the N/O Watchdog contact does not close, 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 3. If the IED reboots automatically, go to test 4. |
| 2 | Record displayed error and re-apply IED supply. | Record whether the same error code is displayed when the IED is rebooted, then contact the local service centre stating the error code and product details. |
| 3 | 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. |

| Test | Check | Action |
|------|-------|--------|
| 4 | The IED resets when the power-up is complete. A record error code is displayed. | Programmable scheme logic error due to excessive execution time. If the IED powers up successfully, check the programmable logic for feedback paths.<br>Other error codes relate to software errors on the main processor board, contact the local service centre. |

## 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:<br>Bit Meaning | |
| | | 0 | The application 'type' field in the Cortec does not match the software ID |
| | | 1 | The 'subset' field in the model number does not match the software ID |
| | | 2 | The 'platform' field in the model number does not match the software ID |
| | | 3 | The 'product type' field in the model number does not match the software ID |
| | | 4 | The 'protocol' field in the Cortec does not match the software ID |
| | | 5 | The 'model' field in the Cortec does not match the software ID |
| | | 6 | The first 'software version' field in the does not match the software ID |
| | | 7 | The second 'software version' field in the Cortec does not match the software ID |
| | | 8 | No VTs are fitted |
| | | 9 | No CTs are fitted |
| | | 10 | No Earth CT is fitted |
| | | 11 | No SEF CT is 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.<br>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 recognized 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 battery 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, in which case the complete cradle should be replaced.

### 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.

## 3.8      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 19

# 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        REAR SERIAL PORT 2

| Optional rear serial port (RP2) | |
|---|---|
| Use | For SCADA communications (multi-drop) |
| Standard | EIA(RS)485, K-bus, EIA(RS)232 |
| Connector | General purpose block, M4 screws (2 wire) |
| Cable | Screened twisted pair (STP) |
| Supported Protocols | Courier |
| Isolation | Isolation to SELV level |
| Constraints | Maximum cable length 1000 m |

### 2.4        IRIG-B PORT

| IRIG-B Interface (De-modulated) | |
|---|---|
| Use | External clock synchronization signal |
| Standard | IRIG 200-98 format B00X |
| Terminal type | MiDOS |
| Connector | General purpose block, M4 screws (2 wire) |
| Cable type | Screened twisted pair (STP) |
| Isolation | Isolation to SELV level |
| Accuracy | < +/- 1 s per day |

## 2.5        REAR ETHERNET PORT COPPER

| Rear Ethernet port using CAT 5/6/7 wiring | |
|---|---|
| Main Use | Substation Ethernet communications |
| Communication protocol | 10BaseT/100BaseTX |
| Connector | RJ45 |
| Cable type | Screened twisted pair (STP) |
| Isolation | 1 kV |
| Supported Protocols | IEC 61850, DNP3.0 OE |
| Constraints | Maximum cable length 100 m |

## 2.6        REAR ETHERNET PORT - FIBRE

| Rear Ethernet port using fibre-optic cabling | |
|---|---|
| Main Use | IEC 61850 or DNP3 OE SCADA communications |
| Connector | UNI SONET OC-3 LC (1 each for Tx and Rx) |
| Communication protocol | 100 BaseFX |
| Fibre type | Multimode 50/125 µm or 62.5/125 µm |
| Supported Protocols | IEC 61850, DNP3.0 OE |
| Wavelength | 1300 nm |

### 2.6.1       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

### 2.6.2       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 CURRENT PROTECTION FUNCTIONS

## 3.1        THREE-PHASE OVERCURRENT PROTECTION

| | |
|---|---|
| IDMT pick-up | 1.05 × Setting +/-5% |
| DT Pick-up | Setting +/- 5% |
| Drop-off (IDMT and DT) | 0.95 × setting +/- 5% |
| IDMT operation (for IEC and UK curves) | +/- 5% or 60 ms, whichever is greater (1.05 – <2) Is<br>+/- 5% or 40 ms, whichever is greater (2 – 20) Is |
| IDMT operation (IEEE and US curves)<br>For TD setting < 100s | +/- 5% or 60 ms, whichever is greater (1.05 – <2) Is<br>+/- 5% or 40 ms, whichever is greater (2 – 20) Is |
| IDMT operation (IEEE and US curves)<br>For TD setting > 100s | +/- 15% (1.05 - 20) Is |
| Disengagement | < 40 ms |
| DT operate | +/- 2% or 70 ms, whichever is greater (1.05 – <2) Is<br>+/- 2% or 50 ms, whichever is greater (2 – 20) Is |
| DT reset | Setting +/- 5% |
| Repeatability | +/- 2.5% |
| Overshoot of overcurrent elements | <30 ms |

## 3.2        EARTH FAULT PROTECTION

| Measured and Derived | |
|---|---|
| IDMT pick-up | 1.05 × Setting +/-5% |
| DT Pick-up | Setting +/- 5% |
| Drop-off (IDMT and DT) for IN1 | 0.95 × Setting +/-5% |
| Drop-off (IDMT and DT) for IN2 | 0.9 × Setting +/-5% |
| IDMT operate | +/- 5% or 60 ms, whichever is greater (1.05 – 2) Is<br>+/- 5% or 40 ms, whichever is greater (2 – 20) Is |
| Disengagement | < 40 ms |
| DT operate | +/- 2% or 70 ms, whichever is greater (1.05 – 2) Is<br>+/- 2% or 50 ms, whichever is greater (2 – 20) Is |
| DT reset | Setting +/- 5% |
| Repeatability | +/- 2.5% (measured), +/-5% (derived) |

## 3.3        SENSITIVE EARTH FAULT PROTECTION

| | |
|---|---|
| IDMT pick-up | 1.05 × Setting +/-5% |
| DT Pick-up | Setting +/- 5% |
| Drop-off (IDMT + DT) | 0.95 × Setting +/-5% |
| IDMT operate | +/- 2% or 70 ms, whichever is greater (1.05 - <2) Is<br>+/- 2% or 50 ms, whichever is greater (2 - 20) Is |
| Disengagement | < 40 ms |

| | |
|---|---|
| DT operate | +/- 2% or 70 ms, whichever is greater (1.05 - <2) Is<br>+/- 2% or 50 ms, whichever is greater (2 - 20) Is |
| DT reset | Setting +/- 5% |
| Repeatability | +/- 5% |

> *Note:*
> *SEF claims apply to SEF input currents of no more than 2 x In. For input ranges above 2 x In, the claim is not supported.*

## 3.4    RESTRICTED EARTH FAULT PROTECTION

| High Impedance Retricted Earth Fault (REF) accuracy | |
|---|---|
| Pick-up | Setting formula +/- 5% |
| Drop-off | 0.95 x Setting formula +/-5% |
| Operating time | < 30 ms |
| High pick-up | Setting +/- 10% |
| Repeatability | < 15% |

| Low Impedance Retricted Earth Fault (REF) accuracy | |
|---|---|
| Pick-up | Setting formula +/- 5% |
| Drop-off | 0.9 x Setting formula +/-5% |
| Operating time | < 60 ms |
| High pick-up | Setting +/- 5% |
| Repeatability | < 15% |

## 3.5    NEGATIVE SEQUENCE OVERCURRENT PROTECTION

| | |
|---|---|
| IDMT pick-up | 1.05 x Setting +/-5% |
| DT pick-up | Setting +/- 5% |
| Drop-off (IDMT + DT) | 0.95 x Setting +/-5% |
| IDMT operate | +/- 5% or 60 ms, whichever is greater (1.05 – <2) Is<br>+/- 5% or 40 ms, whichever is greater (2 – 20) Is |
| Disengagement | < 40 ms |
| DT operate | +/- 2% or 70 ms, whichever is greater (1.05 – <2) Is<br>+/- 2% or 50 ms, whichever is greater (2 – 20) Is |
| DT Reset | Setting +/- 5% |

## 3.6    CIRCUIT BREAKER FAIL AND UNDERCURRENT PROTECTION

| | |
|---|---|
| I< Pick-up | Setting +/- 5% or 20 mA, whichever is greater |
| I< Drop-off | 100% of setting +/- 5% or 20 mA, whichever is greater |
| Timers | +/- 2% or 50 ms, whichever is greater |
| Reset time | < 35 ms |

## 3.7      BROKEN CONDUCTOR PROTECTION

| | |
|---|---|
| Pick-up | Setting +/- 2.5% |
| Drop-off | 0.95 × Setting +/- 2.5% |
| DT operate | +/- 2% or 55 ms, whichever is greater |

## 3.8      THERMAL OVERLOAD PROTECTION

| | |
|---|---|
| Thermal alarm pick-up | Calculated trip time +/- 10% |
| Thermal overload pick-up | Calculated trip time +/- 10% |
| Cooling time accuracy | +/- 15% of theoretical |
| Repeatability | <5% |

> *Note:*
> *Operating time measured with applied current of 20% above thermal setting.*

## 3.9      COLD LOAD PICKUP PROTECTION

| | |
|---|---|
| I> Pick-up | Setting +/- 1.5% |
| IN> Pick-up | Setting +/- 1.5% |
| I> Drop-off | 0.95 × Setting +/- 1.5% |
| IN> Drop-off | 0.95 × Setting +/- 1.5% |
| DT operate | +/- 0.5% or 50 ms, whichever is greater |
| Repeatability | +/- 1% |

## 3.10     SELECTIVE OVERCURRENT PROTECTION

| | |
|---|---|
| Fast Block operation | < 25 ms |
| Fast Block reset | < 30 ms |
| Time delay | Setting +/- 2% or 20 ms, whichever is greater |

# 4 PERFORMANCE OF MONITORING AND CONTROL FUNCTIONS

## 4.1 CB STATE AND CONDITION MONITORING

|  |  |
|---|---|
| Timers | +/- 40 ms or 2%, whichever is greater |
| Broken current accuracy | < +/- 5% |

## 4.2 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 |

## 4.3 DC SUPPLY MONITOR

|  |  |
|---|---|
| Measuring Range | 19 V-310 V ±5% |
| Tolerance | ±1.5 V for 19-100 V<br>±2% for 100-200 V<br>±2.5% for 200-300 V |
| Pickup | 100% of Setting ± Tolerance * |
| Dropoff | Hysteresis 2%<br>102% of Setting ± Tolerance for the upper limit *<br>98% of Setting ± Tolerance for the lower limit * |
| Operate Time | Setting ± (2% or 500 ms whichever is greater) |
| Disengagement Time | < 250 ms |

Note:
* Tested at 21°C

# 5        MEASUREMENTS AND RECORDING

## 5.1        GENERAL

| General Measurement Accuracy | |
|---|---|
| General measurement accuracy | Typically +/- 1%, but +/- 0.5% between 0.2 - 2 In/Vn |
| Current magnitude | 0.05 to 4 In +/- 0.5% of reading (1A input)<br>0.05 to 4 In +/- 1.0% of reading (5A input) |
| Current phase | 0° to 360° +/- 0.5° (0.05 to 4 In for 1A input)<br>0° to 360° +/- 1° (0.05 to 4 In for 5A input) |

## 5.2        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 | 15 |
| Magnitude and relative phases accuracy | ±5% of applied quantities |
| Duration accuracy | ±2% |
| Trigger position accuracy | ±2% (minimum Trigger 100 ms) |

## 5.3        EVENT, FAULT AND MAINTENANCE RECORDS

| Event, Fault & Maintenance Records | |
|---|---|
| Record location | Flash memory |
| Viewing method | Front panel display or MiCOM S1 Agile |
| Extraction method | Extracted via the USB port |
| Number of Event records | Up to 2048 time tagged event records |
| Number of Fault Records | Up to 10 |
| Number of Maintenance Records | Up to 10 |

# 6          REGULATORY COMPLIANCE

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

$CE$

## 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.

# 7          MECHANICAL SPECIFICATIONS

## 7.1       PHYSICAL PARAMETERS

| Physical Measurements | |
|---|---|
| Case Types | 20TE<br>30TE<br>40TE |
| Weight (20TE case) | 2 kg – 3 kg (depending on chosen options) |
| Weight (30TE case) | 3 kg – 4 kg (depending on chosen options) |
| Weight (40TE case) | 5.5 kg |
| Dimensions in mm (w × h × l) (20TE case) | W: 102.4mm H: 177.0mm D: 243.1mm |
| Dimensions in mm (w × h × l) (30TE case) | W: 154.2mm H: 177.0mm D: 243.1mm |
| Dimensions in mm (w × h × l) (40TE case) | W: 206.0mm H: 177.0mm D: 243.1mm |
| Mounting | Panel, rack, or retrofit |

## 7.2       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 |

## 7.3       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 |

## 7.4       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 |

# 8        RATINGS

## 8.1        AC MEASURING INPUTS

| AC Measuring Inputs | |
|---|---|
| Nominal frequency | 50 Hz or 60 Hz (settable) |
| Operating range | 40 Hz to 70 Hz |
| Phase rotation | ABC or CBA |

## 8.2        CURRENT TRANSFORMER INPUTS

| AC Current | |
|---|---|
| Nominal current (In) | 1 A and 5 A dual rated* |
| Nominal burden per phase | < 0.05 VA at In |
| AC current thermal withstand | Continuous: 4 × In<br>10 s: 30 × In<br>1 s: 100 × In<br>Linear to 40 × In (non-offset ac current) |

Note:
A single input is used for both 1 A and 5 A 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.

## 8.3        VOLTAGE TRANSFORMER INPUTS

| AC Voltage | |
|---|---|
| Nominal voltage | 100 V to 120 V |
| Nominal burden per phase | < 0.1 VA at Vn |
| Thermal withstand | Continuous: 2 × Vn, 10 s: 2.6 × Vn |

# 9          POWER SUPPLY

## 9.1          AUXILIARY POWER SUPPLY VOLTAGE

| | |
|---|---|
| Nominal operating range | 24-250 V DC +/-20%<br>110-240 V AC -20% + 10% |
| Maximum operating range | 19 to 300 V DC |
| Frequency range for AC supply | 45 – 65 Hz |
| Ripple | <15% for a DC supply (compliant with IEC 60255-11:2008) |

## 9.2          NOMINAL BURDEN

| | | |
|---|---|---|
| Quiescent burden | 20TE | 5 W max. |
| | 30TE | 6 W max. |
| | 30TE with 2nd rear communications | 6.2 W max. |
| | 30TE with Ethernet or TCS | 7 W max. |
| | 40TE | 8 W max. |
| Additions for energised relay outputs | | 0.26 W per output relay |
| Opto-input burden | 24 V | 0.065 W max. |
| | 48 V | 0.125 W max. |
| | 110 V | 0.36 W max. |
| | 220 V | 0.9 W max. |

## 9.3          AUXILIARY POWER SUPPLY INTERRUPTION

| Standard | IEC 60255-11:2008 (dc)<br>IEC 61000-4-11:2004 (ac) | | | |
|---|---|---|---|---|
| | Quiescent / half load | | Full load | |
| | 19.2 V – 110 V dc | >110 V dc | 19.2 V – 110 V dc | >110 V dc |
| 20TE | 50 ms | 100 ms | 50 ms | 100 ms |
| 30TE | 50 ms | 100 ms | 30 ms | 50 ms |
| 30TE with 2nd rear communications | 30 ms | 100 ms | 20 ms | 50 ms |
| 30TE with Ethernet or TCS | 50 ms | 100 ms | 20 ms | 100 ms |
| 30TE with Redundant Ethernet Board | 50 ms | 100 ms | 10 ms | 100 ms |
| 40TE with 2nd rear communications | 20 ms | 100 ms | 10 ms* | 50 ms |

* for voltages > 48 V dc

> Note:
> Maximum loading = all inputs/outputs energised. Quiescent or 1/2 loading = 1/2 of all inputs/outputs energised.

# 10        INPUT/OUTPUT CONNECTIONS

## 10.1        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 |

### 10.1.1        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.*

## 10.2        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<br>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 |

## 10.3    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) |

## 10.4    SHORTING LINK

| | |
|---|---|
| Maximum operating voltage | 300Vrms, 300Vdc |
| Maximum operating current | 20A |

# 11        ENVIRONMENTAL CONDITIONS

## 11.1        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) |

## 11.2        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)<br>+70°C (96 hours) |
| Storage and transit temperature range | -40°C (96 hours)<br>+85°C (96 hours) |

## 11.3        AMBIENT HUMIDITY RANGE

|  |  |
|---|---|
| Compliance | IEC 60068-2-78: 2012 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 |

## 11.4        CORROSIVE ENVIRONMENTS

|  |  |
|---|---|
| Compliance, Industrial corrosive environment/poor environmental control | IEC 60068-2-42: 2003, IEC 60068-2-43: 2003, IEC 60068-2-52: 1996 |
| Sulphur Dioxide, IEC 60068-2-42: 2003 | 21 days exposure to elevated concentrations (25ppm) of $SO_2$ at 75% relative humidity and +25°C |
| Hydrogen Sulphide, IEC 60068-2-43: 2003 | 21 days exposure to elevated concentrations (10ppm) of $H_2S$ at 75% relative humidity and +25°C |
| Salt mist, IEC 60068-2-52: 1996 | 7 days, KB severity 3 |

## 12        TYPE TESTS

### 12.1        INSULATION

| | |
|---|---|
| Compliance | IEC 60255-27: 2013 |
| Insulation resistance | > 100 M ohm at 500 V DC (Using only electronic/brushless insulation tester) |

### 12.2        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 |

### 12.3        HIGH VOLTAGE (DIELECTRIC) WITHSTAND

| | |
|---|---|
| IEC Compliance | IEC 60255-27: 2005 |
| Between independent opto-inputs or Vx and other circuits | 2.82kV dc for 1 minute |
| Between all other independent circuits | 2 kV ac rms for 1 minute |
| Between Vx or opto-inputs, and protective earth terminal | 2.82kV dc for 1 minute |
| Between all other independent circuits and protective earth terminal | 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 terminal | 1 kV ac rms for 1 minute |
| Between all screw-type EIA(RS)485 contacts and protective earth terminal | 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 |

### 12.4        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.*

# 13    ELECTROMAGNETIC COMPATIBILITY

## 13.1    1 MHZ BURST HIGH FREQUENCY DISTURBANCE TEST

| | |
|---|---|
| Compliance | IEC 60255-26:2013 |
| Common-mode test voltage (level 3) | 2.5 kV |
| Differential test voltage (level 3) | 1.0 kV |

## 13.2    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 |

## 13.3    IMMUNITY TO ELECTROSTATIC DISCHARGE

| | |
|---|---|
| Compliance | IEC 60255-26:2013 |
| Class 4 Condition (20TE, 30TE) | 15 kV discharge in air to user interface, display, and exposed metalwork<br>8 kV contact discharge to communication ports and exposed metalwork |
| Class 3 Condition (40TE) | 6 kV contact discharge to communication ports and exposed metalwork |

## 13.4    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) |

## 13.5    SURGE WITHSTAND CAPABILITY

| | |
|---|---|
| Compliance | IEEE/ANSI C37.90.1: 2012 |
| 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 |

## 13.6    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 |

## 13.7    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 |

## 13.8    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% |

## 13.9    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 |

## 13.10   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 |

## 13.11    MAGNETIC FIELD IMMUNITY

| | |
|---|---|
| Compliance | IEC 61000-4-8:2009 Level 5<br>IEC 61000-4-9:2016 Level 5<br>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 |

## 13.12    CONDUCTED EMISSIONS

| | |
|---|---|
| Compliance | IEC 60255-26:2013, EN 55032: 2015+A1:2020 |
| 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) |

## 13.13    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 |

## 13.14    POWER FREQUENCY

| | |
|---|---|
| Compliance | IEC 60255-26:2013 |
| Opto-inputs (Compliance is achieved using the opto-input filter) | 300 V common-mode (Class A)<br>150 V differential mode (Class A) |

> Note:
> Compliance is achieved using the opto-input filter.

# APPENDIX A

## ORDERING OPTIONS

Information Required with Order :

| Variants | Order Number | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 - 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12-13 | 14 | 15 | | | |
| **Model Type** | | | | | | | | | | | | | | | |
| Feeder Management Protection IED - Non Directional | | P14N | | | | | | | | | | | | | |
| **Application** | | | | | | | | | | | | | | | |
| Base | | | B | | | | | | | | | | | | |
| Autoreclose (plus HIF when used with SEF CT) | | | Z | | | | | | | | | | | | |
| **Current Transformer** | | | | | | | | | | | | | | | |
| Standard Earth CT | | | | 1 | | | | | | | | | | | |
| SEF CT | | | | 2 | | | | | | | | | | | |
| **Hardware Options** | | | | | | | | | | | | | | | |
| EIA RS485/IRIG-B (demodulated) | | 20TE/30TE | | | 1 | | | | | | | | | | |
| EIA RS485/IRIG-B (demodulated) and Ethernet: Single channel Fibre/Copper (setting configurable as Failover*) | | 30TE | | | 6 | | | | | | | | | | |
| EIA RS485/IRIG-B (demodulated) and EIA RS485 | | 30TE | | | 8 | | | | | | | | | | |
| EIA RS485/IRIG-B (demodulated) and Dual Redundant Copper Ethernet: 2x RJ45 Copper (setting configurable as Failover) | | 30TE/40TE | | | A | | | | | | | | | | |
| EIA RS485/IRIG-B (demodulated) and Dual Redundant Fibre Ethernet: 2x multimode fibre (setting configurable as Failover) | | 30TE/40TE | | | B | | | | | | | | | | |
| EIA RS485/IRIG-B (demodulated) and Dual Redundant Copper Ethernet: 2x RJ45 Copper (RSTP) | | 30TE/40TE | | | C | | | | | | | | | | |
| EIA RS485/IRIG-B (demodulated) and Dual Redundant Fibre Ethernet: 2x multimode fibre (RSTP) | | 30TE/40TE | | | D | | | | | | | | | | |
| EIA RS485/IRIG-B (demodulated) and Dual Redundant Copper Ethernet: 2x RJ45 Copper (setting configurable as PRP or HSR) | | 30TE/40TE | | | E | | | | | | | | | | |
| EIA RS485/IRIG-B (demodulated) and Dual Redundant Fibre Ethernet: 2x multimode fibre (setting configurable as PRP or HSR) | | 30TE/40TE | | | F | | | | | | | | | | |
| 40TE only - EIA RS485, EIA RS485/IRIG-B (demodulated) and Dual Redundant Copper Ethernet: 2x RJ45 Copper (setting configurable as Failover) | | 40TE | | | G | | | | | | | | | | |
| 40TE only - EIA RS485, EIA RS485/IRIG-B (demodulated) and Dual Redundant Fibre Ethernet: 2x multimode fibre (setting configurable as Failover) | | 40TE | | | H | | | | | | | | | | |
| 40TE only - EIA RS485, EIA RS485/IRIG-B (demodulated) and Dual Redundant Copper Ethernet: 2x RJ45 Copper (RSTP) | | 40TE | | | J | | | | | | | | | | |
| 40TE only - EIA RS485, EIA RS485/IRIG-B (demodulated) and Dual Redundant Fibre Ethernet: 2x multimode fibre (RSTP) | | 40TE | | | K | | | | | | | | | | |
| 40TE only - EIA RS485, EIA RS485/IRIG-B (demodulated) and Dual Redundant Copper Ethernet: 2x RJ45 Copper (setting configurable as PRP or HSR) | | 40TE | | | L | | | | | | | | | | |
| 40TE only - EIA RS485, EIA RS485/IRIG-B (demodulated) and Dual Redundant Fibre Ethernet: 2x multimode fibre (setting configurable as PRP or HSR) | | 40TE | | | M | | | | | | | | | | |
| EIA RS485/IRIG-B (demodulated) and Dual Copper Ethernet: 2x RJ45 Copper (dual IP) | | 30TE/40TE | | | N | | | | | | | | | | |
| EIA RS485/IRIG-B (demodulated) and Dual Redundant Fibre Ethernet: 2x multimode fibre (dual IP) | | 30TE/40TE | | | P | | | | | | | | | | |
| EIA RS485, EIA RS485/IRIG-B (demodulated) and Dual Copper Ethernet: 2x RJ45 Copper (dual IP) | | 40TE | | | Q | | | | | | | | | | |
| EIA RS485, EIA RS485/IRIG-B (demodulated) and Dual Redundant Fibre Ethernet: 2x multimode fibre (dual IP) | | 40TE | | | R | | | | | | | | | | |
| **I/O Options** | | Case | | | | | | | | | | | | | |
| Standard (8 logic inputs + 8 relay outputs) | | 20TE/30TE | | | | A | | | | | | | | | |
| Total (11 logic inputs + 12 relay outputs) suitable for trip circuit supervision | | 30TE/40TE | | | | C | | | | | | | | | |
| Total (13 logic inputs + 12 relay outputs) | | 30TE/40TE | | | | D | | | | | | | | | |
| Total (3 logic inputs + 4 relay outputs) | | 20TE | | | | E | | | | | | | | | |
| Total (6 logic inputs + 8 relay outputs) suitable for trip circuit supervision | | 30TE | | | | F | | | | | | | | | |
| Total (7 logic inputs + 8 relay outputs) suitable for trip circuit supervision | | 20TE/30TE | | | | G | | | | | | | | | |
| Total (10 logic inputs + 12 relay outputs) suitable for trip circuit supervision * | | 40TE | | | | ⧄ | | | | | | | | | |
| Total (12 logic inputs + 12 relay outputs) suitable for trip circuit supervision * | | 40TE | | | | ⧄ | | | | | | | | | |

* Please contact Product Manager

**Communication Protocol**

| | |
|---|---|
| Courier | 1 |
| Modbus | 2 |
| IEC60870-5-103 (VDEW) | 3 |
| DNP3.0 | 4 |
| IEC 61850 over Ethernet and Courier via rear RS485 | 6 |
| IEC 61850 over Ethernet and IEC60870-5-103 via rear RS485 | 7 |
| DNP3.0 over Ethernet and Courier via rear RS485 | 8 |
| IEC 61850 over Ethernet and Modbus via rear RS485 | 9 |
| IEC 61850 over Ethernet and DNP3.0 via rear RS485 | A |
| IEC61850 over Ethernet + DNP3.0 over Ethernet and Courier via RS485 | B |
| IEC61850 over Ethernet + DNP3.0 over Ethernet and Modbus via RS485 | C |
| IEC61850 over Ethernet + DNP3.0 over Ethernet and IEC60870-5-103 via RS485 | D |

**Case**

| | |
|---|---|
| 20TE Flush (no function keys, 4 programmable LEDs) | B |
| 30TE Flush (3 function keys with LEDs, 8 programmable LEDs) | C |
| Software only | 0 |
| 20TE Flush (Adapted field voltage for KCGG retrofit) | 2 |
| 20TE Flush (without field voltage jumpering for KCGG retrofit) | 4 |
| 30TE Flush (Additional shorting link) | 6 |
| 40TE Flush (3 function keys with LEDs, 8 programmable LEDs) | D |

**Language**

| | |
|---|---|
| Multilingual (English, French, German, Spanish) | 0 |
| Multilingual (English, Russian, Italian, Portuguese) | 6 |
| Chinese, English or French via HMI, with English or French only via Communications port | C |

**Software Reference**

| | |
|---|---|
| Unless specified the latest version will be delivered | ** |

**Customisation/Regionalisation**

| | |
|---|---|
| Default | 0 |
| Customer specific | A |
| High impedance busbar application ** | B |

** Available for 20TE/30TE IO option A and 62 Software and in English Language

**Hardware Design Suffix**

| | |
|---|---|
| Initial release | A |

# APPENDIX B

# SETTINGS AND SIGNALS

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| SYSTEM DATA | 00.00 | | |
| This column contains general system settings and records | | | |
| Language | 00.01 | English | English<br>Francais<br>Deutsch<br>Espanol<br>*[Indexed String]* |
| This setting defines the default language used by the device for ordering option language = 0 | | | |
| Language | 00.01 | English | English<br>Italiano<br>Portuguêse<br>PYCCKŌÖ<br>*[Indexed String]* |
| This setting defines the default language used by the device for ordering option language = 6 | | | |
| Password | 00.02 | | 4 registers for writing 8 character password<br>Each register contains a pair of characters<br>Each register is formatted as follows:-<br>first character of a pair<br>second character of a pair<br>Each character is in the Courier range 33 - 122<br>*[ASCII Password (4 chars)*<br>*ASCII Password (8 chars)]* |
| This setting defines the plain text password. | | | |
| Sys Fn Links | 00.03 | 0 | Trip LED S/Reset (1 = enable self reset)<br>*[Binary Flag (1) Indexed String]* |
| 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 P14N<br>MiCOM P14D<br>MiCOM P94V | From 32 to 163 in steps of 1<br>*[ASCII Text (16 chars)]* |
| In this cell, you can enter and edit a 16 character IED description. | | | |
| Plant Reference | 00.05 | MiCOM | From 32 to 234 in steps of 1<br>*[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<br>*[ASCII Text (16 chars)]* |
| This cell displays the IED model number.  This cannot be edited. | | | |
| Serial Number | 00.08 | Serial Number | Serial Number<br>*[ASCII Text (7 chars)]* |
| This cell displays the IED serial number.  This  cannot be edited | | | |
| Frequency | 00.09 | 50 | 50 or 60<br>*[Unsigned Integer (16 bits)]* |
| This cell sets the mains frequency to either 50 Hz or 60 Hz | | | |
| Comms Level | 00.0A | 2 | Comms Level<br>*[Unsigned Integer (16 bits)]* |
| This cell displays the Courier communications conformance level | | | |
| Relay Address | 00.0B | 255 | From 0 to 255 in steps of 1<br>*[Unsigned Integer (16 bits)]* |
| This cell sets the first rear port IED address. Available settings are dependent on the protocol. This setting can also be made in the COMMUNICATIONS column. | | | |
| Relay Address | 00.0B | 1 | From 1 to 247 in steps of 1<br>*[Unsigned Integer (16 bits)]* |
| This cell sets the first rear port IED address. Available settings are dependent on the protocol. This setting can also be made in the COMMUNICATIONS column. | | | |
| Relay Address | 00.0B | 1 | From 0 to 254 in steps of 1<br>*[Unsigned Integer (16 bits)]* |
| This cell sets the first rear port IED address. Available settings are dependent on the protocol. This setting can also be made in the COMMUNICATIONS column. | | | |
| Relay Address | 00.0B | 1 | From 0 to 65519 in steps of 1<br>*[Unsigned Integer (16 bits)]* |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| This cell sets the first rear port IED address. Available settings are dependent on the protocol. This setting can also be made in the COMMUNICATIONS column. | | | |
| Plant Status | 00.0C | | CB1 Open<br>CB1 Closed<br>*[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<br>*[Binary Flag (16 bits)]* |
| This cell is not used | | | |
| Active Group | 00.0E | 1 | Active Group<br>*[Unsigned Integer (16 bits)]* |
| This cell displays the active settings group | | | |
| CB Trip/Close | 00.10 | No Operation | No Operation<br>Trip<br>Close<br>*[Indexed String]* |
| Supports trip and close commands if enabled in the Circuit Breaker Control menu. | | | |
| CB Trip/Close | 00.10 | No Operation | No Operation<br>Trip<br>Close<br>*[Indexed String]* |
| Supports trip and close commands if enabled in the Circuit Breaker Control menu. | | | |
| Software Ref. 1 | 00.11 | | Software Ref. 1<br>*[ASCII Text (16 chars)]* |
| This cell displays the IED software version including the protocol and IED model. | | | |
| Software Ref. 2 | 00.12 | | Software Ref. 2<br>*[ASCII Text (16 chars)]* |
| This cell displays the software version of the Ethernet card for models equipped with IEC 61850. | | | |
| Opto I/P Status | 00.20 | | Opto 1 Input State (0=Off, 1=Energised)<br>Opto 2 Input State (0=Off, 1=Energised)<br>Opto 3 Input State (0=Off, 1=Energised)<br>Opto 4 Input State (0=Off, 1=Energised)<br>Opto 5 Input State (0=Off, 1=Energised)<br>Opto 6 Input State (0=Off, 1=Energised)<br>Opto 7 Input State (0=Off, 1=Energised)<br>Opto 8 Input State (0=Off, 1=Energised)<br>Opto 9 Input State (0=Off, 1=Energised)<br>Opto 10 Input State (0=Off, 1=Energised)<br>Opto 11 Input State (0=Off, 1=Energised)<br>Opto 12 Input State (0=Off, 1=Energised)<br>Opto 13 Input State (0=Off, 1=Energised)<br>Opto 14 Input State (0=Off, 1=Energised)<br>Opto 15 Input State (0=Off, 1=Energised)<br>Opto 16 Input State (0=Off, 1=Energised)<br>Opto 17 Input State (0=Off, 1=Energised)<br>Opto 18 Input State (0=Off, 1=Energised)<br>Opto 19 Input State (0=Off, 1=Energised)<br>Opto 20 Input State (0=Off, 1=Energised)<br>Opto 21 Input State (0=Off, 1=Energised)<br>Opto 22 Input State (0=Off, 1=Energised)<br>Opto 23 Input State (0=Off, 1=Energised)<br>Opto 24 Input State (0=Off, 1=Energised)<br>Opto 25 Input State (0=Off, 1=Energised)<br>Opto 26 Input State (0=Off, 1=Energised)<br>Opto 27 Input State (0=Off, 1=Energised)<br>Opto 28 Input State (0=Off, 1=Energised)<br>Opto 29 Input State (0=Off, 1=Energised)<br>Opto 30 Input State (0=Off, 1=Energised)<br>Opto 31 Input State (0=Off, 1=Energised)<br>Opto 32 Input State (0=Off, 1=Energised)<br>*[Binary Flag (32 bits) Indexed String]* |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| This cell displays the status of the available opto-inputs. This information is also available in the COMMISSIONING TESTS column | | | |
| Relay O/P Status | 00.21 | | Relay 1 (0=Not Operated, 1=Operated)<br>Relay 2 (0=Not Operated, 1=Operated)<br>Relay 3 (0=Not Operated, 1=Operated)<br>Relay 4 (0=Not Operated, 1=Operated)<br>Relay 5 (0=Not Operated, 1=Operated)<br>Relay 6 (0=Not Operated, 1=Operated)<br>Relay 7 (0=Not Operated, 1=Operated)<br>Relay 8 (0=Not Operated, 1=Operated)<br>Relay 9 (0=Not Operated, 1=Operated)<br>Relay 10 (0=Not Operated, 1=Operated)<br>Relay 11 (0=Not Operated, 1=Operated)<br>Relay 12 (0=Not Operated, 1=Operated)<br>Relay 13 (0=Not Operated, 1=Operated)<br>Relay 14 (0=Not Operated, 1=Operated)<br>Relay 15 (0=Not Operated, 1=Operated)<br>Relay 16 (0=Not Operated, 1=Operated)<br>Relay 17 (0=Not Operated, 1=Operated)<br>Relay 18 (0=Not Operated, 1=Operated)<br>Relay 19 (0=Not Operated, 1=Operated)<br>Relay 20 (0=Not Operated, 1=Operated)<br>Relay 21 (0=Not Operated, 1=Operated)<br>Relay 22 (0=Not Operated, 1=Operated)<br>Relay 23 (0=Not Operated, 1=Operated)<br>Relay 24 (0=Not Operated, 1=Operated)<br>Relay 25 (0=Not Operated, 1=Operated)<br>Relay 26 (0=Not Operated, 1=Operated)<br>Relay 27 (0=Not Operated, 1=Operated)<br>Relay 28 (0=Not Operated, 1=Operated)<br>Relay 29 (0=Not Operated, 1=Operated)<br>Relay 30 (0=Not Operated, 1=Operated)<br>Relay 31 (0=Not Operated, 1=Operated)<br>Relay 32 (0=Not Operated, 1=Operated)<br>[Binary Flag (32 bits) Indexed String] |
| This cell displays the status of the available output relays. | | | |
| Alarm Status 1 | 00.22 | | Thermal Lockout<br>HIF Alarm<br>SG-opto Invalid<br>Prot'n Disabled<br>F out of Range<br>VT Fail Alarm<br>CT Fail Alarm<br>CB Fail Alarm<br>I^ Maint Alarm<br>I^ Lockout Alarm<br>CB Ops Maint<br>CB Ops Lockout<br>CB Op Time Maint<br>CB Op Time Lock<br>Fault Freq Lock<br>CB Status Alarm<br>Man CB Trip Fail<br>Man CB Cls Fail<br>Man CB Unhealthy<br>Man No Checksync<br>A/R Lockout<br>A/R CB Unhealthy<br>A/R No Checksync<br>System Split<br>UV Block<br>User Alarm 1<br>User Alarm 2<br>User Alarm 3 |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
|  |  |  | User Alarm 4 |
|  |  |  | User Alarm 5 |
|  |  |  | User Alarm 6 |
|  |  |  | User Alarm 7 |
|  |  |  | *[Binary Flag (32 bits) Indexed String]* |
| This cell displays the status of the first 32 alarms as a binary string, including fixed and user settable alarms. This information is repeated for system purposes. This cell uses data type G96-1. | | | |
| Opto I/P Status | 00.30 |  | Opto 1 Input State (0=Off, 1=Energised) |
|  |  |  | Opto 2 Input State (0=Off, 1=Energised) |
|  |  |  | Opto 3 Input State (0=Off, 1=Energised) |
|  |  |  | Opto 4 Input State (0=Off, 1=Energised) |
|  |  |  | Opto 5 Input State (0=Off, 1=Energised) |
|  |  |  | Opto 6 Input State (0=Off, 1=Energised) |
|  |  |  | Opto 7 Input State (0=Off, 1=Energised) |
|  |  |  | Opto 8 Input State (0=Off, 1=Energised) |
|  |  |  | Opto 9 Input State (0=Off, 1=Energised) |
|  |  |  | Opto 10 Input State (0=Off, 1=Energised) |
|  |  |  | Opto 11 Input State (0=Off, 1=Energised) |
|  |  |  | Opto 12 Input State (0=Off, 1=Energised) |
|  |  |  | Opto 13 Input State (0=Off, 1=Energised) |
|  |  |  | Opto 14 Input State (0=Off, 1=Energised) |
|  |  |  | Opto 15 Input State (0=Off, 1=Energised) |
|  |  |  | Opto 16 Input State (0=Off, 1=Energised) |
|  |  |  | Opto 17 Input State (0=Off, 1=Energised) |
|  |  |  | Opto 18 Input State (0=Off, 1=Energised) |
|  |  |  | Opto 19 Input State (0=Off, 1=Energised) |
|  |  |  | Opto 20 Input State (0=Off, 1=Energised) |
|  |  |  | Opto 21 Input State (0=Off, 1=Energised) |
|  |  |  | Opto 22 Input State (0=Off, 1=Energised) |
|  |  |  | Opto 23 Input State (0=Off, 1=Energised) |
|  |  |  | Opto 24 Input State (0=Off, 1=Energised) |
|  |  |  | Opto 25 Input State (0=Off, 1=Energised) |
|  |  |  | Opto 26 Input State (0=Off, 1=Energised) |
|  |  |  | Opto 27 Input State (0=Off, 1=Energised) |
|  |  |  | Opto 28 Input State (0=Off, 1=Energised) |
|  |  |  | Opto 29 Input State (0=Off, 1=Energised) |
|  |  |  | Opto 30 Input State (0=Off, 1=Energised) |
|  |  |  | Opto 31 Input State (0=Off, 1=Energised) |
|  |  |  | Opto 32 Input State (0=Off, 1=Energised) |
|  |  |  | *[Binary Flag (32 bits) Indexed String]* |
| This cell display the status of the available opto-inputs. This information is repeated for system purposes. | | | |
| Relay O/P Status | 00.40 |  | High order word of long stored in 1st register |
|  |  |  | Low order word of long stored in 2nd register |
|  |  |  | Example 123456 stored as 123456 |
|  |  |  | *[Binary Flag (32 bits) Indexed String]* |
| This cell displays the status of the available output relays. This information is repeated for system purposes. | | | |
| Alarm Status 1 | 00.50 |  | Thermal Lockout |
|  |  |  | HIF Alarm |
|  |  |  | SG-opto Invalid |
|  |  |  | Prot'n Disabled |
|  |  |  | F out of Range |
|  |  |  | VT Fail Alarm |
|  |  |  | CT Fail Alarm |
|  |  |  | CB Fail Alarm |
|  |  |  | I^ Maint Alarm |
|  |  |  | I^ Lockout Alarm |
|  |  |  | CB Ops Maint |
|  |  |  | CB Ops Lockout |
|  |  |  | CB Op Time Maint |
|  |  |  | CB Op Time Lock |
|  |  |  | Fault Freq Lock |
|  |  |  | CB Status Alarm |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | Man CB Trip Fail |
| | | | Man CB Cls Fail |
| | | | Man CB Unhealthy |
| | | | Man No Checksync |
| | | | A/R Lockout |
| | | | A/R CB Unhealthy |
| | | | A/R No Checksync |
| | | | System Split |
| | | | UV Block |
| | | | User Alarm 1 |
| | | | User Alarm 2 |
| | | | User Alarm 3 |
| | | | User Alarm 4 |
| | | | User Alarm 5 |
| | | | User Alarm 6 |
| | | | User Alarm 7 |
| | | | *[Binary Flag (32 bits) Indexed String]* |
| This cell displays the status of the first 32 alarms as a binary string, including fixed and user settable alarms. This information is repeated for system purposes. This cell uses data type G96-1. | | | |
| Alarm Status 3 | 00.52 | | DC Supply Fail |
| | | | GOOSE IED Absent |
| | | | NIC Not Fitted |
| | | | NIC No Response |
| | | | NIC Fatal Error |
| | | | Bad TCP/IP Cfg. |
| | | | NIC Link Fail |
| | | | NIC SW Mis-Match |
| | | | IP Addr Conflict |
| | | | Port A Link Fail |
| | | | Port B Link Fail |
| | | | DREB Set.Invalid |
| | | | Bad DNP Settings |
| | | | SNTP Failure |
| | | | PTP Failure |
| | | | *[Binary Flag (32 bits) Indexed String]* |
| This cell displays the status of the third set of alarms as a binary string, including fixed and user settable alarms. This cell uses data type G228. | | | |
| User Alarms | 00.54 | | User Alarm 1 (0=Self-reset, 1=Manual reset) |
| | | | User Alarm 2 (0=Self-reset, 1=Manual reset) |
| | | | User Alarm 3 (0=Self-reset, 1=Manual reset) |
| | | | User Alarm 4 (0=Self-reset, 1=Manual reset) |
| | | | User Alarm 5 (0=Self-reset, 1=Manual reset) |
| | | | User Alarm 6 (0=Self-reset, 1=Manual reset) |
| | | | User Alarm 7 (0=Self-reset, 1=Manual reset) |
| | | | User Alarm 8 (0=Self-reset, 1=Manual reset) |
| | | | User Alarm 9 (0=Self-reset, 1=Manual reset) |
| | | | User Alarm 10 (0=Self-reset, 1=Manual reset) |
| | | | User Alarm 11 (0=Self-reset, 1=Manual reset) |
| | | | User Alarm 12 (0=Self-reset, 1=Manual reset) |
| | | | User Alarm 13 (0=Self-reset, 1=Manual reset) |
| | | | User Alarm 14 (0=Self-reset, 1=Manual reset) |
| | | | User Alarm 15 (0=Self-reset, 1=Manual reset) |
| | | | User Alarm 16 (0=Self-reset, 1=Manual reset) |
| | | | User Alarm 17 (0=Self-reset, 1=Manual reset) |
| | | | User Alarm 18 (0=Self-reset, 1=Manual reset) |
| | | | User Alarm 19 (0=Self-reset, 1=Manual reset) |
| | | | User Alarm 20 (0=Self-reset, 1=Manual reset) |
| | | | User Alarm 21 (0=Self-reset, 1=Manual reset) |
| | | | User Alarm 22 (0=Self-reset, 1=Manual reset) |
| | | | User Alarm 23 (0=Self-reset, 1=Manual reset) |
| | | | User Alarm 24 (0=Self-reset, 1=Manual reset) |
| | | | User Alarm 25 (0=Self-reset, 1=Manual reset) |
| | | | User Alarm 26 (0=Self-reset, 1=Manual reset) |
| | | | User Alarm 27 (0=Self-reset, 1=Manual reset) |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | User Alarm 28 (0=Self-reset, 1=Manual reset)<br>User Alarm 29 (0=Self-reset, 1=Manual reset)<br>User Alarm 30 (0=Self-reset, 1=Manual reset)<br>User Alarm 31 (0=Self-reset, 1=Manual reset)<br>User Alarm 32 (0=Self-reset, 1=Manual reset)<br>*[Binary Flag (32 bits) Indexed String]* |
| This cell displays the status of the third set of alarms as a binary string, including fixed and user settable alarms. This cell uses data type G268. | | | |
| Build Date&Time | 00.60 | Build Date & Time | Build Date&Time<br>*[ASCII Text (16 chars)]* |
| This cell displays the build date & time. This cannot be edited. | | | |
| Access Level | 00.D0 | | Level 0 - Logged Out.<br>Level 1 - Password required for level 2.<br>Level 2 - Password required for level 3.<br>Level 3 - No Password required.<br>*[Unsigned Integer (16 bits)]* |
| This cell displays the current access level. | | | |
| Password Level 1 | 00.D2 | blank | 4 registers for writing 8 character password<br>Each register contains a pair of characters<br>Each register is formatted as follows:-<br>first character of a pair<br>second character of a pair<br>Each character is in the Courier range 33 - 122<br>*[ASCII Password (8 chars)]* |
| This setting allows you to change password level 1. | | | |
| Password Level 1 | 00.D2 | blank | 4 registers for writing 8 character password<br>Each register contains a pair of characters<br>Each register is formatted as follows:-<br>first character of a pair<br>second character of a pair<br>Each character is in the Courier range 33 - 122<br>*[ASCII Password (8 chars)]* |
| This setting allows you to change password level 1 for Modbus only. | | | |
| Password Level 2 | 00.D3 | AAAA | 4 registers for writing 8 character password<br>Each register contains a pair of characters<br>Each register is formatted as follows:-<br>first character of a pair<br>second character of a pair<br>Each character is in the Courier range 33 - 122<br>*[ASCII Password (8 chars)]* |
| This setting allows you to change password level 2. | | | |
| Password Level 2 | 00.D3 | AAAA | 4 registers for writing 8 character password<br>Each register contains a pair of characters<br>Each register is formatted as follows:-<br>first character of a pair<br>second character of a pair<br>Each character is in the Courier range 33 - 122<br>*[ASCII Password (8 chars)]* |
| This setting allows you to change password level 2 for Modbus only. | | | |
| Password Level 3 | 00.D4 | AAAA | 4 registers for writing 8 character password<br>Each register contains a pair of characters<br>Each register is formatted as follows:-<br>first character of a pair<br>second character of a pair<br>Each character is in the Courier range 33 - 122<br>*[ASCII Password (8 chars)]* |
| This setting allows you to change password level 3. | | | |
| Password Level 3 | 00.D4 | AAAA | 4 registers for writing 8 character password<br>Each register contains a pair of characters<br>Each register is formatted as follows:-<br>first character of a pair<br>second character of a pair |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| | | **DESCRIPTION** | |
| | | | Each character is in the Courier range 33 - 122 *[ASCII Password (8 chars)]* |
| This setting allows you to change password level 3 for Modbus only. | | | |
| Security Feature | 00.DF | | Security Feature *[Unsigned Integer (16-bits)]* |
| This setting displays the level of cyber security implemented, 1 = phase 1. | | | |
| Password | 00.E1 | | 4 registers for writing encrypted password Registers can contain any bit pattern. *[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 | blank | 4 registers for writing encrypted password Registers can contain any bit pattern. *[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 | 4 registers for writing encrypted password Registers can contain any bit pattern. *[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 | 4 registers for writing encrypted password Registers can contain any bit pattern. *[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 | | |
| This column contains information about records. Most of these cells are not editable. | | | |
| Select Event [0...n] | 01.01 | 0 | From 0 to 2048 in steps of 1 *[Unsigned Integer (16 bits)]* |
| This setting selects the required event record.  A value of 0 corresponds to the latest event, 1 the second latest and so on. | | | |
| Menu Cell Ref | 01.02 | (From Record) | Menu Cell Ref *[Cell Reference]* |
| This cell indicates the type of event | | | |
| Time & Date | 01.03 | (From Record) | Time & Date *[IEC870 Date & Time]* |
| This cell shows the Time & Date of the event, given by the internal Real Time Clock. | | | |
| Event Text | 01.04 | | Event Text *[ASCII Text (32 chars)]* |
| This cell shows the description of the event - up to 32 Characters over 2 lines. | | | |
| Event Value | 01.05 | | Event Value *[Unsigned Integer (32 bits)]* |
| This cell displays a 32 bit binary flag representing the event. | | | |
| Select Fault  [0...n] | 01.06 | 0 | From 0 to 9 in steps of 1 *[Unsigned Integer (16 bits)]* |
| This setting selects the required fault record from those stored.  A value of 0 corresponds to the latest fault and so on. | | | |
| Faulted Phase | 01.07 | | Start A Start B Start C Start N Trip A Trip B Trip C Trip N *[Binary Flag (8 bits)]* |
| This cell displays the faulted phase. | | | |
| Start Elements 1 | 01.08 | | General Start Start I>1 Start I>2 Start I>3 Start I>4 Start BrokenLine Start IN1>1 Start IN1>2 |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
|  |  |  | Start IN1>3 |
|  |  |  | Start IN1>4 |
|  |  |  | Start IN2>1 |
|  |  |  | Start IN2>2 |
|  |  |  | Start IN2>3 |
|  |  |  | Start IN2>4 |
|  |  |  | Start ISEF>1 |
|  |  |  | Start ISEF>2 |
|  |  |  | Start ISEF>3 |
|  |  |  | Start ISEF>4 |
|  |  |  | Start NVD VN>1 |
|  |  |  | Start NVD VN>2 |
|  |  |  | Thermal Alarm |
|  |  |  | Start V2>1 |
|  |  |  | Start V<1 |
|  |  |  | Start V<2 |
|  |  |  | Start V< A/AB |
|  |  |  | Start V< B/BC |
|  |  |  | Start V< C/CA |
|  |  |  | Start V>1 |
|  |  |  | Start V>2 |
|  |  |  | Start V> A/AB |
|  |  |  | Start V> B/BC |
|  |  |  | Start V> C/CA |
|  |  |  | *[Binary Flag (32 bits)* |
|  |  |  | *Indexed String]* |
| This cell displays the status of the first set of 32 start signals. | | | |
| Start Elements 2 | 01.09 |  | Start NVD VN>3 |
|  |  |  | Start V<3 |
|  |  |  | Start V>3 |
|  |  |  | Start NVD VN>4 |
|  |  |  | Start NVD VN<1 |
|  |  |  | Start NVD VN<2 |
|  |  |  | Start YN> |
|  |  |  | Start GN> |
|  |  |  | Start BN> |
|  |  |  | Start df/dt>1 |
|  |  |  | Start df/dt>2 |
|  |  |  | Start df/dt>3 |
|  |  |  | Start df/dt>4 |
|  |  |  | Start I2>1 |
|  |  |  | Start I2>2 |
|  |  |  | Start I2>3 |
|  |  |  | Start I2>4 |
|  |  |  | Start I>5 |
|  |  |  | Start I>6 |
|  |  |  | Power>1 Start |
|  |  |  | Power>2 Start |
|  |  |  | Power> A Start |
|  |  |  | Power> B Start |
|  |  |  | Power> C Start |
|  |  |  | Power<1 Start |
|  |  |  | Power<2 Start |
|  |  |  | Power< A Start |
|  |  |  | Power< B Start |
|  |  |  | Power< C Start |
|  |  |  | SensP1 Start A |
|  |  |  | SensP2 Start A |
|  |  |  | Start V2>2 |
|  |  |  | *[Binary Flag (32 bits)* |
|  |  |  | *Indexed String]* |
| This cell displays the status of the second set of 32 start signals. | | | |
| Start Elements 3 | 01.0A |  | Start F 1 |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| | | | Start F 2 |
| | | | Start F 3 |
| | | | Start F 4 |
| | | | Start F 5 |
| | | | Start F 6 |
| | | | Start F 7 |
| | | | Start F 8 |
| | | | Start F 9 |
| | | | Start df/dt+t 1 |
| | | | Start df/dt+t 2 |
| | | | Start df/dt+t 3 |
| | | | Start df/dt+t 4 |
| | | | Start df/dt+t 5 |
| | | | Start df/dt+t 6 |
| | | | Start df/dt+t 7 |
| | | | Start df/dt+t 8 |
| | | | Start df/dt+t 9 |
| | | | Sta DelF/DelT 1 |
| | | | Sta DelF/DelT 2 |
| | | | Sta DelF/DelT 3 |
| | | | Sta DelF/DelT 4 |
| | | | Sta DelF/DelT 5 |
| | | | Sta DelF/DelT 6 |
| | | | Sta DelF/DelT 7 |
| | | | Sta DelF/DelT 8 |
| | | | Sta DelF/DelT 9 |
| | | | dv/dt1 Start |
| | | | dv/dt2 Start |
| | | | dv/dt StartA/AB |
| | | | dv/dt StartB/BC |
| | | | dv/dt StartC/CA |
| | | | *[Binary Flag (32 bits)* |
| | | | *Indexed String]* |
| This cell displays the status of the third set of 32 start signals. | | | |
| | | | dv/dt3 Start |
| | | | dv/dt4 Start |
| | | | Vdc1 Start |
| | | | Vdc2 Start |
| | | | Vdc3 Start |
| | | | WDE>1 Fwd Start |
| | | | WDE>1 Rev Start |
| | | | WDE>2 Fwd Start |
| | | | WDE>2 Rev Start |
| | | | Start Vavg<1 |
| | | | Start Vavg<2 |
| | | | Start Vavg< PhA |
| | | | Start Vavg< PhB |
| | | | Start Vavg< PhC |
| Start Elements 4 | 01.0B | | Start Vavg>1 |
| | | | Start Vavg>2 |
| | | | Start Vavg> PhA |
| | | | Start Vavg> PhB |
| | | | Start Vavg> PhC |
| | | | Start V0avg>1 |
| | | | Start V0avg>2 |
| | | | Start V1avg>1 |
| | | | Start V1avg>2 |
| | | | Start V2avg>1 |
| | | | Start V2avg>2 |
| | | | Start V1<1 |
| | | | Start V1<2 |
| | | | Start V1>1 |
| | | | Start V1>2 |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | Start Rev. Power<br>*[Binary Flag (32 bits)*<br>*Indexed String]* |
| This cell displays the status of the fourth set of 32 start signals. | | | |
| Trip Elements 1 | 01.0C | | Any Trip<br>Trip I>1<br>Trip I>2<br>Trip I>3<br>Trip I>4<br>Trip Broken Line<br>Trip IN1>1<br>Trip IN1>2<br>Trip IN1>3<br>Trip IN1>4<br>Trip IN2>1<br>Trip IN2>2<br>Trip IN2>3<br>Trip IN2>4<br>Trip ISEF>1<br>Trip ISEF>2<br>Trip ISEF>3<br>Trip ISEF>4<br>Trip IREF><br>Trip NVD VN>1<br>Trip NVD VN>2<br>Trip Thermal<br>Trip V2>1<br>Trip I>5<br>Trip I>6<br>Trip V2>2<br>*[Binary Flag (32 bits)*<br>*Indexed String]* |
| This cell displays the status of the first set of 32 trip signals. | | | |
| Trip Elements 2 | 01.0D | | Trip V<1<br>Trip V<2<br>Trip V< A/AB<br>Trip V< B/BC<br>Trip V< C/CA<br>Trip V>1<br>Trip V>2<br>Trip V> A/AB<br>Trip V> B/BC<br>Trip V> C/CA<br>Trip V<3<br>Trip V>3<br>Trip NVD VN>3<br>Trip NVD VN>4<br>Trip NVD VN<1<br>Trip NVD VN<2<br>Trip YN><br>Trip GN><br>Trip BN><br>Trip df/dt>1<br>Trip df/dt>2<br>Trip df/dt>3<br>Trip df/dt>4<br>Trip I2>1<br>Trip I2>2<br>Trip I2>3<br>Trip I2>4<br>*[Binary Flag (32 bits)*<br>*Indexed String]* |
| This cell displays the status of the second set of 32 trip signals. | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| Trip Elements 3 | 01.0E | | Trip F 1<br>Trip F 2<br>Trip F 3<br>Trip F 4<br>Trip F 5<br>Trip F 6<br>Trip F 7<br>Trip F 8<br>Trip F 9<br>Trip df/dt+t 1<br>Trip df/dt+t 2<br>Trip df/dt+t 3<br>Trip df/dt+t 4<br>Trip df/dt+t 5<br>Trip df/dt+t 6<br>Trip df/dt+t 7<br>Trip df/dt+t 8<br>Trip df/dt+t 9<br>Trip DelF/DelT 1<br>Trip DelF/DelT 2<br>Trip DelF/DelT 3<br>Trip DelF/DelT 4<br>Trip DelF/DelT 5<br>Trip DelF/DelT 6<br>Trip DelF/DelT 7<br>Trip DelF/DelT 8<br>Trip DelF/DelT 9<br>Vdc1 Trip<br>Vdc2 Trip<br>Vdc3 Trip<br>*[Binary Flag (32 bits)*<br>*Indexed String]* |
| This cell displays the status of the third set of 32 trip signals. | | | |
| Trip Elements 4 | 01.0F | | Trip f+df/dt  1<br>Trip f+df/dt  2<br>Trip f+df/dt  3<br>Trip f+df/dt  4<br>Trip f+df/dt  5<br>Trip f+df/dt  6<br>Trip f+df/dt  7<br>Trip f+df/dt  8<br>Trip f+df/dt  9<br>dv/dt1 Trip<br>dv/dt2 Trip<br>dv/dt Trip A/AB<br>dv/dt Trip B/BC<br>dv/dt Trip C/CA<br>Power>1 Trip<br>Power>2 Trip<br>Power> A Trip<br>Power> B Trip<br>Power> C Trip<br>Power<1 Trip<br>Power<2 Trip<br>Power< A Trip<br>Power< B Trip<br>Power< C Trip<br>SensP1 Trip A<br>SensP2 Trip A<br>dv/dt3 Trip<br>dv/dt4 Trip<br>FA HIF<br>CHA HIF |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | WDE>1 Fwd Fault<br>WDE>2 Fwd Fault<br>*[Binary Flag (32 bits)*<br>*Indexed String]* |
| This cell displays the status of the fourth set of 32 trip signals. | | | |
| Fault Alarms | 01.10 | | CB Fail 1<br>CB Fail 2<br>VTS<br>CTS<br>VDep OC<br>CLP<br>AR Trip 1<br>AR Trip 2<br>AR Trip 3<br>AR Trip 4<br>AR Trip 5<br>DC Supply Fail<br>*[Binary Flag (32 bits)*<br>*Indexed String]* |
| This cell displays the status of the fault alarm signals. | | | |
| Fault Time | 01.11 | | Fault Time<br>*[IEC870 Date & Time]* |
| This cell displays the time and date of the fault | | | |
| Active Group | 01.12 | | Active Group<br>*[Unsigned Integer (16 bits)]* |
| This cell displays the active settings group | | | |
| System Frequency | 01.13 | | System Frequency<br>*[Courier Number (frequency)]* |
| This cell displays the system frequency | | | |
| Fault Duration | 01.14 | | Fault Duration<br>*[Courier Number (time-seconds)]* |
| This cell displays the duration of the fault time | | | |
| CB Operate Time | 01.15 | | CB Operate Time<br>*[Courier Number (time-seconds)]* |
| This cell displays the CB operate time | | | |
| Relay Trip Time | 01.16 | | Relay Trip Time<br>*[Courier Number (time-seconds)]* |
| This cell displays the time from protection start to protection trip | | | |
| IA | 01.1B | | IA<br>*[Courier Number (current)]* |
| This cell displays the phase A current | | | |
| IB | 01.1C | | IB<br>*[Courier Number (current)]* |
| This cell displays the phase B current | | | |
| IC | 01.1D | | IC<br>*[Courier Number (current)]* |
| This cell displays the phase C current | | | |
| IN Measured | 01.21 | | IN Measured<br>*[Courier Number (current)]* |
| This cell displays the value of measured neutral current | | | |
| IN Derived | 01.22 | | IN Derived<br>*[Courier Number (current)]* |
| This cell displays the value of derived neutral current | | | |
| IN Sensitive | 01.23 | | IN Sensitive<br>*[Courier Number (current)]* |
| This cell displays the value of sensitive neutral current | | | |
| IREF Diff | 01.24 | | IREF Diff<br>*[Courier Number (current)]* |
| This cell displays the value of Restricted Earth Fault differential current | | | |
| IREF Bias | 01.25 | | IREF Bias |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | *[Courier Number (current)]* |
| This cell displays the value of Restricted Earth Fault bias current | | | |
| DC Supply Mag | 01.30 | | DC Supply Mag<br>*[Courier Number (voltage)]* |
| This cell displays the Auxiliary Supply Voltage level | | | |
| Trip Elements 5 | 01.32 | | Trip Vavg<1<br>Trip Vavg<2<br>Trip Vavg< phA<br>Trip Vavg< phB<br>Trip Vavg< phC<br>Trip Vavg>1<br>Trip Vavg>2<br>Trip Vavg> phA<br>Trip Vavg> phB<br>Trip Vavg> phC<br>Trip V0avg>1<br>Trip V0avg>2<br>Trip V1avg>1<br>Trip V1avg>2<br>Trip V2avg>1<br>Trip V2avg>2<br>Trip V1<1<br>Trip V1<2<br>Trip V1>1<br>Trip V1>2<br>Trip Rev. Power<br>Trip Tstart><br>Trip Tstall> Run<br>Trip Tstall> St.<br>Trip Vdip<br>Trip V Shift<br>*[Binary Flag (32 bits)]*<br>*Indexed String]* |
| This cell displays the status of the fifth set of 32 trip signals. | | | |
| IA Max | 01.33 | | IA Max<br>*[Courier Number (current)]* |
| This cell displays the maximum phase A current | | | |
| IB Max | 01.34 | | IB Max<br>*[Courier Number (current)]* |
| This cell displays the maximum phase B current | | | |
| IC Max | 01.35 | | IC Max<br>*[Courier Number (current)]* |
| This cell displays the maximum phase C current | | | |
| Select Maint [0...n] | 01.F0 | Manual override to select a fault record. | From 0 to 9 in steps of 1<br>*[Unsigned Integer (16 bits)]* |
| This setting selects the required maintenance report from those stored.  A value of 0 corresponds to the latest report. | | | |
| Maint Text | 01.F1 | | Maint Text<br>*[ASCII Text (32 chars)]* |
| This cell displays the description of the maintenance record | | | |
| Maint Type | 01.F2 | | Maint Type<br>*[Unsigned Integer (32 bits)]* |
| This is the type of maintenance record | | | |
| Maint Data | 01.F3 | | Maint Data<br>*[Unsigned Integer (32 bits)]* |
| This is the maintenance record data (error code) | | | |
| Evt Iface Source | 01.FA | | Evt Iface Source<br>*[Unsigned Integer (16 bits)]* |
| This cell displays the interface on which the event was logged | | | |
| Evt Access Level | 01.FB | | Evt Access Level<br>*[Unsigned Integer (16 bits)]* |
| Any security event that indicates that it came from an interface action, such as disabling a port, will also record the access level of the interface | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| that initiated the event. This access level is displayed in this cell. | | | |
| Evt Extra Info | 01.FC | | Evt Extra Info<br>*[Unsigned Integer (16 bits)]* |
| This cell provides supporting information for the event and can vary between the different event types. | | | |
| Evt Unique Id | 01.FE | | Evt Unique Id<br>*[Unsigned Integer (32 bits)]* |
| This cell displays the unique event ID associated with the event. | | | |
| Reset Indication | 01.FF | No | No<br>Yes<br>*[Indexed String]* |
| This command resets the trip LED indications provided that the relevant protection element has reset. | | | |
| MEASUREMENTS 1 | 02.00 | | |
| This column contains measurement parameters | | | |
| IA Magnitude | 02.01 | | IA Magnitude<br>*[Courier Number (current)]* |
| This cell displays the A-phase current magnitude. | | | |
| IA Phase Angle | 02.02 | | IA Phase Angle<br>*[Courier Number (angle)]* |
| This cell displays the A-phase phase angle. | | | |
| IB Magnitude | 02.03 | | IB Magnitude<br>*[Courier Number (current)]* |
| This cell displays the B-phase current magnitude. | | | |
| IB Phase Angle | 02.04 | | IB Phase Angle<br>*[Courier Number (angle)]* |
| This cell displays the B-phase phase angle. | | | |
| IC Magnitude | 02.05 | | IC Magnitude<br>*[Courier Number (current)]* |
| This cell displays the C-phase current magnitude. | | | |
| IC Phase Angle | 02.06 | | IC Phase Angle<br>*[Courier Number (angle)]* |
| This cell displays the C-phase phase angle. | | | |
| IN Measured Mag | 02.07 | | IN Measured Mag<br>*[Courier Number (current)]* |
| This cell displays the measured neutral current magnitude. | | | |
| IN Measured Ang | 02.08 | | IN Measured Ang<br>*[Courier Number (angle)]* |
| This cell displays the measured neutral phase angle. | | | |
| IN Derived Mag | 02.09 | | IN Derived Mag<br>*[Courier Number (current)]* |
| This cell displays the derived neutral current magnitude. | | | |
| IN Derived Angle | 02.0A | | IN Derived Angle<br>*[Courier Number (angle)]* |
| This cell displays the derived neutral phase angle. | | | |
| ISEF Magnitude | 02.0B | | ISEF Magnitude<br>*[Courier Number (current)]* |
| This cell displays the sensitive earth fault current magnitude. | | | |
| ISEF Angle | 02.0C | | ISEF Angle<br>*[Courier Number (angle)]* |
| This cell displays the sensitive earth fault phase angle. | | | |
| I1 Magnitude | 02.0D | | I1 Magnitude<br>*[Courier Number (current)]* |
| This cell displays the positive sequence current magnitude. | | | |
| I2 Magnitude | 02.0E | | I2 Magnitude<br>*[Courier Number (current)]* |
| This cell displays the negative sequence current magnitude. | | | |
| I0 Magnitude | 02.0F | | I0 Magnitude<br>*[Courier Number (current)]* |
| This cell displays the zero sequence current magnitude. | | | |
| IA RMS | 02.10 | | IA RMS |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | *[Courier Number (current)]* |
| This cell displays the A-phase RMS current. | | | |
| IB RMS | 02.11 | | IB RMS<br>*[Courier Number (current)]* |
| This cell displays the B-phase RMS current. | | | |
| IC RMS | 02.12 | | IC RMS<br>*[Courier Number (current)]* |
| This cell displays the C-phase RMS current. | | | |
| IN RMS | 02.13 | | IN RMS<br>*[Courier Number (current)]* |
| This cell displays the C-phase RMS current. | | | |
| Frequency | 02.2D | | Frequency<br>*[Courier Number (frequency)]* |
| This cell displays the system frequency | | | |
| I1 Magnitude | 02.40 | | I1 Magnitude<br>*[Courier Number (current)]* |
| This cell displays the positive sequence current magnitude. | | | |
| I1 Phase Angle | 02.41 | | I1 Phase Angle<br>*[Courier Number (angle)]* |
| This cell displays the positive sequence phase angle. | | | |
| I2 Magnitude | 02.42 | | I2 Magnitude<br>*[Courier Number (current)]* |
| This cell displays the negative sequence current magnitude. | | | |
| I2 Phase Angle | 02.43 | | I2 Phase Angle<br>*[Courier Number (angle)]* |
| This cell displays the negative sequence phase angle. | | | |
| I0 Magnitude | 02.44 | | I0 Magnitude<br>*[Courier Number (current)]* |
| This cell displays the zero sequence current magnitude. | | | |
| I0 Phase Angle | 02.45 | | I0 Phase Angle<br>*[Courier Number (angle)]* |
| This cell displays the zero sequence phase angle. | | | |
| MEASUREMENTS 2 | 03.00 | | |
| This column contains measurement parameters | | | |
| IA  Fixed Demand | 03.18 | | IA  Fixed Demand<br>*[Courier Number (current)]* |
| This cell displays the A-phase current fixed demand measurement | | | |
| IB  Fixed Demand | 03.19 | | IB  Fixed Demand<br>*[Courier Number (current)]* |
| This cell displays the B-phase current fixed demand measurement | | | |
| IC  Fixed Demand | 03.1A | | IC  Fixed Demand<br>*[Courier Number (current)]* |
| This cell displays the C-phase current fixed demand measurement | | | |
| IA Roll Demand | 03.1D | | IA Roll Demand<br>*[Courier Number (current)]* |
| This cell displays the A-phase current rolling demand measurement | | | |
| IB Roll Demand | 03.1E | | IB Roll Demand<br>*[Courier Number (current)]* |
| This cell displays the B-phase current rolling demand measurement | | | |
| IC Roll Demand | 03.1F | | IC Roll Demand<br>*[Courier Number (current)]* |
| This cell displays the C-phase current rolling demand measurement | | | |
| IA Peak Demand | 03.22 | | IA Peak Demand<br>*[Courier Number (current)]* |
| This cell displays the A-phase current peak demand measurement | | | |
| IB Peak Demand | 03.23 | | IB Peak Demand<br>*[Courier Number (current)]* |
| This cell displays the B-phase current peak demand measurement | | | |
| IC Peak Demand | 03.24 | | IC Peak Demand |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | [Courier Number (current)] |
| This cell displays the C-phase current peak demand measurement | | | |
| Reset Demand | 03.25 | No | No<br>Yes<br>[Indexed String] |
| This command resets all acquired demand values. | | | |
| I Average | 03.48 | | I Average<br>[Courier Number (current)] |
| This cell displays the average of IA, IB, IC | | | |
| % I2 / I Average | 03.4A | | % I2 / I Average<br>[Courier Number (percentage)] |
| This cell displays the percentage of I2 / I Average | | | |
| Cur Dem Period | 03.F0 | | Cur Dem Period<br>[Courier Number (Time)] |
| This cell displays the current demand period | | | |
| MEASUREMENTS 3 | 04.00 | | |
| This column contains measurement parameters | | | |
| Highest Phase I | 04.01 | | Highest Phase I<br>[Courier Number (current)] |
| This cell displays the highest phase current | | | |
| Thermal State | 04.02 | | Thermal State<br>[Courier Number (percentage)] |
| This cell displays the thermal state | | | |
| Reset Thermal | 04.03 | No | No<br>Yes<br>[Indexed String] |
| This command resets the thermal state | | | |
| IREF Diff | 04.04 | | IREF Diff<br>[Courier Number (current)] |
| This cell displays the Restricted Earth Fault differential current | | | |
| IREF Bias | 04.05 | | IREF Bias<br>[Courier Number (current)] |
| This cell displays the Restricted Earth Fault bias current | | | |
| I2/I1 Ratio | 04.0C | | I2/I1 Ratio<br>[Courier Number (decimal)] |
| This cell displays the negative sequence current to positive sequence current ratio | | | |
| IA 2ndHarm | 04.0F | | IA 2ndHarm<br>[Courier Number (percentage)] |
| This cell displays the A-phase 2nd harmonic current component | | | |
| IB 2ndHarm | 04.10 | | IB 2ndHarm<br>[Courier Number (percentage)] |
| This cell displays the B-phase 2nd harmonic current component | | | |
| IC 2ndHarm | 04.11 | | IC 2ndHarm<br>[Courier Number (percentage)] |
| This cell displays the C-phase 2nd harmonic current component | | | |
| DC Supply Mag | 04.20 | | DC Supply Mag<br>[Courier Number (voltage)] |
| This cell displays the Auxiliary Supply Voltage level | | | |
| CB CONDITION | 06.00 | | |
| This column contains CB condition monitoring measured parameters | | | |
| CB Operations | 06.01 | | CB Operations<br>[Unsigned Integer (16 bits)] |
| This cell displays the number of CB Operations | | | |
| Total IA Broken | 06.02 | | Total IA Broken<br>[Courier Number (current)] |
| This cell displays the total broken IA since the last maintenance procedure | | | |
| Total IB Broken | 06.03 | | Total IB Broken<br>[Courier Number (current)] |
| This cell displays the total broken IB since the last maintenance procedure | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| Total IC Broken | 06.04 | | Total IC Broken<br>*[Courier Number (current)]* |
| This cell displays the total broken IC since the last maintenance procedure | | | |
| CB Operate Time | 06.05 | | CB Operate Time<br>*[Courier Number (time-seconds)]* |
| This cell displays the CB Operate Time | | | |
| Reset CB Data | 06.06 | No | No<br>Yes<br>*[Indexed String]* |
| This cell resets the CB condition monitoring data | | | |
| CB CONTROL | 07.00 | | |
| This column controls the circuit Breaker Control configuration | | | |
| CB Control by | 07.01 | Disabled | Disabled<br>Local<br>Remote<br>Local+Remote<br>Opto<br>Opto+local<br>Opto+Remote<br>Opto+Rem+local<br>*[Indexed String]* |
| This setting selects the type of circuit breaker control to be used | | | |
| Close Pulse Time | 07.02 | 0.5 | From 0.1 to 50 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting defines the duration of the close pulse within which the CB should close when a close command is issued. | | | |
| Trip Pulse Time | 07.03 | 0.5 | From 0.1 to 5 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting defines the duration of the trip pulse within which the CB should trip when a manual or protection trip command is issued. | | | |
| Man Close Delay | 07.05 | 10 | From 0.01 to 600 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting defines the delay time before the close pulse is executed. | | | |
| CB Healthy Time | 07.06 | 5 | From 0.01 to 9999 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting defines the time period in which a CB needs to indicate a healthy condition before it closes. If the CB does not indicate a healthy condition in this time period following a close command then the IED will lockout and alarm. | | | |
| Lockout Reset | 07.08 | No | No<br>Yes<br>*[Indexed String]* |
| This command resets the Autoreclose Lockout. | | | |
| Reset Lockout by | 07.09 | CB Close | User Interface<br>CB Close<br>*[Indexed String]* |
| This setting defines whether the Lockout signal is to be reset by the user interface or a CB Close signal. | | | |
| Man Close RstDly | 07.0A | 5 | From 0.1 to 600 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the time delay before the Lockout state can be reset following a manual closure. | | | |
| Autoreclose Mode | 07.0B | No Operation | No Operation<br>Auto<br>Non Auto<br>*[Indexed String]* |
| This command changes the Autoreclose mode | | | |
| AR Status | 07.0E | | Auto Mode<br>Non-auto Mode<br>Live Line<br>*[Indexed String]* |
| This cell displays the Autoreclose - In Service or Out of Service | | | |
| Total Reclosures | 07.0F | | Total Reclosures<br>*[Unsigned Integer (16 bits)]* |
| This cell displays the number of successful reclosures. | | | |
| Reset Total AR | 07.10 | No | No |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | Yes<br>[Indexed String] |
| This command allows you to reset the Autoreclose counters. | | | |
| CB Status Input | 07.11 | None | None<br>52A<br>52B<br>Both 52A and 52B<br>[Indexed String] |
| Setting to define the type of circuit breaker contacts that will be used for the circuit breaker control logic. Form A contacts match the status of the circuit breaker primary contacts, form B are opposite to the breaker status. | | | |
| 1 Shot Clearance | 07.12 | | 1 Shot Clearance<br>[Unsigned Integer (16 bits)] |
| This cell displays the total number of successful clearances after 1 shot | | | |
| 2 Shot Clearance | 07.13 | | 2 Shot Clearance<br>[Unsigned Integer (16 bits)] |
| This cell displays the total number of successful clearances after 2 shots | | | |
| 3 Shot Clearance | 07.14 | | 3 Shot Clearance<br>[Unsigned Integer (16 bits)] |
| This cell displays the total number of successful clearances after 3 shots | | | |
| 4 Shot Clearance | 07.15 | | 4 Shot Clearance<br>[Unsigned Integer (16 bits)] |
| This cell displays the total number of successful clearances after 4 shots | | | |
| Persistent Fault | 07.16 | | Persistent Fault<br>[Unsigned Integer (16 bits)] |
| This cell displays the total number of unsuccessful clearances after which the Autoreclose went into lockout. | | | |
| Shot1 Recloses | 07.20 | | Shot1 Recloses<br>[Unsigned Integer (16 bits)] |
| This cell displays the total number of single-shot shot reclose attempts | | | |
| Shot234 Recloses | 07.21 | | Shot234 Recloses<br>[Unsigned Integer (16 bits)] |
| This cell displays the total number of multi-shot reclose attempts | | | |
| DATE AND TIME | 08.00 | | |
| This column contains Date and Time stamp settings | | | |
| Date/Time | 08.01 | | |
| This setting defines the IED's current date and time. | | | |
| IRIG-B Sync | 08.04 | None | None<br>RP1<br>RP2<br>[Indexed String] |
| This setting enables or disables IRIG-B synchronisation and defines which rear port is to be used as an IRIG-B input. | | | |
| IRIG-B Status | 08.05 | | Disabled<br>Signal Healthy<br>No Signal<br>[Indexed String] |
| This cell displays the IRIG-B status | | | |
| Primary Source | 08.08 | PTP | IRIG-B<br>None<br>SNTP<br>PTP<br>[Indexed String] |
| Sets the primary time synchronisation source | | | |
| Secondary Source | 08.09 | None | IRIG-B<br>None<br>SNTP<br>PTP<br>[Indexed String] |
| Sets the secondary time synchronisation source | | | |
| Domain Number | 08.0F | 0 | From 0 to 127 in steps of 1<br>[Integers] |
| Assigns the PTP domain number. A domain is grouping of PTP clocks that synchronise to each other on a network. | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| This provides a way of implementing independent synchronisation of PTP clocks on a shared network | | | |
| Act. Time Source | 08.10 | | IRIG-B<br>None<br>SNTP<br>PTP<br>*[Indexed String]* |
| Displays the active time synchronisation source being used.<br><br>'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. | | | |
| PTP Status | 08.12 | | Not Master Found<br>Illegal Master<br>Valid master<br>*[Indexed String]* |
| IEC61850 versions only. Displays the status of PTP time synchronisation<br><br>No Master Found = No PTP master can be found, the IED has not received a valid 'Announce' message.<br>Illegal Master = Master clock is not valid, typically this will occur when the clock is not using the correct epoch<br>Valid Master = At least valid one master clock is available | | | |
| SNTP Status | 08.13 | | Disabled<br>Trying Server 1<br>Trying Server 2<br>Server 1 OK<br>Server 2 OK<br>No Response<br>No Valid Clock<br>*[Indexed String]* |
| This cell displays the SNTP time synchronisation status for IEC61850 or DNP3 over Ethernet versions. | | | |
| LocalTime Enable | 08.20 | Fixed | Disabled<br>Fixed<br>Flexible<br>*[Indexed String]* |
| Disabled: No local time zone will be maintained<br>Fixed - Local time zone adjustment can be defined (all interfaces)<br>Flexible - Local time zone adjustment can be defined (non-local interfaces) | | | |
| LocalTime Offset | 08.21 | 0 | From -720 to 720 in steps of 15<br>*[Courier Number (time-minutes)]* |
| This setting specifies the offset for the local time zone from -12 hours to +12 hrs in 15 minute intervals. This adjustment is applied to the time based on the UTC/GMT master clock. | | | |
| DST Enable | 08.22 | Enabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting turns daylight saving time adjustment on or off. | | | |
| DST Offset | 08.23 | 60 | 30 or 60<br>*[Courier Number (time-minutes)]* |
| This setting defines the daylight saving offset used for the local time adjustment. | | | |
| DST Start | 08.24 | Last | First<br>Second<br>Third<br>Fourth<br>Last<br>*[Indexed String]* |
| This setting specifies the week of the month in which daylight saving time adjustment starts. | | | |
| DST Start Day | 08.25 | Sunday | Sunday<br>Monday<br>Tuesday<br>Wednesday<br>Thursday<br>Friday<br>Saturday<br>*[Indexed String]* |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| This setting specifies the day of the week in which daylight saving time adjustment starts | | | |
| DST Start Month | 08.26 | March | January<br>February<br>March<br>April<br>May<br>June<br>July<br>August<br>September<br>October<br>November<br>December<br>*[Indexed String]* |
| This setting specifies the month in which daylight saving time adjustment starts | | | |
| DST Start Mins | 08.27 | 60 | From 0 to 1425 in steps of 15<br>*[Courier Number (time-minutes)]* |
| Setting to specify the time of day in which daylight saving time adjustment starts. This is set relative to 00:00 hrs on the selected day when time adjustment is to start | | | |
| DST End | 08.28 | Last | First<br>Second<br>Third<br>Fourth<br>Last<br>*[Indexed String]* |
| This setting specifies the week of the month in which daylight saving time adjustment ends | | | |
| DST End Day | 08.29 | Sunday | Sunday<br>Monday<br>Tuesday<br>Wednesday<br>Thursday<br>Friday<br>Saturday<br>*[Indexed String]* |
| This setting specifies the day of the week in which daylight saving time adjustment ends. | | | |
| DST End Month | 08.2A | October | January<br>February<br>March<br>April<br>May<br>June<br>July<br>August<br>September<br>October<br>November<br>December<br>*[Indexed String]* |
| This setting specifies the month in which daylight saving time adjustment ends. | | | |
| DST End Mins | 08.2B | 60 | From 0 to 1425 in steps of 15<br>*[Courier Number (time-minutes)]* |
| This setting specifies the time of day in which daylight saving time adjustment ends. This is set relative to 00:00 hrs on the selected day when time adjustment is to end. | | | |
| RP1 Time Zone | 08.30 | Local | UTC<br>Local<br>*[Indexed String]* |
| Setting for the rear port 1 interface to specify if time synchronisation received will be local or universal time co-ordinated. | | | |
| RP2 Time Zone | 08.31 | Local | UTC<br>Local<br>*[Indexed String]* |
| Setting for the rear port 2 interface to specify if time synchronisation received will be local or universal time co-ordinated | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| DNPOE Time Zone | 08.32 | Local | UTC<br>Local<br>*[Indexed String]* |
| This setting specifies whether DNP3.0 over Ethernet time synchronisation is coordinated by local time or universal time. | | | |
| Tunnel Time Zone | 08.33 | Local | UTC<br>Local<br>*[Indexed String]* |
| This setting specifies whether tunnelled Courier time synchronisation is coordinated by local time or universal time. | | | |
| CONFIGURATION | 09.00 | | |
| This column contains the general configuration options | | | |
| Restore Defaults | 09.01 | No Operation | No Operation<br>All Settings<br>Setting Group 1<br>Setting Group 2<br>Setting Group 3<br>Setting Group 4<br>*[Indexed String]* |
| This setting restores the chosen setting groups to factory default values. Note: Restoring defaults to all settings may result in communication via the rear port being disrupted if the new (default) settings do not match those of the master station. | | | |
| Setting Group | 09.02 | Select via Menu | Select via Menu<br>Select via Opto<br>*[Indexed String]* |
| This setting allows you to choose whether the setting group changes are to be initiated via an Opto-input or the HMI menu. | | | |
| Active Settings | 09.03 | Group 1 | Group 1<br>Group 2<br>Group 3<br>Group 4<br>*[Indexed String]* |
| This setting selects the active settings group. | | | |
| Save Changes | 09.04 | No Operation | No Operation<br>Save<br>Abort<br>*[Indexed String]* |
| This command saves all IED settings. | | | |
| Copy From | 09.05 | Group 1 | Group 1<br>Group 2<br>Group 3<br>Group 4<br>*[Indexed String]* |
| This setting copies settings from a selected setting group. | | | |
| Copy To | 09.06 | No Operation | No Operation<br>Group 1<br>Group 2<br>Group 3<br>Group 4<br>*[Indexed String]* |
| This command allows the displayed settings to be copied to a selected setting group. | | | |
| Setting Group 1 | 09.07 | Enabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables settings Group 1. | | | |
| Setting Group 2 | 09.08 | Disabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables settings Group 2. | | | |
| Setting Group 3 | 09.09 | Disabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables settings Group 3. | | | |
| Setting Group 4 | 09.0A | Disabled | Disabled<br>Enabled |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | *[Indexed String]* |
| This setting enables or disables settings Group 4. | | | |
| System Config | 09.0B | Visible | Invisible<br>Visible<br>*[Indexed String]* |
| This setting hides or unhides the System Config menu. | | | |
| Overcurrent | 09.10 | Enabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the Phase overcurrent Protection function. | | | |
| Neg Sequence O/C | 09.11 | Disabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the Negative Sequence overcurrent Protection function. | | | |
| Broken Conductor | 09.12 | Disabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the Broken Conductor function. | | | |
| Earth Fault 1 | 09.13 | Disabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the measured Earth Fault Protection function. | | | |
| Earth Fault 2 | 09.14 | Enabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the derived Earth Fault Protection function. | | | |
| SEF Protection | 09.15 | Disabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the Sensitive Earth Fault Protection function. | | | |
| Thermal Overload | 09.17 | Enabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the Thermal Overload Protection function. | | | |
| Cold Load Pickup | 09.19 | Disabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the Cold Load Pickup protection. | | | |
| Selective Logic | 09.1A | Disabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the Selective Logic element. | | | |
| REF Protection | 09.1E | Disabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the Restricted Earth Fault Protection. | | | |
| DC SupplyMonitor | 09.1F | Enabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the DC Supply Monitoring supervision function. | | | |
| CB Fail | 09.20 | Disabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the Circuit Breaker Fail Protection function. | | | |
| Auto-Reclose | 09.24 | Disabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the Autoreclose function. | | | |
| Auto-Reclose | 09.24 | Disabled | Disabled<br>*[Indexed String]* |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| This setting disables the Autoreclose function for some models | | | |
| Input Labels | 09.25 | Visible | Invisible<br>Visible<br>*[Indexed String]* |
| This setting hides or unhides the Input Labels menu from the IED display. | | | |
| Output Labels | 09.26 | Visible | Invisible<br>Visible<br>*[Indexed String]* |
| This setting hides or unhides the Output Labels menu from the IED display. | | | |
| CT & VT Ratios | 09.28 | Visible | Invisible<br>Visible<br>*[Indexed String]* |
| This setting hides or unhides the Transformer Ratios menu from the IED display. | | | |
| Record Control | 09.29 | Invisible | Invisible<br>Visible<br>*[Indexed String]* |
| This setting hides or unhides the Record Control menu from the IED display. | | | |
| Disturb Recorder | 09.2A | Invisible | Invisible<br>Visible<br>*[Indexed String]* |
| This setting hides or unhides the Disturbance Recorder menu from the IED display. | | | |
| Measure't Setup | 09.2B | Invisible | Invisible<br>Visible<br>*[Indexed String]* |
| This setting hides or unhides the Measurement Setup menu from the IED display. | | | |
| Comms Settings | 09.2C | Visible | Invisible<br>Visible<br>*[Indexed String]* |
| This setting hides or unhides the Communication Settings menu from the IED display. | | | |
| Commission Tests | 09.2D | Visible | Invisible<br>Visible<br>*[Indexed String]* |
| This setting hides or unhides the Commission Tests menu from the IED display. | | | |
| Setting Values | 09.2E | Primary | Primary<br>Secondary<br>*[Indexed String]* |
| This setting determines the reference for all settings dependent on the transformer ratios; either referenced to the primary or the secondary. | | | |
| Control Inputs | 09.2F | Visible | Invisible<br>Visible<br>*[Indexed String]* |
| Activates the Control Input status and operation menu further on in the IED setting menu. | | | |
| Ctrl I/P Config | 09.35 | Visible | Invisible<br>Visible<br>*[Indexed String]* |
| Sets the Control Input Configuration menu visible further on in the IED setting menu. | | | |
| Ctrl I/P Labels | 09.36 | Visible | Invisible<br>Visible<br>*[Indexed String]* |
| Sets the Control Input Labels menu visible further on in the IED setting menu. | | | |
| HIF Detection | 09.37 | Disabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the High Impedance (HIF) function. | | | |
| HIF Detection | 09.37 | Disabled | Disabled<br>*[Indexed String]* |
| This setting enables or disables the High Impedance (HIF) function. | | | |
| Direct Access | 09.39 | Enabled | Disabled<br>Enabled<br>Hotkey Only<br>CB Ctrl Only |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| | | **DESCRIPTION** | |
| | | | *[Indexed String]* |
| This setting enables or disables direct control of the Circuit Breakers from the IED's hotkeys. | | | |
| Function Key | 09.50 | Visible | Invisible<br>Visible<br>*[Indexed String]* |
| This setting enables or disables the Function Key menu. | | | |
| PSL Timers | 09.54 | Invisible | Invisible<br>Visible<br>*[Indexed String]* |
| This setting enables or disables the PSL Timers menu. | | | |
| Switch Control | 09.60 | Disabled | Disabled<br>Enabled<br>*[Indexed String]* |
| Activates the user switch Input status and operation menu. | | | |
| DT Timer HystBeh | 09.70 | Freeze | Freeze<br>Count<br>*[Indexed String]* |
| | | | |
| RP1 Read Only | 09.FB | Disabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables Read Only Mode for Rear Port 1. | | | |
| RP2 Read Only | 09.FC | Disabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables Read Only Mode for Rear Port 2. | | | |
| NIC Read Only | 09.FD | Disabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables Read Only Mode of the Network Interface Card for Ethernet models. | | | |
| LCD Contrast | 09.FF | 13 | From 0 to 31 in steps of 1<br>*[Unsigned Integer (16 bits)]* |
| This setting sets the LCD contrast. | | | |
| CT AND VT RATIOS | 0A.00 | | |
| This column contains settings for Current and Voltage Transformer ratios | | | |
| Phase CT Primary | 0A.07 | 1 | From 1 to 30000 in steps of 1<br>*[Courier Number (current)]* |
| This setting sets the phase current transformer input primary current rating. | | | |
| Phase CT Sec'y | 0A.08 | 1 | 1 or 5<br>*[Courier Number (current)]* |
| This setting sets the phase current transformer input secondary current rating. | | | |
| E/F CT Primary | 0A.09 | 1 | From 1 to 30000 in steps of 1<br>*[Courier Number (current)]* |
| This setting sets the earth fault current transformer input primary current rating. | | | |
| E/F CT Secondary | 0A.0A | 1 | 1 or 5<br>*[Courier Number (current)]* |
| This setting sets the earth fault current transformer input secondary current rating. | | | |
| SEF CT Primary | 0A.0B | 1 | From 1 to 30000 in steps of 1<br>*[Courier Number (current)]* |
| This setting sets the sensitive earth fault current transformer input primary current rating. | | | |
| SEF CT Secondary | 0A.0C | 1 | 1 or 5<br>*[Courier Number (current)]* |
| Sets the sensitive earth fault current transformer input secondary current rating. | | | |
| Phas CT Polarity | 0A.20 | Direct | Direct<br>Inverse<br>*[Indexed String]* |
| This setting defines the phase CT polarity | | | |
| Neut CT Polarity | 0A.21 | Direct | Direct<br>Inverse<br>*[Indexed String]* |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| This setting defines the neutral CT polarity | | | |
| RECORD CONTROL | 0B.00 | | |
| This column contains settings for Record Controls. | | | |
| Alarm Event | 0B.04 | Enabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the generation of an event on alarm. Disabling this setting means that no event is generated for alarms. | | | |
| Relay O/P Event | 0B.05 | Enabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the generation of an event for a change of state of output relay contact. Disabling this setting means that no event will be generated for any change in logic output state. | | | |
| Opto Input Event | 0B.06 | Enabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the generation of an event for a change of state of opto-input. Disabling this setting means that no event will be generated for any change in logic input state. | | | |
| General Event | 0B.07 | Enabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the generation of general events. Disabling this setting means that no general events are generated. | | | |
| Fault Rec Event | 0B.08 | Enabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the generation of fault record events. Disabling this setting means that no event will be generated for any fault that produces a fault record. | | | |
| Maint Rec Event | 0B.09 | Enabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the generation of maintenance record events. Disabling this setting means that no event will be generated for any occurrence that produces a maintenance record. | | | |
| Protection Event | 0B.0A | Enabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the generation of protection events. Disabling this setting means that any operation of protection elements will not be logged as an event. | | | |
| DDB 31 - 0 | 0B.40 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 63 - 32 | 0B.41 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 95 - 64 | 0B.42 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 127 - 96 | 0B.43 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 159 - 128 | 0B.44 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|-----------|---------|-----------------|-------------------|
| **DESCRIPTION** | | | |
| DDB 191 - 160 | 0B.45 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 223 - 192 | 0B.46 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 255 - 224 | 0B.47 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 287 - 256 | 0B.48 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 319 - 288 | 0B.49 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 351 - 320 | 0B.4A | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 383 - 352 | 0B.4B | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 415 - 384 | 0B.4C | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 447 - 416 | 0B.4D | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 479 - 448 | 0B.4E | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 511 - 480 | 0B.4F | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 543 - 512 | 0B.50 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 575 - 544 | 0B.51 | 0xFFFFFFFF | High order word of long stored in 1st register |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| | | | Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 607 - 576 | 0B.52 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 639 - 608 | 0B.53 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 671 - 640 | 0B.54 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 703 - 672 | 0B.55 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 735 - 704 | 0B.56 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 767 - 736 | 0B.57 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 799 - 768 | 0B.58 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 831 - 800 | 0B.59 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 863 - 832 | 0B.5A | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 895 - 864 | 0B.5B | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 927 - 896 | 0B.5C | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 959 - 928 | 0B.5D | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| | | DESCRIPTION | |
| | | | Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 991 - 960 | 0B.5E | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 1023 - 992 | 0B.5F | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 1055 - 1024 | 0B.60 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 1087 - 1056 | 0B.61 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 1119 - 1088 | 0B.62 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 1151 - 1120 | 0B.63 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 1183 - 1152 | 0B.64 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 1215 - 1184 | 0B.65 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 1247 - 1216 | 0B.66 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 1279 - 1248 | 0B.67 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 1311 - 1280 | 0B.68 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 1343 - 1312 | 0B.69 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456 |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | *[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 1375 - 1344 | 0B.6A | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 1407 - 1376 | 0B.6B | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 1439 - 1408 | 0B.6C | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 1471 - 1440 | 0B.6D | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 1503 - 1472 | 0B.6E | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 1535 - 1504 | 0B.6F | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 1567 - 1536 | 0B.70 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 1599 - 1568 | 0B.71 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 1631 - 1600 | 0B.72 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 1663 - 1632 | 0B.73 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 1695 - 1664 | 0B.74 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 1727 - 1696 | 0B.75 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 1759- 1728 | 0B.76 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 1791- 1760 | 0B.77 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 1823 - 1792 | 0B.78 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 1855 - 1824 | 0B.79 | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 1887 - 1856 | 0B.7A | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 1919 - 1888 | 0B.7B | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 1951 - 1920 | 0B.7C | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 1983 - 1952 | 0B.7D | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 2015 - 1984 | 0B.7E | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DDB 2047 - 2016 | 0B.7F | 0xFFFFFFFF | High order word of long stored in 1st register<br>Low order word of long stored in 2nd register<br>Example 123456 stored as 123456<br>*[Binary Flag (32 bits)]* |
| These signals can be included or excluded from being stored as a Courier event record (assuming the DDB is capable of creating an event) | | | |
| DISTURB RECORDER | 0C.00 | | |
| This column contains settings for the Disturbance Recorder | | | |
| Duration | 0C.01 | 1.5 | From 0.1 to 10.5 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the overall recording time. | | | |
| Trigger Position | 0C.02 | 33.3 | From 0 to 100 in steps of 0.1<br>*[Courier Number (percentage)]* |
| This setting sets the trigger point as a percentage of the duration.  For example, the default setting, which is set to 33.3% (of 1.5s) gives 0.5s pre-fault and 1s post fault recording times. | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| Trigger Mode | 0C.03 | Single | Single<br>Extended<br>*[Indexed String]* |
| When set to single mode, if a further trigger occurs whilst a recording is taking place, the recorder will ignore the trigger. However, if this has been set to Extended, the post trigger timer will be reset to zero, thereby extending the recording time. | | | |
| Analog Channel 1 | 0C.04 | Analog 1 Unused | VA<br>VB<br>VC<br>4th V<br>IA<br>IB<br>IC<br>IN - ISEF<br>Frequency<br>*[Indexed String]* |
| This setting selects any available analogue input to be assigned to this channel. | | | |
| Analog Channel 2 | 0C.05 | Analog 2 Unused | VA<br>VB<br>VC<br>4th V<br>IA<br>IB<br>IC<br>IN - ISEF<br>Frequency<br>*[Indexed String]* |
| This setting selects any available analogue input to be assigned to this channel. | | | |
| Analog Channel 3 | 0C.06 | Analog 3 Unused | VA<br>VB<br>VC<br>4th V<br>IA<br>IB<br>IC<br>IN - ISEF<br>Frequency<br>*[Indexed String]* |
| This setting selects any available analogue input to be assigned to this channel. | | | |
| Analog Channel 4 | 0C.07 | Analog 4 Unused | VA<br>VB<br>VC<br>4th V<br>IA<br>IB<br>IC<br>IN - ISEF<br>Frequency<br>*[Indexed String]* |
| This setting selects any available analogue input to be assigned to this channel. | | | |
| Analog Channel 5 | 0C.08 | IA | VA<br>VB<br>VC<br>4th V<br>IA<br>IB<br>IC<br>IN - ISEF<br>Frequency<br>*[Indexed String]* |
| This setting selects any available analogue input to be assigned to this channel. | | | |
| Analog Channel 6 | 0C.09 | IB | VA<br>VB |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | VC<br>4th V<br>IA<br>IB<br>IC<br>IN - ISEF<br>Frequency<br>*[Indexed String]* |
| This setting selects any available analogue input to be assigned to this channel. | | | |
| Analog Channel 7 | 0C.0A | IC | VA<br>VB<br>VC<br>4th V<br>IA<br>IB<br>IC<br>IN - ISEF<br>Frequency<br>*[Indexed String]* |
| This setting selects any available analogue input to be assigned to this channel. | | | |
| Analog Channel 8 | 0C.0B | IN-ISEF | VA<br>VB<br>VC<br>4th V<br>IA<br>IB<br>IC<br>IN - ISEF<br>Frequency<br>*[Indexed String]* |
| This setting selects any available analogue input to be assigned to this channel. | | | |
| Analog Channel 9 | 0C.0C | Frequency | VA<br>VB<br>VC<br>4th V<br>IA<br>IB<br>IC<br>IN - ISEF<br>Frequency<br>*[Indexed String]* |
| This setting selects any available analogue input to be assigned to this channel. | | | |
| Digital Input 1 | 0C.0D | Output R1 | From 0 to DDB Size in steps of 1<br>*[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Input 1 Trigger | 0C.0E | No Trigger | No Trigger<br>Trigger L/H<br>Trigger H/L<br>*[Indexed String]* |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |
| Digital Input 2 | 0C.0F | Output R2 | From 0 to DDB Size in steps of 1<br>*[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Input 2 Trigger | 0C.10 | No Trigger | No Trigger<br>Trigger L/H<br>Trigger H/L<br>*[Indexed String]* |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |
| Digital Input 3 | 0C.11 | Output R3 | From 0 to DDB Size in steps of 1 |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Input 3 Trigger | 0C.12 | Trigger L/H | No Trigger<br>Trigger L/H<br>Trigger H/L<br>*[Indexed String]* |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |
| Digital Input 4 | 0C.13 | Output R4 | From 0 to DDB Size in steps of 1<br>*[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Input 4 Trigger | 0C.14 | No Trigger | No Trigger<br>Trigger L/H<br>Trigger H/L<br>*[Indexed String]* |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |
| Digital Input 5 | 0C.15 | Output R5 | From 0 to DDB Size in steps of 1<br>*[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Input 5 Trigger | 0C.16 | No Trigger | No Trigger<br>Trigger L/H<br>Trigger H/L<br>*[Indexed String]* |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |
| Digital Input 6 | 0C.17 | Output R6 | From 0 to DDB Size in steps of 1<br>*[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Input 6 Trigger | 0C.18 | No Trigger | No Trigger<br>Trigger L/H<br>Trigger H/L<br>*[Indexed String]* |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |
| Digital Input 7 | 0C.19 | Output R7 | From 0 to DDB Size in steps of 1<br>*[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Input 7 Trigger | 0C.1A | No Trigger | No Trigger<br>Trigger L/H<br>Trigger H/L<br>*[Indexed String]* |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |
| Digital Input 8 | 0C.1B | Output R8 | From 0 to DDB Size in steps of 1<br>*[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Input 8 Trigger | 0C.1C | No Trigger | No Trigger<br>Trigger L/H<br>Trigger H/L<br>*[Indexed String]* |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |
| Digital Input 9 | 0C.1D | Unused | From 0 to DDB Size in steps of 1<br>*[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Input 9 Trigger | 0C.1E | No Trigger | No Trigger<br>Trigger L/H<br>Trigger H/L<br>*[Indexed String]* |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |
| Digital Input 10 | 0C.1F | Unused | From 0 to DDB Size in steps of 1 <br> *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Input 10 Trigger | 0C.20 | No Trigger | No Trigger <br> Trigger L/H <br> Trigger H/L <br> *[Indexed String]* |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |
| Digital Input 11 | 0C.21 | Unused | From 0 to DDB Size in steps of 1 <br> *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Input 11 Trigger | 0C.22 | No Trigger | No Trigger <br> Trigger L/H <br> Trigger H/L <br> *[Indexed String]* |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |
| Digital Input 12 | 0C.23 | Unused | From 0 to DDB Size in steps of 1 <br> *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Input 12 Trigger | 0C.24 | No Trigger | No Trigger <br> Trigger L/H <br> Trigger H/L <br> *[Indexed String]* |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |
| Digital Input 13 | 0C.25 | Input L1 | From 0 to DDB Size in steps of 1 <br> *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Input 13 Trigger | 0C.26 | No Trigger | No Trigger <br> Trigger L/H <br> Trigger H/L <br> *[Indexed String]* |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |
| Digital Input 14 | 0C.27 | Input L2 | From 0 to DDB Size in steps of 1 <br> *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Input 14 Trigger | 0C.28 | No Trigger | No Trigger <br> Trigger L/H <br> Trigger H/L <br> *[Indexed String]* |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |
| Digital Input 15 | 0C.29 | Input L3 | From 0 to DDB Size in steps of 1 <br> *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Input 15 Trigger | 0C.2A | No Trigger | No Trigger <br> Trigger L/H <br> Trigger H/L <br> *[Indexed String]* |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |
| Digital Input 16 | 0C.2B | Input L4 | From 0 to DDB Size in steps of 1 <br> *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Input 16 Trigger | 0C.2C | No Trigger | No Trigger |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| | | | Trigger L/H<br>Trigger H/L<br>*[Indexed String]* |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |
| Digital Input 17 | 0C.2D | Input L5 | From 0 to DDB Size in steps of 1<br>*[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Input 17 Trigger | 0C.2E | No Trigger | No Trigger<br>Trigger L/H<br>Trigger H/L<br>*[Indexed String]* |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |
| Digital Input 18 | 0C.2F | Input L6 | From 0 to DDB Size in steps of 1<br>*[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Input 18 Trigger | 0C.30 | No Trigger | No Trigger<br>Trigger L/H<br>Trigger H/L<br>*[Indexed String]* |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |
| Digital Input 19 | 0C.31 | Input L7 | From 0 to DDB Size in steps of 1<br>*[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Input 19 Trigger | 0C.32 | No Trigger | No Trigger<br>Trigger L/H<br>Trigger H/L<br>*[Indexed String]* |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |
| Digital Input 20 | 0C.33 | Input L8 | From 0 to DDB Size in steps of 1<br>*[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Input 20 Trigger | 0C.34 | No Trigger | No Trigger<br>Trigger L/H<br>Trigger H/L<br>*[Indexed String]* |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |
| Digital Input 21 | 0C.35 | Unused | From 0 to DDB Size in steps of 1<br>*[Indexed String]* |
| The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc. | | | |
| Input 21 Trigger | 0C.36 | No Trigger | No Trigger<br>Trigger L/H<br>Trigger H/L<br>*[Indexed String]* |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |
| Digital Input 22 | 0C.37 | Unused | From 0 to DDB Size in steps of 1<br>*[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Input 22 Trigger | 0C.38 | No Trigger | No Trigger<br>Trigger L/H<br>Trigger H/L<br>*[Indexed String]* |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |
| Digital Input 23 | 0C.39 | Unused | From 0 to DDB Size in steps of 1<br>*[Indexed String]* |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Input 23 Trigger | 0C.3A | No Trigger | No Trigger<br>Trigger L/H<br>Trigger H/L<br>*[Indexed String]* |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |
| Digital Input 24 | 0C.3B | Unused | From 0 to DDB Size in steps of 1<br>*[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Input 24 Trigger | 0C.3C | No Trigger | No Trigger<br>Trigger L/H<br>Trigger H/L<br>*[Indexed String]* |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |
| Digital Input 25 | 0C.3D | Unused | From 0 to DDB Size in steps of 1<br>*[Indexed String]* |
| The digital channels may monitor any of the opto isolated inputs or output contacts, in addition to a number of internal IED digital signals, such as protection starts, LEDs etc. | | | |
| Input 25 Trigger | 0C.3E | No Trigger | No Trigger<br>Trigger L/H<br>Trigger H/L<br>*[Indexed String]* |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |
| Digital Input 26 | 0C.3F | Unused | From 0 to DDB Size in steps of 1<br>*[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Input 26 Trigger | 0C.40 | No Trigger | No Trigger<br>Trigger L/H<br>Trigger H/L<br>*[Indexed String]* |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |
| Digital Input 27 | 0C.41 | Unused | From 0 to DDB Size in steps of 1<br>*[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Input 27 Trigger | 0C.42 | No Trigger | No Trigger<br>Trigger L/H<br>Trigger H/L<br>*[Indexed String]* |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |
| Digital Input 28 | 0C.43 | Unused | From 0 to DDB Size in steps of 1<br>*[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Input 28 Trigger | 0C.44 | No Trigger | No Trigger<br>Trigger L/H<br>Trigger H/L<br>*[Indexed String]* |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |
| Digital Input 29 | 0C.45 | Unused | From 0 to DDB Size in steps of 1<br>*[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Input 29 Trigger | 0C.46 | No Trigger | No Trigger<br>Trigger L/H<br>Trigger H/L<br>*[Indexed String]* |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| Digital Input 30 | 0C.47 | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Input 30 Trigger | 0C.48 | No Trigger | No Trigger Trigger L/H Trigger H/L *[Indexed String]* |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |
| Digital Input 31 | 0C.49 | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Input 31 Trigger | 0C.4A | No Trigger | No Trigger Trigger L/H Trigger H/L *[Indexed String]* |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |
| Digital Input 32 | 0C.4B | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Input 32 Trigger | 0C.4C | No Trigger | No Trigger Trigger L/H Trigger H/L *[Indexed String]* |
| This setting defines whether the digital input is triggered and if so, the trigger polarity (low to high or high to low). | | | |
| Digital Input 33 | 0C.4D | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Digital Input 34 | 0C.4E | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Digital Input 35 | 0C.4F | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Digital Input 36 | 0C.50 | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Digital Input 37 | 0C.51 | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Digital Input 38 | 0C.52 | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Digital Input 39 | 0C.53 | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Digital Input 40 | 0C.54 | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Digital Input 41 | 0C.55 | Unused | From 0 to DDB Size in steps of 1 |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Digital Input 42 | 0C.56 | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Digital Input 43 | 0C.57 | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Digital Input 44 | 0C.58 | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Digital Input 45 | 0C.59 | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Digital Input 46 | 0C.5A | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Digital Input 47 | 0C.5B | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Digital Input 48 | 0C.5C | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Digital Input 49 | 0C.5D | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Digital Input 50 | 0C.5E | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Digital Input 51 | 0C.5F | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Digital Input 52 | 0C.60 | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Digital Input 53 | 0C.61 | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Digital Input 54 | 0C.62 | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Digital Input 55 | 0C.63 | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Digital Input 56 | 0C.64 | Unused | From 0 to DDB Size in steps of 1 |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Digital Input 57 | 0C.65 | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Digital Input 58 | 0C.66 | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Digital Input 59 | 0C.67 | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Digital Input 60 | 0C.68 | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Digital Input 61 | 0C.69 | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Digital Input 62 | 0C.6A | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Digital Input 63 | 0C.6B | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| Digital Input 64 | 0C.6C | Unused | From 0 to DDB Size in steps of 1 *[Indexed String]* |
| The digital channels may monitor any of the opto-inputs, output relay contacts and other internal digital signals, such as protection starts, LEDs etc. This setting assigns the digital channel to any one of these. | | | |
| MEASURE'T SETUP | 0D.00 | | |
| This column contains settings for the measurement setup | | | |
| Default Display | 0D.01 | Banner | User Banner 3Ph + N Current Date and Time Description Plant Reference Frequency Access Level DC Supply Mag *[Indexed String]* |
| This cell is used to show the default display option. | | | |
| Local Values | 0D.02 | Primary | Primary Secondary *[Indexed String]* |
| This setting controls whether local measured values (via HMI or front port) are displayed as primary or secondary quantities. | | | |
| Remote Values | 0D.03 | Primary | Primary Secondary *[Indexed String]* |
| This setting controls whether remote measured values (via rear comms ports) are displayed as primary or secondary quantities. | | | |
| Measurement Ref | 0D.04 | IA | IA IB IC *[Indexed String]* |
| This setting sets the phase reference for all angular measurements (for Measurements 1 only). | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| Fix Dem Period | 0D.06 | 30 | From 1 to 99 in steps of 1 *[Courier Number (time-minutes)]* |
| This setting defines the length of the fixed demand window in minutes | | | |
| Roll Sub Period | 0D.07 | 30 | From 1 to 99 in steps of 1 *[Courier Number (time-minutes)]* |
| This setting is used to set the length of the window used for the calculation of rolling demand quantities (in minutes). | | | |
| Num Sub Periods | 0D.08 | 1 | From 1 to 15 in steps of 1 *[Unsigned Integer (16 bits)]* |
| This setting is used to set the resolution of the rolling sub window. | | | |
| Remote2 Values | 0D.0B | Primary | Primary Secondary *[Indexed String]* |
| The setting defines whether the values measured via the Second Rear Communication port are displayed in primary or secondary terms. | | | |
| COMMUNICATIONS | 0E.00 | | |
| This column contains general communications settings | | | |
| RP1 Protocol | 0E.01 | | Courier IEC60870-5-103 Modbus DNP 3.0 *[Indexed String]* |
| This setting sets the address of RP1. | | | |
| RP1 Address | 0E.02 | 255 | From 0 to 255 in steps of 1 *[Unsigned Integer (16 bits)]* |
| This setting sets the address of RP1. | | | |
| RP1 Address | 0E.02 | 1 | From 1 to 247 in steps of 1 *[Unsigned Integer (16 bits)]* |
| This setting sets the address of RP1. | | | |
| RP1 Address | 0E.02 | 1 | From 0 to 254 in steps of 1 *[Unsigned Integer (16 bits)]* |
| This setting sets the address of RP1. | | | |
| RP1 Address | 0E.02 | 1 | From 0 to 65519 in steps of 1 *[Unsigned Integer (16 bits)]* |
| This setting sets the address of RP1. | | | |
| RP1 InactivTimer | 0E.03 | 15 | From 1 to 30 in steps of 1 *[Courier Number (time-minutes)]* |
| This setting defines the period of inactivity on RP1 before the IED reverts to its default state. | | | |
| RP1 Baud Rate | 0E.04 | 19200 | 9600 bits/s 19200 bits/s 38400 bits/s *[Indexed String]* |
| This setting sets the communication speed between the IED RP1 port and the master station. It is important that both IED and master station are set at the same speed setting. This cell is applicable for the non-Courier protocols. Build = Modbus | | | |
| RP1 Baud Rate | 0E.04 | 19200 | 9600 bits/s 19200 bits/s *[Indexed String]* |
| This setting sets the communication speed between the IED RP1 port and the master station. It is important that both IED and master station are set at the same speed setting. This cell is applicable for the non-Courier protocols. Build = CS103 | | | |
| RP1 Baud Rate | 0E.04 | 19200 | 1200 bits/s 2400 bits/s 4800 bits/s 9600 bits/s 19200 bits/s 38400 bits/s *[Indexed String]* |
| This setting sets the communication speed between the IED RP1 port and the master station. It is important that both IED and master station are set at the same speed setting. This cell is applicable for the non-Courier protocols. Build = DNP3.0 | | | |
| RP1 Parity | 0E.05 | None | Odd Even None *[Indexed String]* |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| This setting controls the parity format used in the data frames of RP1. It is important that both IED and master station are set with the same parity setting. | | | |
| RP1 Meas Period | 0E.06 | 15 | From 1 to 60 in steps of 1<br>*[Courier Number (time-seconds)]* |
| This setting controls the time interval that the IED will use between sending measurement data to the master station for IEC60870-5-103 versions. | | | |
| RP1 Time Sync | 0E.08 | Disabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting is for DNP3.0 versions only. If set to Enabled the master station can be used to synchronize the time on the IED via RP1. If set to Disabled either the internal free running clock or IRIG-B input are used. | | | |
| Modbus IEC Time | 0E.09 | Standard | Standard IEC  (Existing format)<br>Reverse IEC   (Company agreed format)<br>*[Indexed String]* |
| When 'Standard IEC' is selected the time format complies with IEC60870-5-4 requirements such that byte 1 of the information is transmitted first, followed by bytes 2 through to 7. If 'Reverse' is selected the transmission of information is reversed. | | | |
| RP1 CS103Blcking | 0E.0A | Disabled | Disabled<br>Monitor Blocking<br>Command Blocking<br>*[Indexed String]* |
| This cell sets the blocking type for IEC60870-5-103. With monitor blocking, reading of the status information and disturbance records is not permitted. When in this mode the IED returns a "termination of general interrogation" message to the master station | | | |
| RP1 Card Status | 0E.0B | | K-Bus OK<br>EIA485 OK<br>IRIG-B<br>*[Indexed String]* |
| This setting displays the communication type and status of RP1 | | | |
| RP1 Port Config | 0E.0C | EIA485 (RS485) | K-Bus<br>EIA485 (RS485)<br>*[Indexed String]* |
| This setting selects the type of physical protocol for RP1 - either K-bus or RS485. | | | |
| RP1 Comms Mode | 0E.0D | IEC60870 FT1.2 | IEC60870 FT1.2<br>10-Bit No Parity<br>*[Indexed String]* |
| This setting determines the serial communication mode. | | | |
| RP1 Baud Rate | 0E.0E | 19200 | 9600 bits/s<br>19200 bits/s<br>38400 bits/s<br>*[Indexed String]* |
| This cell controls the communication speed between IED and master station. It is important that both IED and master station are set at the same speed setting. This cell is applicable for the Courier protocol. | | | |
| Meas Scaling | 0E.0F | Primary | Normalised<br>Primary<br>Secondary<br>*[Indexed String]* |
| This setting determines the scaling type of analogue quantities  - in terms of primary, secondary or normalised, for DNP3 models | | | |
| Message Gap (ms) | 0E.10 | 0 | From 0 to 50 in steps of 1<br>*[Courier Number (time-ms)]* |
| This setting allows the master station to have an interframe gap. DNP 3.0 versions only | | | |
| DNP Need Time | 0E.11 | 10 | From 1 to 30 in steps of 1<br>*[Courier Number (time-minutes)]* |
| This setting sets the duration of time waited before requesting another time sync from the master. DNP 3.0 versions only. | | | |
| DNP App Fragment | 0E.12 | 2048 | From 100 to 2048 in steps of 1<br>*[Unsigned Integer (16 bits)]* |
| This setting sets the maximum message length (application fragment size) transmitted by the IED for DNP 3.0 versions. | | | |
| DNP App Timeout | 0E.13 | 2 | From 1 to 120 in steps of 1<br>*[Courier Number (time-seconds)]* |
| This setting sets the maximum waiting time between sending a message fragment and receiving confirmation from the master. DNP 3.0 versions only. | | | |
| 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-seconds)]* |
| This setting sets the maximum waiting time between receiving (sending?) a select command and awaiting an operate confirmation from the master. DNP 3.0 versions only. | | | |
| DNP Link Timeout | 0E.15 | 0 | From 0 to 120 in steps of 1 *[Courier Number (time-seconds)]* |
| This setting sets the maximum waiting time for a Data Link Confirm from the master. A value of 0 means data link support disabled. DNP 3.0 versions only. | | | |
| Class 0 Poll | 0E.16 | 0 | Running Counters Frozen Counters *[Indexed String]* |
| This setting is for DNP3.0 versions only. In response to a Class 0 poll, an outstation device shall report either the count value or the frozen count value. | | | |
| NIC Protocol | 0E.1F | | UCA 2.0 UCA 2.0 GOOSE IEC61850 DNP3 IEC61850+DNP3 *[Indexed String]* |
| This cell indicates which Ethernet protocols are used on the rear Ethernet port. | | | |
| NIC MAC Address | 0E.22 | Ethernet MAC Address | NIC MAC Address *[ASCII Text (17 chars)]* |
| This setting displays the MAC address of the rear Ethernet port, if applicable. | | | |
| NIC Tunl Timeout | 0E.64 | 5.00 min | From 1 to 30 in steps of 1 *[Courier Number (time-minutes)]* |
| This setting sets the maximum waiting time before an inactive tunnel to the application software is reset. DNP 3.0 over Ethernet versions only. | | | |
| NIC Link Report | 0E.6A | Alarm | Alarm Event None *[Indexed String]* |
| This setting defines how a failed or unfitted network link is reported. DNP 3.0 over Ethernet versions only. | | | |
| REAR PORT2 (RP2) | 0E.80 | | |
| The settings in this sub-menu are for models with a second communications port (RP2). | | | |
| RP2 Protocol | 0E.81 | Courier | Courier IEC60870-5-103 Modbus DNP 3.0 *[Indexed String]* |
| This cell displays the communications protocol relevant to main communication port (RP2) of the chosen IED model. | | | |
| RP2 Card Status | 0E.84 | | K-Bus OK EIA485 OK IRIG-B *[Indexed String]* |
| This setting displays the communication type and status of RP2, if applicable | | | |
| RP2 Port Config | 0E.88 | EIA485 (RS485) | K-Bus EIA485 (RS485) *[Indexed String]* |
| This setting selects the type of physical protocol for RP2 - either K-bus or RS485. | | | |
| RP2 Comms Mode | 0E.8A | IEC60870 FT1.2 | IEC60870 FT1.2 10-Bit No Parity *[Indexed String]* |
| This setting determines the serial communication mode. | | | |
| RP2 Address | 0E.90 | 255 | From 0 to 255 in steps of 1 *[Unsigned Integer (16 bits)]* |
| This setting sets the address of RP2. | | | |
| RP2 InactivTimer | 0E.92 | 15 | From 1 to 30 in steps of 1 *[Courier Number (time-minutes)]* |
| This setting defines the period of inactivity on RP2 before the IED reverts to its default state. | | | |
| RP2 Baud Rate | 0E.94 | 19200 | 9600 bits/s 19200 bits/s 38400 bits/s |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| | | | [Indexed String] |
| This setting sets the communication speed between the IED RP2 port and the master station. It is important that both IED and master station are set at the same speed setting. | | | |
| NIC Protocol | 0E.A0 | | UCA 2.0<br>UCA 2.0 GOOSE<br>IEC61850<br>DNP3<br>IEC61850+DNP3<br>[Indexed String] |
| This cell indicates DNP 3.0 over Ethernet are used on the rear Ethernet port. | | | |
| IP Address | 0E.A1 | 0.0.0.0 | IP Address<br>[ASCII Text (16 chars)] |
| This cell displays the IED's IP address. DNP over Ethernet versions only. | | | |
| Subnet Address | 0E.A2 | 0.0.0.0 | Subnet Address<br>[ASCII Text (16 chars)] |
| This cell displays the  LAN's subnet address on which the IED is located. DNP 3.0 over Ethernet versions only. | | | |
| NIC MAC Address | 0E.A3 | Ethernet MAC Address | NIC MAC Address<br>[ASCII Text (17 chars)] |
| This setting displays the MAC address of the rear Ethernet port, if applicable. | | | |
| Gateway | 0E.A4 | 0.0.0.0 | Gateway<br>[ASCII Text (16 chars)] |
| This cell displays the LAN's gateway address on which the IED is located. DNP 3.0 over Ethernet versions only. | | | |
| DNP Time Synch | 0E.A5 | Disabled | Disabled<br>Enabled<br>[Indexed String] |
| If set to 'Enabled' the DNP3.0 master station can be used to synchronise the IED's time clock. If set to 'Disabled' either the internal free running clock, or IRIG-B input are used. DNP 3.0 over Ethernet versions only. | | | |
| Meas Scaling | 0E.A6 | Primary | Normalised<br>Primary<br>Secondary<br>[Indexed String] |
| This setting determines the scaling type of analogue quantities  - in terms of primary, secondary or normalised, for DNP3 models. | | | |
| NIC Tunl Timeout | 0E.A7 | 5 | From 1 to 30 in steps of 1<br>[Courier Number (time-minutes)] |
| This setting sets the maximum waiting time before an inactive tunnel to the application software is reset. DNP 3.0 over Ethernet versions only. | | | |
| NIC Link Report | 0E.A8 | Alarm | Alarm<br>Event<br>None<br>[Indexed String] |
| This setting defines how a failed or unfitted network link is reported. DNP 3.0 over Ethernet  versions only. | | | |
| Media | 0E.A9 | | Media Unknown<br>RJ45<br>FO<br>RJ45 Port A<br>RJ45 Port B<br>FO Port A<br>FO Port B<br>RJ45 Redundant<br>FO Redundant<br>[Indexed String] |
| Displays the communication media of the Ethernet port that is currently in use.<br>DNP 3.0 over Ethernet versions only. | | | |
| SNTP PARAMETERS | 0E.AA | | |
| The settings in this sub-menu are for models using DNP3 over Ethernet. | | | |
| SNTP Server 1 | 0E.AB | 0.0.0.0 | SNTP Server 1<br>[Courier Number (time-minutes)] |
| This cell indicates the SNTP Server 1 address. DNP 3.0 over Ethernet versions only. | | | |
| SNTP Server 2 | 0E.AC | 0.0.0.0 | SNTP Server 2<br>[Indexed String] |
| This cell indicates the SNTP Server 2 address. DNP 3.0 over Ethernet versions only. | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| SNTP Poll Rate | 0E.AD | 64s | SNTP Poll Rate<br>*[Courier Number (time-seconds)]* |
| This cell displays the SNTP poll rate interval in seconds. DNP 3.0 over Ethernet versions only. | | | |
| DNP Need Time | 0E.B1 | 10 | From 1 to 30 in steps of 1<br>*[Courier Number (time-minutes)]* |
| This setting sets the duration of time waited before requesting another time sync from the master. DNP 3.0 versions only. | | | |
| DNP App Fragment | 0E.B2 | 2048 | From 100 to 2048 in steps of 1<br>*[Unsigned Integer (16 bits)]* |
| This setting sets the maximum message length (application fragment size) transmitted by the IED for DNP 3.0 versions. | | | |
| DNP App Timeout | 0E.B3 | 2 | From 1 to 120 in steps of 1<br>*[Courier Number (time-seconds)]* |
| This setting sets the maximum waiting time between sending a message fragment and receiving confirmation from the master. DNP 3.0 versions only. | | | |
| DNP SBO Timeout | 0E.B4 | 10 | From 1 to 10 in steps of 1<br>*[Courier Number (time-seconds)]* |
| This setting sets the maximum waiting time between receiving a select command and awaiting an operate confirmation from the master. DNP 3.0 versions only. | | | |
| Class 0 Poll | 0E.B5 | 0 | Running Counters<br>Frozen Counters<br>*[Indexed String]* |
| This setting is for DNP3.0 versions only. In response to a Class 0 poll, an outstation device shall report either the count value or the frozen count value. | | | |
| Redundancy | 0E.CE | | NONE<br>FAILOVER<br>RSTP<br>PRP<br>HSR<br>*[Indexed String]* |
| The settings is to indicate the type of Ethernet redundancy currently active | | | |
| RSTP | 0E.D0 | | |
| The settings in this sub-menu are for models using RSTP | | | |
| Bridge MAC Address | 0E.D1 | 0.0.0.0 | Bridge MAC Address<br>*[ASCII Text (17 chars)]* |
| This setting displays the Bridge MAC address of the device as per RSTP protocol | | | |
| Bridge Priority | 0E.D2 | 32768 | Bridge Priority<br>*[Unsigned Integer (32 bits)]* |
| This setting displays the Bridge Priority configured in the device | | | |
| Root MAC Address | 0E.D3 | 0.0.0.0 | Root MAC Address<br>*[ASCII Text (17 chars)]* |
| This setting displays the MAC address of the Root device as per RSTP protocol | | | |
| Root Priority | 0E.D4 | 0 | Root Priority<br>*[Unsigned Integer (32 bits)]* |
| This setting displays the Root Priority of the Root device as per RSTP protocol | | | |
| Root Path Cost | 0E.D5 | 0 | Root Path Cost<br>*[Unsigned Integer (32 bits)]* |
| This setting displays the Root Path Cost based on the RSTP network link speed | | | |
| Root Port | 0E.D6 | 0 | Unknown<br>Port A<br>Port B<br>*[Indexed String]* |
| This setting displays the Root Port based on the root path cost in RSTP network. | | | |
| Root Max Age | 0E.D7 | 0 | Root Max Age<br>*[Courier Number (time-seconds)]* |
| This setting displays the maximum age timer which specifies the maximum expected arrival time of hello BPDUs | | | |
| Root Hello Time | 0E.D8 | 0 | Root Hello Time<br>*[Courier Number (time-seconds)]* |
| This setting displays the Hello time during which RSTP BPDUs are sent out | | | |
| RootForwardDelay | 0E.D9 | 0 | RootForwardDelay<br>*[Courier Number (time-seconds)]* |
| This setting displays the Forward delay for the RSTP ports to be in FORWARDING State | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| Port A State | 0E.DA | Discarding | Unknown<br>Disabled<br>Discarding<br>Learning<br>Forwarding<br>*[Indexed String]* |
| This setting displays the RSTP States DISCARDING, LEARNING or FORWARDING for Port A | | | |
| Port B State | 0E.DB | Discarding | Unknown<br>Disabled<br>Discarding<br>Learning<br>Forwarding<br>*[Indexed String]* |
| This setting displays the RSTP States DISCARDING, LEARNING or FORWARDING for Port B | | | |
| COMMISSION TESTS | 0F.00 | | |
| This column contains commissioning test settings | | | |
| Opto I/P Status | 0F.01 | | Opto 1 Input State (0=Off, 1=Energised)<br>Opto 2 Input State (0=Off, 1=Energised)<br>Opto 3 Input State (0=Off, 1=Energised)<br>Opto 4 Input State (0=Off, 1=Energised)<br>Opto 5 Input State (0=Off, 1=Energised)<br>Opto 6 Input State (0=Off, 1=Energised)<br>Opto 7 Input State (0=Off, 1=Energised)<br>Opto 8 Input State (0=Off, 1=Energised)<br>Opto 9 Input State (0=Off, 1=Energised)<br>Opto 10 Input State (0=Off, 1=Energised)<br>Opto 11 Input State (0=Off, 1=Energised)<br>Opto 12 Input State (0=Off, 1=Energised)<br>Opto 13 Input State (0=Off, 1=Energised)<br>Opto 14 Input State (0=Off, 1=Energised)<br>Opto 15 Input State (0=Off, 1=Energised)<br>Opto 16 Input State (0=Off, 1=Energised)<br>Opto 17 Input State (0=Off, 1=Energised)<br>Opto 18 Input State (0=Off, 1=Energised)<br>Opto 19 Input State (0=Off, 1=Energised)<br>Opto 20 Input State (0=Off, 1=Energised)<br>Opto 21 Input State (0=Off, 1=Energised)<br>Opto 22 Input State (0=Off, 1=Energised)<br>Opto 23 Input State (0=Off, 1=Energised)<br>Opto 24 Input State (0=Off, 1=Energised)<br>Opto 25 Input State (0=Off, 1=Energised)<br>Opto 26 Input State (0=Off, 1=Energised)<br>Opto 27 Input State (0=Off, 1=Energised)<br>Opto 28 Input State (0=Off, 1=Energised)<br>Opto 29 Input State (0=Off, 1=Energised)<br>Opto 30 Input State (0=Off, 1=Energised)<br>Opto 31 Input State (0=Off, 1=Energised)<br>Opto 32 Input State (0=Off, 1=Energised)<br>*[Binary Flag (16 bits) Indexed String]* |
| This cell displays the status of the available opto-inputs. | | | |
| Relay O/P Status | 0F.02 | | Relay 1 (0=Not Operated, 1=Operated)<br>Relay 2 (0=Not Operated, 1=Operated)<br>Relay 3 (0=Not Operated, 1=Operated)<br>Relay 4 (0=Not Operated, 1=Operated)<br>Relay 5 (0=Not Operated, 1=Operated)<br>Relay 6 (0=Not Operated, 1=Operated)<br>Relay 7 (0=Not Operated, 1=Operated)<br>Relay 8 (0=Not Operated, 1=Operated)<br>Relay 9 (0=Not Operated, 1=Operated)<br>Relay 10 (0=Not Operated, 1=Operated)<br>Relay 11 (0=Not Operated, 1=Operated)<br>Relay 12 (0=Not Operated, 1=Operated) |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | Relay 13 (0=Not Operated, 1=Operated) |
| | | | Relay 14 (0=Not Operated, 1=Operated) |
| | | | Relay 15 (0=Not Operated, 1=Operated) |
| | | | Relay 16 (0=Not Operated, 1=Operated) |
| | | | Relay 17 (0=Not Operated, 1=Operated) |
| | | | Relay 18 (0=Not Operated, 1=Operated) |
| | | | Relay 19 (0=Not Operated, 1=Operated) |
| | | | Relay 20 (0=Not Operated, 1=Operated) |
| | | | Relay 21 (0=Not Operated, 1=Operated) |
| | | | Relay 22 (0=Not Operated, 1=Operated) |
| | | | Relay 23 (0=Not Operated, 1=Operated) |
| | | | Relay 24 (0=Not Operated, 1=Operated) |
| | | | Relay 25 (0=Not Operated, 1=Operated) |
| | | | Relay 26 (0=Not Operated, 1=Operated) |
| | | | Relay 27 (0=Not Operated, 1=Operated) |
| | | | Relay 28 (0=Not Operated, 1=Operated) |
| | | | Relay 29 (0=Not Operated, 1=Operated) |
| | | | Relay 30 (0=Not Operated, 1=Operated) |
| | | | Relay 31 (0=Not Operated, 1=Operated) |
| | | | Relay 32 (0=Not Operated, 1=Operated) |
| | | | *[Binary Flag (32 bits) Indexed String]* |
| This cell displays the status of the available output relays.<br>Warning; When in Test Mode, this cell cannot be used to confirm operation of the output relays, therefore it will be necessary to monitor the state of each contact in turn. | | | |
| Test Port Status | 0F.03 | | Test Port Status<br>*[Binary Flag (8 bits) Indexed String]* |
| This cell displays the logic state of the DDB signals that have been allocated in the 'Monitor Bit' cells. | | | |
| Monitor Bit 1 | 0F.05 | 640 | From 0 to 2047 in steps of 1<br>*[Unsigned Integer (16 bits)]* |
| The 'Monitor Bit' cells allow the user to select which DDB signals can be observed in the 'Test Port Status' cell. | | | |
| Monitor Bit 2 | 0F.06 | 642 | From 0 to 2047 in steps of 1<br>*[Unsigned Integer (16 bits)]* |
| The 'Monitor Bit' cells allow the user to select which DDB signals can be observed in the 'Test Port Status' cell. | | | |
| Monitor Bit 3 | 0F.07 | 644 | From 0 to 2047 in steps of 1<br>*[Unsigned Integer (16 bits)]* |
| The 'Monitor Bit' cells allow the user to select which DDB signals can be observed in the 'Test Port Status' cell. | | | |
| Monitor Bit 4 | 0F.08 | 646 | From 0 to 2047 in steps of 1<br>*[Unsigned Integer (16 bits)]* |
| The 'Monitor Bit' cells allow the user to select which DDB signals can be observed in the 'Test Port Status' cell. | | | |
| Monitor Bit 5 | 0F.09 | 648 | From 0 to 2047 in steps of 1<br>*[Unsigned Integer (16 bits)]* |
| The 'Monitor Bit' cells allow the user to select which DDB signals can be observed in the 'Test Port Status' cell. | | | |
| Monitor Bit 6 | 0F.0A | 650 | From 0 to 2047 in steps of 1<br>*[Unsigned Integer (16 bits)]* |
| The 'Monitor Bit' cells allow the user to select which DDB signals can be observed in the 'Test Port Status' cell. | | | |
| Monitor Bit 7 | 0F.0B | 652 | From 0 to 2047 in steps of 1<br>*[Unsigned Integer (16 bits)]* |
| The 'Monitor Bit' cells allow the user to select which DDB signals can be observed in the 'Test Port Status' cell. | | | |
| Monitor Bit 8 | 0F.0C | 654 | From 0 to 2047 in steps of 1<br>*[Unsigned Integer (16 bits)]* |
| The 'Monitor Bit' cells allow the user to select which DDB signals can be observed in the 'Test Port Status' cell. | | | |
| Test Mode | 0F.0D | Disabled | Disabled<br>Test Mode<br>Contacts Blocked<br>*[Indexed String]* |
| This cell is used to allow secondary injection testing to be performed on the IED without operation of the trip contacts. It also enables a facility to directly test the output contacts by applying menu controlled test signals | | | |
| Test Pattern | 0F.0E | 0x0 | Relay 1 (0=Not Operated, 1=Operated)<br>Relay 2 (0=Not Operated, 1=Operated)<br>Relay 3 (0=Not Operated, 1=Operated)<br>Relay 4 (0=Not Operated, 1=Operated) |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| | | | Relay 5 (0=Not Operated, 1=Operated) |
| | | | Relay 6 (0=Not Operated, 1=Operated) |
| | | | Relay 7 (0=Not Operated, 1=Operated) |
| | | | Relay 8 (0=Not Operated, 1=Operated) |
| | | | Relay 9 (0=Not Operated, 1=Operated) |
| | | | Relay 10 (0=Not Operated, 1=Operated) |
| | | | Relay 11 (0=Not Operated, 1=Operated) |
| | | | Relay 12 (0=Not Operated, 1=Operated) |
| | | | Relay 13 (0=Not Operated, 1=Operated) |
| | | | Relay 14 (0=Not Operated, 1=Operated) |
| | | | Relay 15 (0=Not Operated, 1=Operated) |
| | | | Relay 16 (0=Not Operated, 1=Operated) |
| | | | Relay 17 (0=Not Operated, 1=Operated) |
| | | | Relay 18 (0=Not Operated, 1=Operated) |
| | | | Relay 19 (0=Not Operated, 1=Operated) |
| | | | Relay 20 (0=Not Operated, 1=Operated) |
| | | | Relay 21 (0=Not Operated, 1=Operated) |
| | | | Relay 22 (0=Not Operated, 1=Operated) |
| | | | Relay 23 (0=Not Operated, 1=Operated) |
| | | | Relay 24 (0=Not Operated, 1=Operated) |
| | | | Relay 25 (0=Not Operated, 1=Operated) |
| | | | Relay 26 (0=Not Operated, 1=Operated) |
| | | | Relay 27 (0=Not Operated, 1=Operated) |
| | | | Relay 28 (0=Not Operated, 1=Operated) |
| | | | Relay 29 (0=Not Operated, 1=Operated) |
| | | | Relay 30 (0=Not Operated, 1=Operated) |
| | | | Relay 31 (0=Not Operated, 1=Operated) |
| | | | Relay 32 (0=Not Operated, 1=Operated) |
| | | | *[Binary Flag (32 bits)]* |
| 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 | No Operation<br>Apply Test<br>Remove Test<br>*[Indexed String]* |
| This command changes the state of the output relay contacts in the Test Pattern cell. After the test has been applied the command text on the LCD changes to 'No Operation' and the contacts will remain in the Test State until reset. | | | |
| Test LEDs | 0F.10 | No Operation | No Operation<br>Apply Test<br>*[Indexed String]* |
| This command illuminates the user-programmable LEDs for approximately 2 seconds, before they extinguish and the command text on the LCD reverts to 'No Operation'. | | | |
| Test Autoreclose | 0F.11 | No Operation | No Operation<br>3 Pole Test<br>*[Indexed String]* |
| This command simulates tripping in order to test Autoreclose cycle. | | | |
| Red LED Status | 0F.15 | | Red LED Status<br>*[Binary Flag(18)]* |
| This cell indicates which of the user-programmable red LEDs are illuminated. | | | |
| Green LED Status | 0F.16 | | Green LED Status<br>*[Binary Flag(18)]* |
| This cell indicates which of the user-programmable green LEDs are illuminated. | | | |
| DDB 31 - 0 | 0F.20 | | DDB 31 - 0<br>*[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 63 - 32 | 0F.21 | | DDB 63 - 32<br>*[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 95 - 64 | 0F.22 | | DDB 95 - 64<br>*[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 127 - 96 | 0F.23 | | DDB 127 - 96 |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| | | | *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 159 - 128 | 0F.24 | | DDB 159 - 128 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 191 - 160 | 0F.25 | | DDB 191 - 160 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 223 - 192 | 0F.26 | | DDB 223 - 192 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 255 - 224 | 0F.27 | | DDB 255 - 224 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 287 - 256 | 0F.28 | | DDB 287 - 256 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 319 - 288 | 0F.29 | | DDB 319 - 288 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 351 - 320 | 0F.2A | | DDB 351 - 320 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 383 - 352 | 0F.2B | | DDB 383 - 352 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 415 - 384 | 0F.2C | | DDB 415 - 384 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 447 - 416 | 0F.2D | | DDB 447 - 416 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 479 - 448 | 0F.2E | | DDB 479 - 448 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 511 - 480 | 0F.2F | | DDB 511 - 480 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 543 - 512 | 0F.30 | | DDB 543 - 512 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 575 - 544 | 0F.31 | | DDB 575 - 544 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 607 - 576 | 0F.32 | | DDB 607 - 576 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 639 - 608 | 0F.33 | | DDB 639 - 608 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 671 - 640 | 0F.34 | | DDB 671 - 640 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 703 - 672 | 0F.35 | | DDB 703 - 672 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 735 - 704 | 0F.36 | | DDB 735 - 704 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| DDB 767 - 736 | 0F.37 | | DDB 767 - 736 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 799 - 768 | 0F.38 | | DDB 799 - 768 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 831 - 800 | 0F.39 | | DDB 831 - 800 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 863 - 832 | 0F.3A | | DDB 863 - 832 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 895 - 864 | 0F.3B | | DDB 895 - 864 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 927 - 896 | 0F.3C | | DDB 927 - 896 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 959 - 928 | 0F.3D | | DDB 959 - 928 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 991 - 960 | 0F.3E | | DDB 991 - 960 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 1023 - 992 | 0F.3F | | DDB 1023 - 992 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 1055 - 1024 | 0F.40 | | DDB 1055 - 1024 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 1087 - 1056 | 0F.41 | | DDB 1087 - 1056 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 1119 - 1088 | 0F.42 | | DDB 1119 - 1088 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 1151 - 1120 | 0F.43 | | DDB 1151 - 1120 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 1183 - 1152 | 0F.44 | | DDB 1183 - 1152 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 1215 - 1184 | 0F.45 | | DDB 1215 - 1184 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 1247 - 1216 | 0F.46 | | DDB 1247 - 1216 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 1279 - 1248 | 0F.47 | | DDB 1279 - 1248 *[Binary Flag(32)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 1311 - 1280 | 0F.48 | | DDB 1311 - 1280 *[Binary Flag (32 bits)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 1343 - 1312 | 0F.49 | | DDB 1343 - 1312 *[Binary Flag (32 bits)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 1375 - 1344 | 0F.4A | | DDB 1375 - 1344 *[Binary Flag (32 bits)]* |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| This cell displays the logic state of the DDB signals | | | |
| DDB 1407 - 1376 | 0F.4B | | DDB 1407 - 1376 *[Binary Flag (32 bits)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 1439 - 1408 | 0F.4C | | DDB 1439 - 1408 *[Binary Flag (32 bits)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 1471 - 1440 | 0F.4D | | DDB 1471 - 1440 *[Binary Flag (32 bits)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 1503 - 1472 | 0F.4E | | DDB 1503 - 1472 *[Binary Flag (32 bits)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 1535 - 1504 | 0F.4F | | DDB 1535 - 1504 *[Binary Flag (32 bits)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 1567 - 1536 | 0F.50 | | DDB 1567 - 1536 *[Binary Flag (32 bits)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 1599 - 1568 | 0F.51 | | DDB 1599 - 1568 *[Binary Flag (32 bits)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 1631 - 1600 | 0F.52 | | DDB 1631 - 1600 *[Binary Flag (32 bits)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 1663 - 1632 | 0F.53 | | DDB 1663 - 1632 *[Binary Flag (32 bits)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 1695 - 1664 | 0F.54 | | DDB 1695 - 1664 *[Binary Flag (32 bits)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 1727 - 1696 | 0F.55 | | DDB 1727 - 1696 *[Binary Flag (32 bits)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 1759- 1728 | 0F.56 | | DDB 1759- 1728 *[Binary Flag (32 bits)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 1791- 1760 | 0F.57 | | DDB 1791- 1760 *[Binary Flag (32 bits)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 1823 - 1792 | 0F.58 | | DDB 1823 - 1792 *[Binary Flag (32 bits)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 1855 - 1824 | 0F.59 | | DDB 1855 - 1824 *[Binary Flag (32 bits)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 1887 - 1856 | 0F.5A | | DDB 1887 - 1856 *[Binary Flag (32 bits)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 1919 - 1888 | 0F.5B | | DDB 1919 - 1888 *[Binary Flag (32 bits)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 1951 - 1920 | 0F.5C | | DDB 1951 - 1920 *[Binary Flag (32 bits)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 1983 - 1952 | 0F.5D | | DDB 1983 - 1952 *[Binary Flag (32 bits)]* |
| This cell displays the logic state of the DDB signals | | | |
| DDB 2015 - 1984 | 0F.5E | | DDB 2015 - 1984 |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| | | | [Binary Flag (32 bits)] |
| This cell displays the logic state of the DDB signals | | | |
| DDB 2047 - 2016 | 0F.5F | | DDB 2047 - 2016 [Binary Flag (32 bits)] |
| This cell displays the logic state of the DDB signals | | | |
| CB MONITOR SETUP | 10.00 | | |
| This column contains Circuit Breaker monitoring parameters | | | |
| Broken I^ | 10.01 | 2 | From 1 to 2 in steps of 0.1 [Courier Number (decimal)] |
| This setting sets the factor to be used for the cumulative broken current counter calculation. This factor is set according to the type of Circuit Breaker used. | | | |
| I^ Maintenance | 10.02 | Alarm Disabled | Alarm Disabled Alarm Enabled [Indexed String] |
| This setting determines whether an alarm is raised or not when the cumulative broken current maintenance counter threshold is exceeded. | | | |
| I^ Maintenance | 10.03 | 1000 | From 1 * NM1 to 25000 * NM1 in steps of 1 * NM1 [Courier Number (current)] |
| This setting determines the threshold for the cumulative broken current maintenance counter. | | | |
| I^ Lockout | 10.04 | Alarm Disabled | Alarm Disabled Alarm Enabled [Indexed String] |
| This setting determines whether an alarm will be raised or not when the cumulative broken current lockout counter threshold is exceeded. | | | |
| I^ Lockout | 10.05 | 2000 | From 1 * NM1 to 25000 * NM1 in steps of 1 * NM1 [Courier Number (current)] |
| This setting determines the threshold for the cumulative broken current lockout counter. | | | |
| No. CB Ops Maint | 10.06 | Alarm Disabled | Alarm Disabled Alarm Enabled [Indexed String] |
| This setting activates the 'number of CB operations' maintenance alarm. | | | |
| No. CB Ops Maint | 10.07 | 10 | From 1 to 10000 in steps of 1 [Unsigned Integer (16 bits)] |
| This setting sets the threshold for the 'Number of CB operations' alarm. | | | |
| No. CB Ops Lock | 10.08 | Alarm Disabled | Alarm Disabled Alarm Enabled [Indexed String] |
| This setting activates the 'number of CB operations' lockout alarm. | | | |
| No. CB Ops Lock | 10.09 | 20 | From 1 to 10000 in steps of 1 [Unsigned Integer (16 bits)] |
| This setting sets the threshold for the 'number of CB operations' lockout. Note: The IED can be set to lockout the Autoreclose function on reaching a second operations threshold. | | | |
| CB Time Maint | 10.0A | Alarm Disabled | Alarm Disabled Alarm Enabled [Indexed String] |
| This setting activates the 'CB operate time' maintenance alarm. | | | |
| CB Time Maint | 10.0B | 0.1 | From 0.005 to 0.5 in steps of 0.001 [Courier Number (time-seconds)] |
| This setting sets the threshold for the allowable accumulated CB interruption time before maintenance should be carried out | | | |
| CB Time Lockout | 10.0C | Alarm Disabled | Alarm Disabled Alarm Enabled [Indexed String] |
| This setting activates the 'CB operate time' lockout alarm. | | | |
| CB Time Lockout | 10.0D | 0.2 | From 0.005 to 0.5 in steps of 0.001 [Courier Number (time-seconds)] |
| This setting sets the threshold for the allowable accumulated CB interruption time before lockout. | | | |
| Fault Freq Lock | 10.0E | Alarm Disabled | Alarm Disabled Alarm Enabled [Indexed String] |
| This setting enables or disables the 'excessive fault frequency' alarm. | | | |
| Fault Freq Count | 10.0F | 10 | From 1 to 9999 in steps of 1 [Unsigned Integer (16 bits)] |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| This setting sets a 'CB frequent operations' counter that monitors the number of operations over a set time period. | | | |
| Fault Freq Time | 10.10 | 3600 | From 0 to 9999 in steps of 1 *[Courier Number (time-seconds)]* |
| This setting sets the time period over which the CB operations are to be monitored. Should the set number of trip operations be accumulated within this time period, an alarm can be raised. | | | |
| OPTO CONFIG | 11.00 | | |
| This column contains opto-input configuration settings | | | |
| Global Nominal V | 11.01 | 48/54V | 24/27V 30/34V 48/54V 110/125V 220/250V Custom *[Indexed String]* |
| This setting sets the nominal DC voltage for all opto-inputs. The Custom setting allows you to set each opto-input to any voltage value individually. | | | |
| Opto Input 1 | 11.02 | 48/54V | 24/27V 30/34V 48/54V 110/125V 220/250V *[Indexed String]* |
| This cell sets the nominal voltage for opto-input 1 | | | |
| Opto Input 2 | 11.03 | 48/54V | 24/27V 30/34V 48/54V 110/125V 220/250V *[Indexed String]* |
| This cell sets the nominal voltage for opto-input 2 | | | |
| Opto Input 3 | 11.04 | 48/54V | 24/27V 30/34V 48/54V 110/125V 220/250V *[Indexed String]* |
| This cell sets the nominal voltage for opto-input 3 | | | |
| Opto Input 4 | 11.05 | 48/54V | 24/27V 30/34V 48/54V 110/125V 220/250V *[Indexed String]* |
| This cell sets the nominal voltage for opto-input 4 | | | |
| Opto Input 5 | 11.06 | 48/54V | 24/27V 30/34V 48/54V 110/125V 220/250V *[Indexed String]* |
| This cell sets the nominal voltage for opto-input 5 | | | |
| Opto Input 6 | 11.07 | 48/54V | 24/27V 30/34V 48/54V 110/125V 220/250V *[Indexed String]* |
| This cell sets the nominal voltage for opto-input 6 | | | |
| Opto Input 7 | 11.08 | 48/54V | 24/27V 30/34V 48/54V |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| | | | 110/125V<br>220/250V<br>*[Indexed String]* |
| This cell sets the nominal voltage for opto-input 7 | | | |
| Opto Input 8 | 11.09 | 48/54V | 24/27V<br>30/34V<br>48/54V<br>110/125V<br>220/250V<br>*[Indexed String]* |
| This cell sets the nominal voltage for opto-input 8 | | | |
| Opto Input 9 | 11.0A | 48/54V | 24/27V<br>30/34V<br>48/54V<br>110/125V<br>220/250V<br>*[Indexed String]* |
| This cell sets the nominal voltage for opto-input 9 | | | |
| Opto Input 10 | 11.0B | 48/54V | 24/27V<br>30/34V<br>48/54V<br>110/125V<br>220/250V<br>*[Indexed String]* |
| This cell sets the nominal voltage for opto-input 10 | | | |
| Opto Input 11 | 11.0C | 48/54V | 24/27V<br>30/34V<br>48/54V<br>110/125V<br>220/250V<br>*[Indexed String]* |
| This cell sets the nominal voltage for opto-input 11 | | | |
| Opto Input 12 | 11.0D | 48/54V | 24/27V<br>30/34V<br>48/54V<br>110/125V<br>220/250V<br>*[Indexed String]* |
| This cell sets the nominal voltage for opto-input 12 | | | |
| Opto Input 13 | 11.0E | 48/54V | 24/27V<br>30/34V<br>48/54V<br>110/125V<br>220/250V<br>*[Indexed String]* |
| This cell sets the nominal voltage for opto-input 13 | | | |
| Opto Filter Cntl | 11.50 | 0xFFFFFFFF | Opto 1 Input State (0=Off, 1=Energised)<br>Opto 2 Input State (0=Off, 1=Energised)<br>Opto 3 Input State (0=Off, 1=Energised)<br>Opto 4 Input State (0=Off, 1=Energised)<br>Opto 5 Input State (0=Off, 1=Energised)<br>Opto 6 Input State (0=Off, 1=Energised)<br>Opto 7 Input State (0=Off, 1=Energised)<br>Opto 8 Input State (0=Off, 1=Energised)<br>Opto 9 Input State (0=Off, 1=Energised)<br>Opto 10 Input State (0=Off, 1=Energised)<br>Opto 11 Input State (0=Off, 1=Energised)<br>Opto 12 Input State (0=Off, 1=Energised)<br>Opto 13 Input State (0=Off, 1=Energised)<br>Opto 14 Input State (0=Off, 1=Energised)<br>Opto 15 Input State (0=Off, 1=Energised)<br>Opto 16 Input State (0=Off, 1=Energised) |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| | | | Opto 17 Input State (0=Off, 1=Energised) |
| | | | Opto 18 Input State (0=Off, 1=Energised) |
| | | | Opto 19 Input State (0=Off, 1=Energised) |
| | | | Opto 20 Input State (0=Off, 1=Energised) |
| | | | Opto 21 Input State (0=Off, 1=Energised) |
| | | | Opto 22 Input State (0=Off, 1=Energised) |
| | | | Opto 23 Input State (0=Off, 1=Energised) |
| | | | Opto 24 Input State (0=Off, 1=Energised) |
| | | | Opto 25 Input State (0=Off, 1=Energised) |
| | | | Opto 26 Input State (0=Off, 1=Energised) |
| | | | Opto 27 Input State (0=Off, 1=Energised) |
| | | | Opto 28 Input State (0=Off, 1=Energised) |
| | | | Opto 29 Input State (0=Off, 1=Energised) |
| | | | Opto 30 Input State (0=Off, 1=Energised) |
| | | | Opto 31 Input State (0=Off, 1=Energised) |
| | | | Opto 32 Input State (0=Off, 1=Energised) |
| | | | *[Binary Flag (32 bits) Indexed String]* |
| This setting determines whether the in-built noise filter is off or on for each opto-input. | | | |
| Characteristic | 11.80 | Standard 60%-80% | Standard 60%-80% <br> 50% - 70% <br> 58% - 75% <br> *[Indexed String]* |
| This setting selects the opto-inputs' pick-up and drop-off characteristics. | | | |
| Opto 1 Mode | 11.88 | Normal | Normal <br> TCS <br> *[Indexed String]* |
| This setting selects the opto-input's mode of operation; either normal opto or Trip Circuit Supervision (TCS). Valid for I/O option G and J only. | | | |
| Opto 2 Mode | 11.89 | Normal | Normal <br> TCS <br> *[Indexed String]* |
| This setting selects the opto-input's mode of operation; either normal opto or Trip Circuit Supervision (TCS). Valid for I/O option G and J only. | | | |
| Opto 4 Mode | 11.8B | Normal | Normal <br> TCS <br> *[Indexed String]* |
| This setting selects the opto-input's mode of operation; either normal opto or Trip Circuit Supervision (TCS). Valid for I/O option F only. | | | |
| Opto 5 Mode | 11.8C | Normal | Normal <br> TCS <br> *[Indexed String]* |
| This setting selects the opto-input's mode of operation; either normal opto or Trip Circuit Supervision (TCS). Valid for I/O option F only. | | | |
| Opto 6 Mode | 11.8D | Normal | Normal <br> TCS <br> *[Indexed String]* |
| This setting selects the opto-input's mode of operation; either normal opto or Trip Circuit Supervision (TCS). Valid for I/O option F only. | | | |
| Opto 9 Mode | 11.90 | Normal | Normal <br> TCS <br> *[Indexed String]* |
| This setting selects the opto-input's mode of operation; either normal opto or Trip Circuit Supervision (TCS). Valid for I/O option C and H only. | | | |
| Opto 10 Mode | 11.91 | Normal | Normal <br> TCS <br> *[Indexed String]* |
| This setting selects the opto-input's mode of operation; either normal opto or Trip Circuit Supervision (TCS). Valid for I/O option C and H only. | | | |
| Opto 11 Mode | 11.92 | Normal | Normal <br> TCS <br> *[Indexed String]* |
| This setting selects the opto-input's mode of operation; either normal opto or Trip Circuit Supervision (TCS). Valid for I/O option C only. | | | |
| CONTROL INPUTS | 12.00 | | |
| This column contains settings for the type of control input | | | |
| Ctrl I/P Status 1 | 12.01 | 0x00000000 | Control Input 1 (0 = Reset, 1 = Set) <br> Control Input 2 (0 = Reset, 1 = Set) <br> Control Input 3 (0 = Reset, 1 = Set) <br> Control Input 4 (0 = Reset, 1 = Set) |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| | | | Control Input 5 (0 = Reset, 1 = Set) |
| | | | Control Input 6 (0 = Reset, 1 = Set) |
| | | | Control Input 7 (0 = Reset, 1 = Set) |
| | | | Control Input 8 (0 = Reset, 1 = Set) |
| | | | Control Input 9 (0 = Reset, 1 = Set) |
| | | | Control Input 10 (0 = Reset, 1 = Set) |
| | | | Control Input 11 (0 = Reset, 1 = Set) |
| | | | Control Input 12 (0 = Reset, 1 = Set) |
| | | | Control Input 13 (0 = Reset, 1 = Set) |
| | | | Control Input 14 (0 = Reset, 1 = Set) |
| | | | Control Input 15 (0 = Reset, 1 = Set) |
| | | | Control Input 16 (0 = Reset, 1 = Set) |
| | | | Control Input 17 (0 = Reset, 1 = Set) |
| | | | Control Input 18 (0 = Reset, 1 = Set) |
| | | | Control Input 19 (0 = Reset, 1 = Set) |
| | | | Control Input 20 (0 = Reset, 1 = Set) |
| | | | Control Input 21 (0 = Reset, 1 = Set) |
| | | | Control Input 22 (0 = Reset, 1 = Set) |
| | | | Control Input 23 (0 = Reset, 1 = Set) |
| | | | Control Input 24 (0 = Reset, 1 = Set) |
| | | | Control Input 25 (0 = Reset, 1 = Set) |
| | | | Control Input 26 (0 = Reset, 1 = Set) |
| | | | Control Input 27 (0 = Reset, 1 = Set) |
| | | | Control Input 28 (0 = Reset, 1 = Set) |
| | | | Control Input 29 (0 = Reset, 1 = Set) |
| | | | Control Input 30 (0 = Reset, 1 = Set) |
| | | | Control Input 31 (0 = Reset, 1 = Set) |
| | | | Control Input 32 (0 = Reset, 1 = Set) |
| | | | [Binary Flag (32 bits) Indexed String] |
| This cell sets or resets the first batch of 32 Control Inputs by scrolling and changing the status of selected bits. Alternatively, each of the 32 Control inputs can be set and reset using the individual Control Input cells. | | | |
| | | | Control Input 33 (0 = Reset, 1 = Set) |
| | | | Control Input 34 (0 = Reset, 1 = Set) |
| | | | Control Input 35 (0 = Reset, 1 = Set) |
| | | | Control Input 36 (0 = Reset, 1 = Set) |
| | | | Control Input 37 (0 = Reset, 1 = Set) |
| | | | Control Input 38 (0 = Reset, 1 = Set) |
| | | | Control Input 39 (0 = Reset, 1 = Set) |
| | | | Control Input 40 (0 = Reset, 1 = Set) |
| | | | Control Input 41 (0 = Reset, 1 = Set) |
| | | | Control Input 42 (0 = Reset, 1 = Set) |
| | | | Control Input 43 (0 = Reset, 1 = Set) |
| | | | Control Input 44 (0 = Reset, 1 = Set) |
| | | | Control Input 45 (0 = Reset, 1 = Set) |
| | | | Control Input 46 (0 = Reset, 1 = Set) |
| | | | Control Input 47 (0 = Reset, 1 = Set) |
| Ctrl I/P Status 2 | 12.02 | 0x00000000 | Control Input 48 (0 = Reset, 1 = Set) |
| | | | Control Input 49 (0 = Reset, 1 = Set) |
| | | | Control Input 50 (0 = Reset, 1 = Set) |
| | | | Control Input 51 (0 = Reset, 1 = Set) |
| | | | Control Input 52 (0 = Reset, 1 = Set) |
| | | | Control Input 53 (0 = Reset, 1 = Set) |
| | | | Control Input 54 (0 = Reset, 1 = Set) |
| | | | Control Input 55 (0 = Reset, 1 = Set) |
| | | | Control Input 56 (0 = Reset, 1 = Set) |
| | | | Control Input 57 (0 = Reset, 1 = Set) |
| | | | Control Input 58 (0 = Reset, 1 = Set) |
| | | | Control Input 59 (0 = Reset, 1 = Set) |
| | | | Control Input 60 (0 = Reset, 1 = Set) |
| | | | Control Input 61 (0 = Reset, 1 = Set) |
| | | | Control Input 62 (0 = Reset, 1 = Set) |
| | | | Control Input 63 (0 = Reset, 1 = Set) |
| | | | Control Input 64 (0 = Reset, 1 = Set) |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | *[Binary Flag (32 bits) Indexed String]* |
| This cell sets or resets the second batch of 32 Control Inputs by scrolling and changing the status of selected bits. Alternatively, each of the 32 Control inputs can be set and reset using the individual Control Input cells. | | | |
| Control Input 1 | 12.10 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 1 | | | |
| Control Input 2 | 12.11 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 2 | | | |
| Control Input 3 | 12.12 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 3 | | | |
| Control Input 4 | 12.13 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 4 | | | |
| Control Input 5 | 12.14 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 5 | | | |
| Control Input 6 | 12.15 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 6 | | | |
| Control Input 7 | 12.16 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 7 | | | |
| Control Input 8 | 12.17 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 8 | | | |
| Control Input 9 | 12.18 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 9 | | | |
| Control Input 10 | 12.19 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 10 | | | |
| Control Input 11 | 12.1A | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 11 | | | |
| Control Input 12 | 12.1B | No Operation | No Operation<br>Set<br>Reset |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | *[Indexed String]* |
| This command sets or resets Control Input 12 | | | |
| Control Input 13 | 12.1C | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 13 | | | |
| Control Input 14 | 12.1D | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 14 | | | |
| Control Input 15 | 12.1E | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 15 | | | |
| Control Input 16 | 12.1F | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 16 | | | |
| Control Input 17 | 12.20 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 17 | | | |
| Control Input 18 | 12.21 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 18 | | | |
| Control Input 19 | 12.22 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 19 | | | |
| Control Input 20 | 12.23 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 20 | | | |
| Control Input 21 | 12.24 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 21 | | | |
| Control Input 22 | 12.25 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 22 | | | |
| Control Input 23 | 12.26 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 23 | | | |
| Control Input 24 | 12.27 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| This command sets or resets Control Input 24 | | | |
| Control Input 25 | 12.28 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 25 | | | |
| Control Input 26 | 12.29 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 26 | | | |
| Control Input 27 | 12.2A | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 27 | | | |
| Control Input 28 | 12.2B | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 28 | | | |
| Control Input 29 | 12.2C | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 29 | | | |
| Control Input 30 | 12.2D | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 30 | | | |
| Control Input 31 | 12.2E | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 31 | | | |
| Control Input 32 | 12.2F | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 32 | | | |
| Control Input 33 | 12.30 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 33 | | | |
| Control Input 34 | 12.31 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 34 | | | |
| Control Input 35 | 12.32 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 35 | | | |
| Control Input 36 | 12.33 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 36 | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| Control Input 37 | 12.34 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 37 | | | |
| Control Input 38 | 12.35 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 38 | | | |
| Control Input 39 | 12.36 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 39 | | | |
| Control Input 40 | 12.37 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 40 | | | |
| Control Input 41 | 12.38 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 41 | | | |
| Control Input 42 | 12.39 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 42 | | | |
| Control Input 43 | 12.3A | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 43 | | | |
| Control Input 44 | 12.3B | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 44 | | | |
| Control Input 45 | 12.3C | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 45 | | | |
| Control Input 46 | 12.3D | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 46 | | | |
| Control Input 47 | 12.3E | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 47 | | | |
| Control Input 48 | 12.3F | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 48 | | | |
| Control Input 49 | 12.40 | No Operation | No Operation |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 49 | | | |
| Control Input 50 | 12.41 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 50 | | | |
| Control Input 51 | 12.42 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 51 | | | |
| Control Input 52 | 12.43 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 52 | | | |
| Control Input 53 | 12.44 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 53 | | | |
| Control Input 54 | 12.45 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 54 | | | |
| Control Input 55 | 12.46 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 55 | | | |
| Control Input 56 | 12.47 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 56 | | | |
| Control Input 57 | 12.48 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 57 | | | |
| Control Input 58 | 12.49 | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 58 | | | |
| Control Input 59 | 12.4A | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 59 | | | |
| Control Input 60 | 12.4B | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 60 | | | |
| Control Input 61 | 12.4C | No Operation | No Operation<br>Set |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| | | | Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 61 | | | |
| Control Input 62 | 12.4D | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 62 | | | |
| Control Input 63 | 12.4E | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 63 | | | |
| Control Input 64 | 12.4F | No Operation | No Operation<br>Set<br>Reset<br>*[Indexed String]* |
| This command sets or resets Control Input 64 | | | |
| CTRL I/P CONFIG | 13.00 | | |
| This column contains configuration settings for the control inputs. | | | |
| Hotkey Enabled 1 | 13.01 | 0xFFFFFFFF | Control Input 1<br>Control Input 2<br>Control Input 3<br>Control Input 4<br>Control Input 5<br>Control Input 6<br>Control Input 7<br>Control Input 8<br>Control Input 9<br>Control Input 10<br>Control Input 11<br>Control Input 12<br>Control Input 13<br>Control Input 14<br>Control Input 15<br>Control Input 16<br>Control Input 17<br>Control Input 18<br>Control Input 19<br>Control Input 20<br>Control Input 21<br>Control Input 22<br>Control Input 23<br>Control Input 24<br>Control Input 25<br>Control Input 26<br>Control Input 27<br>Control Input 28<br>Control Input 29<br>Control Input 30<br>Control Input 31<br>Control Input 32<br>*[Binary Flag (32 bits) Indexed String]* |
| This setting allows the control inputs to be individually assigned to the Hotkey menu. The hotkey menu allows the control inputs to be set, reset or pulsed without the need to enter the CONTROL INPUTS column. | | | |
| Hotkey Enabled 2 | 13.02 | 0xFFFFFFFF | Control Input 33<br>Control Input 34<br>Control Input 35<br>Control Input 36<br>Control Input 37<br>Control Input 38<br>Control Input 39 |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|-----------|---------|-----------------|-------------------|
| DESCRIPTION | | | |
| | | | Control Input 40 |
| | | | Control Input 41 |
| | | | Control Input 42 |
| | | | Control Input 43 |
| | | | Control Input 44 |
| | | | Control Input 45 |
| | | | Control Input 46 |
| | | | Control Input 47 |
| | | | Control Input 48 |
| | | | Control Input 49 |
| | | | Control Input 50 |
| | | | Control Input 51 |
| | | | Control Input 52 |
| | | | Control Input 53 |
| | | | Control Input 54 |
| | | | Control Input 55 |
| | | | Control Input 56 |
| | | | Control Input 57 |
| | | | Control Input 58 |
| | | | Control Input 59 |
| | | | Control Input 60 |
| | | | Control Input 61 |
| | | | Control Input 62 |
| | | | Control Input 63 |
| | | | Control Input 64 |
| | | | *[Binary Flag (32 bits) Indexed String]* |
| This setting allows the control inputs to be individually assigned to the Hotkey menu. The hotkey menu allows the control inputs to be set, reset or pulsed without the need to enter the CONTROL INPUTS column. | | | |
| Control Input 1 | 13.10 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 1 | 13.11 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 2 | 13.14 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 2 | 13.15 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 3 | 13.18 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 3 | 13.19 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 4 | 13.1C | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| Ctrl Command 4 | 13.1D | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 5 | 13.20 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 5 | 13.21 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 6 | 13.24 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 6 | 13.25 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 7 | 13.28 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 7 | 13.29 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 8 | 13.2C | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 8 | 13.2D | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 9 | 13.30 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 9 | 13.31 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 10 | 13.34 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 10 | 13.35 | SET/RESET | ON/OFF |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 11 | 13.38 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 11 | 13.39 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 12 | 13.3C | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 12 | 13.3D | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 13 | 13.40 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 13 | 13.41 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 14 | 13.44 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 14 | 13.45 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 15 | 13.48 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 15 | 13.49 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 16 | 13.4C | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 16 | 13.4D | SET/RESET | ON/OFF<br>SET/RESET |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 17 | 13.50 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 17 | 13.51 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 18 | 13.54 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 18 | 13.55 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 19 | 13.58 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 19 | 13.59 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 20 | 13.5C | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 20 | 13.5D | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 21 | 13.60 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 21 | 13.61 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 22 | 13.64 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 22 | 13.65 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 23 | 13.68 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 23 | 13.69 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 24 | 13.6C | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 24 | 13.6D | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 25 | 13.70 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 25 | 13.71 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 26 | 13.74 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 26 | 13.75 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 27 | 13.78 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 27 | 13.79 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 28 | 13.7C | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 28 | 13.7D | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|-----------|---------|-----------------|-------------------|
| **DESCRIPTION** | | | |
| | | | *[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 29 | 13.80 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 29 | 13.81 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 30 | 13.84 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 30 | 13.85 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 31 | 13.88 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 31 | 13.89 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 32 | 13.8C | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 32 | 13.8D | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 33 | 13.90 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 33 | 13.91 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 34 | 13.93 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 34 | 13.94 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 35 | 13.96 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 35 | 13.97 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 36 | 13.99 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 36 | 13.9A | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 37 | 13.9C | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 37 | 13.9D | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 38 | 13.9F | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 38 | 13.A0 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 39 | 13.A2 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 39 | 13.A3 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 40 | 13.A5 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 40 | 13.A6 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| Control Input 41 | 13.A8 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 41 | 13.A9 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 42 | 13.AB | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 42 | 13.AC | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 43 | 13.AE | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 43 | 13.AF | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 44 | 13.B1 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 44 | 13.B2 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 45 | 13.B4 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 45 | 13.B5 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 46 | 13.B7 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 46 | 13.B8 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 47 | 13.BA | Latched | Latched |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|-----------|---------|-----------------|-------------------|
| **DESCRIPTION** | | | |
| | | | Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 47 | 13.BB | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 48 | 13.BD | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 48 | 13.BE | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 49 | 13.C0 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 49 | 13.C1 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 50 | 13.C3 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 50 | 13.C4 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 51 | 13.C6 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 51 | 13.C7 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 52 | 13.C9 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 52 | 13.CA | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 53 | 13.CC | Latched | Latched<br>Pulsed |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| | | | *[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 53 | 13.CD | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 54 | 13.CF | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 54 | 13.D0 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 55 | 13.D2 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 55 | 13.D3 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 56 | 13.D5 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 56 | 13.D6 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 57 | 13.D8 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 57 | 13.D9 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 58 | 13.DB | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 58 | 13.DC | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 59 | 13.DE | Latched | Latched<br>Pulsed<br>*[Indexed String]* |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 59 | 13.DF | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 60 | 13.E1 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 60 | 13.E2 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 61 | 13.E4 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 61 | 13.E5 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 62 | 13.E7 | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 62 | 13.E8 | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 63 | 13.EA | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 63 | 13.EB | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| Control Input 64 | 13.ED | Latched | Latched<br>Pulsed<br>*[Indexed String]* |
| This setting configures the control input as either 'latched' or 'pulsed'. | | | |
| Ctrl Command 64 | 13.EE | SET/RESET | ON/OFF<br>SET/RESET<br>IN/OUT<br>ENABLED/DISABLED<br>*[Indexed String]* |
| This setting allows you to select the text to be displayed on the hotkey menu. | | | |
| FUNCTION KEYS | 17.00 | | |
| This column contains the function key definitions (only available for 30TE case). | | | |
| Fn Key Status | 17.01 | 0 | Fn Key Status<br>*[Binary Flag (10 bits) Indexed String]* |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| This cell displays the status of each function key | | | |
| Fn Key 1 | 17.02 | Unlocked | Disabled<br>Unlocked<br>Locked<br>*[Indexed String]* |
| This setting activates function key 1. The 'Lock' setting allows a function key, which is in toggle mode, to be locked in its current active state. | | | |
| Fn Key 1 Mode | 17.03 | Toggled | Normal<br>Toggled<br>*[Indexed String]* |
| This setting sets the function key mode. In 'Toggle' mode, a single key press set sand latches the function key output to 'high' or 'low' in the PSL. In 'Normal' mode the function key output remains high as long as key is pressed. | | | |
| Fn Key 1 Label | 17.04 | Function Key 1 | From 32 to 163 in steps of 1<br>*[ASCII Text (16 chars)]* |
| This setting lets you change the function key text to something more suitable for the application. | | | |
| Fn Key 2 | 17.05 | Unlocked | Disabled<br>Unlocked<br>Locked<br>*[Indexed String]* |
| This setting activates function key 2. The 'Lock' setting allows a function key, which is in toggle mode, to be locked in its current active state. | | | |
| Fn Key 2 Mode | 17.06 | Normal | Normal<br>Toggled<br>*[Indexed String]* |
| This setting sets the function key mode. In 'Toggle' mode, a single key press set sand latches the function key output to 'high' or 'low' in the PSL. In 'Normal' mode the function key output remains high as long as key is pressed. | | | |
| Fn Key 2 Label | 17.07 | Function Key 2 | From 32 to 163 in steps of 1<br>*[ASCII Text (16 chars)]* |
| This setting lets you change the function key text to something more suitable for the application. | | | |
| Fn Key 3 | 17.08 | Unlocked | Disabled<br>Unlocked<br>Locked<br>*[Indexed String]* |
| This setting activates function key 3. The 'Lock' setting allows a function key, which is in toggle mode, to be locked in its current active state. | | | |
| Fn Key 3 Mode | 17.09 | Normal | Normal<br>Toggled<br>*[Indexed String]* |
| This setting sets the function key mode. In 'Toggle' mode, a single key press set sand latches the function key output to 'high' or 'low' in the PSL. In 'Normal' mode the function key output remains high as long as key is pressed. | | | |
| Fn Key 3 Label | 17.0A | Function Key 3 | From 32 to 163 in steps of 1<br>*[ASCII Text (16 chars)]* |
| This setting lets you change the function key text to something more suitable for the application. | | | |
| IEC61850 CONFIG. | 19.00 | | |
| This column contains settings for the IEC61850 IED Configurator | | | |
| Switch Conf.Bank | 19.05 | No Action | No Action<br>Switch Banks<br>*[Indexed String]* |
| This command allows you to switch between the current configuration, held in the Active Memory Bank to the configuration held in the Inactive Memory Bank. | | | |
| Restore MCL | 19.0A | No Action | No Action<br>Restore MCL<br>*[Indexed String]* |
| This command lets you restore the MCL (MiCOM Control Language). | | | |
| Active Conf.Name | 19.10 | Not Available | Active Conf.Name<br>*[ASCII Text]* |
| This cell displays the name of the configuration in the Active Memory Bank (usually taken from the SCL file). | | | |
| Active Conf.Rev | 19.11 | Not Available | Active Conf.Rev<br>*[ASCII Text]* |
| This cell displays the configuration revision number of the configuration in the Active Memory Bank (usually taken from the SCL file). | | | |
| Inact.Conf.Name | 19.20 | Not Available | Inact.Conf.Name<br>*[ASCII Text]* |
| This cell displays the name of the configuration in the Inactive Memory Bank (usually taken from the SCL file). | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| Inact.Conf.Rev | 19.21 | Not Available | Inact.Conf.Rev<br>*[ASCII Text]* |
| This cell displays the configuration revision number of the configuration in the Inactive Memory Bank (usually taken from the SCL file). | | | |
| IP PARAMETERS | 19.30 | | |
| The data in this sub-heading relates to the IEC61850 IP parameters | | | |
| IP Address | 19.31 | 0.0.0.0 | IP Address<br>*[ASCII Text]* |
| This cell displays the IED's IP address. | | | |
| Subnet mask | 19.32 | 0.0.0.0 | Subnet mask<br>*[ASCII Text]* |
| This cell displays the subnet mask, which defines the subnet on which the IED is located. | | | |
| Gateway | 19.33 | 0.0.0.0 | Gateway<br>*[ASCII Text]* |
| This cell displays the gateway address of the LAN on which the IED is located. | | | |
| Media | 19.34 | | Media Unknown<br>RJ45<br>FO<br>RJ45 Port A<br>RJ45 Port B<br>FO Port A<br>FO Port B<br>RJ45 Redundant<br>FO Redundant<br>*[Indexed String]* |
| IEC 61850 versions only. Displays the communication media of the Ethernet port that is currently in use. | | | |
| SNTP PARAMETERS | 19.40 | | |
| The data and settings under this sub-heading relate to the IEC61850 SNTP parameters | | | |
| SNTP Server 1 | 19.41 | 0.0.0.0 | SNTP Server 1<br>*[ASCII Text]* |
| This cell displays the IP address of the primary SNTP server. | | | |
| SNTP Server 2 | 19.42 | 0.0.0.0 | SNTP Server 2<br>*[ASCII Text]* |
| This cell displays the IP address of the secondary SNTP server. | | | |
| IEC 61850 SCL | 19.50 | | |
| IEC61850 versions only. | | | |
| IED Name | 19.51 | Not Available | IED Name<br>*[ASCII Text]* |
| This setting displays the unique IED name used on the IEC 61850 network (usually taken from the SCL file). | | | |
| IEC 61850 GOOSE | 19.60 | | |
| IEC61850 versions only. | | | |
| GoEna | 19.70 | 0x00 | From 0x00 to 0xFF in steps of 1<br>*[Binary Flag (8 bits)]* |
| This setting enables the GOOSE publisher settings. | | | |
| Test Mode | 19.71 | 0x00 | From 0x00 to 0xFF in steps of 1<br>*[Binary Flag (8 bits)]* |
| This setting enables or disables the Test flag in the GOOSE message.<br>With '0', the Test flag is not set.<br>With '1', the Test flag is set. Indicates that the message is in test mode and should not be used for operational purposes. | | | |
| Ignore Test Flag | 19.73 | No | No<br>Yes<br>*[Indexed String]* |
| This cell allows you to ignore the test flag, if set. | | | |
| NIC MAC Address | 19.82 | Ethernet MAC Address | NIC MAC Address<br>*[ASCII Text (17 chars)]* |
| This setting displays the MAC address of the rear Ethernet port A in case IEC61850+DNP3 comms and dual IP used | | | |
| NIC Tunl Timeout | 19.83 | 5 | No<br>Yes<br>*[Indexed String]* |
| This setting sets the maximum waiting time before an inactive tunnel to the application software is reset. | | | |
| DNP SETTINGS | 1B.00 | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| This column contains settings for the DNP Configurator | | | |
| Dest Address | 1B.01 | 1 | From 0 to 255 in steps of 1 *[Unsigned Integer (16 bits)]* |
| This setting is for DNP3.0 versions only.Address of Master Device to send the unsolicited response to | | | |
| Unso Mode | 1B.02 | 0 | ON OFF *[Indexed String]* |
| This setting is for DNP3.0 versions only.When unsolicited response is configure off, the device shall never send an unsolicited response, but otherwise responds to master requests | | | |
| Unso Retry | 1B.03 | 3 | From 0 to 5 in steps of 1 *[Unsigned Integer (16 bits)]* |
| This setting is for DNP3.0 versions only. The setting is the number of retries that an outstation transmits in each unsolicited response series if it does not receive confirmation back from the master. | | | |
| Unso Response | 1B.04 | 2 | From 1 to 30 in steps of 1 *[Courier Number (time-seconds)]* |
| This setting is for DNP3.0 versions only. The setting is the amount of time that the outstation shall wait for an Application Layer confirmation back from the master. | | | |
| Unso Offline Time | 1B.05 | 30 | From 1 to 60 in steps of 1 *[Courier Number (time-seconds)]* |
| This setting is for DNP3.0 versions only. If an unsolicited response has been retried (Number of Unsolicited retries ) without a confirmation then this parameter defines the time interval between unsolicited retries from that point forward | | | |
| Unso Class1 Event | 1B.06 | 5 | From 1 to 100 in steps of 1 *[Unsigned Integer (16 bits)]* |
| This setting is for DNP3.0 versions only. The unsolicited message will send if the class 1 event number is larger than this parameter. | | | |
| Unso Class1 Delay | 1B.07 | 3 | From 0.1 to 5 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting is for DNP3.0 versions only. The unsolicited message of class 1 events will send after the delay time. | | | |
| Unso Class2 Event | 1B.08 | 5 | From 1 to 100 in steps of 1 *[Unsigned Integer (16 bits)]* |
| This setting is for DNP3.0 versions only. The unsolicited message will send if the class 2 event number is larger than this parameter. | | | |
| Unso Class2 Delay | 1B.09 | 3 | From 0.1 to 5 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting is for DNP3.0 versions only. The unsolicited message of class 2 events will send after the delay time. | | | |
| Unso Class3 Event | 1B.0A | 5 | From 1 to 100 in steps of 1 *[Unsigned Integer (16 bits)]* |
| This setting is for DNP3.0 versions only. The unsolicited message will send if the class 3 event number is larger than this parameter. | | | |
| Unso Class3 Delay | 1B.0B | 3 | From 0.1 to 5 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting is for DNP3.0 versions only. The unsolicited message of class 3 events will send after the delay time. | | | |
| Backoff Max Time | 1B.0C | 0.5 | From 0 to 0.5 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting is for DNP3.0 versions only. The setting sets the maximum back off time | | | |
| Backoff Min Time | 1B.0D | 0 | From 0 to 0.5 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting is for DNP3.0 versions only. The setting sets the minimum back off time | | | |
| Dest Address | 1B.21 | 1 | From 0 to 255 in steps of 1 *[Unsigned Integer (16 bits)]* |
| This setting is for DNP3.0 over Ethernet versions only.Address of Master Device to send the unsolicited response to | | | |
| Unso Mode | 1B.22 | 0 | ON OFF *[Indexed String]* |
| This setting is for DNP3.0 over Ethernet versions only.When unsolicited response is configure off, the device shall never send an unsolicited response, but otherwise responds to master requests | | | |
| Unso Retry | 1B.23 | 3 | From 0 to 5 in steps of 1 *[Unsigned Integer (16 bits)]* |
| This setting is for DNP3.0 over Ethernet versions only. The setting is the number of retries that an outstation transmits in each unsolicited response series if it does not receive confirmation back from the master. | | | |
| Unso Response | 1B.24 | 2 | From 1 to 30 in steps of 1 *[Courier Number (time-seconds)]* |
| This setting is for DNP3.0 over Ethernet versions only. The setting is the amount of time that the outstation shall wait for an Application Layer | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| confirmation back from the master. | | | |
| Unso Offline Time | 1B.25 | 30 | From 1 to 60 in steps of 1 *[Courier Number (time-seconds)]* |
| This setting is for DNP3.0 over Ethernet versions only. If an unsolicited response has been retried (Number of Unsolicited retries ) without a confirmation then this parameter defines the time interval between unsolicited retries from that point forward | | | |
| Unso Class1 Event | 1B.26 | 5 | From 1 to 100 in steps of 1 *[Unsigned Integer (16 bits)]* |
| This setting is for DNP3.0 over Ethernet versions only. The unsolicited message will send if the class 1 event number is larger than this parameter. | | | |
| Unso Class1 Delay | 1B.27 | 3 | From 0.1 to 5 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting is for DNP3.0 over Ethernet versions only. The unsolicited message of class 1 events will send after the delay time. | | | |
| Unso Class2 Event | 1B.28 | 5 | From 1 to 100 in steps of 1 *[Unsigned Integer (16 bits)]* |
| This setting is for DNP3.0 over Ethernet versions only. The unsolicited message will send if the class 2 event number is larger than this parameter. | | | |
| Unso Class2 Delay | 1B.29 | 3 | From 0.1 to 5 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting is for DNP3.0 over Ethernet versions only. The unsolicited message of class 2 events will send after the delay time. | | | |
| Unso Class3 Event | 1B.2A | 5 | From 1 to 100 in steps of 1 *[Unsigned Integer (16 bits)]* |
| This setting is for DNP3.0 over Ethernet versions only. The unsolicited message will send if the class 3 event number is larger than this parameter. | | | |
| Unso Class3 Delay | 1B.2B | 3 | From 0.1 to 5 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting is for DNP3.0 over Ethernet versions only. The unsolicited message of class 3 events will send after the delay time. | | | |
| Backoff Max Time | 1B.2C | 0.5 | From 0 to 0.5 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting is for DNP3.0 over Ethernet versions only. The setting sets the maximum back off time | | | |
| Backoff Min Time | 1B.2D | 0 | From 0 to 0.5 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting is for DNP3.0 over Ethernet versions only. The setting sets the minimum back off time | | | |
| IP Address | 1B.A1 | 0.0.0.0 | IP Address *[ASCII Text]* |
| This cell displays the IED's IP address for port B ( in case IEC61850+DNP3OE comms) | | | |
| Subnet mask | 1B.A2 | 0.0.0.0 | Subnet mask *[ASCII Text]* |
| This cell displays the subnet mask, which defines the subnet on which the IED is located. | | | |
| DNP MAC Address | 1B.A3 | Ethernet MAC Address | DNP MAC Address *[ASCII Text (17 chars)]* |
| This setting displays the MAC address of the rear Ethernet port A in case IEC61850+DNP3 comms and dual IP used | | | |
| Gateway | 1B.A4 | 0.0.0.0 | Gateway *[ASCII Text]* |
| This cell displays the gateway address of the LAN on which the IED is located. | | | |
| DNP Time Synch | 1B.A5 | Disabled | Disabled Enabled *[Indexed String]* |
| If set to 'Enabled' the DNP3.0 master station can be used to synchronise the IED's time clock. If set to 'Disabled' either the internal free running clock, or IRIG-B input are used. DNP 3.0 over Ethernet versions only. | | | |
| Meas Scaling | 1B.A6 | Primary | Normalised Primary Secondary *[Indexed String]* |
| This setting determines the scaling type of analogue quantities  - in terms of primary, secondary or normalised, for DNP3 models. | | | |
| Media | 1B.A9 | | Media Unknown RJ45 FO RJ45 Port A RJ45 Port B FO Port A |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | FO Port B<br>RJ45 Redundant<br>FO Redundant<br>*[Indexed String]* |
| IEC 61850 versions only. Displays the communication media of the Ethernet port that is currently in use. | | | |
| DNP Need Time | 1B.B1 | 10 | From 1 to 30 in steps of 1<br>*[Courier Number (time-minutes)]* |
| This setting sets the duration of time waited before requesting another time sync from the master. DNP 3.0 versions only. | | | |
| DNP App Fragment | 1B.B2 | 2048 | From 100 to 2048 in steps of 1<br>*[Unsigned Integer (16 bits)]* |
| This setting sets the maximum message length (application fragment size) transmitted by the IED for DNP 3.0 versions. | | | |
| DNP App Timeout | 1B.B3 | 2 | From 1 to 120 in steps of 1<br>*[Courier Number (time-seconds)]* |
| This setting sets the maximum waiting time between sending a message fragment and receiving confirmation from the master. DNP 3.0 versions only. | | | |
| DNP SBO Timeout | 1B.B4 | 10 | From 1 to 10 in steps of 1<br>*[Courier Number (time-seconds)]* |
| This setting sets the maximum waiting time between receiving a select command and awaiting an operate confirmation from the master. DNP 3.0 versions only. | | | |
| Class 0 Poll | 1B.B5 | 0 | Running Counters<br>Frozen Counters<br>*[Indexed String]* |
| This setting is for DNP3.0 versions only. In response to a Class 0 poll, an outstation device shall report either the count value or the frozen count value. | | | |
| SWITCH CONTROL | 22.00 | | |
| This column controls the user switch operation configuration | | | |
| SWITCH 1 | 22.01 | | SWITCH 1<br>*[Indexed String]* |
| This cell indicates that setting below are for Switch 1 | | | |
| SWITCH1 Type | 22.02 | Load Break | Load Break<br>Disconnector<br>Earthing SWI<br>HiSpeed Ear SWI<br>*[Indexed String]* |
| Switch type | | | |
| SWI1 Status Inpt | 22.03 | None | None<br>52A<br>52B<br>Both 52A+52B<br>*[Indexed String]* |
| Setting to define the type of circuit breaker contacts that will be used for the circuit breaker control logic. Form A contacts match the status of the circuit breaker primary contacts, form B are opposite to the breaker status. | | | |
| SWI1 Control by | 22.04 | Disabled | Disabled<br>Local<br>Remote<br>Local+Remote<br>*[Indexed String]* |
| This setting selects the type of switch control to be used | | | |
| SWI1 Trip/Close | 22.05 | No Operation | No Operation<br>Trip<br>Close<br>*[Indexed String]* |
| Supports trip and close commands if enabled in the user switch Control menu. | | | |
| SWI1 Trp Puls T | 22.06 | 0.5 | From 0.1 to 60 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting defines the duration of the close pulse within which the userswitch should close when a close command is issued. | | | |
| SWI1 Cls Puls T | 22.07 | 0.5 | From 0.1 to 60 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting defines the duration of the trip pulse within which the user switch should trip when a manual or protection trip command is issued. | | | |
| SWI1 Trp Alrm T | 22.08 | 0.5 | From 0.1 to 60 in steps of 0.01 |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | *[Courier Number (time-seconds)]* |
| This setting defines the duration of wait timer before the relay raise alarm when a close command is issued. | | | |
| SWI1 Cls Alrm T | 22.09 | 0.5 | From 0.1 to 60 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting defines the duration of wait timer before the relay raise alarm when a protection trip command is issued. | | | |
| SWI1 Sta Alrm T | 22.0A | 0.5 | From 0.1 to 60 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting defines the duration of wait timer before the relay raise a status alarm. | | | |
| SWI1 Operations | 22.0B | | SWI1 Operations *[Indexed String]* |
| This cell displays the number of switch Operations | | | |
| Reset SWI1 Data | 22.0C | No | No Yes *[Indexed String]* |
| This cell resets the switch condition monitoring data | | | |
| SWITCH 2 | 22.0D | | SWITCH 2 *[Indexed String]* |
| This cell indicates that setting below are for Switch 1 | | | |
| SWITCH2 Type | 22.0E | Load Break | Load Break Disconnector Earthing SWI HiSpeed Ear SWI *[Indexed String]* |
| Switch type | | | |
| SWI2 Status Inpt | 22.0F | None | None 52A 52B Both 52A+52B *[Indexed String]* |
| Setting to define the type of circuit breaker contacts that will be used for the circuit breaker control logic. Form A contacts match the status of the circuit breaker primary contacts, form B are opposite to the breaker status. | | | |
| SWI2 Control by | 22.10 | Disabled | Disabled Local Remote Local+Remote *[Indexed String]* |
| This setting selects the type of switch control to be used | | | |
| SWI2 Trip/Close | 22.11 | No Operation | No Operation Trip Close *[Indexed String]* |
| Supports trip and close commands if enabled in the user switch Control menu. | | | |
| SWI2 Trp Puls T | 22.12 | 0.5 | From 0.1 to 60 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting defines the duration of the close pulse within which the userswitch should close when a close command is issued. | | | |
| SWI2 Cls Puls T | 22.13 | 0.5 | From 0.1 to 60 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting defines the duration of the trip pulse within which the user switch should trip when a manual or protection trip command is issued. | | | |
| SWI2 Trp Alrm T | 22.14 | 0.5 | From 0.1 to 60 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting defines the duration of wait timer before the relay raise alarm when a close command is issued. | | | |
| SWI2 Cls Alrm T | 22.15 | 0.5 | From 0.1 to 60 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting defines the duration of wait timer before the relay raise alarm when a protection trip command is issued. | | | |
| SWI2 Sta Alrm T | 22.16 | 0.5 | From 0.1 to 60 in steps of 0.01 *[Courier Number (time-seconds)]* |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| This setting defines the duration of wait timer before the relay raise a status alarm. | | | |
| SWI2 Operations | 22.17 | | SWI2 Operations<br>*[Indexed String]* |
| This cell displays the number of switch Operations | | | |
| Reset SWI2 Data | 22.18 | No | No<br>Yes<br>*[Indexed String]* |
| This cell resets the switch condition monitoring data | | | |
| SWITCH 3 | 22.19 | | SWITCH 3<br>*[Indexed String]* |
| This cell indicates that setting below are for Switch 1 | | | |
| SWITCH3 Type | 22.1A | Load Break | Load Break<br>Disconnector<br>Earthing SWI<br>HiSpeed Ear SWI<br>*[Indexed String]* |
| Switch type | | | |
| SWI3 Status Inpt | 22.1B | None | None<br>52A<br>52B<br>Both 52A+52B<br>*[Indexed String]* |
| Setting to define the type of circuit breaker contacts that will be used for the circuit breaker control logic. Form A contacts match the status of the circuit breaker primary contacts, form B are opposite to the breaker status. | | | |
| SWI3 Control by | 22.1C | Disabled | Disabled<br>Local<br>Remote<br>Local+Remote<br>*[Indexed String]* |
| This setting selects the type of switch control to be used | | | |
| SWI3 Trip/Close | 22.1D | No Operation | No Operation<br>Trip<br>Close<br>*[Indexed String]* |
| Supports trip and close commands if enabled in the user switch Control menu. | | | |
| SWI3 Trp Puls T | 22.1E | 0.5 | From 0.1 to 60 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting defines the duration of the close pulse within which the userswitch should close when a close command is issued. | | | |
| SWI3 Cls Puls T | 22.1F | 0.5 | From 0.1 to 60 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting defines the duration of the trip pulse within which the user switch should trip when a manual or protection trip command is issued. | | | |
| SWI3 Trp Alrm T | 22.20 | 0.5 | From 0.1 to 60 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting defines the duration of wait timer before the relay raise alarm when a close command is issued. | | | |
| SWI3 Cls Alrm T | 22.21 | 0.5 | From 0.1 to 60 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting defines the duration of wait timer before the relay raise alarm when a protection trip command is issued. | | | |
| SWI3 Sta Alrm T | 22.22 | 0.5 | From 0.1 to 60 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting defines the duration of wait timer before the relay raise a status alarm. | | | |
| SWI3 Operations | 22.23 | | SWI3 Operations<br>*[Indexed String]* |
| This cell displays the number of switch Operations | | | |
| Reset SWI3 Data | 22.24 | No | No<br>Yes<br>*[Indexed String]* |
| This cell resets the switch condition monitoring data | | | |
| SWITCH 4 | 22.25 | | SWITCH 4 |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | *[Indexed String]* |
| This cell indicates that setting below are for Switch 1 | | | |
| SWITCH4 Type | 22.26 | Load Break | Load Break<br>Disconnector<br>Earthing SWI<br>HiSpeed Ear SWI<br>*[Indexed String]* |
| Switch type | | | |
| SWI4 Status Inpt | 22.27 | None | None<br>52A<br>52B<br>Both 52A+52B<br>*[Indexed String]* |
| Setting to define the type of circuit breaker contacts that will be used for the circuit breaker control logic. Form A contacts match the status of the circuit breaker primary contacts, form B are opposite to the breaker status. | | | |
| SWI4 Control by | 22.28 | Disabled | Disabled<br>Local<br>Remote<br>Local+Remote<br>*[Indexed String]* |
| This setting selects the type of switch control to be used | | | |
| SWI4 Trip/Close | 22.29 | No Operation | No Operation<br>Trip<br>Close<br>*[Indexed String]* |
| Supports trip and close commands if enabled in the user switch Control menu. | | | |
| SWI4 Trp Puls T | 22.2A | 0.5 | From 0.1 to 60 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting defines the duration of the close pulse within which the userswitch should close when a close command is issued. | | | |
| SWI4 Cls Puls T | 22.2B | 0.5 | From 0.1 to 60 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting defines the duration of the trip pulse within which the user switch should trip when a manual or protection trip command is issued. | | | |
| SWI4 Trp Alrm T | 22.2C | 0.5 | From 0.1 to 60 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting defines the duration of wait timer before the relay raise alarm when a close command is issued. | | | |
| SWI4 Cls Alrm T | 22.2D | 0.5 | From 0.1 to 60 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting defines the duration of wait timer before the relay raise alarm when a protection trip command is issued. | | | |
| SWI4 Sta Alrm T | 22.2E | 0.5 | From 0.1 to 60 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting defines the duration of wait timer before the relay raise a status alarm. | | | |
| SWI4 Operations | 22.2F | | SWI4 Operations<br>*[Indexed String]* |
| This cell displays the number of switch Operations | | | |
| Reset SWI4 Data | 22.30 | No | No<br>Yes<br>*[Indexed String]* |
| This cell resets the switch condition monitoring data | | | |
| SWITCH 5 | 22.31 | | SWITCH 5<br>*[Indexed String]* |
| This cell indicates that setting below are for Switch 1 | | | |
| SWITCH5 Type | 22.32 | Load Break | Load Break<br>Disconnector<br>Earthing SWI<br>HiSpeed Ear SWI<br>*[Indexed String]* |
| Switch type | | | |
| SWI5 Status Inpt | 22.33 | None | None |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| | | | 52A<br>52B<br>Both 52A+52B<br>*[Indexed String]* |
| Setting to define the type of circuit breaker contacts that will be used for the circuit breaker control logic. Form A contacts match the status of the circuit breaker primary contacts, form B are opposite to the breaker status. | | | |
| SWI5 Control by | 22.34 | Disabled | Disabled<br>Local<br>Remote<br>Local+Remote<br>*[Indexed String]* |
| This setting selects the type of switch control to be used | | | |
| SWI5 Trip/Close | 22.35 | No Operation | No Operation<br>Trip<br>Close<br>*[Indexed String]* |
| Supports trip and close commands if enabled in the user switch Control menu. | | | |
| SWI5 Trp Puls T | 22.36 | 0.5 | From 0.1 to 60 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting defines the duration of the close pulse within which the userswitch should close when a close command is issued. | | | |
| SWI5 Cls Puls T | 22.37 | 0.5 | From 0.1 to 60 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting defines the duration of the trip pulse within which the user switch should trip when a manual or protection trip command is issued. | | | |
| SWI5 Trp Alrm T | 22.38 | 0.5 | From 0.1 to 60 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting defines the duration of wait timer before the relay raise alarm when a close command is issued. | | | |
| SWI5 Cls Alrm T | 22.39 | 0.5 | From 0.1 to 60 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting defines the duration of wait timer before the relay raise alarm when a protection trip command is issued. | | | |
| SWI5 Sta Alrm T | 22.3A | 0.5 | From 0.1 to 60 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting defines the duration of wait timer before the relay raise a status alarm. | | | |
| SWI5 Operations | 22.3B | | SWI5 Operations<br>*[Indexed String]* |
| This cell displays the number of switch Operations | | | |
| Reset SWI5 Data | 22.3C | No | No<br>Yes<br>*[Indexed String]* |
| This cell resets the switch condition monitoring data | | | |
| SWITCH 6 | 22.3D | | SWITCH 6<br>*[Indexed String]* |
| This cell indicates that setting below are for Switch 1 | | | |
| SWITCH6 Type | 22.3E | Load Break | Load Break<br>Disconnector<br>Earthing SWI<br>HiSpeed Ear SWI<br>*[Indexed String]* |
| Switch type | | | |
| SWI6 Status Inpt | 22.3F | None | None<br>52A<br>52B<br>Both 52A+52B<br>*[Indexed String]* |
| Setting to define the type of circuit breaker contacts that will be used for the circuit breaker control logic. Form A contacts match the status of the circuit breaker primary contacts, form B are opposite to the breaker status. | | | |
| SWI6 Control by | 22.40 | Disabled | Disabled<br>Local<br>Remote<br>Local+Remote |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | [Indexed String] |
| This setting selects the type of switch control to be used | | | |
| SWI6 Trip/Close | 22.41 | No Operation | No Operation<br>Trip<br>Close<br>[Indexed String] |
| Supports trip and close commands if enabled in the user switch Control menu. | | | |
| SWI6 Trp Puls T | 22.42 | 0.5 | From 0.1 to 60 in steps of 0.01<br>[Courier Number (time-seconds)] |
| This setting defines the duration of the close pulse within which the userswitch should close when a close command is issued. | | | |
| SWI6 Cls Puls T | 22.43 | 0.5 | From 0.1 to 60 in steps of 0.01<br>[Courier Number (time-seconds)] |
| This setting defines the duration of the trip pulse within which the user switch should trip when a manual or protection trip command is issued. | | | |
| SWI6 Trp Alrm T | 22.44 | 0.5 | From 0.1 to 60 in steps of 0.01<br>[Courier Number (time-seconds)] |
| This setting defines the duration of wait timer before the relay raise alarm when a close command is issued. | | | |
| SWI6 Cls Alrm T | 22.45 | 0.5 | From 0.1 to 60 in steps of 0.01<br>[Courier Number (time-seconds)] |
| This setting defines the duration of wait timer before the relay raise alarm when a protection trip command is issued. | | | |
| SWI6 Sta Alrm T | 22.46 | 0.5 | From 0.1 to 60 in steps of 0.01<br>[Courier Number (time-seconds)] |
| This setting defines the duration of wait timer before the relay raise a status alarm. | | | |
| SWI6 Operations | 22.47 | | SWI6 Operations<br>[Indexed String] |
| This cell displays the number of switch Operations | | | |
| Reset SWI6 Data | 22.48 | No | No<br>Yes<br>[Indexed String] |
| This cell resets the switch condition monitoring data | | | |
| SWITCH 7 | 22.49 | | SWITCH 7<br>[Indexed String] |
| This cell indicates that setting below are for Switch 1 | | | |
| SWITCH7 Type | 22.4A | Load Break | Load Break<br>Disconnector<br>Earthing SWI<br>HiSpeed Ear SWI<br>[Indexed String] |
| Switch type | | | |
| SWI7 Status Inpt | 22.4B | None | None<br>52A<br>52B<br>Both 52A+52B<br>[Indexed String] |
| Setting to define the type of circuit breaker contacts that will be used for the circuit breaker control logic. Form A contacts match the status of the circuit breaker primary contacts, form B are opposite to the breaker status. | | | |
| SWI7 Control by | 22.4C | Disabled | Disabled<br>Local<br>Remote<br>Local+Remote<br>[Indexed String] |
| This setting selects the type of switch control to be used | | | |
| SWI7 Trip/Close | 22.4D | No Operation | No Operation<br>Trip<br>Close<br>[Indexed String] |
| Supports trip and close commands if enabled in the user switch Control menu. | | | |
| SWI7 Trp Puls T | 22.4E | 0.5 | From 0.1 to 60 in steps of 0.01<br>[Courier Number (time-seconds)] |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| This setting defines the duration of the close pulse within which the userswitch should close when a close command is issued. | | | |
| SWI7 Cls Puls T | 22.4F | 0.5 | From 0.1 to 60 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting defines the duration of the trip pulse within which the user switch should trip when a manual or protection trip command is issued. | | | |
| SWI7 Trp Alrm T | 22.50 | 0.5 | From 0.1 to 60 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting defines the duration of wait timer before the relay raise alarm when a close command is issued. | | | |
| SWI7 Cls Alrm T | 22.51 | 0.5 | From 0.1 to 60 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting defines the duration of wait timer before the relay raise alarm when a protection trip command is issued. | | | |
| SWI7 Sta Alrm T | 22.52 | 0.5 | From 0.1 to 60 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting defines the duration of wait timer before the relay raise a status alarm. | | | |
| SWI7 Operations | 22.53 | | SWI7 Operations *[Indexed String]* |
| This cell displays the number of switch Operations | | | |
| Reset SWI7 Data | 22.54 | No | No Yes *[Indexed String]* |
| This cell resets the switch condition monitoring data | | | |
| SWITCH 8 | 22.55 | | SWITCH 8 *[Indexed String]* |
| This cell indicates that setting below are for Switch 1 | | | |
| SWITCH8 Type | 22.56 | Load Break | Load Break Disconnector Earthing SWI HiSpeed Ear SWI *[Indexed String]* |
| Switch type | | | |
| SWI8 Status Inpt | 22.57 | None | None 52A 52B Both 52A+52B *[Indexed String]* |
| Setting to define the type of circuit breaker contacts that will be used for the circuit breaker control logic. Form A contacts match the status of the circuit breaker primary contacts, form B are opposite to the breaker status. | | | |
| SWI8 Control by | 22.58 | Disabled | Disabled Local Remote Local+Remote *[Indexed String]* |
| This setting selects the type of switch control to be used | | | |
| SWI8 Trip/Close | 22.59 | No Operation | No Operation Trip Close *[Indexed String]* |
| Supports trip and close commands if enabled in the user switch Control menu. | | | |
| SWI8 Trp Puls T | 22.5A | 0.5 | From 0.1 to 60 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting defines the duration of the close pulse within which the userswitch should close when a close command is issued. | | | |
| SWI8 Cls Puls T | 22.5B | 0.5 | From 0.1 to 60 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting defines the duration of the trip pulse within which the user switch should trip when a manual or protection trip command is issued. | | | |
| SWI8 Trp Alrm T | 22.5C | 0.5 | From 0.1 to 60 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting defines the duration of wait timer before the relay raise alarm when a close command is issued. | | | |
| SWI8 Cls Alrm T | 22.5D | 0.5 | From 0.1 to 60 in steps of 0.01 |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | [Courier Number (time-seconds)] |
| This setting defines the duration of wait timer before the relay raise alarm when a protection trip command is issued. | | | |
| SWI8 Sta Alrm T | 22.5E | 0.5 | From 0.1 to 60 in steps of 0.01 [Courier Number (time-seconds)] |
| This setting defines the duration of wait timer before the relay raise a status alarm. | | | |
| SWI8 Operations | 22.5F | | SWI8 Operations [Indexed String] |
| This cell displays the number of switch Operations | | | |
| Reset SWI8 Data | 22.60 | No | No Yes [Indexed String] |
| This cell resets the switch condition monitoring data | | | |
| SECURITY CONFIG | 25.00 | | |
| This column contains settings for the Cyber Security configuration | | | |
| User Banner | 25.01 | ACCESS ONLY FOR AUTHORISED USERS | From 32 to 234 in steps of 1 [ASCII Text (32 chars)] |
| 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. | | | |
| Attempts Timer | 25.03 | 2 | From 1 to 3 in steps of 1 [Unsigned Integer (16 bits)] |
| This setting defines the time window used in which the number of failed password attempts is counted. | | | |
| Blocking Timer | 25.04 | 5 | From 1 to 30 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 | Disabled Enabled [Indexed String] |
| This setting enables or disables the physical Front Port. | | | |
| Rear Port 1 | 25.06 | Enabled | Disabled Enabled [Indexed String] |
| This setting enables or disables the primary physical rear port (RP1). | | | |
| Rear Port 2 | 25.07 | Enabled | Disabled Enabled [Indexed String] |
| This setting enables or disables the secondary physical rear port (RP2). | | | |
| Ethernet Port | 25.08 | Enabled | Disabled Enabled [Indexed String] |
| This setting enables or disables the physical Ethernet Port | | | |
| Courier Tunnel | 25.09 | Enabled | Disabled Enabled [Indexed String] |
| This setting enables or disables the logical tunnelled Courier port | | | |
| IEC61850 | 25.0A | Enabled | Disabled Enabled [Indexed String] |
| This setting enables or disables the logical IEC61850 port. | | | |
| DNP3 OE | 25.0B | Enabled | Disabled Enabled [Indexed String] |
| This setting enables or disables the logical DNP3 over Ethernet port. | | | |
| 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)] |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| This cell displays the remaining blocking time. | | | |
| Fallbck PW level | 25.20 | | Level 0 - Logged Out.<br>Level 1 - Password required for level 2.<br>Level 2 - Password required for level 3.<br>Level 3 - No Password required.<br>*[Unsigned Integer (16 bits)]* |
| This cell displays the password level adopted by the IED after an inactivity timeout, or after the user logs out. This will be either the level of the highest level password that is blank, or level 0 if no passwords are blank. | | | |
| UserBannerPw Lvl | 25.25 | 3 | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting decide the password level required for the user in order to be able to change the default screen. | | | |
| Security Code | 25.FF | | Security Code<br>*[ASCII Text]* |
| This cell displays the 16-character security code required when requesting a recovery password. UI only cell. | | | |
| USER ALARMS | 28.00 | | |
| This column contains settings for the User Alarms | | | |
| Manual Reset | 28.01 | 0x00000000 | From 0x00000000 to 0xFFFFFFFF in steps of 1<br>*[Binary Flag (32 bits)]* |
| Set the user alarm is manual reset or self reset | | | |
| Labels | 28.10 | Sub-Heading | |
| This sub-heading contains the user alarm labels | | | |
| User Alarm 1 | 28.11 | User Alarm 1 | From 32 to 163 in steps of 1<br>*[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |
| User Alarm 2 | 28.12 | User Alarm 2 | From 32 to 163 in steps of 1<br>*[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |
| User Alarm 3 | 28.13 | User Alarm 3 | From 32 to 163 in steps of 1<br>*[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |
| User Alarm 4 | 28.14 | User Alarm 4 | From 32 to 163 in steps of 1<br>*[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |
| User Alarm 5 | 28.15 | User Alarm 5 | From 32 to 163 in steps of 1<br>*[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |
| User Alarm 6 | 28.16 | User Alarm 6 | From 32 to 163 in steps of 1<br>*[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |
| User Alarm 7 | 28.17 | User Alarm 7 | From 32 to 163 in steps of 1<br>*[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |
| User Alarm 8 | 28.18 | User Alarm 8 | From 32 to 163 in steps of 1<br>*[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |
| User Alarm 9 | 28.19 | User Alarm 9 | From 32 to 163 in steps of 1<br>*[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |
| User Alarm 10 | 28.1A | User Alarm 10 | From 32 to 163 in steps of 1<br>*[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |
| User Alarm 11 | 28.1B | User Alarm 11 | From 32 to 163 in steps of 1<br>*[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |
| User Alarm 12 | 28.1C | User Alarm 12 | From 32 to 163 in steps of 1<br>*[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |
| User Alarm 13 | 28.1D | User Alarm 13 | From 32 to 163 in steps of 1 |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| | | | *[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |
| User Alarm 14 | 28.1E | User Alarm 14 | From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |
| User Alarm 15 | 28.1F | User Alarm 15 | From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |
| User Alarm 16 | 28.20 | User Alarm 16 | From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |
| User Alarm 17 | 28.21 | User Alarm 17 | From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |
| User Alarm 18 | 28.22 | User Alarm 18 | From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |
| User Alarm 19 | 28.23 | User Alarm 19 | From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |
| User Alarm 20 | 28.24 | User Alarm 20 | From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |
| User Alarm 21 | 28.25 | User Alarm 21 | From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |
| User Alarm 22 | 28.26 | User Alarm 22 | From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |
| User Alarm 23 | 28.27 | User Alarm 23 | From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |
| User Alarm 24 | 28.28 | User Alarm 24 | From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |
| User Alarm 25 | 28.29 | User Alarm 25 | From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |
| User Alarm 26 | 28.2A | User Alarm 26 | From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |
| User Alarm 27 | 28.2B | User Alarm 27 | From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |
| User Alarm 28 | 28.2C | User Alarm 28 | From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |
| User Alarm 29 | 28.2D | User Alarm 29 | From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |
| User Alarm 30 | 28.2E | User Alarm 30 | From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |
| User Alarm 31 | 28.2F | User Alarm 31 | From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |
| User Alarm 32 | 28.30 | User Alarm 32 | From 32 to 163 in steps of 1 *[ASCII Text (16 chars)]* |
| Here you can set a text label to describe each user alarm | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| | | DESCRIPTION | |
| CTRL I/P LABELS | 29.00 | | |
| This column contains settings for the Control Input Labels | | | |
| Control Input 1 | 29.01 | Control Input 1 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 2 | 29.02 | Control Input 2 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 3 | 29.03 | Control Input 3 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 4 | 29.04 | Control Input 4 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 5 | 29.05 | Control Input 5 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 6 | 29.06 | Control Input 6 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 7 | 29.07 | Control Input 7 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 8 | 29.08 | Control Input 8 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 9 | 29.09 | Control Input 9 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 10 | 29.0A | Control Input 10 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 11 | 29.0B | Control Input 11 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 12 | 29.0C | Control Input 12 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 13 | 29.0D | Control Input 13 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 14 | 29.0E | Control Input 14 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 15 | 29.0F | Control Input 15 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 16 | 29.10 | Control Input 16 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 17 | 29.11 | Control Input 17 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 18 | 29.12 | Control Input 18 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 19 | 29.13 | Control Input 19 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 20 | 29.14 | Control Input 20 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 21 | 29.15 | Control Input 21 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 22 | 29.16 | Control Input 22 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 23 | 29.17 | Control Input 23 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 24 | 29.18 | Control Input 24 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 25 | 29.19 | Control Input 25 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 26 | 29.1A | Control Input 26 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 27 | 29.1B | Control Input 27 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 28 | 29.1C | Control Input 28 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 29 | 29.1D | Control Input 29 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 30 | 29.1E | Control Input 30 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 31 | 29.1F | Control Input 31 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 32 | 29.20 | Control Input 32 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 33 | 29.21 | Control Input 1 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 34 | 29.22 | Control Input 2 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 35 | 29.23 | Control Input 3 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 36 | 29.24 | Control Input 4 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 37 | 29.25 | Control Input 5 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 38 | 29.26 | Control Input 6 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 39 | 29.27 | Control Input 7 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 40 | 29.28 | Control Input 8 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 41 | 29.29 | Control Input 9 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 42 | 29.2A | Control Input 10 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 43 | 29.2B | Control Input 11 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 44 | 29.2C | Control Input 12 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 45 | 29.2D | Control Input 13 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 46 | 29.2E | Control Input 14 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 47 | 29.2F | Control Input 15 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 48 | 29.30 | Control Input 16 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 49 | 29.31 | Control Input 17 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 50 | 29.32 | Control Input 18 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 51 | 29.33 | Control Input 19 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 52 | 29.34 | Control Input 20 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 53 | 29.35 | Control Input 21 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 54 | 29.36 | Control Input 22 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 55 | 29.37 | Control Input 23 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 56 | 29.38 | Control Input 24 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 57 | 29.39 | Control Input 25 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 58 | 29.3A | Control Input 26 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 59 | 29.3B | Control Input 27 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 60 | 29.3C | Control Input 28 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 61 | 29.3D | Control Input 29 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 62 | 29.3E | Control Input 30 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 63 | 29.3F | Control Input 31 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| Control Input 64 | 29.40 | Control Input 32 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| In this cell you can enter a text label to describe the control input. This text is displayed when a control input is accessed by the hotkey menu and in the programmable scheme logic description of the control input. | | | |
| DC SUP. MONITOR | 2A.00 | | |
| This column contains settings for DC Voltage Supply Supervision | | | |
| DC ZONE ONE | 2A.01 | | |
| The settings under this sub-heading apply to zone 1 | | | |
| Vdc1 Status | 2A.02 | Enabled | Disabled Enabled *[Indexed String]* |
| This setting enables or disables the DC Supply Monitoring supervision function for zone 1 | | | |
| Vdc1 Lower Limit | 2A.03 | 88 | From 19 to 300 in steps of 1 *[Courier Number (voltage)]* |
| This setting set the lower threshold for the ZONE setting. | | | |
| Vdc1 Upper Limit | 2A.04 | 99 | From 19 to 300 in steps of 1 *[Courier Number (voltage)]* |
| This setting sets the upper threshold for the ZONE setting. | | | |
| Vdc1 Time Delay | 2A.05 | 0.4 | From 0 to 7200 in steps of 0.1 *[Courier Number (time-seconds)]* |
| This setting sets the pickup/drop-off for the trip signal of the ZONE Supply Monitoring. | | | |
| DC ZONE TWO | 2A.11 | | |
| The settings under this sub-heading apply to zone 2 | | | |
| Vdc2 Status | 2A.12 | Disabled | Disabled Enabled *[Indexed String]* |
| This setting enables or disables the DC Supply Monitoring supervision function for zone 2 | | | |
| Vdc2 Lower Limit | 2A.13 | 77 | From 19 to 300 in steps of 1 *[Courier Number (voltage)]* |
| This setting set the lower threshold for the ZONE setting. | | | |
| Vdc2 Upper Limit | 2A.14 | 88 | From 19 to 300 in steps of 1 *[Courier Number (voltage)]* |
| This setting sets the upper threshold for the ZONE setting. | | | |
| Vdc2 Time Delay | 2A.15 | 0.4 | From 0 to 7200 in steps of 0.1 *[Courier Number (time-seconds)]* |
| This setting sets the pickup/drop-off for the trip signal of the ZONE Supply Monitoring. | | | |
| DC ZONE THREE | 2A.21 | | |
| The settings under this sub-heading apply to zone 3 | | | |
| Vdc3 Status | 2A.22 | Disabled | Disabled Enabled *[Indexed String]* |
| This setting enables or disables the DC Supply Monitoring supervision function for zone 3 | | | |
| Vdc3 Lower Limit | 2A.23 | 121 | From 19 to 300 in steps of 1 *[Courier Number (voltage)]* |
| This setting set the lower threshold for the ZONE setting. | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| Vdc3 Upper Limit | 2A.24 | 238 | From 19 to 300 in steps of 1 *[Courier Number (voltage)]* |
| This setting sets the upper threshold for the ZONE setting. | | | |
| Vdc3 Time Delay | 2A.25 | 0.4 | From 0 to 7200 in steps of 0.1 *[Courier Number (time-seconds)]* |
| This setting sets the pickup/drop-off for the trip signal of the ZONE Supply Monitoring. | | | |
| GROUP 1: SYSTEM CONFIG | 30.00 | | |
| This column contains settings for setting the phase rotation and 2nd harmonic blocking | | | |
| Phase Sequence | 30.02 | Standard ABC | Standard ABC Reverse ACB *[Indexed String]* |
| This setting sets the phase rotation to standard (ABC) or reverse (ACB). Warning: This will affect the positive and negative sequence quantities calculated by the IED as well as other functions that are dependant on phase quantities. | | | |
| 2NDHARM BLOCKING | 30.03 | | |
| The settings under this sub-heading relate to 2nd harmonic blocking | | | |
| 2nd Harmonic | 30.04 | Disabled | Disabled Enabled *[Indexed String]* |
| This setting enables or disables the 2nd Harmonic blocking of the overcurrent protection. | | | |
| 2ndHarm Thresh | 30.05 | 20 | From 5 to 70 in steps of 1 *[Courier Number (percentage)]* |
| This setting sets the lower threshold for 2nd harmonic blocking in percent. If the 2nd harmonic component exceeds this threshold, the overcurrent protection will be blocked. | | | |
| I>lift 2H | 30.06 | 10 | From 4 to 32 in steps of 0.01 *[Courier Number (current)]* |
| This setting sets the upper threshold for 2nd harmonic blocking in amps If the 2nd harmonic exceeds this threshold, there will be no blocking applied. | | | |
| GROUP 1: OVERCURRENT | 35.00 | | |
| This column contains settings for Overcurrent | | | |
| I>1 Function | 35.23 | IEC S Inverse | Disabled DT IEC S Inverse IEC V Inverse IEC E Inverse UK LT Inverse UK Rectifier RI IEEE M Inverse IEEE V Inverse IEEE E Inverse US Inverse US ST Inverse Def User Curve 1 Def User Curve 2 Def User Curve 3 Def User Curve 4 *[Indexed String]* |
| This setting determines the tripping characteristic for the first stage overcurrent element. | | | |
| I>1 Direction | 35.24 | Non-Directional | Non-Directional *[Indexed String]* |
| This setting determines the direction of measurement for the first stage overcurrent element. | | | |
| I>1 Current Set | 35.27 | 1 | From 0.01 to 4.00*I1 in steps of 0.01*I1 *[Courier Number (current)]* |
| This setting sets the pick-up threshold for the first stage overcurrent element. | | | |
| I>1 Time Delay | 35.29 | 1 | From 0 to 10 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting sets the DT time delay for the first stage overcurrent element. | | | |
| I>1 TMS | 35.2A | 1 | From 0.025 to 1.2 in steps of 0.005 *[Courier Number (decimal)]* |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| This is the Time Multiplier Setting to adjust the operate time of IEC IDMT curves. | | | |
| I>1 Time Dial | 35.2B | 1 | From 0.01 to 10 in steps of 0.01 *[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of IEEE/US IDMT curves. | | | |
| I>1 k (RI) | 35.2C | 1 | From 0.1 to 10 in steps of 0.05 *[Courier Number (decimal)]* |
| This setting defines the TMS constant to adjust the operate time of the RI curve. | | | |
| I>1 DT Adder | 35.2D | 0 | From 0 to 10 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting adds an additional fixed time delay to the IDMT Operate characteristic. | | | |
| I>1 Reset Char | 35.2E | DT | DT Inverse *[Indexed String]* |
| This setting determines the type of Reset characteristic used for the IEEE/US curves. | | | |
| I>1 tRESET | 35.2F | 0 | From 0 to 10 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting determines the Reset time for the Definite Time Reset characteristic | | | |
| I>1 Usr Rst Char | 35.30 | DT | DT Def User Curve 1 Def User Curve 2 Def User Curve 3 Def User Curve 4 *[Indexed String]* |
| This setting determines the type of Reset characteristic used for the user defined curves. | | | |
| I>2 Function | 35.32 | Disabled | Disabled DT IEC S Inverse IEC V Inverse IEC E Inverse UK LT Inverse UK Rectifier RI IEEE M Inverse IEEE V Inverse IEEE E Inverse US Inverse US ST Inverse Def User Curve 1 Def User Curve 2 Def User Curve 3 Def User Curve 4 *[Indexed String]* |
| This setting determines the tripping characteristic for the second stage overcurrent element. | | | |
| I>2 Direction | 35.33 | Non-Directional | Non-Directional *[Indexed String]* |
| This setting determines the direction of measurement for the second stage overcurrent element. | | | |
| I>2 Current Set | 35.36 | 1 | From 0.01*I1 to 4 in steps of 0.01 *[Courier Number (current)]* |
| This setting sets the pick-up threshold for the second stage overcurrent element. | | | |
| I>2 Time Delay | 35.38 | 1 | From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting sets the DT time delay for the second stage element. | | | |
| I>2 TMS | 35.39 | 1 | From 0.025 to 1.2 in steps of 0.005 *[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of IEC IDMT curves. | | | |
| I>2 Time Dial | 35.3A | 1 | From 0.01 to 100 in steps of 0.01 *[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of IEEE/US IDMT curves. | | | |
| I>2 k (RI) | 35.3B | 1 | From 0.1 to 10 in steps of 0.05 *[Courier Number (decimal)]* |
| This setting defines the TMS constant to adjust the operate time of the RI curve. | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| I>2 DT Adder | 35.3C | 0 | From 0 to 100 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting adds an additional fixed time delay to the IDMT Operate characteristic. | | | |
| I>2 Reset Char | 35.3D | DT | DT<br>Inverse<br>*[Indexed String]* |
| This setting determines the type of Reset characteristic used for the IEEE/US curves. | | | |
| I>2 tRESET | 35.3E | 0 | From 0 to 100 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting determines the Reset time for the Definite Time Reset characteristic | | | |
| I>2 Usr Rst Char | 35.3F | DT | DT<br>Def User Curve 1<br>Def User Curve 2<br>Def User Curve 3<br>Def User Curve 4<br>*[Indexed String]* |
| This setting determines the type of Reset characteristic used for the user defined curves. | | | |
| I>3 Status | 35.40 | Disabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the third stage overcurrent element. There is no choice of curves because this stage is DT only. | | | |
| I>3 Direction | 35.41 | Non-Directional | Non-Directional<br>*[Indexed String]* |
| This setting determines the direction of measurement for the third stage overcurrent element. | | | |
| I>3 Current Set | 35.44 | 20 | From 0.01*I1 to 32 in steps of 0.01<br>*[Courier Number (current)]* |
| This setting sets the pick-up threshold for the third stage overcurrent element. | | | |
| I>3 Time Delay | 35.45 | 0 | From 0 to 100 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the DT time delay for the third stage overcurrent element. | | | |
| I>4 Status | 35.47 | Disabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the fourth stage overcurrent element. There is no choice of curves because this stage is DT only. | | | |
| I>4 Direction | 35.48 | Non-Directional | Non-Directional<br>*[Indexed String]* |
| This setting determines the direction of measurement for the fourth stage overcurrent element. | | | |
| I>4 Current Set | 35.4B | 20 | From 0.01*I1 to 32 in steps of 0.01<br>*[Courier Number (current)]* |
| This setting sets the pick-up threshold for the fourth stage overcurrent element. | | | |
| I>4 Time Delay | 35.4C | 0 | From 0 to 100 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the DT time delay for the fourth stage overcurrent element. | | | |
| I> Blocking | 35.4E | 0x00 | AR Blocks I>3<br>AR Blocks I>4<br>AR Blocks I>6<br>2H Blocks I>1<br>2H Blocks I>2<br>2H Blocks I>3<br>2H Blocks I>4<br>2H Blocks I>5<br>2H Blocks I>6<br>2H 1PH Block<br>*[Binary Flag (16 bits)]* |
| This setting cell contains a binary string where you can define which blocking signals block which stage. The available settings depend on the model chosen. This description is for models with Autoreclose and second harmonic blocking. | | | |
| I> Blocking | 35.4E | 0x00 | 2H Blocks I>1<br>2H Blocks I>2<br>2H Blocks I>3<br>2H Blocks I>4<br>2H Blocks I>5 |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
|  |  |  | 2H Blocks I>6<br>2H 1PH Block<br>*[Binary Flag (16 bits)]* |
| This setting cell contains a binary string where you can define which blocking signals block which stage. The available settings depend on the model chosen. This description is for models with second harmonic blocking. | | | |
| I>5 Function | 35.63 | Disabled | Disabled<br>DT<br>IEC S Inverse<br>IEC V Inverse<br>IEC E Inverse<br>UK LT Inverse<br>UK Rectifier<br>RI<br>IEEE M Inverse<br>IEEE V Inverse<br>IEEE E Inverse<br>US Inverse<br>US ST Inverse<br>Def User Curve 1<br>Def User Curve 2<br>Def User Curve 3<br>Def User Curve 4<br>*[Indexed String]* |
| This setting determines the tripping characteristic for the fifth stage overcurrent element. | | | |
| I>5 Direction | 35.64 | Non-Directional | Non-Directional<br>*[Indexed String]* |
| This setting determines the direction of measurement for the fifth stage overcurrent element. | | | |
| I>5 Current Set | 35.67 | 1 | From 0.01*I1 to 4 in steps of 0.01<br>*[Courier Number (current)]* |
| This setting sets the pick-up threshold for the fifth stage overcurrent element. | | | |
| I>5 Time Delay | 35.69 | 1 | From 0 to 100 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the DT time delay for the fifth stage overcurrent element. | | | |
| I>5 TMS | 35.6A | 1 | From 0.025 to 1.2 in steps of 0.005<br>*[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of  IEC IDMT curves. | | | |
| I>5 Time Dial | 35.6B | 1 | From 0.01 to 100 in steps of 0.01<br>*[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of  IEEE/US IDMT curves. | | | |
| I>5 k (RI) | 35.6C | 1 | From 0.1 to 10 in steps of 0.05<br>*[Courier Number (decimal)]* |
| This setting defines the TMS constant to adjust the operate time of the RI curve. | | | |
| I>5 DT Adder | 35.6D | 0 | From 0 to 100 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting adds an additional fixed time delay to the IDMT Operate characteristic. | | | |
| I>5 Reset Char | 35.6E | DT | DT<br>Inverse<br>*[Indexed String]* |
| This setting determines the type of Reset characteristic used for the IEEE/US curves. | | | |
| I>5 tRESET | 35.6F | 0 | From 0 to 100 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting determines the Reset time for the Definite Time Reset characteristic | | | |
| I>5 Usr Rst Char | 35.70 | DT | DT<br>Def User Curve 1<br>Def User Curve 2<br>Def User Curve 3<br>Def User Curve 4<br>*[Indexed String]* |
| This setting determines the type of Reset characteristic used for the user defined curves. | | | |
| I>6 Status | 35.71 | Disabled | Disabled<br>Enabled |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | *[Indexed String]* |
| This setting enables or disables the sixth stage overcurrent element. There is no choice of curves because this stage is DT only. | | | |
| I>6 Direction | 35.72 | Non-Directional | Non-Directional<br>*[Indexed String]* |
| This setting determines the direction of measurement for the sixth stage overcurrent element. | | | |
| I>6 Current Set | 35.75 | 20 | From 0.01*I1 to 32 in steps of 0.01<br>*[Courier Number (current)]* |
| This setting sets the pick-up threshold for the sixth stage overcurrent element. | | | |
| I>6 Time Delay | 35.76 | 0 | From 0 to 100 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the DT time delay for the sixth stage overcurrent element. | | | |
| GROUP 1: NEG SEQ O/C | 36.00 | | |
| This column contains settings for Negative Sequence overcurrent | | | |
| I2>1 Status | 36.10 | Disabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the first stage NPSOC element. | | | |
| I2>1 Direction | 36.12 | Non-Directional | Non-Directional<br>*[Indexed String]* |
| This setting determines the direction of measurement for the first stage NPSOC element. | | | |
| I2>1 Current Set | 36.15 | 0.2 | From 0.08 to 4 in steps of 0.01<br>*[Courier Number (current)]* |
| This setting sets the pick-up threshold for the first stage NPSOC element. | | | |
| I2>1 Time Delay | 36.17 | 10 | From 0 to 100 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the DT time delay for the first stage NPSOC element. | | | |
| I2>1 TMS | 36.18 | 1 | From 0.025 to 1.2 in steps of 0.005<br>*[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of  IEC IDMT curves. | | | |
| I2>1 Time Dial | 36.19 | 1 | From 0.01 to 100 in steps of 0.01<br>*[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of  IEEE/US IDMT curves. | | | |
| I2>1 DT Adder | 36.1B | 0 | From 0 to 100 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting adds an additional fixed time delay to the IDMT Operate characteristic. | | | |
| I2>1 Reset Char | 36.1C | DT | DT<br>Inverse<br>*[Indexed String]* |
| This setting determines the type of Reset characteristic used for the IEEE/US curves. | | | |
| I2>1 tRESET | 36.1D | 0 | From 0 to 100 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting determines the Reset time for the Definite Time Reset characteristic | | | |
| I2>1 Usr RstChar | 36.1E | DT | DT<br>Def User Curve 1<br>Def User Curve 2<br>Def User Curve 3<br>Def User Curve 4<br>*[Indexed String]* |
| This setting determines the type of Reset characteristic used for the user defined curves. | | | |
| I2>2 Status | 36.20 | Disabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the second stage NPSOC element. | | | |
| I2>2 Direction | 36.22 | Non-Directional | Non-Directional<br>*[Indexed String]* |
| This setting determines the direction of measurement for the second stage NPSOC element. | | | |
| I2>2 Current Set | 36.25 | 0.2 | From 0.08 to 4 in steps of 0.01<br>*[Courier Number (current)]* |
| This setting sets the pick-up threshold for the second stage NPSOC element. | | | |
| I2>2 Time Delay | 36.27 | 10 | From 0 to 100 in steps of 0.01 |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | *[Courier Number (time-seconds)]* |
| This setting sets the DT time delay for the second stage NPSOC element. | | | |
| I2>2 TMS | 36.28 | 1 | From 0.025 to 1.2 in steps of 0.005 *[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of IEC IDMT curves. | | | |
| I2>2 Time Dial | 36.29 | 1 | From 0.01 to 100 in steps of 0.01 *[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of IEEE/US IDMT curves. | | | |
| I2>2 DT Adder | 36.2B | 0 | From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting adds an additional fixed time delay to the IDMT Operate characteristic. | | | |
| I2>2 Reset Char | 36.2C | DT | DT Inverse *[Indexed String]* |
| This setting determines the type of Reset characteristic used for the IEEE/US curves. | | | |
| I2>2 tRESET | 36.2D | 0 | From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting determines the Reset time for the Definite Time Reset characteristic | | | |
| I2>2 Usr RstChar | 36.2E | DT | DT Def User Curve 1 Def User Curve 2 Def User Curve 3 Def User Curve 4 *[Indexed String]* |
| This setting determines the type of Reset characteristic used for the user defined curves. | | | |
| I2>3 Status | 36.30 | Disabled | Disabled Enabled *[Indexed String]* |
| This setting enables or disables the third stage NPSOC element. There is no choice of curves because this stage is DT only. | | | |
| I2>3 Direction | 36.32 | Non-Directional | Non-Directional *[Indexed String]* |
| This setting determines the direction of measurement for the third stage NPSOC element. | | | |
| I2>3 Current Set | 36.35 | 0.2 | From 0.08 to 32 in steps of 0.01 *[Courier Number (current)]* |
| This setting sets the pick-up threshold for the third stage NPSOC element. | | | |
| I2>3 Time Delay | 36.37 | 10 | From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting sets the DT time delay for the third stage NPSOC element. | | | |
| I2>4 Status | 36.40 | Disabled | Disabled Enabled *[Indexed String]* |
| This setting enables or disables the fourth stage NPSOC element. There is no choice of curves because this stage is DT only. | | | |
| I2>4 Direction | 36.42 | Non-Directional | Non-Directional *[Indexed String]* |
| This setting determines the direction of measurement for the fourth stage NPSOC element. | | | |
| I2>4 Current Set | 36.45 | 0.2 | From 0.08 to 32 in steps of 0.01 *[Courier Number (current)]* |
| This setting sets the pick-up threshold for the fourth stage NPSOC element. | | | |
| I2>4 Time Delay | 36.47 | 10 | From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting sets the DT time delay for the fourth stage NPSOC element. | | | |
| I2> Blocking | 36.50 | 0x0 | 2H Blocks I2>1 2H Blocks I2>2 2H Blocks I2>3 2H Blocks I2>4 *[Binary Flag (8 bits)]* |
| This setting cell contains a binary string (data type G158N), where you can define which blocking signals block which stage. The available settings depend on the model chosen. This description is for models with 2nd harmonic blocking. | | | |
| GROUP 1: BROKEN CONDUCTOR | 37.00 | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| This column contains settings for Broken Conductor | | | |
| Broken Conductor | 37.01 | Enabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the Broken Conductor function. | | | |
| I2/I1 Setting | 37.02 | 0.1 | From 0.1 to 1 in steps of 0.01<br>*[Courier Number (decimal)]* |
| This setting determines the pick-up threshold of the negative to positive sequence current ratio. | | | |
| I2/I1 Time Delay | 37.03 | 60 | From 0 to 100 in steps of 0.1<br>*[Courier Number (time-seconds)]* |
| This setting sets the time delay for the broken conductor element | | | |
| GROUP 1: EARTH FAULT 1 | 38.00 | | |
| This column contains settings for Measured Earth Fault protection (EF1) | | | |
| IN1> Input | 38.01 | Measured | Measured<br>Derived<br>*[Indexed String]* |
| This cell displays the input type. For EF1 it is always 'Measured' | | | |
| IN1>1 Function | 38.25 | IEC S Inverse | Disabled<br>DT<br>IEC S Inverse<br>IEC V Inverse<br>IEC E Inverse<br>UK LT Inverse<br>RI<br>IEEE M Inverse<br>IEEE V Inverse<br>IEEE E Inverse<br>US Inverse<br>US ST Inverse<br>IDG<br>Def User Curve 1<br>Def User Curve 2<br>Def User Curve 3<br>Def User Curve 4<br>EPATR B<br>*[Indexed String]* |
| This setting determines the tripping characteristic for the first stage EF1 element. | | | |
| IN1>1 Direction | 38.26 | Non-Directional | Non-Directional<br>*[Indexed String]* |
| This setting determines the direction of measurement for the first stage EF1 element. | | | |
| IN1>1 Current | 38.29 | 0.2 | From 0.01 to 4 in steps of 0.01<br>*[Courier Number (current)]* |
| This setting sets the pick-up threshold for the first stage EF1 element. | | | |
| IN1>1 IDG Is | 38.2A | 1.5 | From 1 to 4 in steps of 0.1<br>*[Courier Number (decimal)]* |
| This setting is set as a multiple of the Earth Fault overcurrent setting IN> for the IDG curve. It determines the actual current threshold at which the element starts. | | | |
| IN1>1 Time Delay | 38.2C | 1 | From 0 to 1200 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the DT time delay for the first stage EF1 element. | | | |
| IN1>1 TMS | 38.2D | 1 | From 0.025 to 1.2 in steps of 0.005<br>*[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of IEC IDMT curves. | | | |
| IN1>1 Time Dial | 38.2E | 1 | From 0.01 to 100 in steps of 0.01<br>*[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of IEEE/US IDMT curves. | | | |
| IN1>1 k (RI) | 38.2F | 1 | From 0.1 to 10 in steps of 0.05<br>*[Courier Number (decimal)]* |
| This setting defines the TMS constant to adjust the operate time of the RI curve. | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| IN1>1 IDG Time | 38.30 | 1.2 | From 1 to 2 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the minimum operate time at high levels of fault current for IDG curves. | | | |
| IN1>1 DT Adder | 38.31 | 0 | From 0 to 100 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting adds an additional fixed time delay to the IDMT Operate characteristic. | | | |
| IN1>1 Reset Char | 38.32 | DT | DT<br>Inverse<br>*[Indexed String]* |
| This setting determines the type of Reset characteristic used for the IEEE/US curves. | | | |
| IN1>1 tRESET | 38.33 | 0 | From 0 to 100 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting determines the Reset time for the Definite Time Reset characteristic | | | |
| IN1>1 Usr RstChr | 38.34 | DT | DT<br>Def User Curve 1<br>Def User Curve 2<br>Def User Curve 3<br>Def User Curve 4<br>*[Indexed String]* |
| This setting determines the type of Reset characteristic used for the user defined curves. | | | |
| IN1>2 Function | 38.36 | Disabled | Disabled<br>DT<br>IEC S Inverse<br>IEC V Inverse<br>IEC E Inverse<br>UK LT Inverse<br>RI<br>IEEE M Inverse<br>IEEE V Inverse<br>IEEE E Inverse<br>US Inverse<br>US ST Inverse<br>IDG<br>Def User Curve 1<br>Def User Curve 2<br>Def User Curve 3<br>Def User Curve 4<br>EPATR B<br>*[Indexed String]* |
| This setting determines the tripping characteristic for the second stage EF1 element. | | | |
| IN1>2 Direction | 38.37 | Non-Directional | Non-Directional<br>*[Indexed String]* |
| This setting determines the direction of measurement for the second stage EF1 element. | | | |
| IN1>2 Current | 38.3A | 0.2 | From 0.01 to 4 in steps of 0.01<br>*[Courier Number (current)]* |
| This setting sets the pick-up threshold for the second stage EF1 element. | | | |
| IN1>2 IDG Is | 38.3B | 1.5 | From 1 to 4 in steps of 0.1<br>*[Courier Number (decimal)]* |
| This setting is set as a multiple of the Earth Fault overcurrent setting IN> for the IDG curve. It determines the actual current threshold at which the element starts. | | | |
| IN1>2 Time Delay | 38.3D | 1 | From 0 to 1200 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the DT time delay for the second stage EF1 element. | | | |
| IN1>2 TMS | 38.3E | 1 | From 0.025 to 1.2 in steps of 0.005<br>*[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of IEC IDMT curves. | | | |
| IN1>2 Time Dial | 38.3F | 1 | From 0.01 to 100 in steps of 0.01<br>*[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of IEEE/US IDMT curves. | | | |
| IN1>2 k (RI) | 38.40 | 1 | From 0.1 to 10 in steps of 0.05<br>*[Courier Number (decimal)]* |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| This setting defines the TMS constant to adjust the operate time of the RI curve. | | | |
| IN1>2 IDG Time | 38.41 | 1.2 | From 1 to 2 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting sets the minimum operate time at high levels of fault current for IDG curves. | | | |
| IN1>2 DT Adder | 38.42 | 0 | From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting adds an additional fixed time delay to the IDMT Operate characteristic. | | | |
| IN1>2 Reset Char | 38.43 | DT | DT Inverse *[Indexed String]* |
| This setting determines the type of Reset characteristic used for the IEEE/US curves. | | | |
| IN1>2 tRESET | 38.44 | 0 | From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting determines the Reset time for the Definite Time Reset characteristic | | | |
| IN1>2 Usr RstChr | 38.45 | DT | DT Def User Curve 1 Def User Curve 2 Def User Curve 3 Def User Curve 4 *[Indexed String]* |
| This setting determines the type of Reset characteristic used for the user defined curves. | | | |
| IN1>3 Status | 38.46 | Disabled | Disabled Enabled *[Indexed String]* |
| This setting enables or disables the third stage EF1 element. There is no choice of curves because this stage is DT only. | | | |
| IN1>3 Direction | 38.47 | Non-Directional | Non-Directional *[Indexed String]* |
| This setting determines the direction of measurement for the third stage EF1 element. | | | |
| IN1>3 Current | 38.4A | 0.2 | From 0.01 to 32 in steps of 0.01 *[Courier Number (current)]* |
| This setting sets the pick-up threshold for the third stage EF1 element. | | | |
| IN1>3 Time Delay | 38.4B | 1 | From 0 to 1200 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting sets the DT time delay for the third stage EF1 element. | | | |
| IN1>4 Status | 38.4D | Disabled | Disabled Enabled *[Indexed String]* |
| This setting enables or disables the fourth stage EF1 element. There is no choice of curves because this stage is DT only. | | | |
| IN1>4 Direction | 38.4E | Non-Directional | Non-Directional *[Indexed String]* |
| This setting determines the direction of measurement for the fourth stage EF1 element. | | | |
| IN1>4 Current | 38.51 | 0.2 | From 0.01 to 32 in steps of 0.01 *[Courier Number (current)]* |
| This setting sets the pick-up threshold for the fourth stage EF1 element. | | | |
| IN1>4 Time Delay | 38.52 | 1 | From 0 to 1200 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting sets the DT time delay for the fourth stage EF1 element. | | | |
| IN1> Blocking | 38.54 | 0x00F | AR Blocks IN>3 AR Blocks IN>4 2H Blocks IN>1 2H Blocks IN>2 2H Blocks IN>3 2H Blocks IN>4 *[Binary Flag (12 bits)]* |
| This setting cell contains a binary string (data type G63B), where you can define which blocking signals block which stage. The available settings depend on the model chosen. This description is for models without VTS blocking | | | |
| IN1> Blocking | 38.54 | 0x00F | 2H Blocks IN>1 2H Blocks IN>2 2H Blocks IN>3 2H Blocks IN>4 |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | *[Binary Flag (12 bits)]* |
| This setting cell contains a binary string (data type G63C), where you can define which blocking signals block which stage. The available settings depend on the model chosen. This description is for models without VTS blocking and without Autoreclose. | | | |
| GROUP 1: EARTH FAULT 2 | 39.00 | | |
| This column contains settings for Derived Earth Fault | | | |
| IN2> Input | 39.01 | Derived | Measured<br>Derived<br>*[Indexed String]* |
| This cell displays the input type. For EF2 it is always 'Derived' | | | |
| IN2>1 Function | 39.25 | IEC S Inverse | Disabled<br>DT<br>IEC S Inverse<br>IEC V Inverse<br>IEC E Inverse<br>UK LT Inverse<br>RI<br>IEEE M Inverse<br>IEEE V Inverse<br>IEEE E Inverse<br>US Inverse<br>US ST Inverse<br>IDG<br>Def User Curve 1<br>Def User Curve 2<br>Def User Curve 3<br>Def User Curve 4<br>EPATR B<br>*[Indexed String]* |
| This setting determines the tripping characteristic for the first stage EF2 element. | | | |
| IN2>1 Direction | 39.26 | Non-Directional | Non-Directional<br>*[Indexed String]* |
| This setting determines the direction of measurement for the first stage EF2 element. | | | |
| IN2>1 Current | 39.29 | 0.2 | From 0.05 to 4 in steps of 0.01<br>*[Courier Number (current)]* |
| This setting sets the pick-up threshold for the first stage EF2 element. | | | |
| IN2>1 IDG Is | 39.2A | 1.5 | From 1 to 4 in steps of 0.1<br>*[Courier Number (decimal)]* |
| This setting is set as a multiple of the Earth Fault overcurrent setting IN> for the IDG curve. It determines the actual current threshold at which the element starts. | | | |
| IN2>1 Time Delay | 39.2C | 1 | From 0 to 200 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the DT time delay for the first stage EF2 element. | | | |
| IN2>1 TMS | 39.2D | 1 | From 0.025 to 1.2 in steps of 0.005<br>*[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of  IEC IDMT curves. | | | |
| IN2>1 Time Dial | 39.2E | 1 | From 0.01 to 100 in steps of 0.01<br>*[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of  IEEE/US IDMT curves. | | | |
| IN2>1 k (RI) | 39.2F | 1 | From 0.1 to 10 in steps of 0.05<br>*[Courier Number (decimal)]* |
| This setting defines the TMS constant to adjust the operate time of the RI curve. | | | |
| IN2>1 IDG Time | 39.30 | 1.2 | From 1 to 2 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the minimum operate time at high levels of fault current for IDG curves. | | | |
| IN2>1 DT Adder | 39.31 | 0 | From 0 to 100 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting adds an additional fixed time delay to the IDMT Operate characteristic. | | | |
| IN2>1 Reset Char | 39.32 | DT | DT<br>Inverse<br>*[Indexed String]* |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| This setting determines the type of Reset characteristic used for the IEEE/US curves. | | | |
| IN2>1 tRESET | 39.33 | 0 | From 0 to 100 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting determines the Reset time for the Definite Time Reset characteristic | | | |
| IN2>1 Usr RstChr | 39.34 | DT | DT<br>Def User Curve 1<br>Def User Curve 2<br>Def User Curve 3<br>Def User Curve 4<br>*[Indexed String]* |
| This setting determines the type of Reset characteristic used for the user defined curves. | | | |
| IN2>2 Function | 39.36 | Disabled | Disabled<br>DT<br>IEC S Inverse<br>IEC V Inverse<br>IEC E Inverse<br>UK LT Inverse<br>RI<br>IEEE M Inverse<br>IEEE V Inverse<br>IEEE E Inverse<br>US Inverse<br>US ST Inverse<br>IDG<br>Def User Curve 1<br>Def User Curve 2<br>Def User Curve 3<br>Def User Curve 4<br>EPATR B<br>*[Indexed String]* |
| This setting determines the tripping characteristic for the second stage EF2 element. | | | |
| IN2>2 Direction | 39.37 | Non-Directional | Non-Directional<br>*[Indexed String]* |
| This setting determines the direction of measurement for the second stage EF2 element. | | | |
| IN2>2 Current | 39.3A | 0.2 | From 0.05 to 4 in steps of 0.01<br>*[Courier Number (current)]* |
| This setting sets the pick-up threshold for the second stage EF2 element. | | | |
| IN2>2 IDG Is | 39.3B | 1.5 | From 1 to 4 in steps of 0.1<br>*[Courier Number (decimal)]* |
| This setting is set as a multiple of the Earth Fault overcurrent setting IN> for the IDG curve. It determines the actual current threshold at which the element starts. | | | |
| IN2>2 Time Delay | 39.3D | 1 | From 0 to 200 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the DT time delay for the second stage EF2 element. | | | |
| IN2>2 TMS | 39.3E | 1 | From 0.025 to 1.2 in steps of 0.005<br>*[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of IEC IDMT curves. | | | |
| IN2>2 Time Dial | 39.3F | 1 | From 0.01 to 100 in steps of 0.01<br>*[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of IEEE/US IDMT curves. | | | |
| IN2>2 k (RI) | 39.40 | 1 | From 0.1 to 10 in steps of 0.05<br>*[Courier Number (decimal)]* |
| This setting defines the TMS constant to adjust the operate time of the RI curve. | | | |
| IN2>2 IDG Time | 39.41 | 1.2 | From 1 to 2 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the minimum operate time at high levels of fault current for IDG curves. | | | |
| IN2>2 DT Adder | 39.42 | 0 | From 0 to 100 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting adds an additional fixed time delay to the IDMT Operate characteristic. | | | |
| IN2>2 Reset Char | 39.43 | DT | DT<br>Inverse |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| | | | *[Indexed String]* |
| This setting determines the type of Reset characteristic used for the IEEE/US curves. | | | |
| IN2>2 tRESET | 39.44 | 0 | From 0 to 100 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting determines the Reset time for the Definite Time Reset characteristic | | | |
| IN2>2 Usr RstChr | 39.45 | DT | DT<br>Def User Curve 1<br>Def User Curve 2<br>Def User Curve 3<br>Def User Curve 4<br>*[Indexed String]* |
| This setting determines the type of Reset characteristic used for the user defined curves. | | | |
| IN2>3 Status | 39.46 | Disabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the third stage EF2 element. There is no choice of curves because this stage is DT only. | | | |
| IN2>3 Direction | 39.47 | Non-Directional | Non-Directional<br>*[Indexed String]* |
| This setting determines the direction of measurement for the third stage EF2 element. | | | |
| IN2>3 Current | 39.4A | 0.2 | From 0.05 to 32 in steps of 0.01<br>*[Courier Number (current)]* |
| This setting sets the pick-up threshold for the third stage EF2 element. | | | |
| IN2>3 Time Delay | 39.4B | 1 | From 0 to 200 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the DT time delay for the third stage EF2 element. | | | |
| IN2>4 Status | 39.4D | Disabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the fourth stage EF2 element. There is no choice of curves because this stage is DT only. | | | |
| IN2>4 Direction | 39.4E | Non-Directional | Non-Directional<br>*[Indexed String]* |
| This setting determines the direction of measurement for the fourth stage EF2 element. | | | |
| IN2>4 Current | 39.51 | 0.2 | From 0.05 to 32 in steps of 0.01<br>*[Courier Number (current)]* |
| This setting sets the pick-up threshold for the fourth stage EF2 element. | | | |
| IN2>4 Time Delay | 39.52 | 1 | From 0 to 200 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the DT time delay for the fourth stage EF2 element. | | | |
| IN2> Blocking | 39.54 | 0x00F | AR Blocks IN>3<br>AR Blocks IN>4<br>2H Blocks IN>1<br>2H Blocks IN>2<br>2H Blocks IN>3<br>2H Blocks IN>4<br>*[Binary Flag (12 bits)]* |
| This setting cell contains a binary string (data type G63B), where you can define which blocking signals block which stage. The available settings depend on the model chosen. This description is for models without VTS blocking | | | |
| IN2> Blocking | 39.54 | 0x00F | 2H Blocks IN>1<br>2H Blocks IN>2<br>2H Blocks IN>3<br>2H Blocks IN>4<br>*[Binary Flag (12 bits)]* |
| This setting cell contains a binary string (data type G63C), where you can define which blocking signals block which stage. The available settings depend on the model chosen. This description is for models without VTS blocking and without Autoreclose. | | | |
| GROUP 1: SEF PROTECTION | 3A.00 | | |
| This column contains settings for Sensitive Earth Fault protection | | | |
| SEF Options | 3A.01 | SEF | SEF<br>SEF cos(PHI)<br>SEF sin(PHI) |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | Wattmetric *[Indexed String]* |
| This setting selects the type of sensitive earth fault protection function. For non-directional models, only standard SEF is available. | | | |
| ISEF>1 Function | 3A.2A | DT | Disabled DT IEC S Inverse IEC V Inverse IEC E Inverse UK LT Inverse IEEE M Inverse IEEE V Inverse IEEE E Inverse US Inverse US ST Inverse IDG EPATR B Def User Curve 1 Def User Curve 2 Def User Curve 3 Def User Curve 4 *[Indexed String]* |
| This setting determines the tripping characteristic for the first stage SEF element. | | | |
| ISEF>1 Direction | 3A.2B | Non-Directional | Non-Directional *[Indexed String]* |
| This setting determines the direction of measurement for the first stage SEF element. | | | |
| ISEF>1 Current | 3A.2E | 0.05 | From 0.001 to 0.1 in steps of 0.00025 *[Courier Number (current)]* |
| This setting sets the pick-up threshold for the first stage SEF element. | | | |
| ISEF>1 IDG Is | 3A.2F | 1.5 | From 1 to 4 in steps of 0.1 *[Courier Number (decimal)]* |
| This setting is set as a multiple of ISEF> setting for the IDG curve (Scandinavian) and determines the actual IED current threshold at which the element starts. | | | |
| ISEF>1 Delay | 3A.31 | 1 | From 0 to 200 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting sets the DT time delay for the first stage SEF element. | | | |
| ISEF>1 TMS | 3A.32 | 1 | From 0.025 to 1.2 in steps of 0.005 *[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of IEC IDMT curves. | | | |
| ISEF>1 Time Dial | 3A.33 | 1 | From 0.01 to 100 in steps of 0.01 *[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of IEEE/US IDMT curves. | | | |
| ISEF>1 IDG Time | 3A.34 | 1.2 | From 1 to 2 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting sets the minimum operate time at high levels of fault current for IDG curves. | | | |
| ISEF>1 DT Adder | 3A.35 | 0 | From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting adds an additional fixed time delay to the IDMT Operate characteristic. | | | |
| ISEF>1 Reset Chr | 3A.36 | DT | DT Inverse *[Indexed String]* |
| This setting determines the type of Reset characteristic used for the IEEE/US curves. | | | |
| ISEF>1 tRESET | 3A.37 | 0 | From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting determines the Reset time for the Definite Time Reset characteristic | | | |
| ISEF>1 UsrRstChr | 3A.38 | DT | DT Def User Curve 1 Def User Curve 2 Def User Curve 3 Def User Curve 4 *[Indexed String]* |
| This setting determines the type of Reset characteristic used for the user defined curves. | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| ISEF>2 Function | 3A.3A | Disabled | Disabled<br>DT<br>IEC S Inverse<br>IEC V Inverse<br>IEC E Inverse<br>UK LT Inverse<br>IEEE M Inverse<br>IEEE V Inverse<br>IEEE E Inverse<br>US Inverse<br>US ST Inverse<br>IDG<br>EPATR B<br>Def User Curve 1<br>Def User Curve 2<br>Def User Curve 3<br>Def User Curve 4<br>*[Indexed String]* |
| This setting determines the tripping characteristic for the first stage SEF element. | | | |
| ISEF>2 Direction | 3A.3B | Non-Directional | Non-Directional<br>*[Indexed String]* |
| This setting determines the direction of measurement for the first stage SEF element. | | | |
| ISEF>2 Current | 3A.3E | 0.05 | From 0.001 to 0.1 in steps of 0.00025<br>*[Courier Number (current)]* |
| This setting sets the pick-up threshold for the first stage SEF element. | | | |
| ISEF>2 IDG Is | 3A.3F | 1.5 | From 1 to 4 in steps of 0.1<br>*[Courier Number (decimal)]* |
| This setting is set as a multiple of ISEF> setting for the IDG curve (Scandinavian) and determines the actual IED current threshold at which the element starts. | | | |
| ISEF>2 Delay | 3A.41 | 1 | From 0 to 200 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the DT time delay for the first stage SEF element. | | | |
| ISEF>2 TMS | 3A.42 | 1 | From 0.025 to 1.2 in steps of 0.005<br>*[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of IEC IDMT curves. | | | |
| ISEF>2 Time Dial | 3A.43 | 1 | From 0.01 to 100 in steps of 0.01<br>*[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of IEEE/US IDMT curves. | | | |
| ISEF>2 IDG Time | 3A.44 | 1.2 | From 1 to 2 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the minimum operate time at high levels of fault current for IDG curves. | | | |
| ISEF>2 DT Adder | 3A.45 | 0 | From 0 to 100 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting adds an additional fixed time delay to the IDMT Operate characteristic. | | | |
| ISEF>2 Reset Chr | 3A.46 | DT | DT<br>Inverse<br>*[Indexed String]* |
| This setting determines the type of Reset characteristic used for the IEEE/US curves. | | | |
| ISEF>2 tRESET | 3A.47 | 0 | From 0 to 100 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting determines the Reset time for the Definite Time Reset characteristic | | | |
| ISEF>2 UsrRstChr | 3A.48 | DT | DT<br>Def User Curve 1<br>Def User Curve 2<br>Def User Curve 3<br>Def User Curve 4<br>*[Indexed String]* |
| This setting determines the type of Reset characteristic used for the user defined curves. | | | |
| ISEF>3 Status | 3A.49 | Disabled | Disabled<br>Enabled<br>*[Indexed String]* |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| This setting enables or disables the third stage SEF element. There is no choice of curves because this stage is DT only. | | | |
| ISEF>3 Direction | 3A.4A | Non-Directional | Non-Directional<br>*[Indexed String]* |
| This setting determines the direction of measurement for the third stage SEF element. | | | |
| ISEF>3 Current | 3A.4D | 0.4 | From 0.001 to 2 in steps of 0.001<br>*[Courier Number (current)]* |
| This setting sets the pick-up threshold for the third stage SEF element. | | | |
| ISEF>3 Delay | 3A.4E | 0.5 | From 0 to 200 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the DT time delay for the third stage SEF element. | | | |
| ISEF>4 Status | 3A.50 | Disabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the fourth stage SEF element. There is no choice of curves because this stage is DT only. | | | |
| ISEF>4 Direction | 3A.51 | Non-Directional | Non-Directional<br>*[Indexed String]* |
| This setting determines the direction of measurement for the fourth stage SEF element. | | | |
| ISEF>4 Current | 3A.54 | 0.6 | From 0.001 to 2 in steps of 0.001<br>*[Courier Number (current)]* |
| This setting sets the pick-up threshold for the fourth stage SEF element. | | | |
| ISEF>4 Delay | 3A.55 | 0.25 | From 0 to 200 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the DT time delay for the fourth stage SEF element. | | | |
| ISEF> Blocking | 3A.57 | 0x000 | AR Blks ISEF>3<br>AR Blks ISEF>4<br>2H Blocks ISEF>1<br>2H Blocks ISEF>2<br>2H Blocks ISEF>3<br>2H Blocks ISEF>4<br>*[Binary Flag (12 bits)]* |
| This setting cell contains a binary string (data type G64B), where you can define which blocking signals block which stage. The available settings depend on the model chosen. This description is for models without VTS blocking | | | |
| ISEF> Blocking | 3A.57 | 0x000 | 2H Blocks ISEF>1<br>2H Blocks ISEF>2<br>2H Blocks ISEF>3<br>2H Blocks ISEF>4<br>*[Binary Flag (12 bits)]* |
| This setting cell contains a binary string (data type G64C), where you can define which blocking signals block which stage. The available settings depend on the model chosen. This description is for models without VTS blocking and without Autoreclose. | | | |
| GROUP 1: THERMAL OVERLOAD | 3C.00 | | |
| This column contains settings for Thermal Overload | | | |
| Characteristic | 3C.01 | Single | Disabled<br>Single<br>Dual<br>*[Indexed String]* |
| This setting determines the operate characteristic for the thermal overload element. | | | |
| Thermal Trip | 3C.02 | 1 | From 0.08*I1 to 4.0*I1 in steps of 0.01*I1<br>*[Courier Number (current)]* |
| This setting sets the pick-up threshold of the thermal characteristic. This would normally be the maximum full load current. | | | |
| Thermal Alarm | 3C.03 | 70 | From 50 to 100 in steps of 1<br>*[Courier Number (percentage)]* |
| This setting sets the thermal state threshold at which an alarm will be generated. This corresponds to a percentage of the trip threshold | | | |
| Time Constant 1 | 3C.04 | 10 | From 1 to 200 in steps of 1<br>*[Courier Number (time-minutes)]* |
| This setting sets the thermal time constant for a single time constant characteristic. | | | |
| Time Constant 2 | 3C.05 | 5 | From 1 to 200 in steps of 1<br>*[Courier Number (time-minutes)]* |
| This setting sets the thermal time constant for a dual time constant characteristic. | | | |
| k factor | 3C.06 | 1.05 | From 1 to 1.5 in steps of 0.01 |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| | | | *[Courier Number]* |
| This setting sets the k factor | | | |
| GROUP 1: COLD LOAD PICKUP | 3E.00 | | |
| This column contains settings for Cold Load Pickup | | | |
| tcold Time Delay | 3E.01 | 7200 | From 0 to 14400 in steps of 1 *[Courier Number (time-seconds)]* |
| This setting determines the time the load needs to be de-energised (dead time) before the new settings are applied. | | | |
| tclp Time Delay | 3E.02 | 7200 | From 0 to 14400 in steps of 1 *[Courier Number (time-seconds)]* |
| This setting controls the period of time for which the relevant overcurrent and earth fault settings are altered or inhibited following circuit breaker closure. | | | |
| OVERCURRENT | 3E.20 | | |
| The settings under this sub-heading relate to the Phase Overcurrent elements | | | |
| I>1 Status | 3E.21 | Enable | Block Enable *[Indexed String]* |
| Selecting 'Enable' means that the current and time settings in these cells will be used during the "tclp" time.  Selecting 'Block' simply blocks the protection stage during the "tclp" time. | | | |
| I>1 Current Set | 3E.22 | 1.5 | From 0.01 to 4 in steps of 0.01 *[Courier Number (current)]* |
| This setting determines the new pick-up setting for the first stage Overcurrent element during the tclp time delay. | | | |
| I>1 Time Delay | 3E.24 | 1 | From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting sets the new operate DT time delay for the first stage Overcurrent element during the tclp time. | | | |
| I>1 TMS | 3E.25 | 1 | From 0.025 to 1.2 in steps of 0.005 *[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of  IEC IDMT curves. | | | |
| I>1 Time Dial | 3E.26 | 1 | From 0.01 to 100 in steps of 0.01 *[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of  IEEE/US IDMT curves. | | | |
| I>1 k (RI) | 3E.27 | 1 | From 0.1 to 10 in steps of 0.05 *[Courier Number (decimal)]* |
| This setting sets the new time multiplier setting to adjust the operate time of the RI curve during the tclp time. | | | |
| I>2 Status | 3E.29 | Enable | Block Enable *[Indexed String]* |
| Selecting 'Enable' means that the current and time settings in these cells will be used during the "tclp" time.  Selecting 'Block' simply blocks the protection stage during the "tclp" time. | | | |
| I>2 Current Set | 3E.2A | 1.5 | From 0.01 to 4 in steps of 0.01 *[Courier Number (current)]* |
| This setting determines the new pick-up setting for the second stage Overcurrent element during the tclp time delay. | | | |
| I>2 Time Delay | 3E.2C | 1 | From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting sets the new operate DT time delay for the second stage Overcurrent element during the tclp time. | | | |
| I>2 TMS | 3E.2D | 1 | From 0.025 to 1.2 in steps of 0.005 *[Courier Number (decimal)]* |
| This setting sets the new time multiplier setting for the second stage Overcurrent element to adjust the operate time of the IEC IDMT characteristic during the tclp time. | | | |
| I>2 Time Dial | 3E.2E | 1 | From 0.01 to 100 in steps of 0.01 *[Courier Number (decimal)]* |
| This setting sets the new time multiplier setting to adjust the operate time of the IEEE/US  IDMT curves during the tclp time. | | | |
| I>2 k (RI) | 3E.2F | 1 | From 0.1 to 10 in steps of 0.05 *[Courier Number (decimal)]* |
| This setting defines the TMS constant to adjust the operate time of the RI curve. | | | |
| I>3 Status | 3E.31 | Block | Block Enable *[Indexed String]* |
| Selecting 'Enable' means that the current and time settings in these cells will be used during the "tclp" time.  Selecting 'Block' simply blocks the protection stage during the "tclp" time. | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| I>3 Current Set | 3E.32 | 25 | From 0.01 to 32 in steps of 0.01 *[Courier Number (current)]* |
| This setting sets the new pick-up setting for the third stage Overcurrent element during the tclp time delay. | | | |
| I>3 Time Delay | 3E.33 | 0 | From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting sets the new operate DT time delay for the first stage Overcurrent element during the tclp time. | | | |
| I>4 Status | 3E.35 | Block | Block Enable *[Indexed String]* |
| Selecting 'Enable' means that the current and time settings in these cells will be used during the "tclp" time. Selecting 'Block' simply blocks the protection stage during the "tclp" time. | | | |
| I>4 Current Set | 3E.36 | 25 | From 0.01 to 32 in steps of 0.01 *[Courier Number (current)]* |
| This setting sets the new pick-up setting for the fourth stage Overcurrent element during the tclp time delay. | | | |
| I>4 Time Delay | 3E.37 | 0 | From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]* |
| Setting for the new operate time delay for the fourth stage definite time element during the tclp time. | | | |
| STAGE 1 E/F 1 | 3E.39 | | |
| The settings under this sub-heading relate to measured Earth Fault protection (EF1) | | | |
| IN1>1 Status | 3E.3A | Enable | Block Enable *[Indexed String]* |
| Selecting 'Enable' means that the current and time settings in these cells will be used during the "tclp" time. Selecting 'Block' simply blocks the protection stage during the "tclp" time. | | | |
| IN1>1 Current | 3E.3B | 0.2 | From 0.01 to 4 in steps of 0.01 *[Courier Number (current)]* |
| This setting sets the new pick-up setting for the measured Earth Fault element during the tclp time delay. | | | |
| IN1>1 IDG Is | 3E.3C | 1.5 | From 1 to 4 in steps of 0.1 *[Courier Number (decimal)]* |
| This setting defines the new TMS of the IDG curve during the tclp time. | | | |
| IN1>1 Time Delay | 3E.3E | 1 | From 0 to 1200 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting sets the new operate DT time delay for the measured Earth Fault element during the tclp time. | | | |
| IN1>1 TMS | 3E.3F | 1 | From 0.025 to 1.2 in steps of 0.005 *[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of IEC IDMT curves. | | | |
| IN1>1 Time Dial | 3E.40 | 1 | From 0.01 to 100 in steps of 0.01 *[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of IEEE/IDMT curves. | | | |
| IN1>1 k (RI) | 3E.41 | 1 | From 0.1 to 10 in steps of 0.05 *[Courier Number (decimal)]* |
| This setting defines the TMS constant to adjust the operate time of the RI curve. | | | |
| STAGE 1 E/F 2 | 3E.43 | | |
| The settings under this sub-heading relate to derived Earth Fault protection (EF2) | | | |
| IN2>1 Status | 3E.44 | Enable | Block Enable *[Indexed String]* |
| Selecting 'Enable' means that the current and time settings in these cells will be used during the "tclp" time. Selecting 'Block' simply blocks the protection stage during the "tclp" time. | | | |
| IN2>1 Current | 3E.45 | 0.2 | From 0.05 to 4 in steps of 0.01 *[Courier Number (current)]* |
| This setting sets the new pick-up setting for the derived Earth Fault element during the tclp time delay. | | | |
| IN2>1 IDG Is | 3E.46 | 1.5 | From 1 to 4 in steps of 0.1 *[Courier Number (decimal)]* |
| This setting defines the new TMS of the IDG curve during the tclp time. | | | |
| IN2>1 Time Delay | 3E.48 | 1 | From 0 to 200 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting sets the new operate DT time delay for the derived Earth Fault element during the tclp time. | | | |
| IN2>1 TMS | 3E.49 | 1 | From 0.025 to 1.2 in steps of 0.005 *[Courier Number (decimal)]* |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| This is the Time Multiplier Setting to adjust the operate time of IEC IDMT curves. | | | |
| IN2>1 Time Dial | 3E.4A | 1 | From 0.01 to 100 in steps of 0.01 *[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of IEEE/IDMT curves. | | | |
| IN2>1 k (RI) | 3E.4B | 1 | From 0.1 to 10 in steps of 0.05 *[Courier Number (decimal)]* |
| This setting defines the TMS constant to adjust the operate time of the RI curve. | | | |
| OVERCURRENT | 3E.4F | | |
| The settings under this sub-heading relate to the Phase Overcurrent elements | | | |
| I>5 Status | 3E.50 | Enable | Block Enable *[Indexed String]* |
| Selecting 'Enable' means that the current and time settings in these cells will be used during the "tclp" time.  Selecting 'Block' simply blocks the protection stage during the "tclp" time. | | | |
| I>5 Current Set | 3E.51 | 1.5 | From 0.01 to 4 in steps of 0.01 *[Courier Number (current)]* |
| This setting sets the new pick-up setting for the fifth stage Overcurrent element during the tclp time delay. | | | |
| I>5 Time Delay | 3E.53 | 1 | From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting sets the new operate DT time delay for the fifth stage Overcurrent element during the tclp time. | | | |
| I>5 TMS | 3E.54 | 1 | From 0.025 to 1.2 in steps of 0.005 *[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of IEC IDMT curves. | | | |
| I>5 Time Dial | 3E.55 | 1 | From 0.01 to 100 in steps of 0.01 *[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of IEEE/US IDMT curves. | | | |
| I>5 k (RI) | 3E.56 | 1 | From 0.1 to 10 in steps of 0.05 *[Courier Number (decimal)]* |
| This setting sets the new time multiplier setting to adjust the operate time of the RI curve during the tclp time. | | | |
| I>6 Status | 3E.58 | Block | Block Enable *[Indexed String]* |
| Selecting 'Enable' means that the current and time settings in these cells will be used during the "tclp" time.  Selecting 'Block' simply blocks the protection stage during the "tclp" time. | | | |
| I>6 Current Set | 3E.59 | 25 | From 0.01 to 32 in steps of 0.01 *[Courier Number (current)]* |
| This setting sets the new pick-up setting for the sixth stage Overcurrent element during the tclp time delay. | | | |
| I>6 Time Delay | 3E.5A | 0 | From 0 to 100 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting sets the new operate DT time delay for the sixth stage Overcurrent element during the tclp time. | | | |
| STAGE 2 E/F 1 | 3E.5C | | |
| The settings under this sub-heading relate to measured Earth Fault protection (EF1) | | | |
| IN1>2 Status | 3E.5D | Enable | Block Enable *[Indexed String]* |
| Selecting 'Enable' means that the current and time settings in these cells will be used during the "tclp" time.  Selecting 'Block' simply blocks the protection stage during the "tclp" time. | | | |
| IN1>2 Current | 3E.5E | 0.2 | From 0.01 to 4 in steps of 0.001 *[Courier Number (current)]* |
| This setting sets the new pick-up setting for the measured Earth Fault element during the tclp time delay. | | | |
| IN1>2 IDG Is | 3E.5F | 1.5 | From 1 to 4 in steps of 0.1 *[Courier Number (decimal)]* |
| This setting defines the new TMS of the IDG curve during the tclp time. | | | |
| IN1>2 Time Delay | 3E.60 | 1 | From 0 to 1200 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting sets the new operate DT time delay for the measured Earth Fault element during the tclp time. | | | |
| IN1>2 TMS | 3E.61 | 1 | From 0.025 to 1.2 in steps of 0.005 *[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of IEC IDMT curves. | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|-----------|---------|-----------------|-------------------|
| | | DESCRIPTION | |
| IN1>2 Time Dial | 3E.62 | 1 | From 0.01 to 100 in steps of 0.01 *[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of IEEE/IDMT curves. | | | |
| IN1>2 k (RI) | 3E.63 | 1 | From 0.1 to 10 in steps of 0.05 *[Courier Number (decimal)]* |
| This setting defines the TMS constant to adjust the operate time of the RI curve. | | | |
| STAGE 3 E/F 1 | 3E.65 | | |
| The settings under this sub-heading relate to measured Earth Fault protection (EF1) | | | |
| IN1>3 Status | 3E.66 | Block | Block Enable *[Indexed String]* |
| Selecting 'Enable' means that the current and time settings in these cells will be used during the "tclp" time. Selecting 'Block' simply blocks the protection stage during the "tclp" time. | | | |
| IN1>3 Current | 3E.67 | 0.2 | From 0.01 to 32 in steps of 0.01 *[Courier Number (current)]* |
| This setting sets the new pick-up setting for the measured Earth Fault element during the tclp time delay. | | | |
| IN1>3 Time Delay | 3E.68 | 1 | From 0 to 1200 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting sets the new operate DT time delay for the measured Earth Fault element during the tclp time. | | | |
| STAGE 4 E/F 1 | 3E.6A | | |
| The settings under this sub-heading relate to measured Earth Fault protection (EF1) | | | |
| IN1>4 Status | 3E.6B | Block | Block Enable *[Indexed String]* |
| Selecting 'Enable' means that the current and time settings in these cells will be used during the "tclp" time. Selecting 'Block' simply blocks the protection stage during the "tclp" time. | | | |
| IN1>4 Current | 3E.6C | 0.2 | From 0.01 to 32 in steps of 0.01 *[Courier Number (current)]* |
| This setting sets the new pick-up setting for the measured Earth Fault element during the tclp time delay. | | | |
| IN1>4 Time Delay | 3E.6D | 1 | From 0 to 1200 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting sets the new operate DT time delay for the measured Earth Fault element during the tclp time. | | | |
| STAGE 2 E/F 2 | 3E.6F | | |
| The settings under this sub-heading relate to derived Earth Fault protection (EF2) | | | |
| IN2>2 Status | 3E.70 | Enable | Block Enable *[Indexed String]* |
| Selecting 'Enable' means that the current and time settings in these cells will be used during the "tclp" time. Selecting 'Block' simply blocks the protection stage during the "tclp" time. | | | |
| IN2>2 Current | 3E.71 | 0.2 | From 0.05 to 4 in steps of 0.01 *[Courier Number (current)]* |
| This setting sets the new pick-up setting for the derived Earth Fault element during the tclp time delay. | | | |
| IN2>2 IDG Is | 3E.72 | 1.5 | From 1 to 4 in steps of 0.1 *[Courier Number (decimal)]* |
| This setting defines the new TMS of the IDG curve during the tclp time. | | | |
| IN2>2 Time Delay | 3E.73 | 1 | From 0 to 200 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting sets the new operate DT time delay for the derived Earth Fault element during the tclp time. | | | |
| IN2>2 TMS | 3E.74 | 1 | From 0.025 to 1.2 in steps of 0.005 *[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of IEC IDMT curves. | | | |
| IN2>2 Time Dial | 3E.75 | 1 | From 0.01 to 100 in steps of 0.01 *[Courier Number (decimal)]* |
| This is the Time Multiplier Setting to adjust the operate time of IEEE/IDMT curves. | | | |
| IN2>2 k (RI) | 3E.76 | 1 | From 0.1 to 10 in steps of 0.05 *[Courier Number (decimal)]* |
| This setting defines the TMS constant to adjust the operate time of the RI curve. | | | |
| STAGE 3 E/F 2 | 3E.78 | | |
| The settings under this sub-heading relate to derived Earth Fault protection (EF2) | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| IN2>3 Status | 3E.79 | Block | Block<br>Enable<br>*[Indexed String]* |
| Selecting 'Enable' means that the current and time settings in these cells will be used during the "tclp" time.  Selecting 'Block' simply blocks the protection stage during the "tclp" time. | | | |
| IN2>3 Current | 3E.7A | 0.2 | From 0.01 to 32 in steps of 0.01<br>*[Courier Number (current)]* |
| This setting sets the new pick-up setting for the derived Earth Fault element during the tclp time delay. | | | |
| IN2>3 Time Delay | 3E.7B | 1 | From 0 to 200 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the new operate DT time delay for the derived Earth Fault element during the tclp time. | | | |
| STAGE 4 E/F 2 | 3E.7D | | |
| The settings under this sub-heading relate to derived Earth Fault protection (EF2) | | | |
| IN2>4 Status | 3E.7E | Block | Block<br>Enable<br>*[Indexed String]* |
| Selecting 'Enable' means that the current and time settings in these cells will be used during the "tclp" time.  Selecting 'Block' simply blocks the protection stage during the "tclp" time. | | | |
| IN2>4 Current | 3E.7F | 0.2 | From 0.01 to 32 in steps of 0.01<br>*[Courier Number (current)]* |
| This setting sets the new pick-up setting for the derived Earth Fault element during the tclp time delay. | | | |
| IN2>4 Time Delay | 3E.80 | 1 | From 0 to 200 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the new operate DT time delay for the derived Earth Fault element during the tclp time. | | | |
| GROUP 1: SELECTIVE LOGIC | 3F.00 | | |
| This column contains settings for selective logic | | | |
| OVERCURRENT | 3F.01 | | |
| The settings under this sub-heading relate to Phase Overcurrent Protection (POC). Selective Logic is only available for stages 3 and 4 and 6. | | | |
| I>3 Time Delay | 3F.02 | 1 | From 0 to 100 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the new operate DT time delay for the third stage Overcurrent element when the Selective Logic function is active. | | | |
| I>4 Time Delay | 3F.03 | 1 | From 0 to 100 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the new operate DT time delay for the fourth stage Overcurrent element when the Selective Logic function is active. | | | |
| I>6 Time Delay | 3F.0D | 1 | From 0 to 100 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the new operate DT time delay for the sixth stage Overcurrent element when the Selective Logic function is active. | | | |
| EARTH FAULT 1 | 3F.14 | | |
| The settings under this sub-heading relate to measured Earth Fault Protection (EF1). Selective Logic is only available for stages 3 and 4. | | | |
| IN1>3 Time Delay | 3F.15 | 2 | From 0 to 200 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| Setting for the third stage definite time earth fault (measured) element operate time when the selective logic is active. | | | |
| IN1>4 Time Delay | 3F.16 | 2 | From 0 to 200 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| Setting for the fourth stage definite time earth fault (measured) element operate time when the selective logic is active. | | | |
| EARTH FAULT 2 | 3F.17 | | |
| The settings under this sub-heading relate to derived Earth Fault Protection (EF1). Selective Logic is only available for stages 3 and 4. | | | |
| IN2>3 Time Delay | 3F.18 | 2 | From 0 to 200 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| Setting for the third stage definite time earth fault (derived) element operate time when the selective logic is active. | | | |
| IN2>4 Time Delay | 3F.19 | 2 | From 0 to 200 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| Setting for the fourth stage definite time earth fault (derived) element operate time when the selective logic is active. | | | |
| SENSITIVE E/F | 3F.1A | | |
| The settings under this sub-heading relate to Sensitive Earth Fault Protection (EF1). Selective Logic is only available for stages 3 and 4. | | | |
| ISEF>3 Delay | 3F.1B | 1 | From 0 to 200 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| Setting for the third stage definite time sensitive earth fault element operate time when the selective logic is active. | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| ISEF>4 Delay | 3F.1C | 0.5 | From 0 to 200 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| Setting for the fourth stage definite time sensitive earth fault element operate time when the selective logic is active. | | | |
| GROUP 1: RESTRICTED E/F | 43.00 | | |
| This column contains settings for Restricted Earth Fault Protection | | | |
| REF Options | 43.01 | Lo Z REF | Hi Z REF<br>Lo Z REF<br>*[Indexed String]* |
| This setting determines the Restricted Earth Fault mode of operation - high impedance or low impedance. | | | |
| IREF> k1 | 43.02 | 20 | From 0 to 20 in steps of 1<br>*[Courier Number (percentage)]* |
| This setting sets the first slope constant of the low impedance biased characteristic. | | | |
| IREF> k2 | 43.03 | 150 | From 0 to 150 in steps of 1<br>*[Courier Number (percentage)]* |
| This setting sets the second slope constant of the low impedance biased characteristic. | | | |
| IREF> Is1 | 43.04 | 0.2 | From 0.08 to 1 in steps of 0.01<br>*[Courier Number (current)]* |
| This setting sets the bias current threshold for the first slope of the low impedance characteristic. | | | |
| IREF> Is2 | 43.05 | 1 | From 0.1 to 1.5 in steps of 0.01<br>*[Courier Number (current)]* |
| This setting sets the bias current threshold for the second slope of the low impedance characteristic. | | | |
| IREF> Is | 43.06 | 0.2 | From 0.05 to 1 in steps of 0.01<br>*[Courier Number (current)]* |
| Setting that determines the minimum differential operate current for the hi-impedance element. | | | |
| GROUP 1: CB FAIL & I< | 45.00 | | |
| This column contains settings for circuit breaker fail and undercurrent protection. | | | |
| BREAKER FAIL | 45.01 | | |
| The settings under this sub-heading relate to Circuit Breaker Fail (CB Fail) settings. | | | |
| CB Fail 1 Status | 45.02 | Enabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the first stage of the CB Fail protection. | | | |
| CB Fail 1 Timer | 45.03 | 0.2 | From 0 to 50 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the first stage CB Fail timer in which the CB opening must be detected. | | | |
| CB Fail 2 Status | 45.04 | Disabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the second stage of the CB Fail protection. | | | |
| CB Fail 2 Timer | 45.05 | 0.4 | From 0 to 50 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the second stage CB Fail timer in which the CB opening must be detected. | | | |
| Ext Prot Reset | 45.07 | CB Open & I< | I< Only<br>CB Open & I<<br>Prot Reset & I<<br>*[Indexed String]* |
| This setting determines the elements that will reset the CB fail timer for CB Failures initiated by external protection functions. | | | |
| UNDER CURRENT | 45.08 | | |
| The settings under this sub-heading relate to Undercurrent settings | | | |
| I< Current Set | 45.09 | 0.1 | From 0.02*I1 to 3.2*I1 in steps of 0.01*I1<br>*[Courier Number (current)]* |
| This setting determines the current threshold, which will reset the CB Fail timer for Overcurrent-based protection. | | | |
| IN< Current Set | 45.0A | 0.1 | From 0.02*I2 to 3.2*I2 in steps of 0.01*I2<br>*[Courier Number (current)]* |
| This setting determines the current threshold, which will reset the CB Fail timer for Earth Fault-based protection | | | |
| ISEF< Current | 45.0B | 0.02 | From 0.001*I3 to 0.8*I3 in steps of 0.0005*I3<br>*[Courier Number (current)]* |
| This setting determines the current threshold, which will reset the CB Fail timer for SEF-based protection. | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| BLOCKED O/C | 45.0C | | |
| The settings under this sub-heading relate to Blocked Overcurrent settings. | | | |
| Remove I> Start | 45.0D | Disabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the  Remove I>Start signal. | | | |
| Remove IN> Start | 45.0E | Disabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the  Remove IN>Start signal. | | | |
| GROUP 1:<br>AUTORECLOSE | 49.00 | | |
| This column contains settings for Autoreclose (AR) | | | |
| AR Mode Select | 49.01 | Command Mode | Command Mode<br>Opto Set Mode<br>User Set Mode<br>Pulse Set Mode<br>*[Indexed String]* |
| This setting determines the Autoreclose mode. | | | |
| Number of Shots | 49.02 | 1 | From 1 to 4 in steps of 1<br>*[Unsigned Integer (16 bits)]* |
| This setting sets the required number of Autoreclose cycles for Overcurrent trips. | | | |
| Number SEF Shots | 49.03 | 0 | From 0 to 4 in steps of 1<br>*[Unsigned Integer (16 bits)]* |
| This setting sets the number of required Autoreclose cycles for SEF trips. | | | |
| Sequence Co-ord | 49.04 | Disabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables the sequence co-ordination function to ensure the correct protection grading between an upstream and downstream re-closing device. | | | |
| Dead Time 1 | 49.06 | 10 | From 0.01 to 300 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the dead time for the first Autoreclose cycle. | | | |
| Dead Time 2 | 49.07 | 60 | From 0.01 to 300 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the dead time for the second Autoreclose cycle. | | | |
| Dead Time 3 | 49.08 | 180 | From 0.01 to 9999 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the dead time for the third Autoreclose cycle. | | | |
| Dead Time 4 | 49.09 | 180 | From 0.01 to 9999 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the dead time for the fourth Autoreclose cycle. | | | |
| CB Healthy Time | 49.0A | 5 | From 0.01 to 9999 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting defines the CB lockout time | | | |
| Start Dead t On | 49.0B | Protection Reset | Protection Reset<br>CB Trips<br>*[Indexed String]* |
| This setting determines whether the dead time has started when the circuit breaker trips or when the protection trip resets. | | | |
| tReclaim Extend | 49.0C | No Operation | On Prot Start<br>No Operation<br>*[Indexed String]* |
| This setting allows the user to control whether the reclaim timer is suspended by the protection start contacts or not (i.e. whether the IED is permitted to reclaim if a fault condition is present and will be cleared in a long time-scale). | | | |
| Reclaim Time 1 | 49.0D | 180 | From 1 to 600 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| Sets the Autoreclose reclaim time for the first Autoreclose cycle. | | | |
| Reclaim Time 2 | 49.0E | 180 | From 1 to 600 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| Sets the Autoreclose reclaim time for the second Autoreclose cycle. | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|-----------|---------|-----------------|-------------------|
| **DESCRIPTION** | | | |
| Reclaim Time 3 | 49.0F | 180 | From 1 to 600 in steps of 0.01 *[Courier Number (time-seconds)]* |
| Sets the Autoreclose reclaim time for the third Autoreclose cycle. | | | |
| Reclaim Time 4 | 49.10 | 180 | From 1 to 600 in steps of 0.01 *[Courier Number (time-seconds)]* |
| Sets the Autoreclose reclaim time for the fourth Autoreclose cycle. | | | |
| AR Inhibit Time | 49.11 | 5 | From 0.01 to 600 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting defines the inhibit time before Autoreclose is initiated following a manual CB closure. | | | |
| AR Lockout | 49.12 | No Block | No Block Block Inst Prot *[Indexed String]* |
| This setting is used to block instantaneous protection if the IED has undergone Autoreclose Lockout. | | | |
| EFF Maint Lock | 49.13 | No Block | No Block Block Inst Prot *[Indexed String]* |
| This setting is used to block instantaneous protection for the last circuit breaker trip before lockout occurs. | | | |
| AR Deselected | 49.14 | No Block | No Block Block Inst Prot *[Indexed String]* |
| This setting allows the instantaneous protection to be blocked when Autoreclose is in non-auto mode of operation. | | | |
| Manual Close | 49.15 | No Block | No Block Block Inst Prot *[Indexed String]* |
| This setting is used to block instantaneous protection when the circuit breaker is closed manually whilst there is no auto-reclose sequence in progress or Autoreclose is inhibited. | | | |
| Trip 1 Main | 49.16 | No Block | No Block Block Inst Prot *[Indexed String]* |
| The Trip (n) Main settings are used to selectively block the instantaneous elements of phase and earth fault protection elements for a circuit breaker trip sequence. | | | |
| Trip 2 Main | 49.17 | Block Inst Prot | No Block Block Inst Prot *[Indexed String]* |
| The Trip (n) Main settings are used to selectively block the instantaneous elements of phase and earth fault protection elements for a circuit breaker trip sequence. | | | |
| Trip 3 Main | 49.18 | Block Inst Prot | No Block Block Inst Prot *[Indexed String]* |
| The Trip (n) Main settings are used to selectively block the instantaneous elements of phase and earth fault protection elements for a circuit breaker trip sequence. | | | |
| Trip 4 Main | 49.19 | Block Inst Prot | No Block Block Inst Prot *[Indexed String]* |
| The Trip (n) Main settings are used to selectively block the instantaneous elements of phase and earth fault protection elements for a circuit breaker trip sequence. | | | |
| Trip 5 Main | 49.1A | Block Inst Prot | No Block Block Inst Prot *[Indexed String]* |
| The Trip (n) Main settings are used to selectively block the instantaneous elements of phase and earth fault protection elements for a circuit breaker trip sequence. | | | |
| Trip 1 SEF | 49.1B | Block Inst Prot | No Block Block Inst Prot *[Indexed String]* |
| The Trip (n) SEF settings are used to selectively block the instantaneous elements of sensitive earth fault protection elements for a circuit breaker trip sequence. | | | |
| Trip 2 SEF | 49.1C | Block Inst Prot | No Block Block Inst Prot *[Indexed String]* |
| The Trip (n) SEF settings are used to selectively block the instantaneous elements of sensitive earth fault protection elements for a circuit | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| breaker trip sequence. | | | |
| Trip 3 SEF | 49.1D | Block Inst Prot | No Block<br>Block Inst Prot<br>*[Indexed String]* |
| The Trip (n) SEF settings are used to selectively block the instantaneous elements of sensitive earth fault protection elements for a circuit breaker trip sequence. | | | |
| Trip 4 SEF | 49.1E | Block Inst Prot | No Block<br>Block Inst Prot<br>*[Indexed String]* |
| The Trip (n) SEF settings are used to selectively block the instantaneous elements of sensitive earth fault protection elements for a circuit breaker trip sequence. | | | |
| Trip 5 SEF | 49.1F | Block Inst Prot | No Block<br>Block Inst Prot<br>*[Indexed String]* |
| The Trip (n) SEF settings are used to selectively block the instantaneous elements of sensitive earth fault protection elements for a circuit breaker trip sequence. | | | |
| Man Close on Flt | 49.20 | Lockout | No Lockout<br>Lockout<br>*[Indexed String]* |
| This setting decides whether the AR should lockout or not after a Manual Close on Fault operation. | | | |
| Trip AR Inactive | 49.21 | No Lockout | No Lockout<br>Lockout<br>*[Indexed String]* |
| When AR is inactive (Non-auto, or Live Line mode), this setting determines whether The AR should be locked out or not. | | | |
| Reset Lockout by | 49.22 | User Interface | User Interface<br>Select NonAuto<br>*[Indexed String]* |
| This setting is used to determine the method by which the Lockout is reset. | | | |
| AR on Man Close | 49.24 | Inhibited | Enabled<br>Inhibited<br>*[Indexed String]* |
| If this is set to 'Enabled', autoreclosing can be initiated immediately on circuit breaker closure, overriding the settings AR Inhibit Time, Man Close on Flt and Manual Close. | | | |
| Sys Check Time | 49.25 | 5 | From 0.01 to 9999 in steps of 0.01<br>*[Courier Number (time-seconds)]* |
| This setting sets the amount of time set for System Checks for Autoreclose operation. | | | |
| AR Skip Shot 1 | 49.26 | Disabled | Disabled<br>Enabled<br>*[Indexed String]* |
| When enabled this setting allows the Autoreclose sequence counter to be incremented by one via a DDB input signal. This will therefore decrease the number of available re-close shots. | | | |
| AR INITIATION | 49.28 | | |
| The settings under this sub-heading relate to Autoreclose initiation | | | |
| I>1 AR | 49.29 | Initiate Main AR | No Action<br>Initiate Main AR<br>*[Indexed String]* |
| This setting determines impact of the first stage overcurrent protection on AR operation. | | | |
| I>2 AR | 49.2A | Initiate Main AR | No Action<br>Initiate Main AR<br>*[Indexed String]* |
| This setting determines impact of the second stage overcurrent protection on AR operation. | | | |
| I>3 AR | 49.2B | Initiate Main AR | No Action<br>Initiate Main AR<br>Block AR<br>*[Indexed String]* |
| This setting determines impact of the third stage overcurrent protection on AR operation. | | | |
| I>4 AR | 49.2C | Initiate Main AR | No Action<br>Initiate Main AR<br>Block AR<br>*[Indexed String]* |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| This setting determines impact of the fourth stage overcurrent protection on AR operation. | | | |
| IN1>1 AR | 49.2D | Initiate Main AR | No Action<br>Initiate Main AR<br>*[Indexed String]* |
| This setting determines impact of the first stage measured earth fault overcurrent protection on AR operation. | | | |
| IN1>2 AR | 49.2E | Initiate Main AR | No Action<br>Initiate Main AR<br>*[Indexed String]* |
| This setting determines impact of the second stage measured earth fault overcurrent protection on AR operation. | | | |
| IN1>3 AR | 49.2F | Initiate Main AR | No Action<br>Initiate Main AR<br>Block AR<br>*[Indexed String]* |
| This setting determines impact of the third stage measured earth fault overcurrent protection on AR operation. | | | |
| IN1>4 AR | 49.30 | Initiate Main AR | No Action<br>Initiate Main AR<br>Block AR<br>*[Indexed String]* |
| This setting determines impact of the fourth stage measured earth fault overcurrent protection on AR operation. | | | |
| IN2>1 AR | 49.31 | No Action | No Action<br>Initiate Main AR<br>*[Indexed String]* |
| This setting determines impact of the first stage derived earth fault overcurrent protection on AR operation. | | | |
| IN2>2 AR | 49.32 | No Action | No Action<br>Initiate Main AR<br>*[Indexed String]* |
| This setting determines impact of the second stage derived earth fault overcurrent protection on AR operation. | | | |
| IN2>3 AR | 49.33 | No Action | No Action<br>Initiate Main AR<br>Block AR<br>*[Indexed String]* |
| This setting determines impact of the third stage derived earth fault overcurrent protection on AR operation. | | | |
| IN2>4 AR | 49.34 | No Action | No Action<br>Initiate Main AR<br>Block AR<br>*[Indexed String]* |
| This setting determines impact of the fourth stage derived earth fault overcurrent protection on AR operation. | | | |
| ISEF>1 AR | 49.35 | No Action | No Action<br>Initiate Main AR<br>Initiate SEF AR<br>Block AR<br>*[Indexed String]* |
| This setting determines impact of the first stage sensitive earth fault overcurrent protection on AR operation. | | | |
| ISEF>2 AR | 49.36 | No Action | No Action<br>Initiate Main AR<br>Initiate SEF AR<br>Block AR<br>*[Indexed String]* |
| This setting determines impact of the second stage sensitive earth fault overcurrent protection on AR operation. | | | |
| ISEF>3 AR | 49.37 | No Action | No Action<br>Initiate Main AR<br>Initiate SEF AR<br>Block AR<br>*[Indexed String]* |
| This setting determines impact of the third stage sensitive earth fault overcurrent protection on AR operation. | | | |
| ISEF>4 AR | 49.38 | No Action | No Action<br>Initiate Main AR<br>Initiate SEF AR<br>Block AR<br>*[Indexed String]* |
| This setting determines impact of the fourth stage sensitive earth fault overcurrent protection on AR operation. | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| Ext Prot | 49.3C | No Action | No Action<br>Initiate Main AR<br>*[Indexed String]* |
| This setting determines if external protection inputs initiates auto-reclose.  This must be mapped in programmable scheme logic. | | | |
| I>5 AR | 49.3D | Initiate Main AR | No Action<br>Initiate Main AR<br>*[Indexed String]* |
| This setting determines impact of the fifth stage overcurrent protection on AR operation. | | | |
| I>6 AR | 49.3E | Initiate Main AR | No Action<br>Initiate Main AR<br>Block AR<br>*[Indexed String]* |
| This setting determines impact of the sixth stage overcurrent protection on AR operation. | | | |
| SYSTEM CHECKS | 49.40 | | |
| The settings under this sub-heading relate to Autoreclose system checks | | | |
| Live/Dead Ccts | 49.43 | Disabled | Disabled<br>Enabled<br>*[Indexed String]* |
| When enabled, this setting will produce an "AR Check Ok" DDB signal when the Live/Dead Ccts DDB signal is high. | | | |
| No System Checks | 49.44 | Enabled | Disabled<br>Enabled<br>*[Indexed String]* |
| When enabled this setting completely disables system checks thus allowing Autoreclose initiation without system checks. | | | |
| SysChk on Shot 1 | 49.45 | Enabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting is used to enable/disable system checks for the first auto-reclose shot. | | | |
| GROUP 1: INPUT LABELS | 4A.00 | | |
| This column contains settings for the opto-input Labels | | | |
| Opto Input 1 | 4A.01 | Input L1 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| This setting defines the label for opto-input 1 | | | |
| Opto Input 2 | 4A.02 | Input L2 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| This setting defines the label for opto-input 2 | | | |
| Opto Input 3 | 4A.03 | Input L3 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| This setting defines the label for opto-input 3 | | | |
| Opto Input 4 | 4A.04 | Input L4 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| This setting defines the label for opto-input 4 | | | |
| Opto Input 5 | 4A.05 | Input L5 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| This setting defines the label for opto-input 5 | | | |
| Opto Input 6 | 4A.06 | Input L6 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| This setting defines the label for opto-input 6 | | | |
| Opto Input 7 | 4A.07 | Input L7 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| This setting defines the label for opto-input 7 | | | |
| Opto Input 8 | 4A.08 | Input L8 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| This setting defines the label for opto-input 8 | | | |
| Opto Input 9 | 4A.09 | Input L9 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| This setting defines the label for opto-input 9 | | | |
| Opto Input 10 | 4A.0A | Input L10 | From 32 to 234 in steps of 1<br>*[ASCII Text (16 chars)]* |
| This setting defines the label for opto-input 10 | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|-----------|---------|-----------------|-------------------|
| DESCRIPTION | | | |
| Opto Input 11 | 4A.0B | Input L11 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| This setting defines the label for opto-input 11 | | | |
| Opto Input 12 | 4A.0C | Input L12 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| This setting defines the label for opto-input 12 | | | |
| Opto Input 13 | 4A.0D | Input L13 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| This setting defines the label for opto-input 13 | | | |
| GROUP 1: OUTPUT LABELS | 4B.00 | | |
| This column contains settings for the output relay labels | | | |
| Relay 1 | 4B.01 | Output R1 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| This setting defines the label for output relay 1 | | | |
| Relay 2 | 4B.02 | Output R2 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| This setting defines the label for output relay 2 | | | |
| Relay 3 | 4B.03 | Output R3 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| This setting defines the label for output relay 3 | | | |
| Relay 4 | 4B.04 | Output R4 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| This setting defines the label for output relay 4 | | | |
| Relay 5 | 4B.05 | Output R5 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| This setting defines the label for output relay 5 | | | |
| Relay 6 | 4B.06 | Output R6 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| This setting defines the label for output relay 6 | | | |
| Relay 7 | 4B.07 | Output R7 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| This setting defines the label for output relay 7 | | | |
| Relay 8 | 4B.08 | Output R8 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| This setting defines the label for output relay 8 | | | |
| Relay 9 | 4B.09 | Output R9 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| This setting defines the label for output relay 9 | | | |
| Relay 10 | 4B.0A | Output R10 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| This setting defines the label for output relay 10 | | | |
| Relay 11 | 4B.0B | Output R11 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| This setting defines the label for output relay 11 | | | |
| Relay 12 | 4B.0C | Output R12 | From 32 to 234 in steps of 1 *[ASCII Text (16 chars)]* |
| This setting defines the label for output relay 12 | | | |
| GROUP 1: HIF/TEFD | 4C.00 | | |
| This column contains settings for High Impedance Fault Detection | | | |
| HIF SEF AnyStart | 4C.01 | Disabled | Disabled Enabled *[Indexed String]* |
| This setting allows the ISEF> Any Start DDB signal to trigger the HIF detection | | | |
| HIF tPREPARE | 4C.02 | 2 | From 0.03 to 30 in steps of 0.01 *[Courier Number (time-seconds)]* |
| This setting sets the preparation time required to produce the initial data, such as the average amplitude value. | | | |
| FUNDAMENT.ANALYS | 4C.05 | | |
| This sub-heading contains settings for the Fundamental Analysis (FA) algorithm. | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| FA Status | 4C.06 | Enabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables Fundamental Analysis. | | | |
| FA> Start Thresh | 4C.07 | 0.01 | From 0.00025 to 2 in steps of 0.00025<br>*[Courier Number (current)]* |
| This setting defines the Fundamental Analysis increment Start threshold. The FA algorithm starts the evaluation process when the current increments exceeds this threshold. | | | |
| AdaptBurstThresh | 4C.08 | Enabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables the Adaptive Burst Threshold setting. When enabled, the Burst Threshold is adapted automatically. | | | |
| FA> Burst Thresh | 4C.09 | 0.05 | From 0.00025 to 2 in steps of 0.00025<br>*[Courier Number (current)]* |
| This setting defines the Burst Valid threshold. When the measured current amplitude exceeds this threshold, a valid burst is recognised. | | | |
| FA tAVERAGE | 4C.0A | 10 | From 1 to 60 in steps of 1<br>*[Courier Number (time-seconds)]* |
| This setting defines the time duration window for calculating the average value. | | | |
| FA tINTERMITTENT | 4C.0B | 2 | From 0.5 to 5 in steps of 0.5<br>*[Courier Number (time-seconds)]* |
| This setting defines the time duration in which the Burst Valid shots are counted for a HIF to be recognised. | | | |
| FA tRESET | 4C.0C | 10 | From 10 to 60 in steps of 5<br>*[Courier Number (time-seconds)]* |
| This setting defines the reset time for the FA evaluation process. | | | |
| FA> Burst Count | 4C.0D | 8 | From 3 to 30 in steps of 1<br>*[Courier Number]* |
| This setting sets the number of burst valid shots which is used to determine a HIF condition. | | | |
| FA Trans Sec Lmt | 4C.0E | 3 | From 1 to 10 in steps of 1<br>*[Courier Number]* |
| This setting sets the number of sections which are evaluated for determining a FA transient event. | | | |
| FA DIR Status | 4C.10 | Disabled | Disabled<br>*[Indexed String]* |
| This setting enables or disables FA Direction Detection. | | | |
| COMP.HARM.ANALYS | 4C.20 | | |
| This sub-heading contains settings for the Component Harmonic Analysis (CHA) algorithm. | | | |
| CHA Status | 4C.21 | Enabled | Disabled<br>Enabled<br>*[Indexed String]* |
| This setting enables or disables CHA. | | | |
| CHA> Fund Thresh | 4C.22 | 0.01 | From 0.00025 to 2 in steps of 0.00025<br>*[Courier Number (current)]* |
| This setting defines the CHA amplitude threshold. | | | |
| CHA>3rdHarmThrsh | 4C.23 | 2 | From 0.5 to 70 in steps of 0.5<br>*[Courier Number (percentage)]* |
| This setting defines the amplitude ratio (3Harmonic to fundamental). | | | |
| CHA Del Ang180-x | 4C.24 | 85 | From 0 to 90 in steps of 1<br>*[Courier Number (angle)]* |
| This setting sets the lower angle boundary of the phase angle between third harmonic and fundamental. | | | |
| CHA Del Ang180+x | 4C.25 | 0 | From 0 to 90 in steps of 1<br>*[Courier Number (angle)]* |
| This setting sets the upper angle boundary of the phase angle between third harmonic and fundamental. | | | |
| CHA tAVERAGE | 4C.26 | 20 | From 5 to 60 in steps of 1<br>*[Courier Number (time-seconds)]* |
| This setting defines the time duration window for calculating the average value. | | | |
| CHA tTRANSIENT | 4C.27 | 0.2 | From 0.04 to 1 in steps of 0.02<br>*[Courier Number (time-seconds)]* |
| This setting defines the time duration for determining a transient event | | | |
| CHA tDURATION | 4C.28 | 2 | From 1 to 5 in steps of 1<br>*[Courier Number (time-seconds)]* |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| This setting defines the time duration for determining a HIF condition. | | | |
| CHA tRESET | 4C.29 | 10 | From 10 to 30 in steps of 5 <br> *[Courier Number (time-seconds)]* |
| This setting defines the reset time for the CHA evaluation process. | | | |
| CHA Trans SecLmt | 4C.2A | 3 | From 1 to 10 in steps of 1 <br> *[Courier Number]* |
| This setting sets the number of sections which are evaluated for determining a CHA transient event. | | | |
| GROUP 1: PSL TIMERS | 4E.00 | | |
| This column contains settings for frequency protection. | | | |
| Timer 1 | 4E.01 | 0 | See 50300.3110.004 <br> *[Courier Number (time-ms)]* |
| This setting sets PSL timer #1 | | | |
| Timer 2 | 4E.02 | 0 | See 50300.3110.004 <br> *[Courier Number (time-ms)]* |
| This setting sets PSL timer #2 | | | |
| Timer 3 | 4E.03 | 0 | See 50300.3110.004 <br> *[Courier Number (time-ms)]* |
| This setting sets PSL timer #3 | | | |
| Timer 4 | 4E.04 | 0 | See 50300.3110.004 <br> *[Courier Number (time-ms)]* |
| This setting sets PSL timer #4 | | | |
| Timer 5 | 4E.05 | 0 | See 50300.3110.004 <br> *[Courier Number (time-ms)]* |
| This setting sets PSL timer #5 | | | |
| Timer 6 | 4E.06 | 0 | See 50300.3110.004 <br> *[Courier Number (time-ms)]* |
| This setting sets PSL timer #6 | | | |
| Timer 7 | 4E.07 | 0 | See 50300.3110.004 <br> *[Courier Number (time-ms)]* |
| This setting sets PSL timer #7 | | | |
| Timer 8 | 4E.08 | 0 | See 50300.3110.004 <br> *[Courier Number (time-ms)]* |
| This setting sets PSL timer #8 | | | |
| Timer 9 | 4E.09 | 0 | See 50300.3110.004 <br> *[Courier Number (time-ms)]* |
| This setting sets PSL timer #9 | | | |
| Timer 10 | 4E.0A | 0 | See 50300.3110.004 <br> *[Courier Number (time-ms)]* |
| This setting sets PSL timer #10 | | | |
| Timer 11 | 4E.0B | 0 | See 50300.3110.004 <br> *[Courier Number (time-ms)]* |
| This setting sets PSL timer #11 | | | |
| Timer 12 | 4E.0C | 0 | See 50300.3110.004 <br> *[Courier Number (time-ms)]* |
| This setting sets PSL timer #12 | | | |
| Timer 13 | 4E.0D | 0 | See 50300.3110.004 <br> *[Courier Number (time-ms)]* |
| This setting sets PSL timer #13 | | | |
| Timer 14 | 4E.0E | 0 | See 50300.3110.004 <br> *[Courier Number (time-ms)]* |
| This setting sets PSL timer #14 | | | |
| Timer 15 | 4E.0F | 0 | See 50300.3110.004 <br> *[Courier Number (time-ms)]* |
| This setting sets PSL timer #15 | | | |
| Timer 16 | 4E.10 | 0 | See 50300.3110.004 <br> *[Courier Number (time-ms)]* |
| This setting sets PSL timer #16 | | | |
| Domain | B2.04 | PSL Settings | PSL Settings <br> PSL Configuration |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | *[Indexed String]* |
| | | | |
| Sub-Domain | B2.08 | Group 1 | Group 1<br>Group 2<br>Group 3<br>Group 4<br>*[Indexed String]* |
| | | | |
| Version | B2.0C | 256 | From 0 to 65535 in steps of 1<br>*[Unsigned Integer (16 bits)]* |
| | | | |
| Transfer Mode | B2.1C | 6 | Prepare Rx<br>Complete Rx<br>Prepare Tx<br>Complete Tx<br>Rx Prepared<br>Tx Prepared<br>OK<br>Error<br>*[Indexed String]* |
| | | | |
| Data Transfer | B2.20 | | |
| | | | |
| Select Record Number - n | B4.01 | 0 | From -199 to 199 in steps of 1<br>*[Unsigned Integer]* |
| | | | |
| Trigger Time | B4.02 | | Trigger Time<br>*[IEC870 Date & Time]* |
| | | | |
| Active Channels | B4.03 | | Active Channels<br>*[Binary Flag]* |
| | | | |
| Channel Types | B4.04 | | Channel Types<br>*[Binary Flag]* |
| | | | |
| Channel Offsets | B4.05 | | Channel Offsets<br>*[Courier Number (decimal)]* |
| | | | |
| Channel Scaling | B4.06 | | Channel Scaling<br>*[Courier Number (decimal)]* |
| | | | |
| Channel SkewVal | B4.07 | | Channel SkewVal<br>*[Integer]* |
| | | | |
| Channel MinVal | B4.08 | | Channel MinVal<br>*[Integer]* |
| | | | |
| Channel MaxVal | B4.09 | | Channel MaxVal<br>*[Integer]* |
| | | | |
| Compression Format | B4.0A | 1 | Compression Format<br>*[Unsigned Integer (16 bits)]* |
| | | | |
| Upload Compression Record | B4.0B | | Upload Compression Record<br>*[Unsigned Integer (16 bits)]* |
| | | | |
| No. Of Samples | B4.10 | | No. Of Samples<br>*[Unsigned Integer]* |
| | | | |
| Trig Position | B4.11 | | Trig Position |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| | | | *[Unsigned Integer]* |
| | | | |
| Time Base | B4.12 | | Time Base *[Courier Number (time-seconds)]* |
| | | | |
| 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]* |
| | | | |
| 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 29 | B4.3C | | Dist. Channel 29 *[Binary Flag]* |
| | | | |
| Dist. Channel 30 | B4.3D | | Dist. Channel 30 *[Binary Flag]* |
| | | | |
| Dist. Channel 31 | B4.3E | | Dist. Channel 31 *[Binary Flag]* |
| | | | |
| Dist. Channel 32 | B4.3F | | Dist. Channel 32 *[Binary Flag]* |
| | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| PSL DATA | B7.00 | | |
| This column contains information about the Programmable Scheme Logic | | | |
| Grp1 PSL Ref | B7.01 | | Grp1 PSL Ref<br>*[ASCII Text (32 chars)]* |
| This setting displays the Group 1 PSL reference | | | |
| Date/Time | B7.02 | | Date/Time<br>*[IEC870 Date & Time]* |
| This setting displays the date and time the PSL was created | | | |
| Grp1 PSL ID | B7.03 | | Grp1 PSL ID<br>*[Unsigned Integer (32 bits)]* |
| This setting displays the Group 1 PSL ID | | | |
| Grp2 PSL Ref | B7.11 | | Grp2 PSL Ref<br>*[ASCII Text (32 chars)]* |
| This setting displays the Group 2 PSL reference | | | |
| Date/Time | B7.12 | | Date/Time<br>*[IEC870 Date & Time]* |
| This setting displays the date and time the PSL was created | | | |
| Grp2 PSL ID | B7.13 | | Grp2 PSL ID<br>*[Unsigned Integer (32 bits)]* |
| This setting displays the Group 2 PSL ID | | | |
| Grp3 PSL Ref | B7.21 | | Grp3 PSL Ref<br>*[ASCII Text (32 chars)]* |
| This setting displays the Group 3 PSL reference | | | |
| Date/Time | B7.22 | | Date/Time<br>*[IEC870 Date & Time]* |
| This setting displays the date and time the PSL was created | | | |
| Grp3 PSL ID | B7.23 | | Grp3 PSL ID<br>*[Unsigned Integer (32 bits)]* |
| This setting displays the Group 3 PSL ID | | | |
| Grp4 PSL Ref | B7.31 | | Grp4 PSL Ref<br>*[ASCII Text (32 chars)]* |
| This setting displays the Group 4 PSL reference | | | |
| Date/Time | B7.32 | | Date/Time<br>*[IEC870 Date & Time]* |
| This setting displays the date and time the PSL was created | | | |
| Grp4 PSL ID | B7.33 | | Grp4 PSL ID<br>*[Unsigned Integer (32 bits)]* |
| This setting displays the Group 4 PSL ID | | | |
| USER CURVES DATA | B8.00 | | |
| This column contains settings and data for the user curves | | | |
| Curve 1 Name | B8.01 | Def User Curve 1 | Curve 1 Name<br>*[ASCII Text (32 Chars)]* |
| This cell displays the name of user curve 1 | | | |
| Date & Time | B8.02 | | Date & Time<br>*[IEC 870 Date & Time]* |
| This cell displays the date and time the user curve was downloaded to the IED | | | |
| Curve 1 ID | B8.03 | | Curve 1 ID<br>*[Unsigned Integer (16 bits)]* |
| This cell displays the ID of user curve 1 | | | |
| UsrCrv1 Vrsn | B8.04 | Operate Curve | Operate Curve<br>Reset Curve<br>*[Indexed String]* |
| This setting sets the curve type; either operate or reset. | | | |
| Curve 2 Name | B8.11 | Def User Curve 2 | Curve 2 Name<br>*[ASCII Text (32 Chars)]* |
| This cell displays the name of user curve 2 | | | |
| Date & Time | B8.12 | | Date & Time<br>*[IEC 870 Date & Time]* |
| This cell displays the date and time the user curve was downloaded to the IED | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| **DESCRIPTION** | | | |
| Curve 2 ID | B8.13 | | Curve 2 ID<br>*[Unsigned Integer (16 bits)]* |
| This cell displays the ID of user curve 2 | | | |
| UsrCrv2 Vrsn | B8.14 | Operate Curve | Operate Curve<br>Reset Curve<br>*[Indexed String]* |
| This setting sets the curve type; either operate or reset. | | | |
| Curve 3 Name | B8.21 | Def User Curve 3 | Curve 3 Name<br>*[ASCII Text (32 Chars)]* |
| This cell displays the name of user curve 3 | | | |
| Date & Time | B8.22 | | Date & Time<br>*[IEC 870 Date & Time]* |
| This cell displays the date and time the user curve was downloaded to the IED | | | |
| Curve 3 ID | B8.23 | | Curve 3 ID<br>*[Unsigned Integer (16 bits)]* |
| This cell displays the ID of user curve 3 | | | |
| UsrCrv3 Vrsn | B8.24 | Reset Curve | Operate Curve<br>Reset Curve<br>*[Indexed String]* |
| This setting sets the curve type; either operate or reset. | | | |
| UsrCrv3 Vrsn | B8.24 | Reset Curve | Operate Curve<br>Reset Curve<br>Th Operate Curve<br>Th Reset Curve<br>*[Indexed String]* |
| This setting sets the curve type; either operate or reset. | | | |
| Curve 4 Name | B8.31 | Def User Curve 4 | Curve 4 Name<br>*[ASCII Text (32 Chars)]* |
| This cell displays the name of user curve 4 | | | |
| Date & Time | B8.32 | | Date & Time<br>*[IEC 870 Date & Time]* |
| This cell displays the date and time the user curve was downloaded to the IED | | | |
| Curve 4 ID | B8.33 | | Curve 4 ID<br>*[Unsigned Integer (16 bits)]* |
| This cell displays the ID of user curve 4 | | | |
| UsrCrv4 Vrsn | B8.34 | Reset Curve | Operate Curve<br>Reset Curve<br>*[Indexed String]* |
| This setting sets the curve type; either operate or reset. | | | |
| UsrCrv4 Vrsn | B8.34 | Reset Curve | Operate Curve<br>Reset Curve<br>Th Operate Curve<br>Th Reset Curve<br>*[Indexed String]* |
| This setting sets the curve type; either operate or reset. | | | |
| COMMS SYS DATA | BF.00 | | |
| | | | |
| Dist Record Cntrl Ref | BF.01 | B300 | Dist Record Cntrl Ref<br>*[Menu Cell(2)]* |
| | | | |
| Dist Record Extract Ref | BF.02 | B400 | Dist Record Extract Ref<br>*[Menu Cell(2)]* |
| | | | |
| Setting Transfer | BF.03 | | |
| | | | |
| Reset Demand Timers | BF.04 | | |
| | | | |
| Block Transfer Ref | BF.06 | B200 | Block Transfer Ref<br>*[Menu Cell(2)]* |
| | | | |

| MENU TEXT | COL.ROW | DEFAULT SETTING | AVAILABLE OPTIONS |
|---|---|---|---|
| DESCRIPTION | | | |
| Read Only Mode | BF.07 | | Read Only Mode<br>*[Menu Cell]* |
| | | | |
| Encryption Key | BF.10 | | Encryption Key<br>*[Foreign Data]* |
| | | | |
| Connected i/face | BF.11 | | Connected i/face<br>*[Unsigned Integer (16 bit)]* |
| | | | |
| Security Column | BF.12 | | Security Column<br>*[Menu Cell]* |
| | | | |
| Port Disable | BF.13 | | Port Disable<br>*[Menu Cell]* |
| | | | |
| Port Disable end | BF.14 | | Port Disable end<br>*[Menu Cell]* |
| | | | |
| PW Entry Needed | BF.15 | | PW Entry Needed<br>*[Unsigned Integer (32 bits)]* |
| | | | |
| ETHERNET STATUS | F0.00 | | |
| | | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---|---|---|
| **DESCRIPTION** | | |
| 0 | Relay 1 | DDB_OUTPUT_RELAY_1 |
| DDB signal connected to output relay contact 1 | | |
| 1 | Relay 2 | DDB_OUTPUT_RELAY_2 |
| DDB signal connected to output relay contact 2 | | |
| 2 | Relay 3 | DDB_OUTPUT_RELAY_3 |
| DDB signal connected to output relay contact 3 | | |
| 3 | Relay 4 | DDB_OUTPUT_RELAY_4 |
| DDB signal connected to output relay contact 4 | | |
| 4 | Relay 5 | DDB_OUTPUT_RELAY_5 |
| DDB signal connected to output relay contact 5 | | |
| 5 | Relay 6 | DDB_OUTPUT_RELAY_6 |
| DDB signal connected to output relay contact 6 | | |
| 6 | Relay 7 | DDB_OUTPUT_RELAY_7 |
| DDB signal connected to output relay contact 7 | | |
| 7 | Relay 8 | DDB_OUTPUT_RELAY_8 |
| DDB signal connected to output relay contact 8 | | |
| 8 | Relay 9 | DDB_OUTPUT_RELAY_9 |
| DDB signal connected to output relay contact 9 | | |
| 9 | Relay 10 | DDB_OUTPUT_RELAY_10 |
| DDB signal connected to output relay contact 10 | | |
| 10 | Relay 11 | DDB_OUTPUT_RELAY_11 |
| DDB signal connected to output relay contact 11 | | |
| 11 | Relay 12 | DDB_OUTPUT_RELAY_12 |
| DDB signal connected to output relay contact 12 | | |
| 32 | Opto Input 1 | DDB_OPTO_ISOLATOR_1 |
| DDB signal connected to opto-input 1 | | |
| 33 | Opto Input 2 | DDB_OPTO_ISOLATOR_2 |
| DDB signal connected to opto-input 2 | | |
| 34 | Opto Input 3 | DDB_OPTO_ISOLATOR_3 |
| DDB signal connected to opto-input 3 | | |
| 35 | Opto Input 4 | DDB_OPTO_ISOLATOR_4 |
| DDB signal connected to opto-input 4 | | |
| 36 | Opto Input 5 | DDB_OPTO_ISOLATOR_5 |
| DDB signal connected to opto-input 5 | | |
| 37 | Opto Input 6 | DDB_OPTO_ISOLATOR_6 |
| DDB signal connected to opto-input 6 | | |
| 38 | Opto Input 7 | DDB_OPTO_ISOLATOR_7 |
| DDB signal connected to opto-input 7 | | |
| 39 | Opto Input 8 | DDB_OPTO_ISOLATOR_8 |
| DDB signal connected to opto-input 8 | | |
| 40 | Opto Input 9 | DDB_OPTO_ISOLATOR_9 |
| DDB signal connected to opto-input 9 | | |
| 41 | Opto Input 10 | DDB_OPTO_ISOLATOR_10 |
| DDB signal connected to opto-input 10 | | |
| 42 | Opto Input 11 | DDB_OPTO_ISOLATOR_11 |
| DDB signal connected to opto-input 11 | | |
| 43 | Opto Input 12 | DDB_OPTO_ISOLATOR_12 |
| DDB signal connected to opto-input 12 | | |
| 44 | Opto Input 13 | DDB_OPTO_ISOLATOR_13 |
| DDB signal connected to opto-input 13 | | |
| 72 | Relay Cond 1 | DDB_OUTPUT_CON_1 |
| DDB signal connected to output relay conditioner 1 | | |
| 73 | Relay Cond 2 | DDB_OUTPUT_CON_2 |
| DDB signal connected to output relay conditioner 2 | | |
| 74 | Relay Cond 3 | DDB_OUTPUT_CON_3 |
| DDB signal connected to output relay conditioner 3 | | |
| 75 | Relay Cond 4 | DDB_OUTPUT_CON_4 |
| DDB signal connected to output relay conditioner 4 | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---------|-------------|--------------|
| **DESCRIPTION** | | |
| 76 | Relay Cond 5 | DDB_OUTPUT_CON_5 |
| DDB signal connected to output relay conditioner 5 | | |
| 77 | Relay Cond 6 | DDB_OUTPUT_CON_6 |
| DDB signal connected to output relay conditioner 6 | | |
| 78 | Relay Cond 7 | DDB_OUTPUT_CON_7 |
| DDB signal connected to output relay conditioner 7 | | |
| 79 | Relay Cond 8 | DDB_OUTPUT_CON_8 |
| DDB signal connected to output relay conditioner 8 | | |
| 80 | Relay Cond 9 | DDB_OUTPUT_CON_9 |
| DDB signal connected to output relay conditioner 9 | | |
| 81 | Relay Cond 10 | DDB_OUTPUT_CON_10 |
| DDB signal connected to output relay conditioner 10 | | |
| 82 | Relay Cond 11 | DDB_OUTPUT_CON_11 |
| DDB signal connected to output relay conditioner 11 | | |
| 83 | Relay Cond 12 | DDB_OUTPUT_CON_12 |
| DDB signal connected to output relay conditioner 12 | | |
| 112 | Timer in 1 | DDB_TIMERIN_1 |
| DDB signal connected to timer 1 input | | |
| 113 | Timer in 2 | DDB_TIMERIN_2 |
| DDB signal connected to timer 2 input | | |
| 114 | Timer in 3 | DDB_TIMERIN_3 |
| DDB signal connected to timer 3 input | | |
| 115 | Timer in 4 | DDB_TIMERIN_4 |
| DDB signal connected to timer 4 input | | |
| 116 | Timer in 5 | DDB_TIMERIN_5 |
| DDB signal connected to timer 5 input | | |
| 117 | Timer in 6 | DDB_TIMERIN_6 |
| DDB signal connected to timer 6 input | | |
| 118 | Timer in 7 | DDB_TIMERIN_7 |
| DDB signal connected to timer 7 input | | |
| 119 | Timer in 8 | DDB_TIMERIN_8 |
| DDB signal connected to timer 8 input | | |
| 120 | Timer in 9 | DDB_TIMERIN_9 |
| DDB signal connected to timer 9 input | | |
| 121 | Timer in 10 | DDB_TIMERIN_10 |
| DDB signal connected to timer 10 input | | |
| 122 | Timer in 11 | DDB_TIMERIN_11 |
| DDB signal connected to timer 11 input | | |
| 123 | Timer in 12 | DDB_TIMERIN_12 |
| DDB signal connected to timer 12 input | | |
| 124 | Timer in 13 | DDB_TIMERIN_13 |
| DDB signal connected to timer 13 input | | |
| 125 | Timer in 14 | DDB_TIMERIN_14 |
| DDB signal connected to timer 14 input | | |
| 126 | Timer in 15 | DDB_TIMERIN_15 |
| DDB signal connected to timer 15 input | | |
| 127 | Timer in 16 | DDB_TIMERIN_16 |
| DDB signal connected to timer 16 input | | |
| 128 | Timer out 1 | DDB_TIMEROUT_1 |
| DDB signal connected to timer 1 output | | |
| 129 | Timer out 2 | DDB_TIMEROUT_2 |
| DDB signal connected to timer 2 output | | |
| 130 | Timer out 3 | DDB_TIMEROUT_3 |
| DDB signal connected to timer 3 output | | |
| 131 | Timer out 4 | DDB_TIMEROUT_4 |
| DDB signal connected to timer 4 output | | |
| 132 | Timer out 5 | DDB_TIMEROUT_5 |
| DDB signal connected to timer 5 output | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---------|-------------|--------------|
| **DESCRIPTION** | | |
| 133 | Timer out 6 | DDB_TIMEROUT_6 |
| DDB signal connected to timer 6 output | | |
| 134 | Timer out 7 | DDB_TIMEROUT_7 |
| DDB signal connected to timer 7 output | | |
| 135 | Timer out 8 | DDB_TIMEROUT_8 |
| DDB signal connected to timer 8 output | | |
| 136 | Timer out 9 | DDB_TIMEROUT_9 |
| DDB signal connected to timer 9 output | | |
| 137 | Timer out 10 | DDB_TIMEROUT_10 |
| DDB signal connected to timer 10 output | | |
| 138 | Timer out 11 | DDB_TIMEROUT_11 |
| DDB signal connected to timer 11output | | |
| 139 | Timer out 12 | DDB_TIMEROUT_12 |
| DDB signal connected to timer 12 output | | |
| 140 | Timer out 13 | DDB_TIMEROUT_13 |
| DDB signal connected to timer 13 output | | |
| 141 | Timer out 14 | DDB_TIMEROUT_14 |
| DDB signal connected to timer 1 4 output | | |
| 142 | Timer out 15 | DDB_TIMEROUT_15 |
| DDB signal connected to timer 15 output | | |
| 143 | Timer out 16 | DDB_TIMEROUT_16 |
| DDB signal connected to timer 16 output | | |
| 144 | Fault REC TRIG | DDB_FAULT_RECORDER_START |
| This DDB triggers the fault recorder | | |
| 145 | SG-opto Invalid | DDB_ILLEGAL_OPTO_SETTINGS_GROUP |
| This DDB signal indicates that the Setting Group selection via opto-input is invalid | | |
| 146 | Prot'n Disabled | DDB_OOS_ALARM |
| This DDB signal indicates an Out-of-Service condition | | |
| 147 | F out of Range | DDB_FREQ_ALARM |
| This DDB signal indicates a 'Frequency out of range' condition | | |
| 150 | CB Fail Alarm | DDB_BREAKER_FAIL_ALARM |
| This DDB signal is an alarm indicating CB Failure | | |
| 151 | I^ Maint Alarm | DDB_BROKEN_CURRENT_ALARM |
| This DDB signal indicates that the total Broken Current has exceeded the set maintenance threshold | | |
| 152 | I^ Lockout Alarm | DDB_BROKEN_CURRENT_LOCKOUT |
| This DDB signal initiates a CB lockout when the set Broken Current threshold has been exceeded | | |
| 153 | CB Ops Maint | DDB_MAINTENANCE_ALARM |
| This DDB signal indicates that the number of CB operations has exceeded the set maintenance threshold | | |
| 154 | CB Ops Lockout | DDB_MAINTENANCE_LOCKOUT |
| This DDB signal initiates a CB lockout when the set maintenance threshold has been exceeded | | |
| 155 | CB Op Time Maint | DDB_EXCESSIVE_OP_TIME_ALARM |
| This DDB signal indicates that the total amount of CB operating time has exceeded the set maintenance threshold | | |
| 156 | CB Op Time Lock | DDB_EXCESSIVE_OP_TIME_LOCKOUT |
| This DDB signal initiates a CB lockout when the set CB operating time threshold has been exceeded | | |
| 157 | Fault Freq Lock | DDB_EFF_LOCKOUT |
| This DDB signal initiates a CB lockout when the set Excessive Fault Frequency threshold has been exceeded | | |
| 158 | CB Status Alarm | DDB_CB_STATUS_ALARM |
| This DDB signal indicates that the CB is in an invalid state | | |
| 159 | Man CB Trip Fail | DDB_CB_FAILED_TO_TRIP |
| This DDB signal indicates that the CB has failed to trip following manual trip | | |
| 160 | CB Cls Fail | DDB_CB_FAILED_TO_CLOSE |
| This DDB signal indicates that the CB has failed to close | | |
| 161 | Man CB Unhealthy | DDB_CONTROL_CB_UNHEALTHY |
| This DDB signal indicates that the CB is unhealthy | | |
| 163 | AR Lockout | DDB_AR_LOCKOUT |
| This DDB signal indicates that the AR did not result in successful reclosure and locks out further reclose attempts | | |
| 164 | AR CB Unhealthy | DDB_AR_CB_UNHEALTHY |
| The scheme has waited for the "CB HEALTHY" signal for the HEALTHY WINDOW time. | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---|---|---|
| DESCRIPTION | | |
| 165 | AR No Sys Check | DDB_AR_NO_SYS_CHECK |
| The scheme has waited for the "SYSTEM OK TO CLOSE" input for the SYSTEM CHECK WINDOW time | | |
| 168 | User Alarm 1 | DDB_USER_ALARM_1 |
| This DDB signal can be configured as a user-defined Alarm | | |
| 169 | User Alarm 2 | DDB_USER_ALARM_2 |
| This DDB signal can be configured as a user-defined Alarm | | |
| 170 | User Alarm 3 | DDB_USER_ALARM_3 |
| This DDB signal can be configured as a user-defined Alarm | | |
| 171 | User Alarm 4 | DDB_USER_ALARM_4 |
| This DDB signal can be configured as a user-defined Alarm | | |
| 172 | User Alarm 5 | DDB_USER_ALARM_5 |
| This DDB signal can be configured as a user-defined Alarm | | |
| 173 | User Alarm 6 | DDB_USER_ALARM_6 |
| This DDB signal can be configured as a user-defined Alarm | | |
| 174 | User Alarm 7 | DDB_USER_ALARM_7 |
| This DDB signal can be configured as a user-defined Alarm | | |
| 175 | User Alarm 8 | DDB_USER_ALARM_8 |
| This DDB signal can be configured as a user-defined Alarm | | |
| 176 | User Alarm 9 | DDB_USER_ALARM_9 |
| This DDB signal can be configured as a user-defined Alarm | | |
| 177 | User Alarm 10 | DDB_USER_ALARM_10 |
| This DDB signal can be configured as a user-defined Alarm | | |
| 178 | User Alarm 11 | DDB_USER_ALARM_11 |
| This DDB signal can be configured as a user-defined Alarm | | |
| 179 | User Alarm 12 | DDB_USER_ALARM_12 |
| This DDB signal can be configured as a user-defined Alarm | | |
| 180 | User Alarm 13 | DDB_USER_ALARM_13 |
| This DDB signal can be configured as a user-defined Alarm | | |
| 181 | User Alarm 14 | DDB_USER_ALARM_14 |
| This DDB signal can be configured as a user-defined Alarm | | |
| 182 | User Alarm 15 | DDB_USER_ALARM_15 |
| This DDB signal can be configured as a user-defined Alarm | | |
| 183 | User Alarm 16 | DDB_USER_ALARM_16 |
| This DDB signal can be configured as a user-defined Alarm | | |
| 184 | User Alarm 17 | DDB_USER_ALARM_17 |
| This DDB signal can be configured as a user-defined Alarm | | |
| 185 | User Alarm 18 | DDB_USER_ALARM_18 |
| This DDB signal can be configured as a user-defined Alarm | | |
| 186 | User Alarm 19 | DDB_USER_ALARM_19 |
| This DDB signal can be configured as a user-defined Alarm | | |
| 187 | User Alarm 20 | DDB_USER_ALARM_20 |
| This DDB signal can be configured as a user-defined Alarm | | |
| 188 | User Alarm 21 | DDB_USER_ALARM_21 |
| This DDB signal can be configured as a user-defined Alarm | | |
| 189 | User Alarm 22 | DDB_USER_ALARM_22 |
| This DDB signal can be configured as a user-defined Alarm | | |
| 190 | User Alarm 23 | DDB_USER_ALARM_23 |
| This DDB signal can be configured as a user-defined Alarm | | |
| 191 | User Alarm 24 | DDB_USER_ALARM_24 |
| This DDB signal can be configured as a user-defined Alarm | | |
| 192 | User Alarm 25 | DDB_USER_ALARM_25 |
| This DDB signal can be configured as a user-defined Alarm | | |
| 193 | User Alarm 26 | DDB_USER_ALARM_26 |
| This DDB signal can be configured as a user-defined Alarm | | |
| 194 | User Alarm 27 | DDB_USER_ALARM_27 |
| This DDB signal can be configured as a user-defined Alarm | | |
| 195 | User Alarm 28 | DDB_USER_ALARM_28 |
| This DDB signal can be configured as a user-defined Alarm | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---------|-------------|--------------|
| **DESCRIPTION** | | |
| 196 | User Alarm 29 | DDB_USER_ALARM_29 |
| This DDB signal can be configured as a user-defined Alarm | | |
| 197 | User Alarm 30 | DDB_USER_ALARM_30 |
| This DDB signal can be configured as a user-defined Alarm | | |
| 198 | User Alarm 31 | DDB_USER_ALARM_31 |
| This DDB signal can be configured as a user-defined Alarm | | |
| 199 | User Alarm 32 | DDB_USER_ALARM_32 |
| This DDB signal can be configured as a user-defined Alarm | | |
| 200 | MR User Alarm 33 | DDB_USER_ALARM_33 |
| This DDB signal can be configured as manual reset alarm | | |
| 201 | MR User Alarm 34 | DDB_USER_ALARM_34 |
| This DDB signal can be configured as manual reset alarm | | |
| 202 | MR User Alarm 35 | DDB_USER_ALARM_35 |
| This DDB signal can be configured as manual reset alarm | | |
| 203 | I>1 Timer Block | DDB_POC_1_TIMER_BLOCK |
| This DDB signal blocks the first stage overcurrent time delay | | |
| 204 | I>2 Timer Block | DDB_POC_2_TIMER_BLOCK |
| This DDB signal blocks the second stage overcurrent time delay | | |
| 205 | I>3 Timer Block | DDB_POC_3_TIMER_BLOCK |
| This DDB signal blocks the third stage overcurrent time delay | | |
| 206 | I>4 Timer Block | DDB_POC_4_TIMER_BLOCK |
| This DDB signal blocks the fourth stage overcurrent time delay | | |
| 207 | Inhibit CBF | DDB_INHIBIT_CBF |
| This DDB signal is used to inhibit the CB Fail function and reset all associated DDBs. | | |
| 208 | IN1>1 Timer Blk | DDB_EF1_1_TIMER_BLOCK |
| This DDB signal blocks the first stage measured Earth Fault time delay | | |
| 209 | IN1>2 Timer Blk | DDB_EF1_2_TIMER_BLOCK |
| This DDB signal blocks the second stage measured Earth Fault time delay | | |
| 210 | IN1>3 Timer Blk | DDB_EF1_3_TIMER_BLOCK |
| This DDB signal blocks the third stage measured Earth Fault time delay | | |
| 211 | IN1>4 Timer Blk | DDB_EF1_4_TIMER_BLOCK |
| This DDB signal blocks the fourth stage measured Earth Fault time delay | | |
| 212 | IN2>1 Timer Blk | DDB_EF2_1_TIMER_BLOCK |
| This DDB signal blocks the first stage derived Earth Fault time delay | | |
| 213 | IN2>2 Timer Blk | DDB_EF2_2_TIMER_BLOCK |
| This DDB signal blocks the second stage derived Earth Fault time delay | | |
| 214 | IN2>3 Timer Blk | DDB_EF2_3_TIMER_BLOCK |
| This DDB signal blocks the third stage derived Earth Fault time delay | | |
| 215 | IN2>4 Timer Blk | DDB_EF2_4_TIMER_BLOCK |
| This DDB signal blocks the fourth stage derived Earth Fault time delay | | |
| 216 | ISEF>1 Timer Blk | DDB_SEF_1_TIMER_BLOCK |
| This DDB signal blocks the first stage Sensitive Earth Fault time delay | | |
| 217 | ISEF>2 Timer Blk | DDB_SEF_2_TIMER_BLOCK |
| This DDB signal blocks the second stage Sensitive Earth Fault time delay | | |
| 218 | ISEF>3 Timer Blk | DDB_SEF_3_TIMER_BLOCK |
| This DDB signal blocks the third stage Sensitive Earth Fault time delay | | |
| 219 | ISEF>4 Timer Blk | DDB_SEF_4_TIMER_BLOCK |
| This DDB signal blocks the fourth stage Sensitive Earth Fault time delay | | |
| 226 | CLP Initiate | DDB_CLP_INITIATE |
| This DDB signal initiates the CLP operation | | |
| 227 | Ext. Trip 3ph | DDB_EXTERNAL_TRIP_3PH |
| This DDB signal receives an external three-phase trip signal | | |
| 228 | CB Aux 3ph(52-A) | DDB_CB_THREE_PHASE_52A |
| This DDB signal is the 3-phase 52A signal (signal indicating state of CB) | | |
| 229 | CB Aux 3ph(52-B) | DDB_CB_THREE_PHASE_52B |
| This DDB signal is the 3-phase 52B signal (signal indicating inverse state of CB) | | |
| 230 | CB Healthy | DDB_CB_HEALTHY |
| This DDB signal indicates that the CB is healthy. | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---|---|---|
| **DESCRIPTION** | | |
| 232 | Init Trip CB | DDB_LOGIC_INPUT_TRIP |
| This DDB signals the circuit breaker to open | | |
| 233 | Init Close CB | DDB_LOGIC_INPUT_CLOSE |
| This DDB signals the circuit breaker to open | | |
| 234 | Reset Close Dly | DDB_RESET_CB_CLOSE_DELAY |
| This DDB signal resets the Manual CB Close Time Delay | | |
| 235 | Reset Relays/LED | DDB_RESET_RELAYS_LEDS |
| This DDB resets all latched output relays and LEDs | | |
| 236 | Reset Thermal | DDB_RESET_THERMAL |
| This DDB signal resets the Thermal State | | |
| 237 | Reset Lockout | DDB_RESET_LOCKOUT |
| This DDB Resets a lockout condition | | |
| 238 | Reset CB Data | DDB_RESET_ALL_VALUES |
| This DDB resets the CB Maintenance Values | | |
| 239 | Block AR | DDB_BLOCK_AR |
| This DDB signal blocks the Autoreclose function | | |
| 240 | AR LiveLine Mode | DDB_LIVE_LINE_MODE |
| This DB indicates that the autoreclose function is in Live Line mode | | |
| 241 | AR Auto Mode | DDB_AUTO_MODE |
| This DB indicates that the autoreclose function is in Auto mode | | |
| 242 | Telecontrol Mode | DDB_TELECONTROL_MODE |
| This DB indicates that the autoreclose function is in Telecontrol mode | | |
| 243 | I>1 Trip | DDB_POC_1_3PH_TRIP |
| This DDB signal is the first stage any-phase Phase Overcurrent trip signal | | |
| 244 | I>1 Trip A | DDB_POC_1_PH_A_TRIP |
| This DDB signal is the first stage A-phase Phase Overcurrent trip signal | | |
| 245 | I>1 Trip B | DDB_POC_1_PH_B_TRIP |
| This DDB signal is the first stage B-phase Phase Overcurrent trip signal | | |
| 246 | I>1 Trip C | DDB_POC_1_PH_C_TRIP |
| This DDB signal is the first stage C-phase Phase Overcurrent trip signal | | |
| 247 | I>2 Trip | DDB_POC_2_3PH_TRIP |
| This DDB signal is the second stage any-phase Phase Overcurrent trip signal | | |
| 248 | I>2 Trip A | DDB_POC_2_PH_A_TRIP |
| This DDB signal is the second stage A-phase Phase Overcurrent trip signal | | |
| 249 | I>2 Trip B | DDB_POC_2_PH_B_TRIP |
| This DDB signal is the second stage B-phase Phase Overcurrent trip signal | | |
| 250 | I>2 Trip C | DDB_POC_2_PH_C_TRIP |
| This DDB signal is the second stage C-phase Phase Overcurrent trip signal | | |
| 251 | I>3 Trip | DDB_POC_3_3PH_TRIP |
| This DDB signal is the third stage any-phase Phase Overcurrent trip signal | | |
| 252 | I>3 Trip A | DDB_POC_3_PH_A_TRIP |
| This DDB signal is the third stage A-phase Phase Overcurrent trip signal | | |
| 253 | I>3 Trip B | DDB_POC_3_PH_B_TRIP |
| This DDB signal is the third stage B-phase Phase Overcurrent trip signal | | |
| 254 | I>3 Trip C | DDB_POC_3_PH_C_TRIP |
| This DDB signal is the third stage C-phase Phase Overcurrent trip signal | | |
| 255 | I>4 Trip | DDB_POC_4_3PH_TRIP |
| This DDB signal is the fourth stage any-phase Phase Overcurrent trip signal | | |
| 256 | I>4 Trip A | DDB_POC_4_PH_A_TRIP |
| This DDB signal is the fourth stage A-phase Phase Overcurrent trip signal | | |
| 257 | I>4 Trip B | DDB_POC_4_PH_B_TRIP |
| This DDB signal is the fourth stage B-phase Phase Overcurrent trip signal | | |
| 258 | I>4 Trip C | DDB_POC_4_PH_C_TRIP |
| This DDB signal is the fourth stage C-phase Phase Overcurrent trip signal | | |
| 260 | Broken Line Trip | DDB_BROKEN_CONDUCTOR_TRIP |
| This DDB signal is the Broken Conductor trip signal | | |
| 261 | IN1>1 Trip | DDB_EF1_1_TRIP |
| This DDB signal is the first stage measured Earth Fault trip signal | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---------|-------------|--------------|
| DESCRIPTION | | |
| 262 | IN1>2 Trip | DDB_EF1_2_TRIP |
| This DDB signal is the second stage measured Earth Fault trip signal | | |
| 263 | IN1>3 Trip | DDB_EF1_3_TRIP |
| This DDB signal is the third stage measured Earth Fault trip signal | | |
| 264 | IN1>4 Trip | DDB_EF1_4_TRIP |
| This DDB signal is the fourth stage measured Earth Fault trip signal | | |
| 265 | IN2>1 Trip | DDB_EF2_1_TRIP |
| This DDB signal is the first stage derived Earth Fault trip signal | | |
| 266 | IN2>2 Trip | DDB_EF2_2_TRIP |
| This DDB signal is the second stage derived Earth Fault trip signal | | |
| 267 | IN2>3 Trip | DDB_EF2_3_TRIP |
| This DDB signal is the third stage derived Earth Fault trip signal | | |
| 268 | IN2>4 Trip | DDB_EF2_4_TRIP |
| This DDB signal is the fourth stage derived Earth Fault trip signal | | |
| 269 | ISEF>1 Trip | DDB_SEF_1_TRIP |
| This DDB signal is the first stage Sensitive Earth Fault trip signal | | |
| 270 | ISEF>2 Trip | DDB_SEF_2_TRIP |
| This DDB signal is the second stage Sensitive Earth Fault trip signal | | |
| 271 | ISEF>3 Trip | DDB_SEF_3_TRIP |
| This DDB signal is the third stage Sensitive Earth Fault trip signal | | |
| 272 | ISEF>4 Trip | DDB_SEF_4_TRIP |
| This DDB signal is the fourth stage Sensitive Earth Fault trip signal | | |
| 273 | IREF> Trip | DDB_REF_TRIP |
| This DDB signal is the Restricted Earth Fault trip signal | | |
| 276 | Thermal Trip | DDB_THERMAL_TRIP |
| This DDB signal is the Thermal Overload trip signal | | |
| 294 | Any Start | DDB_ANY_START |
| This DDB signal is the Any Start signal originating from the fixed scheme logic | | |
| 295 | I>1 Start | DDB_POC_1_3PH_START |
| This DDB signal is the first stage any-phase Overcurrent start signal | | |
| 296 | I>1 Start A | DDB_POC_1_PH_A_START |
| This DDB signal is the first stage A-phase Overcurrent start signal | | |
| 297 | I>1 Start B | DDB_POC_1_PH_B_START |
| This DDB signal is the first stage B-phase Overcurrent start signal | | |
| 298 | I>1 Start C | DDB_POC_1_PH_C_START |
| This DDB signal is the first stage C-phase Overcurrent start signal | | |
| 299 | I>2 Start | DDB_POC_2_3PH_START |
| This DDB signal is the second stage any-phase Overcurrent start signal | | |
| 300 | I>2 Start A | DDB_POC_2_PH_A_START |
| This DDB signal is the second stage A-phase Overcurrent start signal | | |
| 301 | I>2 Start B | DDB_POC_2_PH_B_START |
| This DDB signal is the second stage B-phase Overcurrent start signal | | |
| 302 | I>2 Start C | DDB_POC_2_PH_C_START |
| This DDB signal is the second stage C-phase Overcurrent start signal | | |
| 303 | I>3 Start | DDB_POC_3_3PH_START |
| This DDB signal is the third stage any-phase Overcurrent start signal | | |
| 304 | I>3 Start A | DDB_POC_3_PH_A_START |
| This DDB signal is the third stage A-phase Overcurrent start signal | | |
| 305 | I>3 Start B | DDB_POC_3_PH_B_START |
| This DDB signal is the third stage B-phase Overcurrent start signal | | |
| 306 | I>3 Start C | DDB_POC_3_PH_C_START |
| This DDB signal is the third stage C-phase Overcurrent start signal | | |
| 307 | I>4 Start | DDB_POC_4_3PH_START |
| This DDB signal is the fourth stage any-phase Overcurrent start signal | | |
| 308 | I>4 Start A | DDB_POC_4_PH_A_START |
| This DDB signal is the fourth stage A-phase Overcurrent start signal | | |
| 309 | I>4 Start B | DDB_POC_4_PH_B_START |
| This DDB signal is the fourth stage B-phase Overcurrent start signal | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---|---|---|
| **DESCRIPTION** | | |
| 310 | I>4 Start C | DDB_POC_4_PH_C_START |
| This DDB signal is the fourth stage C-phase Overcurrent start signal | | |
| 315 | IN1>1 Start | DDB_EF1_1_START |
| This DDB signal is the first stage measured Earth Fault start signal | | |
| 316 | IN1>2 Start | DDB_EF1_2_START |
| This DDB signal is the second stage measured Earth Fault start signal | | |
| 317 | IN1>3 Start | DDB_EF1_3_START |
| This DDB signal is the third stage measured Earth Fault start signal | | |
| 318 | IN1>4 Start | DDB_EF1_4_START |
| This DDB signal is the fourth stage measured Earth Fault start signal | | |
| 319 | IN2>1 Start | DDB_EF2_1_START |
| This DDB signal is the first stage derived Earth Fault start signal | | |
| 320 | IN2>2 Start | DDB_EF2_2_START |
| This DDB signal is the second stage derived Earth Fault start signal | | |
| 321 | IN2>3 Start | DDB_EF2_3_START |
| This DDB signal is the third stage derived Earth Fault start signal | | |
| 322 | IN2>4 Start | DDB_EF2_4_START |
| This DDB signal is the fourth stage derived Earth Fault start signal | | |
| 323 | ISEF>1 Start | DDB_SEF_1_START |
| This DDB signal is the first stage Sensitive Earth Fault start signal | | |
| 324 | ISEF>2 Start | DDB_SEF_2_START |
| This DDB signal is the second stage Sensitive Earth Fault start signal | | |
| 325 | ISEF>3 Start | DDB_SEF_3_START |
| This DDB signal is the third stage Sensitive Earth Fault start signal | | |
| 326 | ISEF>4 Start | DDB_SEF_4_START |
| This DDB signal is the fourth stage Sensitive Earth Fault start signal | | |
| 329 | Thermal Alarm | DDB_THERMAL_ALARM |
| This DDB signal is the Thermal Overload start signal | | |
| 347 | CLP Operation | DDB_CLP_OPERATION |
| This DDB signal indicates that the CLP is operating and informs the Overcurrent protection to use the CLP settings | | |
| 348 | I> BlockStart | DDB_PH_BLOCKED_OC_START |
| This DDB signal is the start signal for Blocked Overcurrent functionality | | |
| 349 | IN/SEF>Blk Start | DDB_N_BLOCKED_OC_START |
| This DDB signal is the start signal for Blocked Earth Fault functionality | | |
| 353 | Bfail1 Trip 3ph | DDB_CBF1_TRIP_3PH |
| This DDB signal is the three-phase trip signal for the stage 1 CB Fail function | | |
| 354 | Bfail2 Trip 3ph | DDB_CBF2_TRIP_3PH |
| This DDB signal is the three-phase trip signal for the stage 2 CB Fail function | | |
| 355 | Control Trip | DDB_CONTROL_TRIP |
| This DDB signal tells the CB to trip | | |
| 356 | Control Close | DDB_CONTROL_CLOSE |
| This DDB signal tells the CB to close | | |
| 357 | Close in Prog | DDB_CONTROL_CLOSE_IN_PROGRESS |
| This DDB signal indicates that CB closure is in progress | | |
| 358 | AR Blk Main Prot | DDB_AR_BLOCK_MAIN_PROTECTION |
| This DDB signal, generated by the Autoreclose function, blocks the Main Protection elements (POC, EF1, EF2, NPSOC) | | |
| 359 | AR Blk SEF Prot | DDB_AR_BLOCK_SEF_PROTECTION |
| This DDB signal, generated by the Autoreclose function, blocks the SEF Protection element (POC, EF1, EF2, NPSOC) | | |
| 360 | AR In Progress | DDB_AR_3_POLE_IN_PROGRESS |
| This DDB signal indicates that three-pole Autoreclose is in progress | | |
| 361 | AR In Service | DDB_AR_IN_SERVICE |
| This DDB signal indicates that Autoreclose is in or out of service (auto, or non-auto mode) | | |
| 362 | AR SeqCounter 0 | DDB_SEQ_COUNT_0 |
| This DDB signal indicates that the AR has not been initiated | | |
| 363 | AR SeqCounter 1 | DDB_SEQ_COUNT_1 |
| This DDB signal indicates that the AR function is in its first shot | | |
| 364 | AR SeqCounter 2 | DDB_SEQ_COUNT_2 |
| This DDB signal indicates that the AR function is in its second shot | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---|---|---|
| **DESCRIPTION** | | |
| 365 | AR SeqCounter 3 | DDB_SEQ_COUNT_3 |
| This DDB signal indicates that the AR function is in its third shot | | |
| 366 | AR SeqCounter 4 | DDB_SEQ_COUNT_4 |
| This DDB signal indicates that the AR function is in its fourth shot | | |
| 367 | Successful Close | DDB_AR_SUCCESSFUL_RECLOSE |
| This DDB signal indicates a successful reclosure | | |
| 368 | DeadTime in Prog | DDB_DEAD_TIME_IN_PROGRESS |
| This DDB signal indicates that the Autoreclose dead time is in progress | | |
| 369 | Protection Lockt | DDB_AR_PROTECTION_LOCKOUT |
| This DB signal locks out the Autoreclose function | | |
| 370 | Reset Lckout Alm | DDB_AR_RESET_LOCKOUT_ALARM |
| This DDB signal indicates that a lockout has been reset. | | |
| 371 | Auto Close | DDB_AUTO_CLOSE |
| This DDB signal tells the CB to close, originating from Autoreclose only. This DDB signal has a fixed reset time. | | |
| 372 | AR Trip Test | DDB_AR_TRIP_TEST |
| This DDB signal is used to test the Autoreclose function Autoreclose trip test | | |
| 373 | IA< Start | DDB_PHASE_A_UNDERCURRENT |
| This DDB signal is the A-phase Phase Undercurrent start signal | | |
| 374 | IB< Start | DDB_PHASE_B_UNDERCURRENT |
| This DDB signal is the B-phase Phase Undercurrent start signal | | |
| 375 | IC< Start | DDB_PHASE_C_UNDERCURRENT |
| This DDB signal is the C-phase Phase Undercurrent start signal | | |
| 376 | IN< Start | DDB_EF_UNDERCURRENT |
| This DDB signal is the Earth Fault undercurrent start signal | | |
| 377 | ISEF< Start | DDB_SEF_UNDERCURRENT |
| This DDB signal is the Sensitive Earth Fault undercurrent start signal | | |
| 378 | CB Open 3 ph | DDB_CB_OPEN |
| This DDB signal indicates that the CB is open on all 3 phases | | |
| 379 | CB Closed 3 ph | DDB_CB_CLOSED |
| This DDB signal indicates that the CB is closed on all 3 phases | | |
| 380 | All Poles Dead | DDB_ALL_POLEDEAD |
| This DDB signal indicates that all poles are dead | | |
| 381 | Any Pole Dead | DDB_ANY_POLEDEAD |
| This DDB signal indicates that one or more of the poles is dead. | | |
| 382 | Pole Dead A | DDB_PHASE_A_POLEDEAD |
| This DDB signal indicates that the A-phase pole is dead. | | |
| 383 | Pole Dead B | DDB_PHASE_B_POLEDEAD |
| This DDB signal indicates that the B-phase pole is dead. | | |
| 384 | Pole Dead C | DDB_PHASE_C_POLEDEAD |
| This DDB signal indicates that the C-phase pole is dead. | | |
| 398 | CBF SEF Trip | DDB_CURRENT_PROT_SEF_TRIP |
| This DDB signal is the CBF current protection SEF Trip | | |
| 400 | CBF SEF Trip-1 | DDB_CBF_SEF_STAGE_TRIP |
| This DDB signal is the Fixed Scheme Logic CBF SEF Stage Trip | | |
| 403 | AR Sys Checks | DDB_SYNC_AR_SYS_CHECK_OK |
| This DDB signal tells the Autoreclose that the system checks are satisfied. | | |
| 404 | Lockout Alarm | DDB_CB_LOCKOUT_ALARM |
| This DDB signal is the Composite circuit breaker Lockout Alarm | | |
| 405 | Pre-Lockout | DDB_CB_PRE_LOCKOUT |
| This DDB signal is for CB conditioning and monitoring pre-Lockout. It is related to the number of trips and EFF | | |
| 406 | Freq High | DDB_FREQ_ABOVE_RANGE_LIMIT |
| This DDB signal indicates that the frequency is above 70Hz | | |
| 407 | Freq Low | DDB_FREQ_BELOW_RANGE_LIMIT |
| This DDB signal indicates that the frequency is below 40Hz | | |
| 408 | Stop Freq Track | DDB_FREQ_STOP_TRACK |
| This DDB signal stops frequency Tracking | | |
| 409 | Start N | DDB_EF_START |
| This DDB signal is the composite EF Start signal used in the FSL | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---|---|---|
| **DESCRIPTION** | | |
| 411 | Freq Not Found | DDB_FREQ_NOT_FOUND |
| This DDB signal indicates that no frequency has been found | | |
| 439 | Ext AR Prot Trip | DDB_EXT_AR_PROT_TRIP |
| This DDB can initiate an Autoreclose sequence from an external trip | | |
| 440 | Ext AR Prot Strt | DDB_EXT_AR_PROT_START |
| This DDB informs the Autoreclose function of an external start | | |
| 441 | Test Mode | DDB_TEST_MODE |
| This DDB signal initiates the test mode | | |
| 442 | Inhibit SEF | DDB_SEF_INHIBIT |
| This DDB signal inhibits Sensitive Earth Fault protection | | |
| 453 | DAR Complete | DDB_DAR_COMPLETE |
| This DDB signal resets the AR in Progress 1 signal | | |
| 454 | CB in Service | DDB_CB_IN_SERVICE |
| This DDB signal indicates that the Circuit Breaker is in service | | |
| 455 | AR Restart | DDB_AR_RESTART |
| This DDB signal triggers a Restart of the Autoreclose initiation process | | |
| 456 | DAR In Progress | DDB_AR_IP_1 |
| This DDB signal indicates that delayed Auto-Reclose is in progress | | |
| 457 | DeadTime Enabled | DDB_DEADTIME_ENABLE |
| This DDB signal enables the Dead Time timers | | |
| 458 | DT OK To Start | DDB_DEADTIME_OK_TO_START |
| This DDB signal tells the AR  that it is OK to start the Autoreclose Dead Timer. | | |
| 459 | DT Complete | DDB_DEADTIME_COMPLETE |
| This DDB signal indicates that the Autoreclose Dead Time is complete | | |
| 460 | Reclose Checks | DDB_ARCHECKS_IN_PROGRESS |
| This DDB signal indicates that Autoreclose system checks are in progress | | |
| 463 | AR SysChecks OK | DDB_AR_SYSTEMCHECKS_OK |
| This DDB signal indicates that the Autoreclose System Checks are is OK | | |
| 464 | AR Init TripTest | DDB_INIT_AR_TRIP_TEST |
| This DDB signal initiates an Autoreclose trip test. | | |
| 465 | 103 MonitorBlock | DDB_MONITOR_BLOCKING |
| This DDB signal enables the Monitor Blocking for the IEC60870-103 protocol | | |
| 466 | 103 CommandBlock | DDB_COMMAND_BLOCKING |
| This DDB signal enables the Command Blocking for the IEC60870-103 protocol | | |
| 467 | ISEF1 Start Watt | DDB_SEF_1_START_2 |
| This signal indicates that the SEF has picked up but not fully satisfied the decision of the Wattmetric SEF | | |
| 468 | ISEF2 Start Watt | DDB_SEF_2_START_2 |
| This signal indicates that the SEF has picked up but not fully satisfied the decision of the Wattmetric SEF | | |
| 469 | ISEF3 Start Watt | DDB_SEF_3_START_2 |
| This signal indicates that the SEF has picked up but not fully satisfied the decision of the Wattmetric SEF | | |
| 470 | ISEF4 Start Watt | DDB_SEF_4_START_2 |
| This signal indicates that the SEF has picked up but not fully satisfied the decision of the Wattmetric SEF | | |
| 478 | I> Inhibit | DDB_POC_INHIBIT |
| I> Inhibit | | |
| 499 | External Trip A | DDB_EXTERNAL_TRIP_A |
| This DDB signal is connected to an external A-Phase trip, which initiates a CB Fail condition | | |
| 500 | External Trip B | DDB_EXTERNAL_TRIP_B |
| This DDB signal is connected to an external B-Phase trip, which initiates a CB Fail condition | | |
| 501 | External Trip C | DDB_EXTERNAL_TRIP_C |
| This DDB signal is connected to an external C-Phase Trip, which initiates a CB Fail condition | | |
| 502 | External Trip EF | DDB_EXTERNAL_TRIP_EF |
| This DDB signal is connected to an external Earth Fault trip, which initiates a CB Fail condition | | |
| 503 | External TripSEF | DDB_EXTERNAL_TRIP_SEF |
| This DDB signal is connected to an external Sensitive Earth Fault trip, which initiates a CB Fail condition | | |
| 504 | I2> Inhibit | DDB_NPSOC_INHIBIT |
| This DDB signal inhibits the Negative Phase Overcurrent protection | | |
| 505 | I2>1 Tmr Blk | DDB_NPSOC_1_TIMER_BLOCK |
| This DDB signal blocks the first stage Negative Phase Overcurrent timer | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---------|-------------|--------------|
| | | DESCRIPTION |
| 506 | I2>2 Tmr Blk | DDB_NPSOC_2_TIMER_BLOCK |
| This DDB signal blocks the second stage Negative Phase Overcurrent timer | | |
| 507 | I2>3 Tmr Blk | DDB_NPSOC_3_TIMER_BLOCK |
| This DDB signal blocks the third stage Negative Phase Overcurrent timer | | |
| 508 | I2>4 Tmr Blk | DDB_NPSOC_4_TIMER_BLOCK |
| This DDB signal blocks the fourth stage Negative Phase Overcurrent timer | | |
| 509 | I2>1 Start | DDB_NPSOC_1_START |
| This DDB signal is the first stage NPSOC start signal | | |
| 510 | I2>2 Start | DDB_NPSOC_2_START |
| This DDB signal is the second stage NPSOC start signal | | |
| 511 | I2>3 Start | DDB_NPSOC_3_START |
| This DDB signal is the third stage NPSOC start signal | | |
| 512 | I2>4 Start | DDB_NPSOC_4_START |
| This DDB signal is the fourth stage NPSOC start signal | | |
| 513 | I2>1 Trip | DDB_NPSOC_1_TRIP |
| This DDB signal is the first stage NPSOC trip signal | | |
| 514 | I2>2 Trip | DDB_NPSOC_2_TRIP |
| This DDB signal is the second stage NPSOC trip signal | | |
| 515 | I2>3 Trip | DDB_NPSOC_3_TRIP |
| This DDB signal is the third stage NPSOC trip signal | | |
| 516 | I2>4 Trip | DDB_NPSOC_4_TRIP |
| This DDB signal is the fourth stage NPSOC trip signal | | |
| 518 | Trip LED Trigger | DDB_TRIP_LED_TRIGGER |
| This DDB triggers the fixed trip LED | | |
| 525 | Blk Rmt. CB Ops | DDB_BLOCK_REMOTE_CB_OPS |
| This DDB signal blocks remote CB Trip and Close commands. | | |
| 526 | SG Select x1 | DDB_SG_SELECTOR_X1 |
| This DDB signal sets the setting group | | |
| 527 | SG Select 1x | DDB_SG_SELECTOR_1X |
| This DDB signal sets the setting group | | |
| 528 | IN1> Inhibit | DDB_EF1_INHIBIT |
| This DDB signal inhibits the measured Earth Fault protection | | |
| 529 | IN2> Inhibit | DDB_EF2_INHIBIT |
| This DDB signal inhibits the derived Earth Fault protection | | |
| 530 | AR Skip Shot 1 | DDB_AR_SKIP_SHOT_1 |
| This DDB signal forces the Autoreclose function to skip shot 1 of a reclose sequence. | | |
| 531 | Logic 0 Ref. | DDB_LOGIC_0 |
| This DDB signal is a logic 0 for use in the programmable scheme logic. It never changes state. | | |
| 532 | Inh Reclaim Time | DDB_AR_INHIBIT_RECLAIM_TIME |
| This DDB signal inhibits the Autoreclose Reclaim Timer | | |
| 533 | Reclaim In Prog | DDB_AR_RECLAIM_IN_PROGRESS |
| This DDB signal indicates that the Autoreclose Reclaim Time is in progress | | |
| 534 | Reclaim Complete | DDB_AR_RECLAIM_TIME_COMPLETE |
| This DDB signal indicates that the Autoreclose Reclaim Time is complete | | |
| 535 | BrokenLine Start | DDB_BROKEN_CONDUCTOR_START |
| This DDB signal is the Broken Conductor start signal | | |
| 536 | Trip Command In | DDB_ANY_TRIP |
| This DDB signal is the Trip Command In signal, which triggers the fixed trip LED and is mapped to the Trip Command Out signal in the FSL. | | |
| 537 | Trip Command Out | DDB_TRIP_INITIATE |
| This is the Trip Command Out signal, which is mapped to the trip relay in the default PSL | | |
| 538 | IA2H Start | DDB_2ND_HARMONIC_IA |
| This DDB signal is the A-phase 2nd Harmonic start signal | | |
| 539 | IB2H Start | DDB_2ND_HARMONIC_IB |
| This DDB signal is the B-phase 2nd Harmonic start signal | | |
| 540 | IC2H Start | DDB_2ND_HARMONIC_IC |
| This DDB signal is the C-phase 2nd Harmonic start signal | | |
| 541 | I2H Any Start | DDB_2ND_HARMONIC |
| This DDB signal is the 2nd Harmonic start signal for any phase | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---|---|---|
| **DESCRIPTION** | | |
| 542 | RP1 Read Only | DDB_RP1_READ_ONLY |
| This DDB signal enables Read-only mode for rear port 1 (RP1) | | |
| 543 | RP2 Read Only | DDB_RP2_READ_ONLY |
| This DDB signal enables Read-only mode for the optional rear port 2 (RP2) | | |
| 544 | NIC Read Only | DDB_NIC_READ_ONLY |
| This DDB signal enables Read-only mode for the optional network interface Card (NIC) | | |
| 563 | ZCD IA< | DDB_PHASE_A_ZCD |
| This DDB signal indicates an A-phase Undercurrent condition using a zero-crossing method. It is used only to reset CB Fail. | | |
| 564 | ZCD IB< | DDB_PHASE_B_ZCD |
| This DDB signal indicates a B-phase Undercurrent condition using a zero-crossing method. It is used only to reset CB Fail. | | |
| 565 | ZCD IC< | DDB_PHASE_C_ZCD |
| This DDB signal indicates a C-phase Undercurrent condition using a zero-crossing method. It is used only to reset CB Fail. | | |
| 566 | ZCD IN< | DDB_EF_ZCD |
| This DDB signal indicates an Earth Fault Undercurrent condition using a zero-crossing method. It is used only to reset CB Fail. | | |
| 567 | I>5 Timer Block | DDB_POC_5_TIMER_BLOCK |
| This DDB signal blocks the fifth stage overcurrent time delay | | |
| 568 | I>6 Timer Block | DDB_POC_6_TIMER_BLOCK |
| This DDB signal blocks the sixth stage overcurrent time delay | | |
| 569 | ZCD ISEF< | DDB_SEF_ZCD |
| This DDB signal indicates a Sensitive Earth Fault Undercurrent condition using a zero-crossing method. It is used only to reset CB Fail. | | |
| 570 | I>5 Trip | DDB_POC_5_3PH_TRIP |
| This DDB signal is the fifth stage three-phase Phase Overcurrent trip signal | | |
| 571 | I>5 Trip A | DDB_POC_5_PH_A_TRIP |
| This DDB signal is the fifth stage A-phase Phase Overcurrent trip signal | | |
| 572 | I>5 Trip B | DDB_POC_5_PH_B_TRIP |
| This DDB signal is the fifth stage B-phase Phase Overcurrent trip signal | | |
| 573 | I>5 Trip C | DDB_POC_5_PH_C_TRIP |
| This DDB signal is the fifth stage C-phase Phase Overcurrent trip signal | | |
| 574 | I>6 Trip | DDB_POC_6_3PH_TRIP |
| This DDB signal is the sixth stage three-phase Phase Overcurrent trip signal | | |
| 575 | I>6 Trip A | DDB_POC_6_PH_A_TRIP |
| This DDB signal is the sixth stage A-phase Phase Overcurrent trip signal | | |
| 576 | I>6 Trip B | DDB_POC_6_PH_B_TRIP |
| This DDB signal is the sixth stage B-phase Phase Overcurrent trip signal | | |
| 577 | I>6 Trip C | DDB_POC_6_PH_C_TRIP |
| This DDB signal is the sixth stage C-phase Phase Overcurrent trip signal | | |
| 579 | I>5 Start | DDB_POC_5_3PH_START |
| This DDB signal is the fifth stage three-phase Phase Overcurrent start signal | | |
| 580 | I>5 Start A | DDB_POC_5_PH_A_START |
| This DDB signal is the fifth stage A-phase Phase Overcurrent start signal | | |
| 581 | I>5 Start B | DDB_POC_5_PH_B_START |
| This DDB signal is the fifth stage B-phase Phase Overcurrent start signal | | |
| 582 | I>5 Start C | DDB_POC_5_PH_C_START |
| This DDB signal is the fifth stage C-phase Phase Overcurrent start signal | | |
| 583 | I>6 Start | DDB_POC_6_3PH_START |
| This DDB signal is the sixth stage three-phase Phase Overcurrent start signal | | |
| 584 | I>6 Start A | DDB_POC_6_PH_A_START |
| This DDB signal is the sixth stage A-phase Phase Overcurrent start signal | | |
| 585 | I>6 Start B | DDB_POC_6_PH_B_START |
| This DDB signal is the sixth stage B-phase Phase Overcurrent start signal | | |
| 586 | I>6 Start C | DDB_POC_6_PH_C_START |
| This DDB signal is the sixth stage C-phase Phase Overcurrent start signal | | |
| 626 | ISEF> Any Start | DDB_SEF_ANY_START |
| This DDB signal is the any-phase start signal for SEF | | |
| 640 | LED1 Red | DDB_OUTPUT_TRI_LED_1_RED |
| DDB signal indicates that the red LED is active | | |
| 641 | LED1 Grn | DDB_OUTPUT_TRI_LED_1_GRN |
| DDB signal indicates that the green LED is active | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---------|-------------|--------------|
| **DESCRIPTION** | | |
| 642 | LED2 Red | DDB_OUTPUT_TRI_LED_2_RED |
| DDB signal indicates that the red LED is active | | |
| 643 | LED2 Grn | DDB_OUTPUT_TRI_LED_2_GRN |
| DDB signal indicates that the green LED is active | | |
| 644 | LED3 Red | DDB_OUTPUT_TRI_LED_3_RED |
| DDB signal indicates that the red LED is active | | |
| 645 | LED3 Grn | DDB_OUTPUT_TRI_LED_3_GRN |
| DDB signal indicates that the green LED is active | | |
| 646 | LED4 Red | DDB_OUTPUT_TRI_LED_4_RED |
| DDB signal indicates that the red LED is active | | |
| 647 | LED4 Grn | DDB_OUTPUT_TRI_LED_4_GRN |
| DDB signal indicates that the green LED is active | | |
| 648 | LED5 Red(30TE) | DDB_OUTPUT_TRI_LED_5_RED |
| DDB signal indicates that the red LED is active | | |
| 649 | LED5 Grn(30TE) | DDB_OUTPUT_TRI_LED_5_GRN |
| DDB signal indicates that the green LED is active | | |
| 650 | LED6 Red(30TE) | DDB_OUTPUT_TRI_LED_6_RED |
| DDB signal indicates that the red LED is active | | |
| 651 | LED6 Grn(30TE) | DDB_OUTPUT_TRI_LED_6_GRN |
| DDB signal indicates that the green LED is active | | |
| 652 | LED7 Red(30TE) | DDB_OUTPUT_TRI_LED_7_RED |
| DDB signal indicates that the red LED is active | | |
| 653 | LED7 Grn(30TE) | DDB_OUTPUT_TRI_LED_7_GRN |
| DDB signal indicates that the green LED is active | | |
| 654 | LED8 Red(30TE) | DDB_OUTPUT_TRI_LED_8_RED |
| DDB signal indicates that the red LED is active | | |
| 655 | LED8 Grn(30TE) | DDB_OUTPUT_TRI_LED_8_GRN |
| DDB signal indicates that the green LED is active | | |
| 656 | FnKey LED1 Red | DDB_OUTPUT_TRI_LED_9_RED |
| DDB signal indicates that the red Function Key LED is active | | |
| 657 | FnKey LED1 Grn | DDB_OUTPUT_TRI_LED_9_GRN |
| DDB signal indicates that the green Function Key LED is active | | |
| 658 | FnKey LED2 Red | DDB_OUTPUT_TRI_LED_10_RED |
| DDB signal indicates that the red Function Key LED is active | | |
| 659 | FnKey LED2 Grn | DDB_OUTPUT_TRI_LED_10_GRN |
| DDB signal indicates that the green Function Key LED is active | | |
| 660 | FnKey LED3 Red | DDB_OUTPUT_TRI_LED_11_RED |
| DDB signal indicates that the red Function Key LED is active | | |
| 661 | FnKey LED3 Grn | DDB_OUTPUT_TRI_LED_11_GRN |
| DDB signal indicates that the green Function Key LED is active | | |
| 676 | LED1 Con R | DDB_TRI_LED_RED_CON_1 |
| This DDB signal drives the red LED Conditioner 1 | | |
| 677 | LED1 Con G | DDB_TRI_LED_GRN_CON_1 |
| This DDB signal drives the green LED Conditioner 1 | | |
| 678 | LED2 Con R | DDB_TRI_LED_RED_CON_2 |
| This DDB signal drives the red LED Conditioner 2 | | |
| 679 | LED2 Con G | DDB_TRI_LED_GRN_CON_2 |
| This DDB signal drives the green LED Conditioner 2 | | |
| 680 | LED3 Con R | DDB_TRI_LED_RED_CON_3 |
| This DDB signal drives the red LED Conditioner 3 | | |
| 681 | LED3 Con G | DDB_TRI_LED_GRN_CON_3 |
| This DDB signal drives the green LED Conditioner 3 | | |
| 682 | LED4 Con R | DDB_TRI_LED_RED_CON_4 |
| This DDB signal drives the red LED Conditioner 4 | | |
| 683 | LED4 Con G | DDB_TRI_LED_GRN_CON_4 |
| This DDB signal drives the green LED Conditioner 4 | | |
| 684 | LED5 Con R(30TE) | DDB_TRI_LED_RED_CON_5 |
| This DDB signal drives the red LED Conditioner 5 | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---|---|---|
| **DESCRIPTION** | | |
| 685 | LED5 Con G(30TE) | DDB_TRI_LED_GRN_CON_5 |
| This DDB signal drives the green LED Conditioner 5 | | |
| 686 | LED6 Con R(30TE) | DDB_TRI_LED_RED_CON_6 |
| This DDB signal drives the red LED Conditioner 6 | | |
| 687 | LED6 Con G(30TE) | DDB_TRI_LED_GRN_CON_6 |
| This DDB signal drives the green LED Conditioner 6 | | |
| 688 | LED7 Con R(30TE) | DDB_TRI_LED_RED_CON_7 |
| This DDB signal drives the red LED Conditioner 7 | | |
| 689 | LED7 Con G(30TE) | DDB_TRI_LED_GRN_CON_7 |
| This DDB signal drives the green LED Conditioner 7 | | |
| 690 | LED8 Con R(30TE) | DDB_TRI_LED_RED_CON_8 |
| This DDB signal drives the red LED Conditioner 8 | | |
| 691 | LED8 Con G(30TE) | DDB_TRI_LED_GRN_CON_8 |
| This DDB signal drives the green LED Conditioner 8 | | |
| 692 | FnKey LED1 ConR | DDB_TRI_LED_RED_CON_9 |
| This DDB signal drives the red Function Key LED Conditioner 1 | | |
| 693 | FnKey LED1 ConG | DDB_TRI_LED_GRN_CON_9 |
| This DDB signal drives the green Function Key LED Conditioner 1 | | |
| 694 | FnKey LED2 ConR | DDB_TRI_LED_RED_CON_10 |
| This DDB signal drives the red Function Key LED Conditioner 2 | | |
| 695 | FnKey LED2 ConG | DDB_TRI_LED_GRN_CON_10 |
| This DDB signal drives the green Function Key LED Conditioner 2 | | |
| 696 | FnKey LED3 ConR | DDB_TRI_LED_RED_CON_11 |
| This DDB signal drives the red Function Key LED Conditioner 3 | | |
| 697 | FnKey LED3 ConG | DDB_TRI_LED_GRN_CON_11 |
| This DDB signal drives the red Function Key LED Conditioner 3 | | |
| 712 | Function Key 1 | DDB_FN_KEY_1 |
| DDB signal indicates that Function key 1 is active | | |
| 713 | Function Key 2 | DDB_FN_KEY_2 |
| DDB signal indicates that Function key 2 is active | | |
| 714 | Function Key 3 | DDB_FN_KEY_3 |
| DDB signal indicates that Function key 3 is active | | |
| 762 | Vdc1 Start | DDB_ZONE_1_VDC_START |
| This DDB signal is the DC Supply Monitoring Zone 1 Start signal | | |
| 763 | Vdc2 Start | DDB_ZONE_2_VDC_START |
| This DDB signal is the DC Supply Monitoring Zone 2 Start signal | | |
| 764 | Vdc3 Start | DDB_ZONE_3_VDC_START |
| This DDB signal is the DC Supply Monitoring Zone 3 Start signal | | |
| 765 | Vdc1 Trip | DDB_ZONE_1_VDC_TRIP |
| This DDB signal is the DC Supply Monitoring Zone 1 Trip signal | | |
| 766 | Vdc2 Trip | DDB_ZONE_2_VDC_TRIP |
| This DDB signal is the DC Supply Monitoring Zone 2 Trip signal | | |
| 767 | Vdc3 Trip | DDB_ZONE_3_VDC_TRIP |
| This DDB signal is the DC Supply Monitoring Zone 3 Trip signal | | |
| 768 | InhibitDC SupMon | DDB_DC_SUPPLY_MON_INHIBIT |
| This DDB signal is the DC Supply Monitoring Inhibit Signal | | |
| 769 | DC Supply Fail | DDB_DC_SUPPLY_MON_ALARM |
| This DDB signal is the DC Supply Monitoring Alarm Signal | | |
| 771 | GOOSE IED Absent | DDB_GOOSE_MISSING_IED_ALARM |
| This is a GOOSE alarm indicating that the IED is absent. | | |
| 772 | NIC Not Fitted | DDB_ECARD_NOT_FITTED_ALARM |
| This DDB signal indicates that an Ethernet card is not fitted | | |
| 773 | NIC No Response | DDB_NIC_NOT_RESPONDING_ALARM |
| This DDB signal indicates that the Ethernet card is not responding | | |
| 774 | NIC Fatal Error | DDB_NIC_FATAL_ERROR_ALARM |
| This DDB signal indicates that the Ethernet card has a fatal error | | |
| 776 | Bad TCP/IP Cfg. | DDB_INVALID_TCP_IP_CONFIG_ALARM |
| This DDB signal indicates that the TCP/IP configuration is invalid | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---|---|---|
| **DESCRIPTION** | | |
| 778 | NIC Link Fail | DDB_NIC_LINK_FAIL_ALARM |
| This DDB signal indicates that there is a communication failure on the Ethernet card | | |
| 779 | NIC SW Mis-Match | DDB_SW_MISMATCH_ALARM |
| This DDB signal is the main card/Ethernet card software mismatch Alarm | | |
| 780 | IP Addr Conflict | DDB_IP_ADDRESS_CONFLICT_ALARM |
| This DDB signal indicates that there is an IP Address conflict | | |
| 781 | Port A Link Fail | DDB_NIC_LINK_PORT_A_FAIL_ALARM |
| This DDB signal indicates that Port A has no link | | |
| 782 | Port B Link Fail | DDB_NIC_LINK_PORT_B_FAIL_ALARM |
| This DDB signal indicates that Port B has no link | | |
| 783 | DREB Set.Invalid | DDB_NIC_SETTING_INVALID_ALARM |
| This DDB signal indicates that the redundancy settings are not valid for this IED model no | | |
| 788 | SNTP Failure | DDB_SNTP_FAIL_ALARM |
| SNTP Alarm | | |
| 790 | PTP Failure | DDB_PTP_FAIL_ALARM |
| IEEE 1588 PTP time synchronisation failure alarm | | |
| 800 | Control Input 1 | DDB_CONTROL_1 |
| This DDB signal is a control input signal | | |
| 801 | Control Input 2 | DDB_CONTROL_2 |
| This DDB signal is a control input signal | | |
| 802 | Control Input 3 | DDB_CONTROL_3 |
| This DDB signal is a control input signal | | |
| 803 | Control Input 4 | DDB_CONTROL_4 |
| This DDB signal is a control input signal | | |
| 804 | Control Input 5 | DDB_CONTROL_5 |
| This DDB signal is a control input signal | | |
| 805 | Control Input 6 | DDB_CONTROL_6 |
| This DDB signal is a control input signal | | |
| 806 | Control Input 7 | DDB_CONTROL_7 |
| This DDB signal is a control input signal | | |
| 807 | Control Input 8 | DDB_CONTROL_8 |
| This DDB signal is a control input signal | | |
| 808 | Control Input 9 | DDB_CONTROL_9 |
| This DDB signal is a control input signal | | |
| 809 | Control Input 10 | DDB_CONTROL_10 |
| This DDB signal is a control input signal | | |
| 810 | Control Input 11 | DDB_CONTROL_11 |
| This DDB signal is a control input signal | | |
| 811 | Control Input 12 | DDB_CONTROL_12 |
| This DDB signal is a control input signal | | |
| 812 | Control Input 13 | DDB_CONTROL_13 |
| This DDB signal is a control input signal | | |
| 813 | Control Input 14 | DDB_CONTROL_14 |
| This DDB signal is a control input signal | | |
| 814 | Control Input 15 | DDB_CONTROL_15 |
| This DDB signal is a control input signal | | |
| 815 | Control Input 16 | DDB_CONTROL_16 |
| This DDB signal is a control input signal | | |
| 816 | Control Input 17 | DDB_CONTROL_17 |
| This DDB signal is a control input signal | | |
| 817 | Control Input 18 | DDB_CONTROL_18 |
| This DDB signal is a control input signal | | |
| 818 | Control Input 19 | DDB_CONTROL_19 |
| This DDB signal is a control input signal | | |
| 819 | Control Input 20 | DDB_CONTROL_20 |
| This DDB signal is a control input signal | | |
| 820 | Control Input 21 | DDB_CONTROL_21 |
| This DDB signal is a control input signal | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---|---|---|
| | DESCRIPTION | |
| 821 | Control Input 22 | DDB_CONTROL_22 |
| This DDB signal is a control input signal | | |
| 822 | Control Input 23 | DDB_CONTROL_23 |
| This DDB signal is a control input signal | | |
| 823 | Control Input 24 | DDB_CONTROL_24 |
| This DDB signal is a control input signal | | |
| 824 | Control Input 25 | DDB_CONTROL_25 |
| This DDB signal is a control input signal | | |
| 825 | Control Input 26 | DDB_CONTROL_26 |
| This DDB signal is a control input signal | | |
| 826 | Control Input 27 | DDB_CONTROL_27 |
| This DDB signal is a control input signal | | |
| 827 | Control Input 28 | DDB_CONTROL_28 |
| This DDB signal is a control input signal | | |
| 828 | Control Input 29 | DDB_CONTROL_29 |
| This DDB signal is a control input signal | | |
| 829 | Control Input 30 | DDB_CONTROL_30 |
| This DDB signal is a control input signal | | |
| 830 | Control Input 31 | DDB_CONTROL_31 |
| This DDB signal is a control input signal | | |
| 831 | Control Input 32 | DDB_CONTROL_32 |
| This DDB signal is a control input signal | | |
| 832 | Virtual Input 1 | DDB_GOOSEIN_1 |
| This DDB signal is a GOOSE virtual input | | |
| 833 | Virtual Input 2 | DDB_GOOSEIN_2 |
| This DDB signal is a GOOSE virtual input | | |
| 834 | Virtual Input 3 | DDB_GOOSEIN_3 |
| This DDB signal is a GOOSE virtual input | | |
| 835 | Virtual Input 4 | DDB_GOOSEIN_4 |
| This DDB signal is a GOOSE virtual input | | |
| 836 | Virtual Input 5 | DDB_GOOSEIN_5 |
| This DDB signal is a GOOSE virtual input | | |
| 837 | Virtual Input 6 | DDB_GOOSEIN_6 |
| This DDB signal is a GOOSE virtual input | | |
| 838 | Virtual Input 7 | DDB_GOOSEIN_7 |
| This DDB signal is a GOOSE virtual input | | |
| 839 | Virtual Input 8 | DDB_GOOSEIN_8 |
| This DDB signal is a GOOSE virtual input | | |
| 840 | Virtual Input 9 | DDB_GOOSEIN_9 |
| This DDB signal is a GOOSE virtual input | | |
| 841 | Virtual Input 10 | DDB_GOOSEIN_10 |
| This DDB signal is a GOOSE virtual input | | |
| 842 | Virtual Input 11 | DDB_GOOSEIN_11 |
| This DDB signal is a GOOSE virtual input | | |
| 843 | Virtual Input 12 | DDB_GOOSEIN_12 |
| This DDB signal is a GOOSE virtual input | | |
| 844 | Virtual Input 13 | DDB_GOOSEIN_13 |
| This DDB signal is a GOOSE virtual input | | |
| 845 | Virtual Input 14 | DDB_GOOSEIN_14 |
| This DDB signal is a GOOSE virtual input | | |
| 846 | Virtual Input 15 | DDB_GOOSEIN_15 |
| This DDB signal is a GOOSE virtual input | | |
| 847 | Virtual Input 16 | DDB_GOOSEIN_16 |
| This DDB signal is a GOOSE virtual input | | |
| 848 | Virtual Input 17 | DDB_GOOSEIN_17 |
| This DDB signal is a GOOSE virtual input | | |
| 849 | Virtual Input 18 | DDB_GOOSEIN_18 |
| This DDB signal is a GOOSE virtual input | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---|---|---|
| | DESCRIPTION | |
| 850 | Virtual Input 19 | DDB_GOOSEIN_19 |
| This DDB signal is a GOOSE virtual input | | |
| 851 | Virtual Input 20 | DDB_GOOSEIN_20 |
| This DDB signal is a GOOSE virtual input | | |
| 852 | Virtual Input 21 | DDB_GOOSEIN_21 |
| This DDB signal is a GOOSE virtual input | | |
| 853 | Virtual Input 22 | DDB_GOOSEIN_22 |
| This DDB signal is a GOOSE virtual input | | |
| 854 | Virtual Input 23 | DDB_GOOSEIN_23 |
| This DDB signal is a GOOSE virtual input | | |
| 855 | Virtual Input 24 | DDB_GOOSEIN_24 |
| This DDB signal is a GOOSE virtual input | | |
| 856 | Virtual Input 25 | DDB_GOOSEIN_25 |
| This DDB signal is a GOOSE virtual input | | |
| 857 | Virtual Input 26 | DDB_GOOSEIN_26 |
| This DDB signal is a GOOSE virtual input | | |
| 858 | Virtual Input 27 | DDB_GOOSEIN_27 |
| This DDB signal is a GOOSE virtual input | | |
| 859 | Virtual Input 28 | DDB_GOOSEIN_28 |
| This DDB signal is a GOOSE virtual input | | |
| 860 | Virtual Input 29 | DDB_GOOSEIN_29 |
| This DDB signal is a GOOSE virtual input | | |
| 861 | Virtual Input 30 | DDB_GOOSEIN_30 |
| This DDB signal is a GOOSE virtual input | | |
| 862 | Virtual Input 31 | DDB_GOOSEIN_31 |
| This DDB signal is a GOOSE virtual input | | |
| 863 | Virtual Input 32 | DDB_GOOSEIN_32 |
| This DDB signal is a GOOSE virtual input | | |
| 864 | Virtual Input 33 | DDB_GOOSEIN_33 |
| This DDB signal is a GOOSE virtual input | | |
| 865 | Virtual Input 34 | DDB_GOOSEIN_34 |
| This DDB signal is a GOOSE virtual input | | |
| 866 | Virtual Input 35 | DDB_GOOSEIN_35 |
| This DDB signal is a GOOSE virtual input | | |
| 867 | Virtual Input 36 | DDB_GOOSEIN_36 |
| This DDB signal is a GOOSE virtual input | | |
| 868 | Virtual Input 37 | DDB_GOOSEIN_37 |
| This DDB signal is a GOOSE virtual input | | |
| 869 | Virtual Input 38 | DDB_GOOSEIN_38 |
| This DDB signal is a GOOSE virtual input | | |
| 870 | Virtual Input 39 | DDB_GOOSEIN_39 |
| This DDB signal is a GOOSE virtual input | | |
| 871 | Virtual Input 40 | DDB_GOOSEIN_40 |
| This DDB signal is a GOOSE virtual input | | |
| 872 | Virtual Input 41 | DDB_GOOSEIN_41 |
| This DDB signal is a GOOSE virtual input | | |
| 873 | Virtual Input 42 | DDB_GOOSEIN_42 |
| This DDB signal is a GOOSE virtual input | | |
| 874 | Virtual Input 43 | DDB_GOOSEIN_43 |
| This DDB signal is a GOOSE virtual input | | |
| 875 | Virtual Input 44 | DDB_GOOSEIN_44 |
| This DDB signal is a GOOSE virtual input | | |
| 876 | Virtual Input 45 | DDB_GOOSEIN_45 |
| This DDB signal is a GOOSE virtual input | | |
| 877 | Virtual Input 46 | DDB_GOOSEIN_46 |
| This DDB signal is a GOOSE virtual input | | |
| 878 | Virtual Input 47 | DDB_GOOSEIN_47 |
| This DDB signal is a GOOSE virtual input | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---------|-------------|--------------|
| **DESCRIPTION** | | |
| 879 | Virtual Input 48 | DDB_GOOSEIN_48 |
| This DDB signal is a GOOSE virtual input | | |
| 880 | Virtual Input 49 | DDB_GOOSEIN_49 |
| This DDB signal is a GOOSE virtual input | | |
| 881 | Virtual Input 50 | DDB_GOOSEIN_50 |
| This DDB signal is a GOOSE virtual input | | |
| 882 | Virtual Input 51 | DDB_GOOSEIN_51 |
| This DDB signal is a GOOSE virtual input | | |
| 883 | Virtual Input 52 | DDB_GOOSEIN_52 |
| This DDB signal is a GOOSE virtual input | | |
| 884 | Virtual Input 53 | DDB_GOOSEIN_53 |
| This DDB signal is a GOOSE virtual input | | |
| 885 | Virtual Input 54 | DDB_GOOSEIN_54 |
| This DDB signal is a GOOSE virtual input | | |
| 886 | Virtual Input 55 | DDB_GOOSEIN_55 |
| This DDB signal is a GOOSE virtual input | | |
| 887 | Virtual Input 56 | DDB_GOOSEIN_56 |
| This DDB signal is a GOOSE virtual input | | |
| 888 | Virtual Input 57 | DDB_GOOSEIN_57 |
| This DDB signal is a GOOSE virtual input | | |
| 889 | Virtual Input 58 | DDB_GOOSEIN_58 |
| This DDB signal is a GOOSE virtual input | | |
| 890 | Virtual Input 59 | DDB_GOOSEIN_59 |
| This DDB signal is a GOOSE virtual input | | |
| 891 | Virtual Input 60 | DDB_GOOSEIN_60 |
| This DDB signal is a GOOSE virtual input | | |
| 892 | Virtual Input 61 | DDB_GOOSEIN_61 |
| This DDB signal is a GOOSE virtual input | | |
| 893 | Virtual Input 62 | DDB_GOOSEIN_62 |
| This DDB signal is a GOOSE virtual input | | |
| 894 | Virtual Input 63 | DDB_GOOSEIN_63 |
| This DDB signal is a GOOSE virtual input | | |
| 895 | Virtual Input 64 | DDB_GOOSEIN_64 |
| This DDB signal is a GOOSE virtual input | | |
| 923 | | DDB_PSLINT_1 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 924 | | DDB_PSLINT_2 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 925 | | DDB_PSLINT_3 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 926 | | DDB_PSLINT_4 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 927 | | DDB_PSLINT_5 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 928 | | DDB_PSLINT_6 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 929 | | DDB_PSLINT_7 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 930 | | DDB_PSLINT_8 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 931 | | DDB_PSLINT_9 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 932 | | DDB_PSLINT_10 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 933 | | DDB_PSLINT_11 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 934 | | DDB_PSLINT_12 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---|---|---|
| DESCRIPTION | | |
| 935 | | DDB_PSLINT_13 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 936 | | DDB_PSLINT_14 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 937 | | DDB_PSLINT_15 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 938 | | DDB_PSLINT_16 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 939 | | DDB_PSLINT_17 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 940 | | DDB_PSLINT_18 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 941 | | DDB_PSLINT_19 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 942 | | DDB_PSLINT_20 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 943 | | DDB_PSLINT_21 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 944 | | DDB_PSLINT_22 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 945 | | DDB_PSLINT_23 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 946 | | DDB_PSLINT_24 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 947 | | DDB_PSLINT_25 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 948 | | DDB_PSLINT_26 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 949 | | DDB_PSLINT_27 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 950 | | DDB_PSLINT_28 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 951 | | DDB_PSLINT_29 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 952 | | DDB_PSLINT_30 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 953 | | DDB_PSLINT_31 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 954 | | DDB_PSLINT_32 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 955 | | DDB_PSLINT_33 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 956 | | DDB_PSLINT_34 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 957 | | DDB_PSLINT_35 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 958 | | DDB_PSLINT_36 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 959 | | DDB_PSLINT_37 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 960 | | DDB_PSLINT_38 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 961 | | DDB_PSLINT_39 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 962 | | DDB_PSLINT_40 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 963 | | DDB_PSLINT_41 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---|---|---|
| **DESCRIPTION** | | |
| 964 | | DDB_PSLINT_42 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 965 | | DDB_PSLINT_43 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 966 | | DDB_PSLINT_44 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 967 | | DDB_PSLINT_45 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 968 | | DDB_PSLINT_46 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 969 | | DDB_PSLINT_47 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 970 | | DDB_PSLINT_48 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 971 | | DDB_PSLINT_49 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 972 | | DDB_PSLINT_50 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 973 | | DDB_PSLINT_51 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 974 | | DDB_PSLINT_52 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 975 | | DDB_PSLINT_53 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 976 | | DDB_PSLINT_54 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 977 | | DDB_PSLINT_55 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 978 | | DDB_PSLINT_56 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 979 | | DDB_PSLINT_57 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 980 | | DDB_PSLINT_58 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 981 | | DDB_PSLINT_59 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 982 | | DDB_PSLINT_60 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 983 | | DDB_PSLINT_61 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 984 | | DDB_PSLINT_62 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 985 | | DDB_PSLINT_63 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 986 | | DDB_PSLINT_64 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 987 | | DDB_PSLINT_65 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 988 | | DDB_PSLINT_66 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 989 | | DDB_PSLINT_67 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 990 | | DDB_PSLINT_68 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 991 | | DDB_PSLINT_69 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 992 | | DDB_PSLINT_70 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---|---|---|
| | | **DESCRIPTION** |
| 993 | | DDB_PSLINT_71 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 994 | | DDB_PSLINT_72 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 995 | | DDB_PSLINT_73 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 996 | | DDB_PSLINT_74 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 997 | | DDB_PSLINT_75 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 998 | | DDB_PSLINT_76 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 999 | | DDB_PSLINT_77 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 1000 | | DDB_PSLINT_78 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 1001 | | DDB_PSLINT_79 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 1002 | | DDB_PSLINT_80 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 1003 | | DDB_PSLINT_81 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 1004 | | DDB_PSLINT_82 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 1005 | | DDB_PSLINT_83 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 1006 | | DDB_PSLINT_84 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 1007 | | DDB_PSLINT_85 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 1008 | | DDB_PSLINT_86 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 1009 | | DDB_PSLINT_87 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 1010 | | DDB_PSLINT_88 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 1011 | | DDB_PSLINT_89 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 1012 | | DDB_PSLINT_90 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 1013 | | DDB_PSLINT_91 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 1014 | | DDB_PSLINT_92 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 1015 | | DDB_PSLINT_93 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 1016 | | DDB_PSLINT_94 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 1017 | | DDB_PSLINT_95 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 1018 | | DDB_PSLINT_96 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 1019 | | DDB_PSLINT_97 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 1020 | | DDB_PSLINT_98 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 1021 | | DDB_PSLINT_99 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---|---|---|
| | DESCRIPTION | |
| 1022 | | DDB_PSLINT_100 |
| This DDB signal is assigned to a PSL node used internally, and is defined by the Programmable Scheme Logic | | |
| 1024 | Virtual Output 1 | DDB_GOOSEOUT_1 |
| This DDB signal is a GOOSE virtual output | | |
| 1025 | Virtual Output 2 | DDB_GOOSEOUT_2 |
| This DDB signal is a GOOSE virtual output | | |
| 1026 | Virtual Output 3 | DDB_GOOSEOUT_3 |
| This DDB signal is a GOOSE virtual output | | |
| 1027 | Virtual Output 4 | DDB_GOOSEOUT_4 |
| This DDB signal is a GOOSE virtual output | | |
| 1028 | Virtual Output 5 | DDB_GOOSEOUT_5 |
| This DDB signal is a GOOSE virtual output | | |
| 1029 | Virtual Output 6 | DDB_GOOSEOUT_6 |
| This DDB signal is a GOOSE virtual output | | |
| 1030 | Virtual Output 7 | DDB_GOOSEOUT_7 |
| This DDB signal is a GOOSE virtual output | | |
| 1031 | Virtual Output 8 | DDB_GOOSEOUT_8 |
| This DDB signal is a GOOSE virtual output | | |
| 1032 | Virtual Output 9 | DDB_GOOSEOUT_9 |
| This DDB signal is a GOOSE virtual output | | |
| 1033 | Virtual Output10 | DDB_GOOSEOUT_10 |
| This DDB signal is a GOOSE virtual output | | |
| 1034 | Virtual Output11 | DDB_GOOSEOUT_11 |
| This DDB signal is a GOOSE virtual output | | |
| 1035 | Virtual Output12 | DDB_GOOSEOUT_12 |
| This DDB signal is a GOOSE virtual output | | |
| 1036 | Virtual Output13 | DDB_GOOSEOUT_13 |
| This DDB signal is a GOOSE virtual output | | |
| 1037 | Virtual Output14 | DDB_GOOSEOUT_14 |
| This DDB signal is a GOOSE virtual output | | |
| 1038 | Virtual Output15 | DDB_GOOSEOUT_15 |
| This DDB signal is a GOOSE virtual output | | |
| 1039 | Virtual Output16 | DDB_GOOSEOUT_16 |
| This DDB signal is a GOOSE virtual output | | |
| 1040 | Virtual Output17 | DDB_GOOSEOUT_17 |
| This DDB signal is a GOOSE virtual output | | |
| 1041 | Virtual Output18 | DDB_GOOSEOUT_18 |
| This DDB signal is a GOOSE virtual output | | |
| 1042 | Virtual Output19 | DDB_GOOSEOUT_19 |
| This DDB signal is a GOOSE virtual output | | |
| 1043 | Virtual Output20 | DDB_GOOSEOUT_20 |
| This DDB signal is a GOOSE virtual output | | |
| 1044 | Virtual Output21 | DDB_GOOSEOUT_21 |
| This DDB signal is a GOOSE virtual output | | |
| 1045 | Virtual Output22 | DDB_GOOSEOUT_22 |
| This DDB signal is a GOOSE virtual output | | |
| 1046 | Virtual Output23 | DDB_GOOSEOUT_23 |
| This DDB signal is a GOOSE virtual output | | |
| 1047 | Virtual Output24 | DDB_GOOSEOUT_24 |
| This DDB signal is a GOOSE virtual output | | |
| 1048 | Virtual Output25 | DDB_GOOSEOUT_25 |
| This DDB signal is a GOOSE virtual output | | |
| 1049 | Virtual Output26 | DDB_GOOSEOUT_26 |
| This DDB signal is a GOOSE virtual output | | |
| 1050 | Virtual Output27 | DDB_GOOSEOUT_27 |
| This DDB signal is a GOOSE virtual output | | |
| 1051 | Virtual Output28 | DDB_GOOSEOUT_28 |
| This DDB signal is a GOOSE virtual output | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---|---|---|
| DESCRIPTION | | |
| 1052 | Virtual Output29 | DDB_GOOSEOUT_29 |
| This DDB signal is a GOOSE virtual output | | |
| 1053 | Virtual Output30 | DDB_GOOSEOUT_30 |
| This DDB signal is a GOOSE virtual output | | |
| 1054 | Virtual Output31 | DDB_GOOSEOUT_31 |
| This DDB signal is a GOOSE virtual output | | |
| 1055 | Virtual Output32 | DDB_GOOSEOUT_32 |
| This DDB signal is a GOOSE virtual output | | |
| 1056 | Quality VIP 1 | DDB_VIP_QUALITY_1 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1057 | Quality VIP 2 | DDB_VIP_QUALITY_2 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1058 | Quality VIP 3 | DDB_VIP_QUALITY_3 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1059 | Quality VIP 4 | DDB_VIP_QUALITY_4 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1060 | Quality VIP 5 | DDB_VIP_QUALITY_5 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1061 | Quality VIP 6 | DDB_VIP_QUALITY_6 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1062 | Quality VIP 7 | DDB_VIP_QUALITY_7 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1063 | Quality VIP 8 | DDB_VIP_QUALITY_8 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1064 | Quality VIP 9 | DDB_VIP_QUALITY_9 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1065 | Quality VIP 10 | DDB_VIP_QUALITY_10 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1066 | Quality VIP 11 | DDB_VIP_QUALITY_11 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1067 | Quality VIP 12 | DDB_VIP_QUALITY_12 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1068 | Quality VIP 13 | DDB_VIP_QUALITY_13 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1069 | Quality VIP 14 | DDB_VIP_QUALITY_14 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1070 | Quality VIP 15 | DDB_VIP_QUALITY_15 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1071 | Quality VIP 16 | DDB_VIP_QUALITY_16 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1072 | Quality VIP 17 | DDB_VIP_QUALITY_17 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1073 | Quality VIP 18 | DDB_VIP_QUALITY_18 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1074 | Quality VIP 19 | DDB_VIP_QUALITY_19 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1075 | Quality VIP 20 | DDB_VIP_QUALITY_20 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1076 | Quality VIP 21 | DDB_VIP_QUALITY_21 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1077 | Quality VIP 22 | DDB_VIP_QUALITY_22 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1078 | Quality VIP 23 | DDB_VIP_QUALITY_23 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1079 | Quality VIP 24 | DDB_VIP_QUALITY_24 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1080 | Quality VIP 25 | DDB_VIP_QUALITY_25 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---------|-------------|--------------|
| DESCRIPTION | | |
| 1081 | Quality VIP 26 | DDB_VIP_QUALITY_26 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1082 | Quality VIP 27 | DDB_VIP_QUALITY_27 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1083 | Quality VIP 28 | DDB_VIP_QUALITY_28 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1084 | Quality VIP 29 | DDB_VIP_QUALITY_29 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1085 | Quality VIP 30 | DDB_VIP_QUALITY_30 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1086 | Quality VIP 31 | DDB_VIP_QUALITY_31 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1087 | Quality VIP 32 | DDB_VIP_QUALITY_32 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1088 | Quality VIP 33 | DDB_VIP_QUALITY_33 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1089 | Quality VIP 34 | DDB_VIP_QUALITY_34 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1090 | Quality VIP 35 | DDB_VIP_QUALITY_35 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1091 | Quality VIP 36 | DDB_VIP_QUALITY_36 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1092 | Quality VIP 37 | DDB_VIP_QUALITY_37 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1093 | Quality VIP 38 | DDB_VIP_QUALITY_38 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1094 | Quality VIP 39 | DDB_VIP_QUALITY_39 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1095 | Quality VIP 40 | DDB_VIP_QUALITY_40 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1096 | Quality VIP 41 | DDB_VIP_QUALITY_41 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1097 | Quality VIP 42 | DDB_VIP_QUALITY_42 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1098 | Quality VIP 43 | DDB_VIP_QUALITY_43 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1099 | Quality VIP 44 | DDB_VIP_QUALITY_44 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1100 | Quality VIP 45 | DDB_VIP_QUALITY_45 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1101 | Quality VIP 46 | DDB_VIP_QUALITY_46 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1102 | Quality VIP 47 | DDB_VIP_QUALITY_47 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1103 | Quality VIP 48 | DDB_VIP_QUALITY_48 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1104 | Quality VIP 49 | DDB_VIP_QUALITY_49 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1105 | Quality VIP 50 | DDB_VIP_QUALITY_50 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1106 | Quality VIP 51 | DDB_VIP_QUALITY_51 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1107 | Quality VIP 52 | DDB_VIP_QUALITY_52 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1108 | Quality VIP 53 | DDB_VIP_QUALITY_53 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1109 | Quality VIP 54 | DDB_VIP_QUALITY_54 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---|---|---|
| **DESCRIPTION** | | |
| 1110 | Quality VIP 55 | DDB_VIP_QUALITY_55 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1111 | Quality VIP 56 | DDB_VIP_QUALITY_56 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1112 | Quality VIP 57 | DDB_VIP_QUALITY_57 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1113 | Quality VIP 58 | DDB_VIP_QUALITY_58 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1114 | Quality VIP 59 | DDB_VIP_QUALITY_59 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1115 | Quality VIP 60 | DDB_VIP_QUALITY_60 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1116 | Quality VIP 61 | DDB_VIP_QUALITY_61 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1117 | Quality VIP 62 | DDB_VIP_QUALITY_62 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1118 | Quality VIP 63 | DDB_VIP_QUALITY_63 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1119 | Quality VIP 64 | DDB_VIP_QUALITY_64 |
| This DDB signal is a GOOSE Virtual input Quality bit | | |
| 1120 | PubPres VIP 1 | DDB_VIP_PUB_PRES_1 |
| GOOSE Virtual input 1 publisher bit | | |
| 1121 | PubPres VIP 2 | DDB_VIP_PUB_PRES_2 |
| GOOSE Virtual input 2 publisher bit | | |
| 1122 | PubPres VIP 3 | DDB_VIP_PUB_PRES_3 |
| GOOSE Virtual input 3 publisher bit | | |
| 1123 | PubPres VIP 4 | DDB_VIP_PUB_PRES_4 |
| GOOSE Virtual input 4 publisher bit | | |
| 1124 | PubPres VIP 5 | DDB_VIP_PUB_PRES_5 |
| GOOSE Virtual input 5 publisher bit | | |
| 1125 | PubPres VIP 6 | DDB_VIP_PUB_PRES_6 |
| GOOSE Virtual input 6 publisher bit | | |
| 1126 | PubPres VIP 7 | DDB_VIP_PUB_PRES_7 |
| GOOSE Virtual input 7 publisher bit | | |
| 1127 | PubPres VIP 8 | DDB_VIP_PUB_PRES_8 |
| GOOSE Virtual input 8 publisher bit | | |
| 1128 | PubPres VIP 9 | DDB_VIP_PUB_PRES_9 |
| GOOSE Virtual input 9 publisher bit | | |
| 1129 | PubPres VIP 10 | DDB_VIP_PUB_PRES_10 |
| GOOSE Virtual input 10 publisher bit | | |
| 1130 | PubPres VIP 11 | DDB_VIP_PUB_PRES_11 |
| GOOSE Virtual input 11 publisher bit | | |
| 1131 | PubPres VIP 12 | DDB_VIP_PUB_PRES_12 |
| GOOSE Virtual input 12 publisher bit | | |
| 1132 | PubPres VIP 13 | DDB_VIP_PUB_PRES_13 |
| GOOSE Virtual input 13 publisher bit | | |
| 1133 | PubPres VIP 14 | DDB_VIP_PUB_PRES_14 |
| GOOSE Virtual input 14 publisher bit | | |
| 1134 | PubPres VIP 15 | DDB_VIP_PUB_PRES_15 |
| GOOSE Virtual input 15 publisher bit | | |
| 1135 | PubPres VIP 16 | DDB_VIP_PUB_PRES_16 |
| GOOSE Virtual input 16 publisher bit | | |
| 1136 | PubPres VIP 17 | DDB_VIP_PUB_PRES_17 |
| GOOSE Virtual input 17 publisher bit | | |
| 1137 | PubPres VIP 18 | DDB_VIP_PUB_PRES_18 |
| GOOSE Virtual input 18 publisher bit | | |
| 1138 | PubPres VIP 19 | DDB_VIP_PUB_PRES_19 |
| GOOSE Virtual input 19 publisher bit | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---|---|---|
| **DESCRIPTION** | | |
| 1139 | PubPres VIP 20 | DDB_VIP_PUB_PRES_20 |
| GOOSE Virtual input 20 publisher bit | | |
| 1140 | PubPres VIP 21 | DDB_VIP_PUB_PRES_21 |
| GOOSE Virtual input 21 publisher bit | | |
| 1141 | PubPres VIP 22 | DDB_VIP_PUB_PRES_22 |
| GOOSE Virtual input 22 publisher bit | | |
| 1142 | PubPres VIP 23 | DDB_VIP_PUB_PRES_23 |
| GOOSE Virtual input 23 publisher bit | | |
| 1143 | PubPres VIP 24 | DDB_VIP_PUB_PRES_24 |
| GOOSE Virtual input 24 publisher bit | | |
| 1144 | PubPres VIP 25 | DDB_VIP_PUB_PRES_25 |
| GOOSE Virtual input 25 publisher bit | | |
| 1145 | PubPres VIP 26 | DDB_VIP_PUB_PRES_26 |
| GOOSE Virtual input 26 publisher bit | | |
| 1146 | PubPres VIP 27 | DDB_VIP_PUB_PRES_27 |
| GOOSE Virtual input 27 publisher bit | | |
| 1147 | PubPres VIP 28 | DDB_VIP_PUB_PRES_28 |
| GOOSE Virtual input 28 publisher bit | | |
| 1148 | PubPres VIP 29 | DDB_VIP_PUB_PRES_29 |
| GOOSE Virtual input 29 publisher bit | | |
| 1149 | PubPres VIP 30 | DDB_VIP_PUB_PRES_30 |
| GOOSE Virtual input 30 publisher bit | | |
| 1150 | PubPres VIP 31 | DDB_VIP_PUB_PRES_31 |
| GOOSE Virtual input 31 publisher bit | | |
| 1151 | PubPres VIP 32 | DDB_VIP_PUB_PRES_32 |
| GOOSE Virtual input 32 publisher bit | | |
| 1152 | PubPres VIP 33 | DDB_VIP_PUB_PRES_33 |
| GOOSE Virtual input 33 publisher bit | | |
| 1153 | PubPres VIP 34 | DDB_VIP_PUB_PRES_34 |
| GOOSE Virtual input 34 publisher bit | | |
| 1154 | PubPres VIP 35 | DDB_VIP_PUB_PRES_35 |
| GOOSE Virtual input 35 publisher bit | | |
| 1155 | PubPres VIP 36 | DDB_VIP_PUB_PRES_36 |
| GOOSE Virtual input 36 publisher bit | | |
| 1156 | PubPres VIP 37 | DDB_VIP_PUB_PRES_37 |
| GOOSE Virtual input 37 publisher bit | | |
| 1157 | PubPres VIP 38 | DDB_VIP_PUB_PRES_38 |
| GOOSE Virtual input 38 publisher bit | | |
| 1158 | PubPres VIP 39 | DDB_VIP_PUB_PRES_39 |
| GOOSE Virtual input 39 publisher bit | | |
| 1159 | PubPres VIP 40 | DDB_VIP_PUB_PRES_40 |
| GOOSE Virtual input 40 publisher bit | | |
| 1160 | PubPres VIP 41 | DDB_VIP_PUB_PRES_41 |
| GOOSE Virtual input 41 publisher bit | | |
| 1161 | PubPres VIP 42 | DDB_VIP_PUB_PRES_42 |
| GOOSE Virtual input 42 publisher bit | | |
| 1162 | PubPres VIP 43 | DDB_VIP_PUB_PRES_43 |
| GOOSE Virtual input 43 publisher bit | | |
| 1163 | PubPres VIP 44 | DDB_VIP_PUB_PRES_44 |
| GOOSE Virtual input 44 publisher bit | | |
| 1164 | PubPres VIP 45 | DDB_VIP_PUB_PRES_45 |
| GOOSE Virtual input 45 publisher bit | | |
| 1165 | PubPres VIP 46 | DDB_VIP_PUB_PRES_46 |
| GOOSE Virtual input 46publisher bit | | |
| 1166 | PubPres VIP 47 | DDB_VIP_PUB_PRES_47 |
| GOOSE Virtual input 47 publisher bit | | |
| 1167 | PubPres VIP 48 | DDB_VIP_PUB_PRES_48 |
| GOOSE Virtual input 48 publisher bit | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---|---|---|
| **DESCRIPTION** | | |
| 1168 | PubPres VIP 49 | DDB_VIP_PUB_PRES_49 |
| GOOSE Virtual input 49 publisher bit | | |
| 1169 | PubPres VIP 50 | DDB_VIP_PUB_PRES_50 |
| GOOSE Virtual input 50 publisher bit | | |
| 1170 | PubPres VIP 51 | DDB_VIP_PUB_PRES_51 |
| GOOSE Virtual input 51 publisher bit | | |
| 1171 | PubPres VIP 52 | DDB_VIP_PUB_PRES_52 |
| GOOSE Virtual input 52 publisher bit | | |
| 1172 | PubPres VIP 53 | DDB_VIP_PUB_PRES_53 |
| GOOSE Virtual input 53 publisher bit | | |
| 1173 | PubPres VIP 54 | DDB_VIP_PUB_PRES_54 |
| GOOSE Virtual input 54 publisher bit | | |
| 1174 | PubPres VIP 55 | DDB_VIP_PUB_PRES_55 |
| GOOSE Virtual input 55 publisher bit | | |
| 1175 | PubPres VIP 56 | DDB_VIP_PUB_PRES_56 |
| GOOSE Virtual input 56 publisher bit | | |
| 1176 | PubPres VIP 57 | DDB_VIP_PUB_PRES_57 |
| GOOSE Virtual input 57 publisher bit | | |
| 1177 | PubPres VIP 58 | DDB_VIP_PUB_PRES_58 |
| GOOSE Virtual input 58 publisher bit | | |
| 1178 | PubPres VIP 59 | DDB_VIP_PUB_PRES_59 |
| GOOSE Virtual input 59 publisher bit | | |
| 1179 | PubPres VIP 60 | DDB_VIP_PUB_PRES_60 |
| GOOSE Virtual input 60 publisher bit | | |
| 1180 | PubPres VIP 61 | DDB_VIP_PUB_PRES_61 |
| GOOSE Virtual input 61 publisher bit | | |
| 1181 | PubPres VIP 62 | DDB_VIP_PUB_PRES_62 |
| GOOSE Virtual input 62 publisher bit | | |
| 1182 | PubPres VIP 63 | DDB_VIP_PUB_PRES_63 |
| GOOSE Virtual input 63 publisher bit | | |
| 1183 | PubPres VIP 64 | DDB_VIP_PUB_PRES_64 |
| GOOSE Virtual input 64 publisher bit | | |
| 1184 | HMI Access Lvl 1 | DDB_UIPASSWORD_ONE |
| level 1 access for HMI interface | | |
| 1185 | HMI Access Lvl 2 | DDB_UIPASSWORD_TWO |
| level 2 access for HMI interface | | |
| 1186 | FPort AccessLvl1 | DDB_FCURPASSWORD_ONE |
| level 1 access for the front port interface | | |
| 1187 | FPort AccessLvl2 | DDB_FCURPASSWORD_TWO |
| level 2 access for the front port  interface | | |
| 1188 | RPrt1 AccessLvl1 | DDB_REMOTEPASSWORD_ONE |
| level 1 access for the rear port 1 interface | | |
| 1189 | RPrt1 AccessLvl2 | DDB_REMOTEPASSWORD_TWO |
| level 2 access for the rear port 1 interface | | |
| 1190 | RPrt2 AccessLvl1 | DDB_REMOTE2PASSWORD_ONE |
| level 1 access for the rear port 2 interface | | |
| 1191 | RPrt2 AccessLvl2 | DDB_REMOTE2PASSWORD_TWO |
| level 2 access for the rear port 2 interface | | |
| 1192 | HMI Access Lvl 3 | DDB_UIPASSWORD_THREE |
| level 3 access for HMI interface | | |
| 1193 | FPort AccessLvl3 | DDB_FCURPASSWORD_THREE |
| Level 3 access for the front port  interface | | |
| 1194 | RPrt1 AccessLvl3 | DDB_REMOTEPASSWORD_THREE |
| level 3 access for the rear port 1 interface | | |
| 1195 | RPrt2 AccessLvl3 | DDB_REMOTE2PASSWORD_THREE |
| level 3 access for the rear port 2 interface | | |
| 1200 | Monitor bit 1 | DDB_MONITOR1 |
| This DDB signal can be assigned to any other DDB for commissioning purposes | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---|---|---|
| **DESCRIPTION** | | |
| 1201 | Monitor bit 2 | DDB_MONITOR2 |
| This DDB signal can be assigned to any other DDB for commissioning purposes | | |
| 1202 | Monitor bit 3 | DDB_MONITOR3 |
| This DDB signal can be assigned to any other DDB for commissioning purposes | | |
| 1203 | Monitor bit 4 | DDB_MONITOR4 |
| This DDB signal can be assigned to any other DDB for commissioning purposes | | |
| 1204 | Monitor bit 5 | DDB_MONITOR5 |
| This DDB signal can be assigned to any other DDB for commissioning purposes | | |
| 1205 | Monitor bit 6 | DDB_MONITOR6 |
| This DDB signal can be assigned to any other DDB for commissioning purposes | | |
| 1206 | Monitor bit 7 | DDB_MONITOR7 |
| This DDB signal can be assigned to any other DDB for commissioning purposes | | |
| 1207 | Monitor bit 8 | DDB_MONITOR8 |
| This DDB signal can be assigned to any other DDB for commissioning purposes | | |
| 1208 | HIF Any Start | DDB_HIZ_START |
| HIF Any Start | | |
| 1209 | HIF Alarm | DDB_HIZ_ALARM |
| HIF Alarm = FA HIF \|\| CHA HIF | | |
| 1210 | FA HIF | DDB_HIZ_FA_HIF |
| HIF FA detected HIF | | |
| 1211 | FA Transient | DDB_HIZ_FA_TRANSIENT |
| HIF FA detected Transient Event | | |
| 1212 | FA Steady Fault | DDB_HIZ_FA_STEADY |
| HIF FA detected Steady Event | | |
| 1213 | CHA HIF | DDB_HIZ_CHA_HIF |
| HIF CHA detected HIF | | |
| 1214 | CHA Transient | DDB_HIZ_CHA_TRANSIENT |
| HIF CHA detected Transient Event | | |
| 1215 | FA Burst Valid | DDB_HIZ_FA_BURST_VALID |
| HIF FA Burst Valid Signal | | |
| 1216 | HIF Forced Reset | DDB_HIZ_RESET |
| HIF Forced Resetting of all calculation | | |
| 1217 | CHA SS Valid | DDB_HIZ_CHA_SATISFIED_STATE |
| HIF CHA Satisfied State | | |
| 1220 | FA IntermitTimer | DDB_FA_INTERMITTENT_COUNTING |
| FA tINTERMITTENT timer counting | | |
| 1221 | CHA tDuration | DDB_HIZ_CHA_DURATION_TIMER |
| | | |
| 1222 | CHA tTransient | DDB_HIZ_CHA_TRANSIENT_TIMER |
| | | |
| 1223 | FA Prepare | DDB_FA_PREPARE |
| | | |
| 1224 | FA Ready | DDB_FA_READY |
| | | |
| 1225 | FA Start | DDB_FA_START |
| | | |
| 1226 | FA Alarm | DDB_FA_ALARM |
| | | |
| 1227 | CHA Prepare | DDB_CHA_PREPARE |
| | | |
| 1228 | CHA Ready | DDB_CHA_READY |
| | | |
| 1229 | CHA Start | DDB_CHA_START |
| | | |
| 1230 | CHA Alarm | DDB_CHA_ALARM |
| | | |
| 1240 | Reset Demand | DDB_RESET_DEMAND |
| This DDB signal resets Demand Period | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---|---|---|
| | | **DESCRIPTION** |
| 1248 | Control Input 33 | DDB_CONTROL_33 |
| This DDB signal is a control input signal | | |
| 1249 | Control Input 34 | DDB_CONTROL_34 |
| This DDB signal is a control input signal | | |
| 1250 | Control Input 35 | DDB_CONTROL_35 |
| This DDB signal is a control input signal | | |
| 1251 | Control Input 36 | DDB_CONTROL_36 |
| This DDB signal is a control input signal | | |
| 1252 | Control Input 37 | DDB_CONTROL_37 |
| This DDB signal is a control input signal | | |
| 1253 | Control Input 38 | DDB_CONTROL_38 |
| This DDB signal is a control input signal | | |
| 1254 | Control Input 39 | DDB_CONTROL_39 |
| This DDB signal is a control input signal | | |
| 1255 | Control Input 40 | DDB_CONTROL_40 |
| This DDB signal is a control input signal | | |
| 1256 | Control Input 41 | DDB_CONTROL_41 |
| This DDB signal is a control input signal | | |
| 1257 | Control Input 42 | DDB_CONTROL_42 |
| This DDB signal is a control input signal | | |
| 1258 | Control Input 43 | DDB_CONTROL_43 |
| This DDB signal is a control input signal | | |
| 1259 | Control Input 44 | DDB_CONTROL_44 |
| This DDB signal is a control input signal | | |
| 1260 | Control Input 45 | DDB_CONTROL_45 |
| This DDB signal is a control input signal | | |
| 1261 | Control Input 46 | DDB_CONTROL_46 |
| This DDB signal is a control input signal | | |
| 1262 | Control Input 47 | DDB_CONTROL_47 |
| This DDB signal is a control input signal | | |
| 1263 | Control Input 48 | DDB_CONTROL_48 |
| This DDB signal is a control input signal | | |
| 1264 | Control Input 49 | DDB_CONTROL_49 |
| This DDB signal is a control input signal | | |
| 1265 | Control Input 50 | DDB_CONTROL_50 |
| This DDB signal is a control input signal | | |
| 1266 | Control Input 51 | DDB_CONTROL_51 |
| This DDB signal is a control input signal | | |
| 1267 | Control Input 52 | DDB_CONTROL_52 |
| This DDB signal is a control input signal | | |
| 1268 | Control Input 53 | DDB_CONTROL_53 |
| This DDB signal is a control input signal | | |
| 1269 | Control Input 54 | DDB_CONTROL_54 |
| This DDB signal is a control input signal | | |
| 1270 | Control Input 55 | DDB_CONTROL_55 |
| This DDB signal is a control input signal | | |
| 1271 | Control Input 56 | DDB_CONTROL_56 |
| This DDB signal is a control input signal | | |
| 1272 | Control Input 57 | DDB_CONTROL_57 |
| This DDB signal is a control input signal | | |
| 1273 | Control Input 58 | DDB_CONTROL_58 |
| This DDB signal is a control input signal | | |
| 1274 | Control Input 59 | DDB_CONTROL_59 |
| This DDB signal is a control input signal | | |
| 1275 | Control Input 60 | DDB_CONTROL_60 |
| This DDB signal is a control input signal | | |
| 1276 | Control Input 61 | DDB_CONTROL_61 |
| This DDB signal is a control input signal | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---|---|---|
| | **DESCRIPTION** | |
| 1277 | Control Input 62 | DDB_CONTROL_62 |
| This DDB signal is a control input signal | | |
| 1278 | Control Input 63 | DDB_CONTROL_63 |
| This DDB signal is a control input signal | | |
| 1279 | Control Input 64 | DDB_CONTROL_64 |
| This DDB signal is a control input signal | | |
| 1450 | User Alarm in 1 | DDB_USER_ALARM_INPUT_1 |
| User Alarm | | |
| 1451 | User Alarm in 2 | DDB_USER_ALARM_INPUT_2 |
| User Alarm | | |
| 1452 | User Alarm in 3 | DDB_USER_ALARM_INPUT_3 |
| User Alarm | | |
| 1453 | User Alarm in 4 | DDB_USER_ALARM_INPUT_4 |
| User Alarm | | |
| 1454 | User Alarm in 5 | DDB_USER_ALARM_INPUT_5 |
| User Alarm | | |
| 1455 | User Alarm in 6 | DDB_USER_ALARM_INPUT_6 |
| User Alarm | | |
| 1456 | User Alarm in 7 | DDB_USER_ALARM_INPUT_7 |
| User Alarm | | |
| 1457 | User Alarm in 8 | DDB_USER_ALARM_INPUT_8 |
| User Alarm | | |
| 1458 | User Alarm in 9 | DDB_USER_ALARM_INPUT_9 |
| User Alarm | | |
| 1459 | User Alarm in 10 | DDB_USER_ALARM_INPUT_10 |
| User Alarm | | |
| 1460 | User Alarm in 11 | DDB_USER_ALARM_INPUT_11 |
| User Alarm | | |
| 1461 | User Alarm in 12 | DDB_USER_ALARM_INPUT_12 |
| User Alarm | | |
| 1462 | User Alarm in 13 | DDB_USER_ALARM_INPUT_13 |
| User Alarm | | |
| 1463 | User Alarm in 14 | DDB_USER_ALARM_INPUT_14 |
| User Alarm | | |
| 1464 | User Alarm in 15 | DDB_USER_ALARM_INPUT_15 |
| User Alarm | | |
| 1465 | User Alarm in 16 | DDB_USER_ALARM_INPUT_16 |
| User Alarm | | |
| 1466 | User Alarm in 17 | DDB_USER_ALARM_INPUT_17 |
| User Alarm | | |
| 1467 | User Alarm in 18 | DDB_USER_ALARM_INPUT_18 |
| User Alarm | | |
| 1468 | User Alarm in 19 | DDB_USER_ALARM_INPUT_19 |
| User Alarm | | |
| 1469 | User Alarm in 20 | DDB_USER_ALARM_INPUT_20 |
| User Alarm | | |
| 1470 | User Alarm in 21 | DDB_USER_ALARM_INPUT_21 |
| User Alarm | | |
| 1471 | User Alarm in 22 | DDB_USER_ALARM_INPUT_22 |
| User Alarm | | |
| 1472 | User Alarm in 23 | DDB_USER_ALARM_INPUT_23 |
| User Alarm | | |
| 1473 | User Alarm in 24 | DDB_USER_ALARM_INPUT_24 |
| User Alarm | | |
| 1474 | User Alarm in 25 | DDB_USER_ALARM_INPUT_25 |
| User Alarm | | |
| 1475 | User Alarm in 26 | DDB_USER_ALARM_INPUT_26 |
| User Alarm | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---|---|---|
| DESCRIPTION | | |
| 1476 | User Alarm in 27 | DDB_USER_ALARM_INPUT_27 |
| User Alarm | | |
| 1477 | User Alarm in 28 | DDB_USER_ALARM_INPUT_28 |
| User Alarm | | |
| 1478 | User Alarm in 29 | DDB_USER_ALARM_INPUT_29 |
| User Alarm | | |
| 1479 | User Alarm in 30 | DDB_USER_ALARM_INPUT_30 |
| User Alarm | | |
| 1480 | User Alarm in 31 | DDB_USER_ALARM_INPUT_31 |
| User Alarm | | |
| 1481 | User Alarm in 32 | DDB_USER_ALARM_INPUT_32 |
| User Alarm | | |
| 1599 | | DDB_PSLINT_101 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1600 | | DDB_PSLINT_102 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1601 | | DDB_PSLINT_103 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1602 | | DDB_PSLINT_104 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1603 | | DDB_PSLINT_105 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1604 | | DDB_PSLINT_106 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1605 | | DDB_PSLINT_107 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1606 | | DDB_PSLINT_108 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1607 | | DDB_PSLINT_109 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1608 | | DDB_PSLINT_110 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1609 | | DDB_PSLINT_111 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1610 | | DDB_PSLINT_112 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1611 | | DDB_PSLINT_113 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1612 | | DDB_PSLINT_114 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1613 | | DDB_PSLINT_115 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1614 | | DDB_PSLINT_116 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1615 | | DDB_PSLINT_117 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1616 | | DDB_PSLINT_118 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1617 | | DDB_PSLINT_119 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1618 | | DDB_PSLINT_120 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1619 | | DDB_PSLINT_121 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1620 | | DDB_PSLINT_122 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1621 | | DDB_PSLINT_123 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---------|-------------|--------------|
| DESCRIPTION |||
| 1622 | | DDB_PSLINT_124 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1623 | | DDB_PSLINT_125 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1624 | | DDB_PSLINT_126 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1625 | | DDB_PSLINT_127 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1626 | | DDB_PSLINT_128 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1627 | | DDB_PSLINT_129 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1628 | | DDB_PSLINT_130 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1629 | | DDB_PSLINT_131 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1630 | | DDB_PSLINT_132 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1631 | | DDB_PSLINT_133 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1632 | | DDB_PSLINT_134 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1633 | | DDB_PSLINT_135 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1634 | | DDB_PSLINT_136 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1635 | | DDB_PSLINT_137 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1636 | | DDB_PSLINT_138 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1637 | | DDB_PSLINT_139 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1638 | | DDB_PSLINT_140 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1639 | | DDB_PSLINT_141 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1640 | | DDB_PSLINT_142 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1641 | | DDB_PSLINT_143 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1642 | | DDB_PSLINT_144 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1643 | | DDB_PSLINT_145 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1644 | | DDB_PSLINT_146 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1645 | | DDB_PSLINT_147 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1646 | | DDB_PSLINT_148 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1647 | | DDB_PSLINT_149 |
| This DDB signal can be defined by the user in the Programmmable Scheme Logic |||
| 1648 | | DDB_PSLINT_150 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1649 | | DDB_PSLINT_151 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1650 | | DDB_PSLINT_152 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---|---|---|
| | | DESCRIPTION |
| 1651 | | DDB_PSLINT_153 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1652 | | DDB_PSLINT_154 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1653 | | DDB_PSLINT_155 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1654 | | DDB_PSLINT_156 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1655 | | DDB_PSLINT_157 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1656 | | DDB_PSLINT_158 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1657 | | DDB_PSLINT_159 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1658 | | DDB_PSLINT_160 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1659 | | DDB_PSLINT_161 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1660 | | DDB_PSLINT_162 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1661 | | DDB_PSLINT_163 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1662 | | DDB_PSLINT_164 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1663 | | DDB_PSLINT_165 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1664 | | DDB_PSLINT_166 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1665 | | DDB_PSLINT_167 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1666 | | DDB_PSLINT_168 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1667 | | DDB_PSLINT_169 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1668 | | DDB_PSLINT_170 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1669 | | DDB_PSLINT_171 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1670 | | DDB_PSLINT_172 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1671 | | DDB_PSLINT_173 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1672 | | DDB_PSLINT_174 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1673 | | DDB_PSLINT_175 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1674 | | DDB_PSLINT_176 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1675 | | DDB_PSLINT_177 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1676 | | DDB_PSLINT_178 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1677 | | DDB_PSLINT_179 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1678 | | DDB_PSLINT_180 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1679 | | DDB_PSLINT_181 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---|---|---|
| **DESCRIPTION** | | |
| 1680 | | DDB_PSLINT_182 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1681 | | DDB_PSLINT_183 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1682 | | DDB_PSLINT_184 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1683 | | DDB_PSLINT_185 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1684 | | DDB_PSLINT_186 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1685 | | DDB_PSLINT_187 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1686 | | DDB_PSLINT_188 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1687 | | DDB_PSLINT_189 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1688 | | DDB_PSLINT_190 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1689 | | DDB_PSLINT_191 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1690 | | DDB_PSLINT_192 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1691 | | DDB_PSLINT_193 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1692 | | DDB_PSLINT_194 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1693 | | DDB_PSLINT_195 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1694 | | DDB_PSLINT_196 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1695 | | DDB_PSLINT_197 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1696 | | DDB_PSLINT_198 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1697 | | DDB_PSLINT_199 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1698 | | DDB_PSLINT_200 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1699 | | DDB_PSLINT_201 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1700 | | DDB_PSLINT_202 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1701 | | DDB_PSLINT_203 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1702 | | DDB_PSLINT_204 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1703 | | DDB_PSLINT_205 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1704 | | DDB_PSLINT_206 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1705 | | DDB_PSLINT_207 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1706 | | DDB_PSLINT_208 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1707 | | DDB_PSLINT_209 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1708 | | DDB_PSLINT_210 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---------|-------------|--------------|
| DESCRIPTION | | |
| 1709 | | DDB_PSLINT_211 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1710 | | DDB_PSLINT_212 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1711 | | DDB_PSLINT_213 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1712 | | DDB_PSLINT_214 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1713 | | DDB_PSLINT_215 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1714 | | DDB_PSLINT_216 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1715 | | DDB_PSLINT_217 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1716 | | DDB_PSLINT_218 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1717 | | DDB_PSLINT_219 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1718 | | DDB_PSLINT_220 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1719 | | DDB_PSLINT_221 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1720 | | DDB_PSLINT_222 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1721 | | DDB_PSLINT_223 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1722 | | DDB_PSLINT_224 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1723 | | DDB_PSLINT_225 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1724 | | DDB_PSLINT_226 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1725 | | DDB_PSLINT_227 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1726 | | DDB_PSLINT_228 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1727 | | DDB_PSLINT_229 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1728 | | DDB_PSLINT_230 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1729 | | DDB_PSLINT_231 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1730 | | DDB_PSLINT_232 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1731 | | DDB_PSLINT_233 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1732 | | DDB_PSLINT_234 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1733 | | DDB_PSLINT_235 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1734 | | DDB_PSLINT_236 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1735 | | DDB_PSLINT_237 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1736 | | DDB_PSLINT_238 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1737 | | DDB_PSLINT_239 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---|---|---|
| **DESCRIPTION** | | |
| 1738 | | DDB_PSLINT_240 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1739 | | DDB_PSLINT_241 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1740 | | DDB_PSLINT_242 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1741 | | DDB_PSLINT_243 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1742 | | DDB_PSLINT_244 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1743 | | DDB_PSLINT_245 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1744 | | DDB_PSLINT_246 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1745 | | DDB_PSLINT_247 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1746 | | DDB_PSLINT_248 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1747 | | DDB_PSLINT_249 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1748 | | DDB_PSLINT_250 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1749 | | DDB_PSLINT_251 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1750 | | DDB_PSLINT_252 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1751 | | DDB_PSLINT_253 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1752 | | DDB_PSLINT_254 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1753 | | DDB_PSLINT_255 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1754 | | DDB_PSLINT_256 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1755 | | DDB_PSLINT_257 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1756 | | DDB_PSLINT_258 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1757 | | DDB_PSLINT_259 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1758 | | DDB_PSLINT_260 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1759 | | DDB_PSLINT_261 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1760 | | DDB_PSLINT_262 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1761 | | DDB_PSLINT_263 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1762 | | DDB_PSLINT_264 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1763 | | DDB_PSLINT_265 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1764 | | DDB_PSLINT_266 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1765 | | DDB_PSLINT_267 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1766 | | DDB_PSLINT_268 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---------|-------------|--------------|
| DESCRIPTION ||| 
| 1767 | | DDB_PSLINT_269 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1768 | | DDB_PSLINT_270 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1769 | | DDB_PSLINT_271 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1770 | | DDB_PSLINT_272 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1771 | | DDB_PSLINT_273 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1772 | | DDB_PSLINT_274 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1773 | | DDB_PSLINT_275 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1774 | | DDB_PSLINT_276 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1775 | | DDB_PSLINT_277 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1776 | | DDB_PSLINT_278 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1777 | | DDB_PSLINT_279 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1778 | | DDB_PSLINT_280 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1779 | | DDB_PSLINT_281 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1780 | | DDB_PSLINT_282 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1781 | | DDB_PSLINT_283 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1782 | | DDB_PSLINT_284 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1783 | | DDB_PSLINT_285 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1784 | | DDB_PSLINT_286 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1785 | | DDB_PSLINT_287 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1786 | | DDB_PSLINT_288 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1787 | | DDB_PSLINT_289 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1788 | | DDB_PSLINT_290 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1789 | | DDB_PSLINT_291 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1790 | | DDB_PSLINT_292 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1791 | | DDB_PSLINT_293 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1792 | | DDB_PSLINT_294 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1793 | | DDB_PSLINT_295 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1794 | | DDB_PSLINT_296 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||
| 1795 | | DDB_PSLINT_297 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic |||

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---|---|---|
| **DESCRIPTION** | | |
| 1796 | | DDB_PSLINT_298 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1797 | | DDB_PSLINT_299 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1798 | | DDB_PSLINT_300 |
| This DDB signal can be defined by the user in the Programmable Scheme Logic | | |
| 1843 | Inter PSL 1 IN | DDB_INTER_PSL_1_IN |
| Inter PSL 1 Input | | |
| 1844 | Inter PSL 2 IN | DDB_INTER_PSL_2_IN |
| Inter PSL 2 Input | | |
| 1845 | Inter PSL 3 IN | DDB_INTER_PSL_3_IN |
| Inter PSL 3 Input | | |
| 1846 | Inter PSL 4 IN | DDB_INTER_PSL_4_IN |
| Inter PSL 4 Input | | |
| 1847 | Inter PSL 5 IN | DDB_INTER_PSL_5_IN |
| Inter PSL 5 Input | | |
| 1848 | Inter PSL 6 IN | DDB_INTER_PSL_6_IN |
| Inter PSL 6 Input | | |
| 1849 | Inter PSL 7 IN | DDB_INTER_PSL_7_IN |
| Inter PSL 7 Input | | |
| 1850 | Inter PSL 8 IN | DDB_INTER_PSL_8_IN |
| Inter PSL 8 Input | | |
| 1851 | Inter PSL 9 IN | DDB_INTER_PSL_9_IN |
| Inter PSL 9 Input | | |
| 1852 | Inter PSL 10 IN | DDB_INTER_PSL_10_IN |
| Inter PSL 10 Input | | |
| 1853 | Inter PSL 11 IN | DDB_INTER_PSL_11_IN |
| Inter PSL 11 Input | | |
| 1854 | Inter PSL 12 IN | DDB_INTER_PSL_12_IN |
| Inter PSL 12 Input | | |
| 1855 | Inter PSL 13 IN | DDB_INTER_PSL_13_IN |
| Inter PSL 13 Input | | |
| 1856 | Inter PSL 14 IN | DDB_INTER_PSL_14_IN |
| Inter PSL 14 Input | | |
| 1857 | Inter PSL 15 IN | DDB_INTER_PSL_15_IN |
| Inter PSL 15 Input | | |
| 1858 | Inter PSL 16 IN | DDB_INTER_PSL_16_IN |
| Inter PSL 16 Input | | |
| 1859 | Inter PSL 17 IN | DDB_INTER_PSL_17_IN |
| Inter PSL 17 Input | | |
| 1860 | Inter PSL 18 IN | DDB_INTER_PSL_18_IN |
| Inter PSL 18 Input | | |
| 1861 | Inter PSL 19 IN | DDB_INTER_PSL_19_IN |
| Inter PSL 19 Input | | |
| 1862 | Inter PSL 20 IN | DDB_INTER_PSL_20_IN |
| Inter PSL 20 Input | | |
| 1863 | Inter PSL 21 IN | DDB_INTER_PSL_21_IN |
| Inter PSL 21 Input | | |
| 1864 | Inter PSL 22 IN | DDB_INTER_PSL_22_IN |
| Inter PSL 22 Input | | |
| 1865 | Inter PSL 23 IN | DDB_INTER_PSL_23_IN |
| Inter PSL 23 Input | | |
| 1866 | Inter PSL 24 IN | DDB_INTER_PSL_24_IN |
| Inter PSL 24 Input | | |
| 1867 | Inter PSL 25 IN | DDB_INTER_PSL_25_IN |
| Inter PSL 25 Input | | |
| 1868 | Inter PSL 26 IN | DDB_INTER_PSL_26_IN |
| Inter PSL 26 Input | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---------|-------------|--------------|
| **DESCRIPTION** | | |
| 1869 | Inter PSL 27 IN | DDB_INTER_PSL_27_IN |
| Inter PSL 27 Input | | |
| 1870 | Inter PSL 28 IN | DDB_INTER_PSL_28_IN |
| Inter PSL 28 Input | | |
| 1871 | Inter PSL 29 IN | DDB_INTER_PSL_29_IN |
| Inter PSL 29 Input | | |
| 1872 | Inter PSL 30 IN | DDB_INTER_PSL_30_IN |
| Inter PSL 30 Input | | |
| 1873 | Inter PSL 31 IN | DDB_INTER_PSL_31_IN |
| Inter PSL 31 Input | | |
| 1874 | Inter PSL 32 IN | DDB_INTER_PSL_32_IN |
| Inter PSL 32 Input | | |
| 1875 | Inter PSL 1 OUT | DDB_INTER_PSL_1_OUT |
| Inter PSL 1 Output | | |
| 1876 | Inter PSL 2 OUT | DDB_INTER_PSL_2_OUT |
| Inter PSL 2 Output | | |
| 1877 | Inter PSL 3 OUT | DDB_INTER_PSL_3_OUT |
| Inter PSL 3 Output | | |
| 1878 | Inter PSL 4 OUT | DDB_INTER_PSL_4_OUT |
| Inter PSL 4 Output | | |
| 1879 | Inter PSL 5 OUT | DDB_INTER_PSL_5_OUT |
| Inter PSL 5 Output | | |
| 1880 | Inter PSL 6 OUT | DDB_INTER_PSL_6_OUT |
| Inter PSL 6 Output | | |
| 1881 | Inter PSL 7 OUT | DDB_INTER_PSL_7_OUT |
| Inter PSL 7 Output | | |
| 1882 | Inter PSL 8 OUT | DDB_INTER_PSL_8_OUT |
| Inter PSL 8 Output | | |
| 1883 | Inter PSL 9 OUT | DDB_INTER_PSL_9_OUT |
| Inter PSL 9 Output | | |
| 1884 | Inter PSL 10 OUT | DDB_INTER_PSL_10_OUT |
| Inter PSL 10 Output | | |
| 1885 | Inter PSL 11 OUT | DDB_INTER_PSL_11_OUT |
| Inter PSL 11 Output | | |
| 1886 | Inter PSL 12 OUT | DDB_INTER_PSL_12_OUT |
| Inter PSL 12 Output | | |
| 1887 | Inter PSL 13 OUT | DDB_INTER_PSL_13_OUT |
| Inter PSL 13 Output | | |
| 1888 | Inter PSL 14 OUT | DDB_INTER_PSL_14_OUT |
| Inter PSL 14 Output | | |
| 1889 | Inter PSL 15 OUT | DDB_INTER_PSL_15_OUT |
| Inter PSL 15 Output | | |
| 1890 | Inter PSL 16 OUT | DDB_INTER_PSL_16_OUT |
| Inter PSL 16 Output | | |
| 1891 | Inter PSL 17 OUT | DDB_INTER_PSL_17_OUT |
| Inter PSL 17 Output | | |
| 1892 | Inter PSL 18 OUT | DDB_INTER_PSL_18_OUT |
| Inter PSL 18 Output | | |
| 1893 | Inter PSL 19 OUT | DDB_INTER_PSL_19_OUT |
| Inter PSL 19 Output | | |
| 1894 | Inter PSL 20 OUT | DDB_INTER_PSL_20_OUT |
| Inter PSL 20 Output | | |
| 1895 | Inter PSL 21 OUT | DDB_INTER_PSL_21_OUT |
| Inter PSL 21 Output | | |
| 1896 | Inter PSL 22 OUT | DDB_INTER_PSL_22_OUT |
| Inter PSL 22 Output | | |
| 1897 | Inter PSL 23 OUT | DDB_INTER_PSL_23_OUT |
| Inter PSL 23 Output | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---------|-------------|--------------|
| **DESCRIPTION** | | |
| 1898 | Inter PSL 24 OUT | DDB_INTER_PSL_24_OUT |
| Inter PSL 24 Output | | |
| 1899 | Inter PSL 25 OUT | DDB_INTER_PSL_25_OUT |
| Inter PSL 25 Output | | |
| 1900 | Inter PSL 26 OUT | DDB_INTER_PSL_26_OUT |
| Inter PSL 26 Output | | |
| 1901 | Inter PSL 27 OUT | DDB_INTER_PSL_27_OUT |
| Inter PSL 27 Output | | |
| 1902 | Inter PSL 28 OUT | DDB_INTER_PSL_28_OUT |
| Inter PSL 28 Output | | |
| 1903 | Inter PSL 29 OUT | DDB_INTER_PSL_29_OUT |
| Inter PSL 29 Output | | |
| 1904 | Inter PSL 30 OUT | DDB_INTER_PSL_30_OUT |
| Inter PSL 30 Output | | |
| 1905 | Inter PSL 31 OUT | DDB_INTER_PSL_31_OUT |
| Inter PSL 31 Output | | |
| 1906 | Inter PSL 32 OUT | DDB_INTER_PSL_32_OUT |
| Inter PSL 32 Output | | |
| 1950 | Test Mode Info | DDB_TEST_MODE_INFO |
| Test Mode In progress | | |
| 1959 | SWI1 Aux (52-A) | DDB_SWI1_STATUS_INPUT_52A |
| This DDB signal is the 3-phase 52A signal (signal indicating state of switch 1) | | |
| 1960 | SWI1 Aux (52-B) | DDB_SWI1_STATUS_INPUT_52B |
| This DDB signal is the 3-phase 52B signal (signal indicating inverse state of switch 1) | | |
| 1961 | SWI1 Input Alm | DDB_SWI1_STATUS_ALARM |
| This DDB signal indicates that the switch 1 is in an invalid state | | |
| 1962 | SWI2 Aux (52-A) | DDB_SWI2_STATUS_INPUT_52A |
| This DDB signal is the 3-phase 52A signal (signal indicating state of switch 2) | | |
| 1963 | SWI2 Aux (52-B) | DDB_SWI2_STATUS_INPUT_52B |
| This DDB signal is the 3-phase 52B signal (signal indicating inverse state of switch 2) | | |
| 1964 | SWI2 Input Alm | DDB_SWI2_STATUS_ALARM |
| This DDB signal indicates that the switch 2 is in an invalid state | | |
| 1965 | SWI3 Aux (52-A) | DDB_SWI3_STATUS_INPUT_52A |
| This DDB signal is the 3-phase 52A signal (signal indicating state of switch 3) | | |
| 1966 | SWI3 Aux (52-B) | DDB_SWI3_STATUS_INPUT_52B |
| This DDB signal is the 3-phase 52B signal (signal indicating inverse state of switch 3) | | |
| 1967 | SWI3 Input Alm | DDB_SWI3_STATUS_ALARM |
| This DDB signal indicates that the switch 3 is in an invalid state | | |
| 1968 | SWI4 Aux (52-A) | DDB_SWI4_STATUS_INPUT_52A |
| This DDB signal is the 3-phase 52A signal (signal indicating state of switch 4) | | |
| 1969 | SWI4 Aux (52-B) | DDB_SWI4_STATUS_INPUT_52B |
| This DDB signal is the 3-phase 52B signal (signal indicating inverse state of switch 4) | | |
| 1970 | SWI4 Input Alm | DDB_SWI4_STATUS_ALARM |
| This DDB signal indicates that the switch 4 is in an invalid state | | |
| 1971 | SWI5 Aux (52-A) | DDB_SWI5_STATUS_INPUT_52A |
| This DDB signal is the 3-phase 52A signal (signal indicating state of switch 5) | | |
| 1972 | SWI5 Aux (52-B) | DDB_SWI5_STATUS_INPUT_52B |
| This DDB signal is the 3-phase 52B signal (signal indicating inverse state of switch 5) | | |
| 1973 | SWI5 Input Alm | DDB_SWI5_STATUS_ALARM |
| This DDB signal indicates that the switch 5 is in an invalid state | | |
| 1974 | SWI6 Aux (52-A) | DDB_SWI6_STATUS_INPUT_52A |
| This DDB signal is the 3-phase 52A signal (signal indicating state of switch 6) | | |
| 1975 | SWI6 Aux (52-B) | DDB_SWI6_STATUS_INPUT_52B |
| This DDB signal is the 3-phase 52B signal (signal indicating inverse state of switch 6) | | |
| 1976 | SWI6 Input Alm | DDB_SWI6_STATUS_ALARM |
| This DDB signal indicates that the switch 6 is in an invalid state | | |
| 1977 | SWI7 Aux (52-A) | DDB_SWI7_STATUS_INPUT_52A |
| This DDB signal is the 3-phase 52A signal (signal indicating state of switch 7) | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---------|-------------|--------------|
| DESCRIPTION | | |
| 1978 | SWI7 Aux (52-B) | DDB_SWI7_STATUS_INPUT_52B |
| This DDB signal is the 3-phase 52B signal (signal indicating inverse state of switch 7) | | |
| 1979 | SWI7 Input Alm | DDB_SWI7_STATUS_ALARM |
| This DDB signal indicates that the switch 7 is in an invalid state | | |
| 1980 | SWI8 Aux (52-A) | DDB_SWI8_STATUS_INPUT_52A |
| This DDB signal is the 3-phase 52A signal (signal indicating state of switch 8) | | |
| 1981 | SWI8 Aux (52-B) | DDB_SWI8_STATUS_INPUT_52B |
| This DDB signal is the 3-phase 52B signal (signal indicating inverse state of switch 8) | | |
| 1982 | SWI8 Input Alm | DDB_SWI8_STATUS_ALARM |
| This DDB signal indicates that the switch 8 is in an invalid state | | |
| 1983 | SWI1 Control Trp | DDB_SWI1_CONTROL_TRIP |
| This DDB signal tells the switch 1 to trip | | |
| 1984 | SWI1 Control Cls | DDB_SWI1_CONTROL_CLOSE |
| This DDB signal tells the switch 1 to close | | |
| 1985 | SWI2 Control Trp | DDB_SWI2_CONTROL_TRIP |
| This DDB signal tells the switch 2 to trip | | |
| 1986 | SWI2 Control Cls | DDB_SWI2_CONTROL_CLOSE |
| This DDB signal tells the switch 2 to close | | |
| 1987 | SWI3 Control Trp | DDB_SWI3_CONTROL_TRIP |
| This DDB signal tells the switch 3 to trip | | |
| 1988 | SWI3 Control Cls | DDB_SWI3_CONTROL_CLOSE |
| This DDB signal tells the switch 3 to close | | |
| 1989 | SWI4 Control Trp | DDB_SWI4_CONTROL_TRIP |
| This DDB signal tells the switch 4 to trip | | |
| 1990 | SWI4 Control Cls | DDB_SWI4_CONTROL_CLOSE |
| This DDB signal tells the switch 4 to close | | |
| 1991 | SWI5 Control Trp | DDB_SWI5_CONTROL_TRIP |
| This DDB signal tells the switch 5 to trip | | |
| 1992 | SWI5 Control Cls | DDB_SWI5_CONTROL_CLOSE |
| This DDB signal tells the switch 5 to close | | |
| 1993 | SWI6 Control Trp | DDB_SWI6_CONTROL_TRIP |
| This DDB signal tells the switch 6 to trip | | |
| 1994 | SWI6 Control Cls | DDB_SWI6_CONTROL_CLOSE |
| This DDB signal tells the switch 6 to close | | |
| 1995 | SWI7 Control Trp | DDB_SWI7_CONTROL_TRIP |
| This DDB signal tells the switch 7 to trip | | |
| 1996 | SWI7 Control Cls | DDB_SWI7_CONTROL_CLOSE |
| This DDB signal tells the switch 7 to close | | |
| 1997 | SWI8 Control Trp | DDB_SWI8_CONTROL_TRIP |
| This DDB signal tells the switch 8 to trip | | |
| 1998 | SWI8 Control Cls | DDB_SWI8_CONTROL_CLOSE |
| This DDB signal tells the switch 8 to close | | |
| 1999 | Blk Rmt SWI1 Ops | DDB_BLK_REMOTE_SWI1_OPS |
| This DDB signal blocks remote switch 1 Trip and Close | | |
| 2000 | Blk Rmt SWI2 Ops | DDB_BLK_REMOTE_SWI2_OPS |
| This DDB signal blocks remote switch 2 Trip and Close | | |
| 2001 | Blk Rmt SWI3 Ops | DDB_BLK_REMOTE_SWI3_OPS |
| This DDB signal blocks remote switch 3 Trip and Close | | |
| 2002 | Blk Rmt SWI4 Ops | DDB_BLK_REMOTE_SWI4_OPS |
| This DDB signal blocks remote switch 4 Trip and Close | | |
| 2003 | Blk Rmt SWI5 Ops | DDB_BLK_REMOTE_SWI5_OPS |
| This DDB signal blocks remote switch 5 Trip and Close | | |
| 2004 | Blk Rmt SWI6 Ops | DDB_BLK_REMOTE_SWI6_OPS |
| This DDB signal blocks remote switch 6 Trip and Close | | |
| 2005 | Blk Rmt SWI7 Ops | DDB_BLK_REMOTE_SWI7_OPS |
| This DDB signal blocks remote switch 7 Trip and Close | | |
| 2006 | Blk Rmt SWI8 Ops | DDB_BLK_REMOTE_SWI8_OPS |
| This DDB signal blocks remote switch 8 Trip and Close | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---------|-------------|--------------|
| **DESCRIPTION** | | |
| 2007 | SWI1 Status Opn | DDB_SWI1_STATUS_OPEN |
| This DDB signal is assigned to output the switch1 status-Open | | |
| 2008 | SWI1 Status Cls | DDB_SWI1_STATUS_CLOSE |
| This DDB signal is assigned to output the switch1 status-Close | | |
| 2009 | SWI2 Status Opn | DDB_SWI2_STATUS_OPEN |
| This DDB signal is assigned to output the switch2 status-Open | | |
| 2010 | SWI2 Status Cls | DDB_SWI2_STATUS_CLOSE |
| This DDB signal is assigned to output the switch2 status-Close | | |
| 2011 | SWI3 Status Opn | DDB_SWI3_STATUS_OPEN |
| This DDB signal is assigned to output the switch3 status-Open | | |
| 2012 | SWI3 Status Cls | DDB_SWI3_STATUS_CLOSE |
| This DDB signal is assigned to output the switch3 status-Close | | |
| 2013 | SWI4 Status Opn | DDB_SWI4_STATUS_OPEN |
| This DDB signal is assigned to output the switch4 status-Open | | |
| 2014 | SWI4 Status Cls | DDB_SWI4_STATUS_CLOSE |
| This DDB signal is assigned to output the switch4 status-Close | | |
| 2015 | SWI5 Status Opn | DDB_SWI5_STATUS_OPEN |
| This DDB signal is assigned to output the switch5 status-Open | | |
| 2016 | SWI5 Status Cls | DDB_SWI5_STATUS_CLOSE |
| This DDB signal is assigned to output the switch5 status-Close | | |
| 2017 | SWI6 Status Opn | DDB_SWI6_STATUS_OPEN |
| This DDB signal is assigned to output the switch6 status-Open | | |
| 2018 | SWI6 Status Cls | DDB_SWI6_STATUS_CLOSE |
| This DDB signal is assigned to output the switch6 status-Close | | |
| 2019 | SWI7 Status Opn | DDB_SWI7_STATUS_OPEN |
| This DDB signal is assigned to output the switch7 status-Open | | |
| 2020 | SWI7 Status Cls | DDB_SWI7_STATUS_CLOSE |
| This DDB signal is assigned to output the switch7 status-Close | | |
| 2021 | SWI8 Status Opn | DDB_SWI8_STATUS_OPEN |
| This DDB signal is assigned to output the switch8 status-Open | | |
| 2022 | SWI8 Status Cls | DDB_SWI8_STATUS_CLOSE |
| This DDB signal is assigned to output the switch8 status-Close | | |
| 2023 | SWI1 Trip Fail | DDB_SWI1_FAILED_TO_TRIP |
| This DDB signal indicates that the switch 1 has failed to trip | | |
| 2024 | SWI1 Cls Fail | DDB_SWI1_FAILED_TO_CLOSE |
| This DDB signal indicates that the switch 1 has failed to close | | |
| 2025 | SWI2 Trip Fail | DDB_SWI2_FAILED_TO_TRIP |
| This DDB signal indicates that the switch 2 has failed to trip | | |
| 2026 | SWI2 Cls Fail | DDB_SWI2_FAILED_TO_CLOSE |
| This DDB signal indicates that the switch 2 has failed to close | | |
| 2027 | SWI3 Trip Fail | DDB_SWI3_FAILED_TO_TRIP |
| This DDB signal indicates that the switch 3 has failed to trip | | |
| 2028 | SWI3 Cls Fail | DDB_SWI3_FAILED_TO_CLOSE |
| This DDB signal indicates that the switch 3 has failed to close | | |
| 2029 | SWI4 Trip Fail | DDB_SWI4_FAILED_TO_TRIP |
| This DDB signal indicates that the switch 4 has failed to trip | | |
| 2030 | SWI4 Cls Fail | DDB_SWI4_FAILED_TO_CLOSE |
| This DDB signal indicates that the switch 4 has failed to close | | |
| 2031 | SWI5 Trip Fail | DDB_SWI5_FAILED_TO_TRIP |
| This DDB signal indicates that the switch 5 has failed to trip | | |
| 2032 | SWI5 Cls Fail | DDB_SWI5_FAILED_TO_CLOSE |
| This DDB signal indicates that the switch 5 has failed to close | | |
| 2033 | SWI6 Trip Fail | DDB_SWI6_FAILED_TO_TRIP |
| This DDB signal indicates that the switch 6 has failed to trip | | |
| 2034 | SWI6 Cls Fail | DDB_SWI6_FAILED_TO_CLOSE |
| This DDB signal indicates that the switch 6 has failed to close | | |
| 2035 | SWI7 Trip Fail | DDB_SWI7_FAILED_TO_TRIP |
| This DDB signal indicates that the switch 7 has failed to trip | | |

| ORDINAL | SIGNAL NAME | ELEMENT NAME |
|---------|-------------|--------------|
| DESCRIPTION | | |
| 2036 | SWI7 Cls Fail | DDB_SWI7_FAILED_TO_CLOSE |
| This DDB signal indicates that the switch 7 has failed to close | | |
| 2037 | SWI8 Trip Fail | DDB_SWI8_FAILED_TO_TRIP |
| This DDB signal indicates that the switch 8 has failed to trip | | |
| 2038 | SWI8 Cls Fail | DDB_SWI8_FAILED_TO_CLOSE |
| This DDB signal indicates that the switch 8 has failed to close | | |

# APPENDIX C

## WIRING DIAGRAMS

| MODEL | CORTEC OPTION* | EXTERNAL CONNECTION DIAGRAM TITLE | DRAWING-SHEET | ISSUE |
|---|---|---|---|---|
| P14N | IO option A | NON DIRECTIONAL PHASE OVER CURRENT AND E/F (8 I/P & 8 O/P) | 10P14N01-1 | C |
| | IO option A | NON DIRECTIONAL PHASE OVERCURRENT AND SEF (8 I/P & 8 O/P) | 10P14N02-1 | D |
| | IO option A | NON DIRECTIONAL PHASE OVERCURRENT AND E/F (8 I/P & 8 O/P) WITH ETHERNET<br>NON DIRECTIONAL PHASE OVERCURRENT AND E/F (8 I/P & 8 O/P) WITH DUAL COPPER ETHERNET<br>NON DIRECTIONAL PHASE OVERCURRENT AND E/F (8 I/P & 8 O/P) WITH DUAL FIBRE ETHERNET | 10P14N03-1<br>10P14N03-2<br>10P14N03-3 | D<br>C<br>C |
| | IO option A | NON DIRECTIONAL PHASE OVERCURRENT & SEF (8 I/P 8 O/P) WITH ETHERNET & OPTIONAL SHORTING LINK<br>NON DIRECTIONAL PHASE OVERCURRENT & SEF (8 I/P 8 O/P) WITH DUAL COPPER ETHERNET<br>NON DIRECTIONAL PHASE OVERCURRENT & SEF (8 I/P 8 O/P) WITH DUAL FIBRE ETHERNET | 10P14N04-1<br>10P14N04-2<br>10P14N04-3 | E<br>C<br>C |
| | IO option B | NON DIRECTIONAL PHASE OVERCURRENT AND E/F (11 I/P & 12 O/P) WITH 2 RS485<br>NON DIRECTIONAL PHASE OVERCURRENT AND E/F (11 I/P & 12 O/P) WITH 2 RS485 & ETHERNET<br>NON DIRECTIONAL PHASE OVERCURRENT AND E/F (11 I/P & 12 O/P) WITH 2 RS485 & DUAL COPPER ETHERNET<br>NON DIRECTIONAL PHASE OVERCURRENT AND E/F (11 I/P & 12 O/P) WITH 2 RS485 & DUAL FIBRE ETHERNET | 10P14N05-1<br>10P14N05-2<br>10P14N05-3<br>10P14N05-4 | C<br>C<br>C<br>C |
| | IO option B | NON DIRECTIONAL PHASE OVERCURRENT AND SEF (11 I/P & 12 O/P) WITH 2 RS485<br>NON DIRECTIONAL PHASE OVERCURRENT AND SEF (11 I/P & 12 O/P) WITH 2 RS485 & ETHERNET<br>NON DIRECTIONAL PHASE OVERCURRENT AND SEF (11 I/P & 12 O/P) WITH 2 RS485 & DUAL COPPER ETHERNET<br>NON DIRECTIONAL PHASE OVERCURRENT AND SEF (11 I/P & 12 O/P) WITH 2 RS485 & DUAL FIBRE ETHERNET | 10P14N06-1<br>10P14N06-2<br>10P14N06-3<br>10P14N06-4 | D<br>C<br>C<br>C |
| | IO option C | NON DIRECTIONAL PHASE OVERCURRENT AND E/F (11 I/P & 12 O/P) WITH TCS<br>NON DIRECTIONAL PHASE OVERCURRENT AND E/F (11 I/P & 12 O/P) WITH TCS & ETHERNET<br>NON DIRECTIONAL PHASE OVERCURRENT AND E/F (11 I/P & 12 O/P) WITH TCS & DUAL COPPER ETHERNET<br>NON DIRECTIONAL PHASE OVERCURRENT AND E/F (11 I/P & 12 O/P) WITH TCS & DUAL FIBRE ETHERNET | 10P14N07-1<br>10P14N07-2<br>10P14N07-3<br>10P14N07-4 | C<br>C<br>C<br>C |
| | IO option C | NON DIRECTIONAL PHASE OVERCURRENT AND SEF (11 I/P & 12 O/P) WITH TCS<br>NON DIRECTIONAL PHASE OVERCURRENT AND SEF (11 I/P & 12 O/P) WITH TCS & ETHERNET<br>NON DIRECTIONAL PHASE OVERCURRENT AND SEF (11 I/P & 12 O/P) WITH TCS & DUAL COPPER ETHERNET<br>NON DIRECTIONAL PHASE OVERCURRENT AND SEF (11 I/P & 12 O/P) WITH TCS & DUAL FIBRE ETHERNET | 10P14N08-1<br>10P14N08-2<br>10P14N08-3<br>10P14N08-4 | D<br>C<br>C<br>C |
| | IO option D | NON DIRECTIONAL PHASE OVERCURRENT AND E/F (13 I/P & 12 O/P)<br>NON DIRECTIONAL PHASE OVERCURRENT AND E/F (13 I/P & 12 O/P) & ETHERNET<br>NON DIRECTIONAL PHASE OVERCURRENT AND E/F (13 I/P & 12 O/P) & DUAL COPPER ETHERNET<br>NON DIRECTIONAL PHASE OVERCURRENT AND E/F (13 I/P & 12 O/P) & DUAL FIBRE ETHERNET | 10P14N09-1<br>10P14N09-2<br>10P14N09-3<br>10P14N09-4 | C<br>C<br>C<br>C |
| | IO option D | NON DIRECTIONAL PHASE OVERCURRENT AND SEF (13 I/P & 12 O/P)<br>NON DIRECTIONAL PHASE OVERCURRENT AND SEF (13 I/P & 12 O/P) & ETHERNET<br>NON DIRECTIONAL PHASE OVERCURRENT AND SEF (13 I/P & 12 O/P) & DUAL COPPER ETHERNET<br>NON DIRECTIONAL PHASE OVERCURRENT AND SEF (13 I/P & 12 O/P) & DUAL FIBRE ETHERNET | 10P14N10-1<br>10P14N10-2<br>10P14N10-3<br>10P14N10-4 | D<br>C<br>C<br>C |
| | IO option A | NON DIRECTIONAL PHASE OVERCURRENT AND EARTH FAULT (8 I/P & 8 O/P) FOR KCGG 140/142 RETROFIT | 10P14N11-1 | C |
| | IO option E | NON DIRECTIONAL PHASE OVER CURRENT AND EARTH FAULT (3 I/P & 4 O/P) | 10P14N12-1 | C |
| | IO option F | NON DIRECTIONAL PHASE OVER CURRENT AND EARTH FAULT (6 I/P & 8 O/P) WITH TCS | 10P14N13-1 | C |
| | IO option H | NON DIRECTIONAL PHASE OVERCURRENT AND E/F (10 I/P & 12 O/P) WITH 2 RS485<br>NON DIRECTIONAL PHASE OVERCURRENT AND E/F (10 I/P & 12 O/P) WITH 2 RS485 & ETHERNET<br>NON DIRECTIONAL PHASE OVERCURRENT AND E/F (10 I/P & 12 O/P) WITH 2 RS485 & DUAL COPPER ETHERNET<br>NON DIRECTIONAL PHASE OVERCURRENT AND E/F (10 I/P & 12 O/P) WITH 2 RS485 & DUAL FIBRE ETHERNET | 10P14N14-1<br>10P14N14-2<br>10P14N14-3<br>10P14N14-4 | C<br>C<br>C<br>C |
| | IO option H | NON DIRECTIONAL PHASE OVERCURRENT AND SEF (10 I/P & 12 O/P) WITH 2 RS485<br>NON DIRECTIONAL PHASE OVERCURRENT AND SEF (10 I/P & 12 O/P) WITH 2 RS485 & ETHERNET<br>NON DIRECTIONAL PHASE OVERCURRENT AND SEF (10 I/P & 12 O/P) WITH 2 RS485 & DUAL COPPER ETHERNET<br>NON DIRECTIONAL PHASE OVERCURRENT AND SEF (10 I/P & 12 O/P) WITH 2 RS485 & DUAL FIBRE ETHERNET | 10P14N15-1<br>10P14N15-2<br>10P14N15-3<br>10P14N15-4 | C<br>C<br>C<br>C |
| | IO option J | NON DIRECTIONAL PHASE OVERCURRENT AND E/F (12 I/P & 12 O/P)<br>NON DIRECTIONAL PHASE OVERCURRENT AND E/F (12 I/P & 12 O/P) & ETHERNET<br>NON DIRECTIONAL PHASE OVERCURRENT AND E/F (12 I/P & 12 O/P) & DUAL COPPER ETHERNET<br>NON DIRECTIONAL PHASE OVERCURRENT AND E/F (12 I/P & 12 O/P) & DUAL FIBRE ETHERNET | 10P14N16-1<br>10P14N16-2<br>10P14N16-3<br>10P14N16-4 | C<br>C<br>C<br>C |
| | IO option J | NON DIRECTIONAL PHASE OVERCURRENT AND SEF (12 I/P & 12 O/P)<br>NON DIRECTIONAL PHASE OVERCURRENT AND SEF (12 I/P & 12 O/P) & ETHERNET<br>NON DIRECTIONAL PHASE OVERCURRENT AND SEF (12 I/P & 12 O/P) & DUAL COPPER ETHERNET<br>NON DIRECTIONAL PHASE OVERCURRENT AND SEF (12 I/P & 12 O/P) & DUAL FIBRE ETHERNET | 10P14N17-1<br>10P14N17-2<br>10P14N17-3<br>10P14N17-4 | C<br>C<br>C<br>C |

* When selecting applicable connection diagram(s), it may be helpful to reference the appropriate model's CORTEC.

DIRECTION OF FORWARD CURRENT FLOW

PHASE ROTATION

NOTES:

1. (a)   C.T. SHORTING LINKS MAKE
         BEFORE (b) & (c) DISCONNECT.

   (b)   SHORT TERMINALS BREAK BEFORE (c).

   (c)   LONG TERMINAL.

   (d)   PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS
   ARE TYPICAL ONLY.
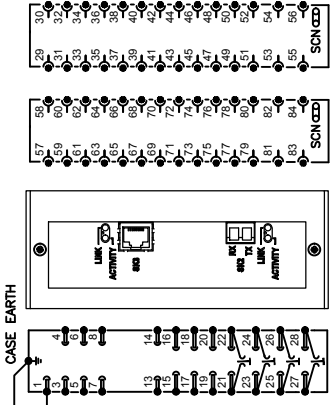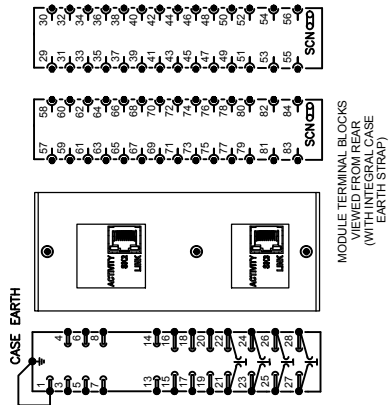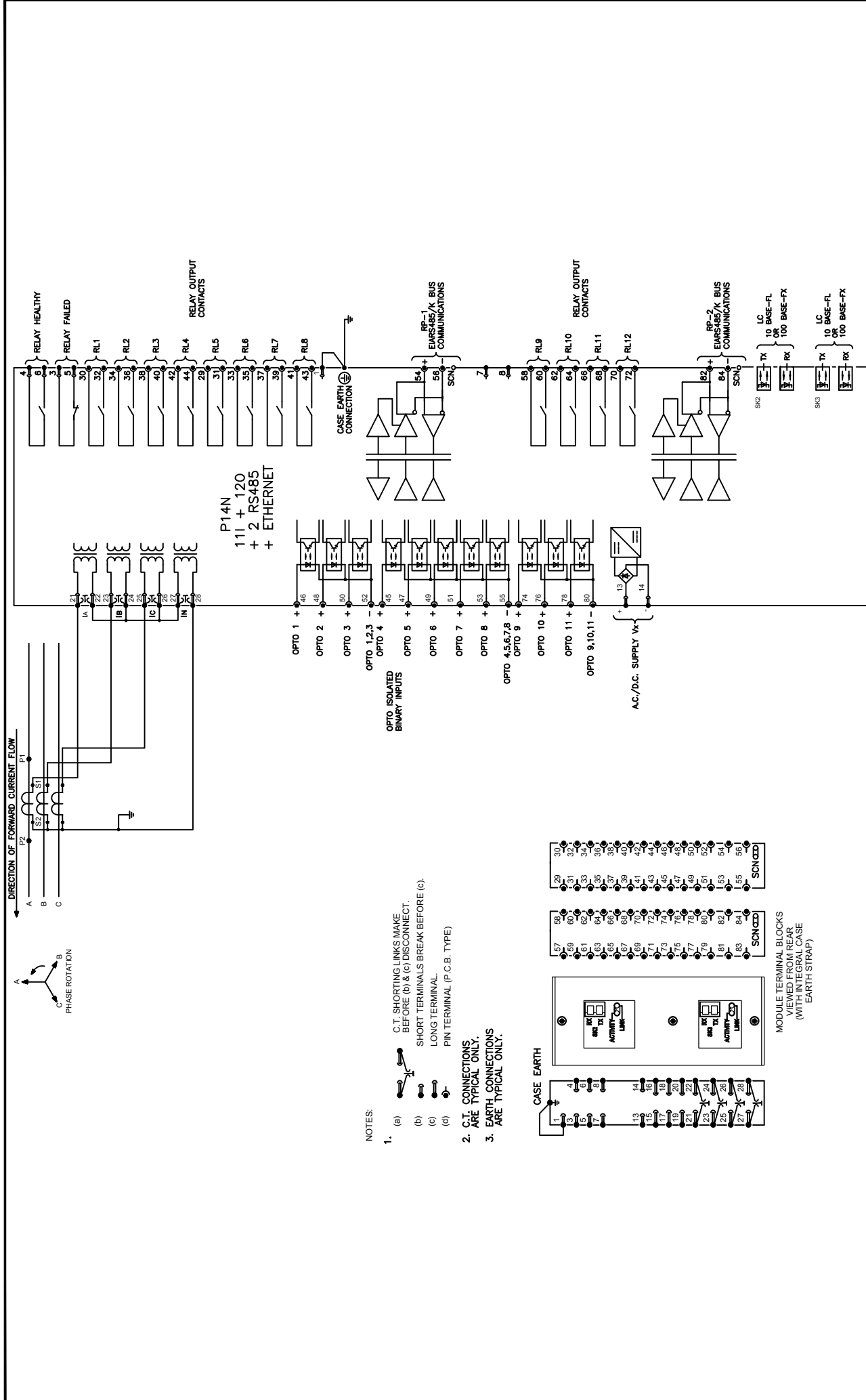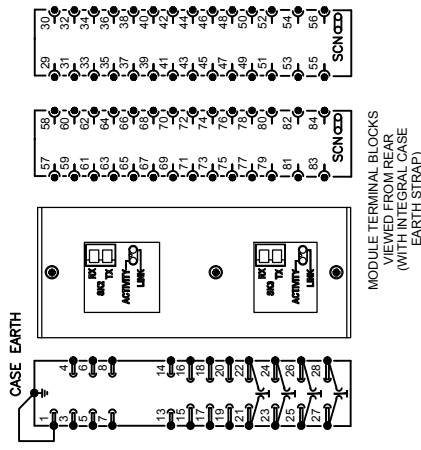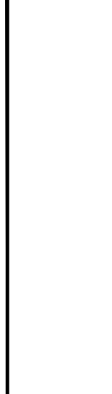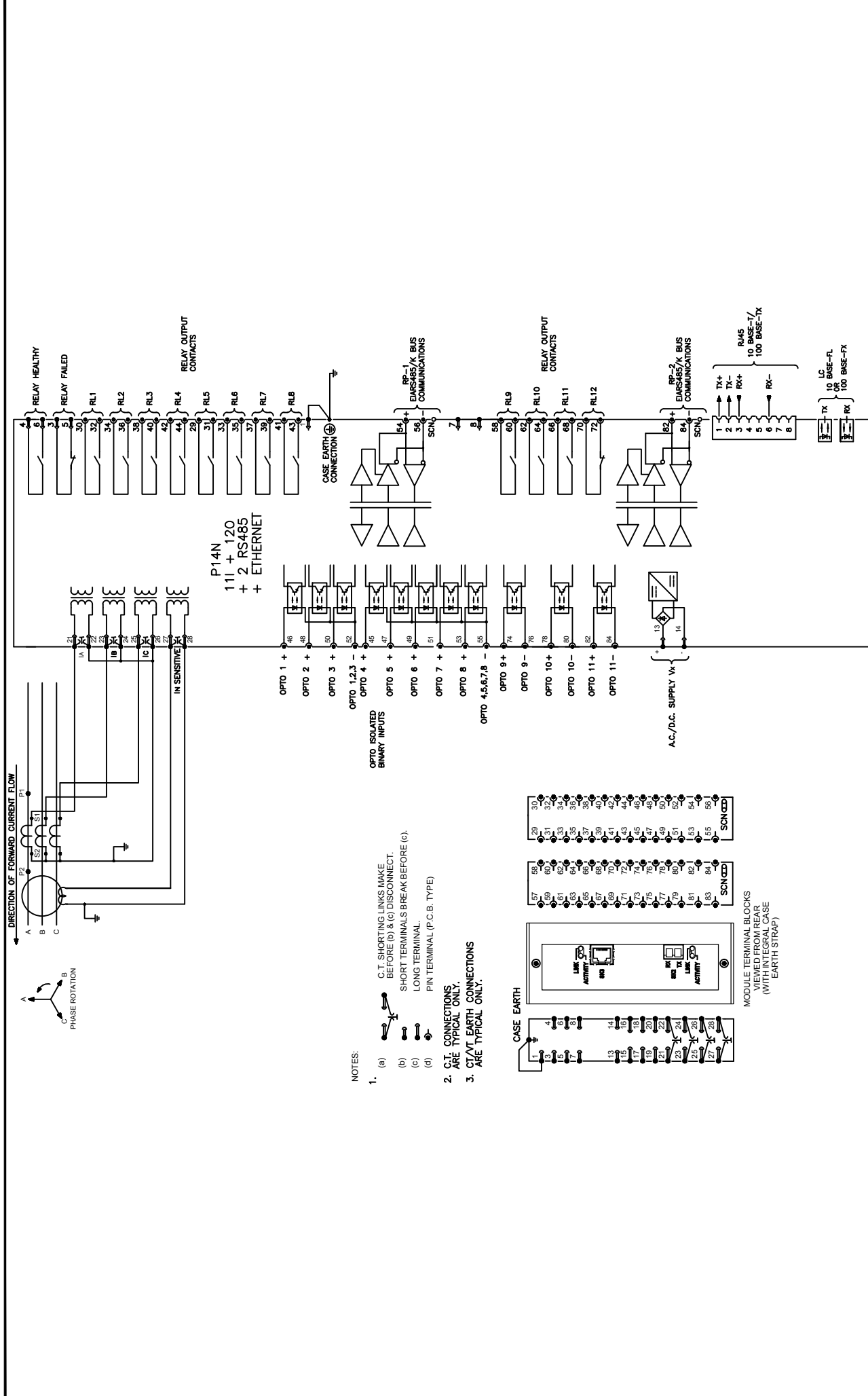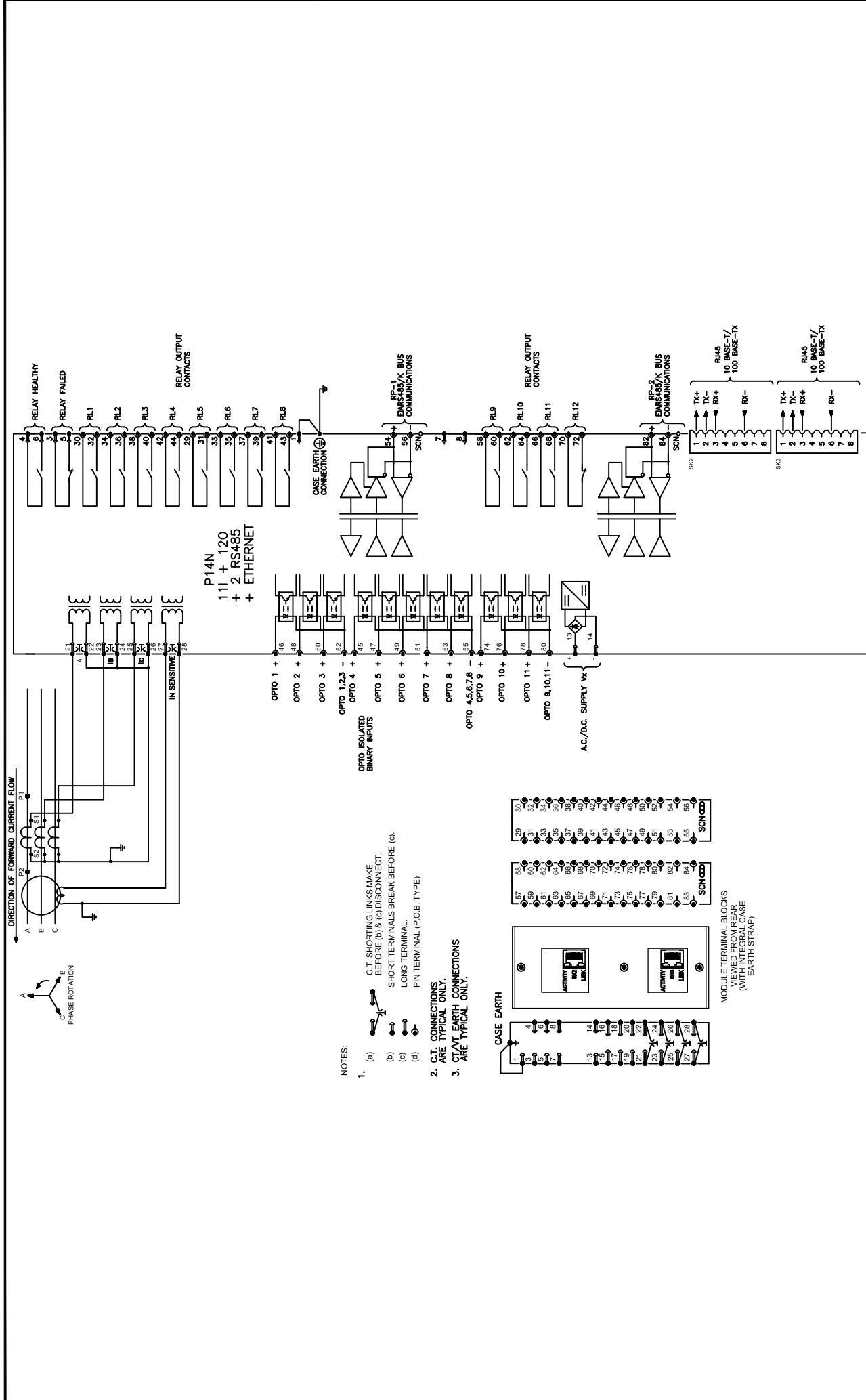
3. EARTH CONNECTIONS
   ARE TYPICAL ONLY.

CASE EARTH

MODULE TERMINAL BLOCKS
VIEWED FROM REAR
(WITH INTEGRAL CASE
EARTH STRAP)

RELAY HEALTHY

RELAY FAILED

RL1
RL2
RL3
RL4
RL5
RL6
RL7
RL8

RELAY OUTPUT
CONTACTS

CASE EARTH
CONNECTION

EIARS485/K BUS
COMMUNICATIONS

A.C./D.C. SUPPLY Vx

P14N
8I + 8O

OPTO 1+
OPTO 2+
OPTO 3+
OPTO 1,2,3 −
OPTO 4+
OPTO 5+
OPTO 6+
OPTO 7+
OPTO 8+
OPTO 4,5,6,7,8 −

OPTO ISOLATED
BINARY INPUTS

Title: P14N NON DIRECTIONAL PHASE OVER CURRENT AND EARTH FAULT (8 I/P & 8 O/P)

Drg No: 10P14N01

Sht: 1
Next Sht: -

| Issue: C | Revision: CID006234 Outlines updated to GE Format | | |
|---|---|---|---|
| Date: 5/1/2020 | Name: S.J.BURTON | | |
| Date: 03/12/2011 | Chkd: K.VENKATARAMAN | | |

RELAY HEALTHY

RELAY FAILED

RELAY OUTPUT CONTACTS

RL1
RL2
RL3
RL4
RL5
RL6
RL7
RL8

CASE EARTH CONNECTION

EIARS485/K BUS COMMUNICATIONS

A.C./D.C. SUPPLY Vx

P14N
8I + 80

IN SENSITIVE

OPTO 1 +
OPTO 2 +
OPTO 3 +
OPTO 1,2,3 −
OPTO 4 +
OPTO 5 +
OPTO 6 +
OPTO 7 +
OPTO 8 +
OPTO 4,5,6,7,8 −

OPTO ISOLATED BINARY INPUTS

DIRECTION OF FORWARD CURRENT FLOW

P1
S1
S2
P2

A
B
C

PHASE ROTATION

NOTES:

1. (a)   C.T. SHORTING LINKS MAKE
         BEFORE (b) & (c) DISCONNECT.

   (b)   SHORT TERMINALS BREAK BEFORE (c).

   (c)   LONG TERMINAL.

   (d)   PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS
   ARE TYPICAL ONLY.

3. CT/VT EARTH CONNECTIONS
   ARE TYPICAL ONLY.

CASE EARTH

MODULE TERMINAL BLOCKS
VIEWED FROM REAR
(WITH INTEGRAL CASE
EARTH STRAP)

| Title: | P14N NON DIRECTIONAL PHASE OVERCURRENT AND SEF (8 I/P & 8 O/P) |
|---|---|

Drg No: **10P14N02**

Sht: 1
Next Sht: −

| Issue: D | Revision: CID006234 Outlines updated to GE Format | |
|---|---|---|
| Date: 5/1/2020 | Name: S.J.BURTON | |
| Date: 02/12/2011 | Chkd: K.VENKATARAMAN | |

DIRECTION OF FORWARD CURRENT FLOW

PHASE ROTATION

NOTES:

1. (a) C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.
   (b) SHORT TERMINALS BREAK BEFORE (c).
   (c) LONG TERMINAL.
   (d) PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS ARE TYPICAL ONLY.

3. CT/VT EARTH CONNECTIONS ARE TYPICAL ONLY.

CASE EARTH

MODULE TERMINAL BLOCKS
VIEWED FROM REAR
(WITH INTEGRAL CASE
EARTH STRAP)

P14N
8I + 8O
+ Ethernet

RELAY HEALTHY
RELAY FAILED

RELAY OUTPUT CONTACTS

CASE EARTH CONNECTION

EIARS485/K BUS COMMUNICATIONS

RJ45
10 BASE-T/
100 BASE-TX

LC
10 BASE-FL
OR
100 BASE-FX

OPTO ISOLATED BINARY INPUTS

A.C./D.C. SUPPLY Vx

Title: P14N NON DIRECTIONAL PHASE OVERCURRENT AND EARTH FAULT (8 I/P & 8 O/P) WITH ETHERNET

Drg No: 10P14N03

Sht: 1
Next Sht: 2

Issue: D

Revision: CID006234 Outlines updated to GE Format

Date: 5/1/2020 | Name: S.J.BURTON
Date: 03/12/2011 | Chkd: K.VENKATARAMAN

DIRECTION OF FORWARD CURRENT FLOW

P1 P2 S1 S2

IA 21 22
IB 23 24
IC 25 26
IN 27 28

A B C
PHASE ROTATION

P14N
8I + 8O
+ Ethernet

RELAY HEALTHY
4
6

RELAY FAILED
3
5

RL1  30
32

RL2  34
36

RL3  38
40

RL4  42
44

RL5  29
31

RL6  33
35

RL7  37
39

RL8  41
43
1

RELAY OUTPUT CONTACTS

CASE EARTH CONNECTION

EIARS485/K BUS COMMUNICATIONS
54 +
56 −
SCNo
7

8

OPTO 1 + 46
         48
OPTO 2 + 50
         − 52
OPTO 1,2,3 −
OPTO 4 + 45
         47
OPTO 5 + 49
         51
OPTO 6 +
         53
OPTO 7 +
         55
OPTO 8 +
OPTO 4,5,6,7,8 −

OPTO ISOLATED BINARY INPUTS

A.C./D.C. SUPPLY Vx
+ 13
− 14

SK2
RJ45
10 BASE−T/
100 BASE−TX
TX+ 1
TX− 2
RX+ 3
4
5
RX− 6
7
8

SK3
RJ45
10 BASE−T/
100 BASE−TX
TX+ 1
TX− 2
RX+ 3
4
5
RX− 6
7
8

NOTES:

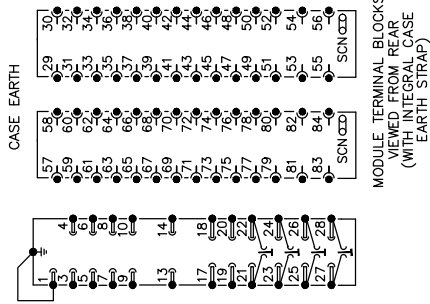1. (a)  C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.
   (b)  SHORT TERMINALS BREAK BEFORE (c).
   (c)  LONG TERMINAL.
   (d)  PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS ARE TYPICAL ONLY.
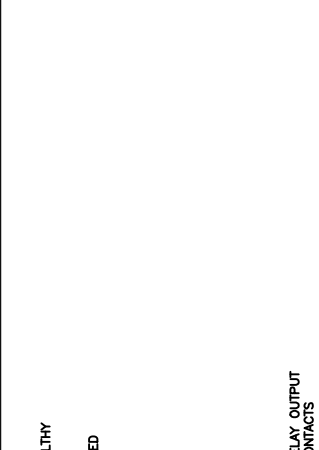
3. CT/VT EARTH CONNECTIONS ARE TYPICAL ONLY.

CASE EARTH

1 2 3 4 5 6 7 8 9 10 13 14 17 18 19 20 21 22 23 24 25 26 27 28

29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 SCN

ACTIVITY SK6 LINK
ACTIVITY SK6 LINK

MODULE TERMINAL BLOCKS
VIEWED FROM REAR
(WITH INTEGRAL CASE EARTH STRAP)

Title: P14N NON DIRECTIONAL PHASE OVERCURRENT AND EARTH FAULT (8 I/P & 8 O/P) WITH DUAL COPPER ETHERNET

Drg No: 10P14N03

Sht: 2
Next Sht: 3

Issue: C

Revision: CID006234 Outlines updated to GE Format

Date: 5/1/2020   Name: S.J.BURTON
Chkd: CP.TEOH

DIRECTION OF FORWARD CURRENT FLOW

P1
P2
A
B
C
S1
S2

PHASE ROTATION
A
B
C

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RL4
RL5
RL6
RL7
RL8

RELAY OUTPUT CONTACTS

4
6
3
5
30
32
34
36
38
40
42
44
29
31
33
35
37
39
41
43
1

CASE EARTH CONNECTION

EIA RS485/K BUS COMMUNICATIONS

54
56  SCN₀
+
−
7
8

P14N
8I + 8O
+ Ethernet

IA  21  22
IB  23  24
IC  25  26
IN  27  28

OPTO 1 +  46
−  48
OPTO 2 +  50
OPTO 3 +  52
OPTO 1,2,3 −
OPTO 4 +  45
47
OPTO 5 +  49
OPTO 6 +  51
OPTO 7 +  53
OPTO 8 +  55
OPTO 4,5,6,7,8 −

OPTO ISOLATED BINARY INPUTS

A.C./D.C. SUPPLY Vx
+  13
−  14

LC
10 BASE−FL
OR
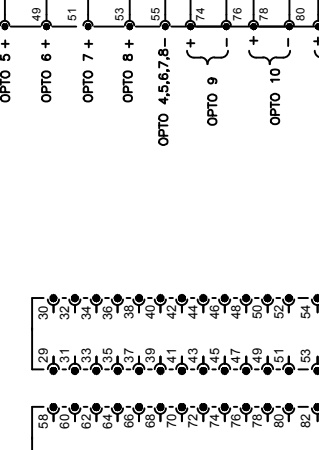100 BASE−FX
TX
RX
SK2
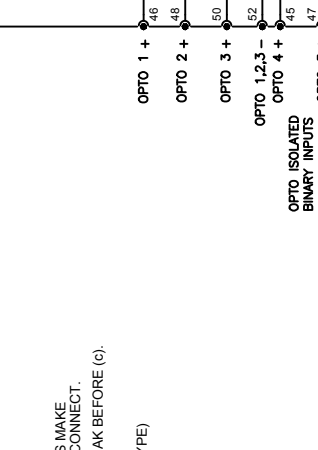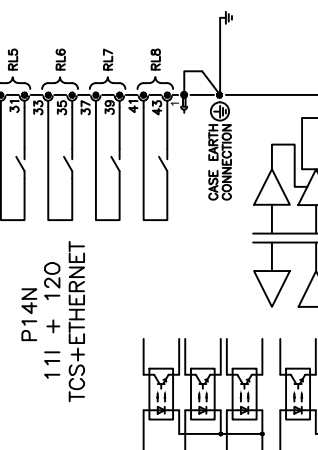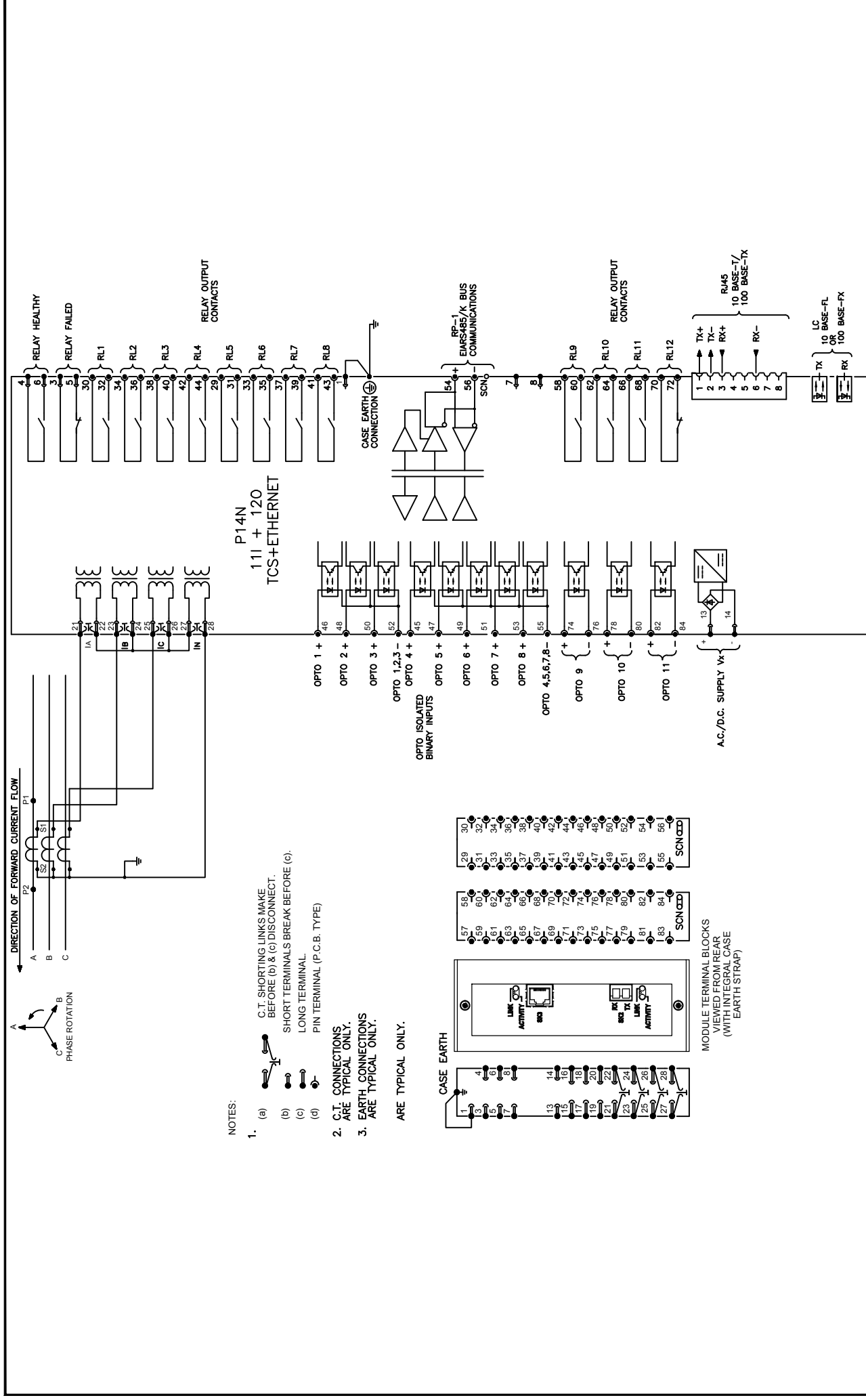
LC
10 BASE−FL
OR
100 BASE−FX
TX
RX
SK3

NOTES:

1. (a)  C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.
   (b)  SHORT TERMINALS BREAK BEFORE (c).
   (c)  LONG TERMINAL.
   (d)  PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS ARE TYPICAL ONLY.

3. CT/VT EARTH CONNECTIONS ARE TYPICAL ONLY.

CASE EARTH

1 2 3 4 5 6 7 8 9 10 13 14 17 18 19 20 21 22 23 24 25 26 27 28

29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56  SCN

RX TX ACTIVITY LINK
SK2
RX TX ACTIVITY LINK
SK3

MODULE TERMINAL BLOCKS
VIEWED FROM REAR
(WITH INTEGRAL CASE EARTH STRAP)

Title: P14N NON DIRECTIONAL PHASE OVERCURRENT AND EARTH FAULT (8 I/P & 8 O/P) WITH DUAL FIBRE ETHERNET

Drg No: 10P14N03

Sht: 3
Next Sht: −

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St Leonards Building
Harry Kerr Drive, Stafford.
ST16 1WT, UK

Issue: C

Revision: CID006234 Outlines updated to GE Format

Date: 5/1/2020   Name: S.J.BURTON
Date:            Chkd: CP.TEOH

**Title:** P14N NON DIRECTIONAL PHASE OVERCURRENT & SEF (8 I/P 8 O/P) WITH ETHERNET & OPTIONAL SHORTING LINK

**Drg No:** 10P14N04

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RL4
RL5
RL6
RL7
RL8

RELAY OUTPUT CONTACTS

OPTIONAL FEATURE SEE NOTE 4

P14N
8I + 8O
+ Ethernet

CASE EARTH CONNECTION

EIARS485/K BUS COMMUNICATIONS

RJ45
10 BASE-T/
100 BASE-TX

LC
10 BASE-FL
OR
100 BASE-FX

OPTO 1 +
OPTO 2 +
OPTO 3 +
OPTO 1,2,3 –
OPTO 4 +
OPTO 5 +
OPTO 6 +
OPTO 7 +
OPTO 8 +
OPTO 4,5,6,7,8 –

OPTO ISOLATED BINARY INPUTS

A.C./D.C. SUPPLY Vx
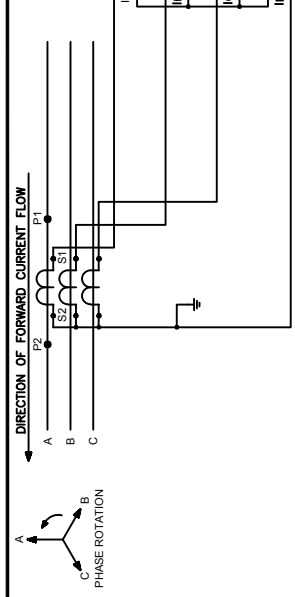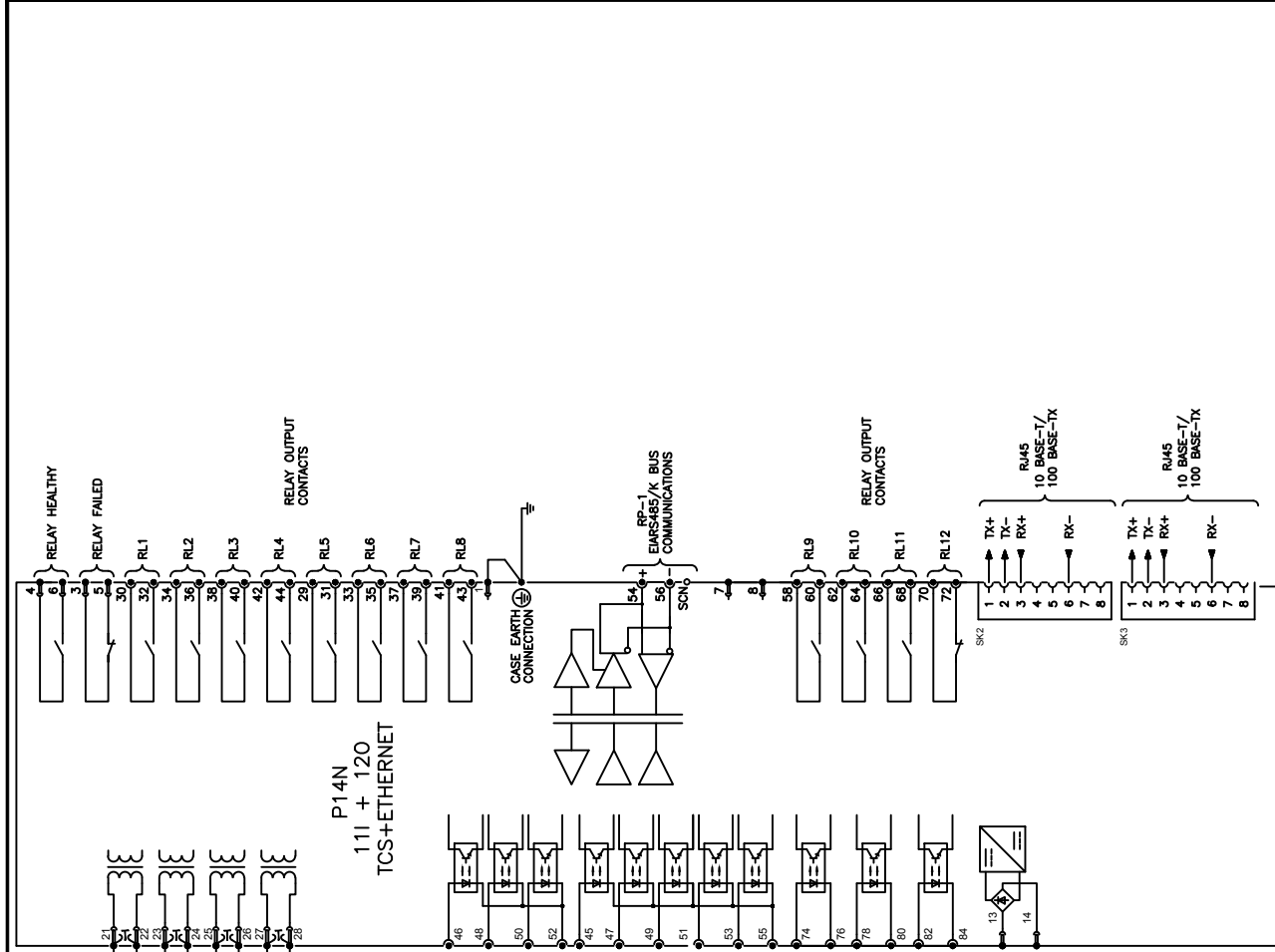
IA
IB
IC
IN SENSITIVE

PHASE ROTATION

NOTES:

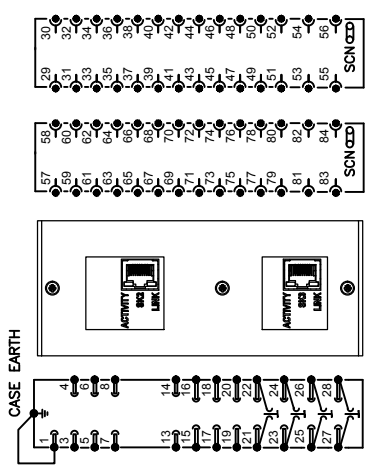1. (a)    C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.
   (b)    SHORT TERMINALS BREAK BEFORE (c).
   (c)    LONG TERMINAL.
   (d)    PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS ARE TYPICAL ONLY.

3. CT/VT EARTH CONNECTIONS ARE TYPICAL ONLY.

4. TERMINALS 9 & 10: OPTIONAL SHORTING LINK (ORDERING OPTION). ONLY AVAILABLE FOR THE 30TE MODEL VARIANTS. WHEN THESE TERMINALS ARE USED FOR CAPACITOR CONE APPLICATIONS PLEASE REFER TO ALSTOM GRID APPLICATION GUIDE AG013 FOR SAFETY PROCEDURE.

CASE EARTH

MODULE TERMINAL BLOCKS VIEWED FROM REAR (WITH INTEGRAL CASE EARTH STRAP)

Issue: E
Revision: CID006234 Outlines updated to GE Format

Date: 5/1/2020   Name: S.J.BURTON
Date: 03/12/2011   Chkd: K.VENKATARAMAN

DIRECTION OF FORWARD CURRENT FLOW

PHASE ROTATION

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RL4
RL5
RL6
RL7
RL8

RELAY OUTPUT CONTACTS

P14N
8I + 8O
+ Ethernet

OPTIONAL FEATURE SEE NOTE 4

CASE EARTH CONNECTION

EIARS485/K BUS COMMUNICATIONS

SK2

RJ45
10 BASE-T/
100 BASE-TX

TX+
TX-
RX+
RX-

SK3

RJ45
10 BASE-T/
100 BASE-TX

TX+
TX-
RX+
RX-

OPTO 1 +
OPTO 2 +
OPTO 3 +
OPTO 1,2,3 -
OPTO 4 +
OPTO 5 +
OPTO 6 +
OPTO 7 +
OPTO 8 +
OPTO 4,5,6,7,8 -

OPTO ISOLATED BINARY INPUTS

IN SENSITIVE

A.C./D.C. SUPPLY Vx

NOTES:

1.
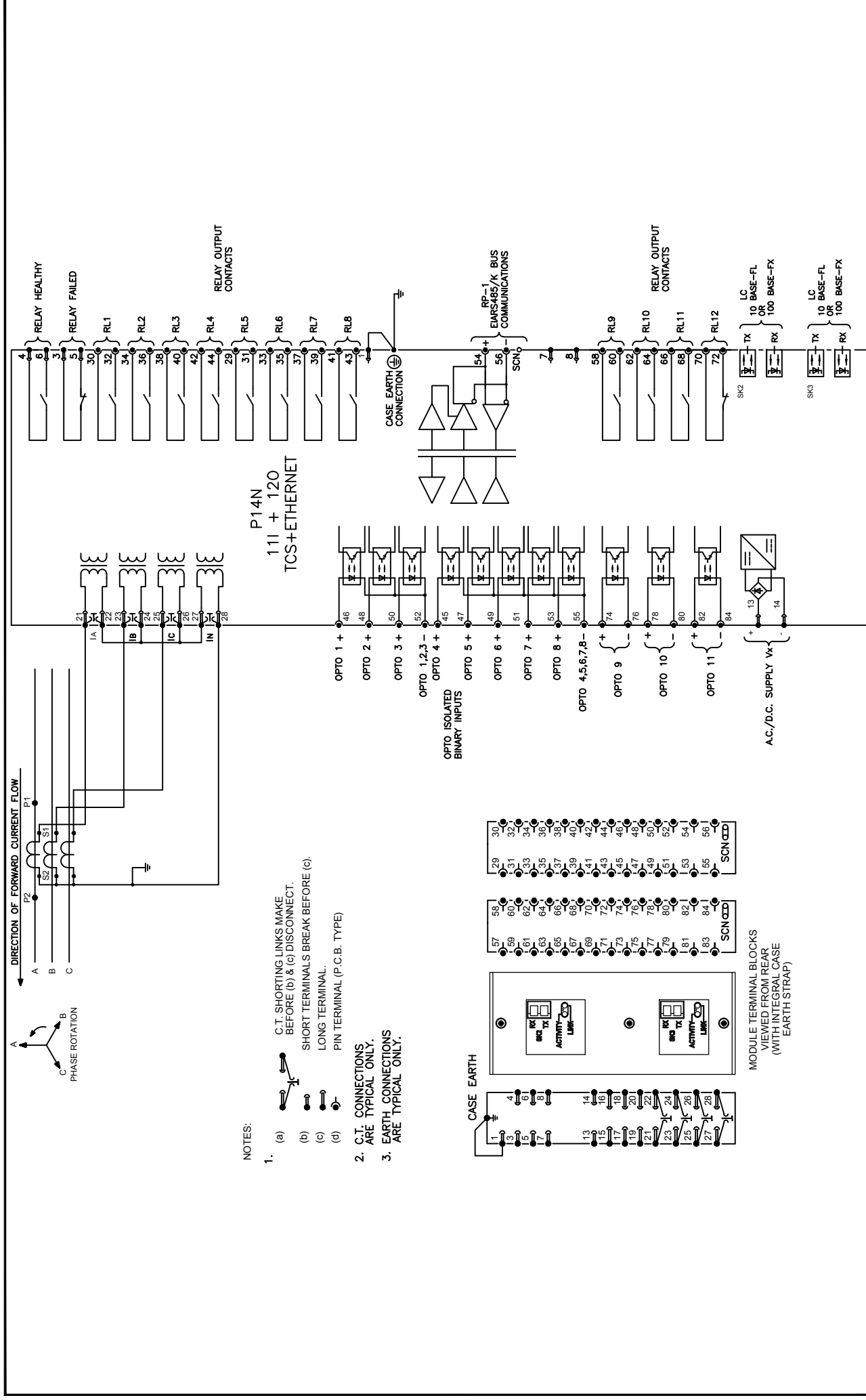(a)     C.T. SHORTING LINKS MAKE
        BEFORE (b) & (c) DISCONNECT.

(b)     SHORT TERMINALS BREAK BEFORE (c).

(c)     LONG TERMINAL.

(d)     PIN TERMINAL (P.C.B. TYPE)

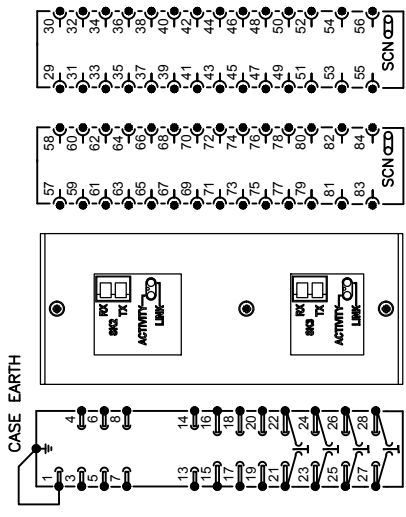2. C.T. CONNECTIONS ARE TYPICAL ONLY.

3. CT/VT EARTH CONNECTIONS ARE TYPICAL ONLY.

4. TERMINALS 9 & 10: OPTIONAL SHORTING LINK (ORDERING OPTION). ONLY
AVAILABLE FOR THE 30TE MODEL VARIANTS.
WHEN THESE TERMINALS ARE USED FOR CAPACITOR CONE APPLICATIONS
PLEASE REFER TO ALSTOM GRID APPLICATION GUIDE AG013 FOR SAFETY
PROCEDURE.

CASE EARTH

MODULE TERMINAL BLOCKS
VIEWED FROM REAR
(WITH INTEGRAL CASE
EARTH STRAP)

| Issue: | Revision: | | |
|---|---|---|---|
| C | CID006234 Outlines updated to GE Format | | |
| Date: | 5/1/2020 | Name: | S.J.BURTON |
| Date: | | Chkd: | CP.TEOH |

Title: P14N NON DIRECTIONAL PHASE OVERCURRENT AND SEF (8 I/P & 8 O/P) WITH DUAL COPPER ETHERNET

Drg No: 10P14N04

Sht: 2
Next Sht: 3

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Harry Kerr Drive, Stafford.
ST16 1WT, UK

DIRECTION OF FORWARD CURRENT FLOW

P1
P2
S1
S2
A
B
C

A
B
C
PHASE ROTATION

RELAY HEALTHY
4
6
RELAY FAILED
3
5
RL1  30
32
RL2  34
36
RL3  38
40
RL4  42
44
RL5  29
31
RL6  33
35
RL7  37
39
RL8  41
43

RELAY OUTPUT CONTACTS

CASE EARTH CONNECTION

EIARS485/K BUS COMMUNICATIONS
54
56
SCN

7
8

SK2   TX   LC 10 BASE-FL OR 100 BASE-FX
RX

SK3   TX   LC 10 BASE-FL OR 100 BASE-FX
RX

OPTIONAL FEATURE SEE NOTE 4
9
10

P14N
8I + 8O
+ Ethernet

IA  21
22
IB  23
24
IC  25
26
IN SENSITIVE  27
28

OPTO 1+  46
OPTO 2+  48
OPTO 3+  50
OPTO 1,2,3 –  52
OPTO 4+  45
OPTO 5+  47
OPTO 6+  49
OPTO 7+  51
OPTO 8+  53
OPTO 4,5,6,7,8 –  55

OPTO ISOLATED BINARY INPUTS

A.C./D.C. SUPPLY Vx
+  13
–  14

Title: P14N NON DIRECTIONAL PHASE OVERCURRENT AND
SEF (8 I/P & 8 O/P) WITH DUAL FIBRE ETHERNET
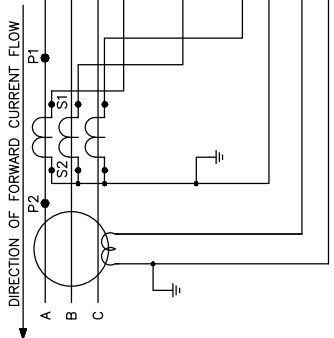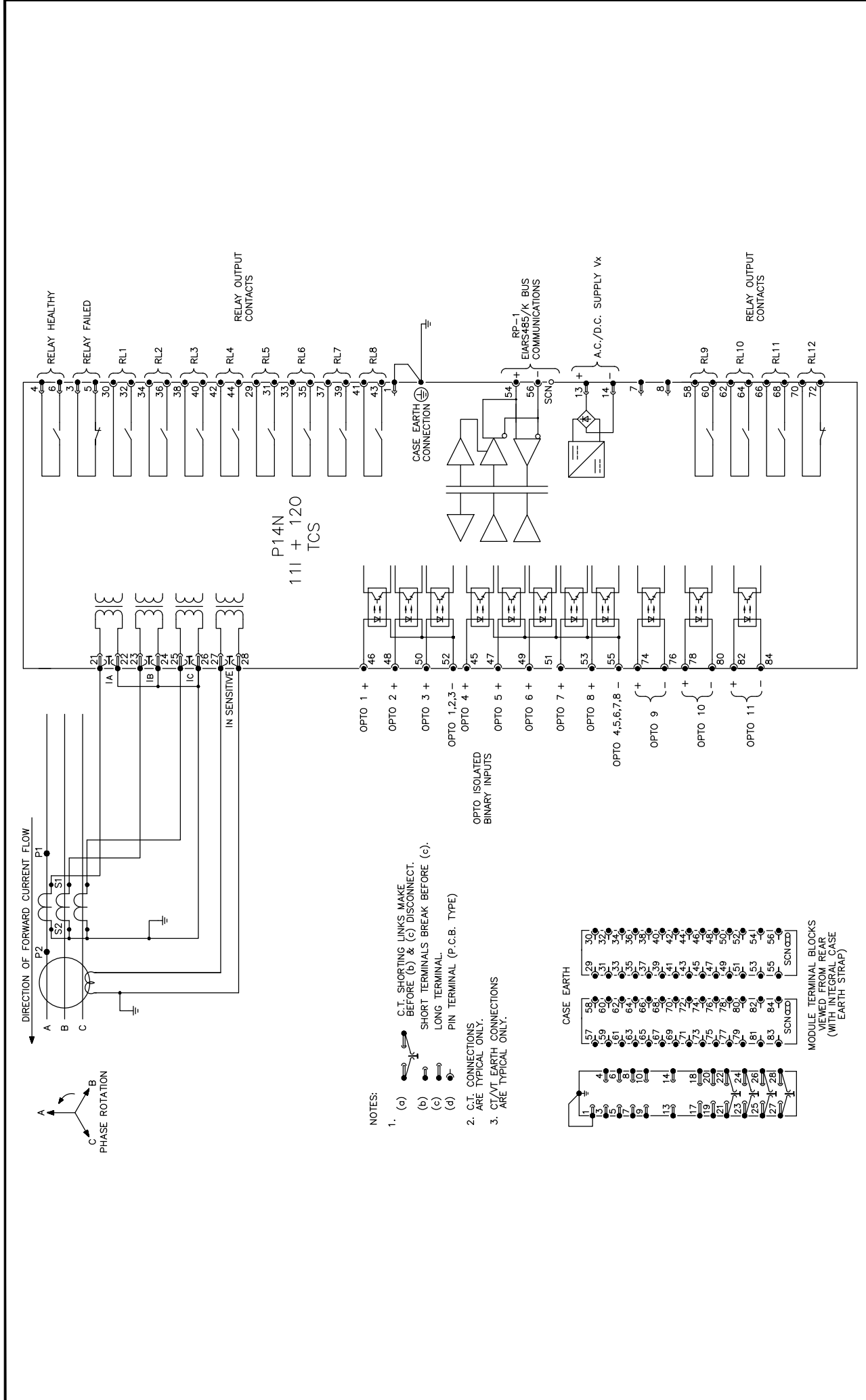
Drg No: 10P14N04

Sht: 3
Next Sht: –

NOTES:

1.
(a)  C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.
(b)  SHORT TERMINALS BREAK BEFORE (c).
(c)  LONG TERMINAL.
(d)  PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS ARE TYPICAL ONLY.
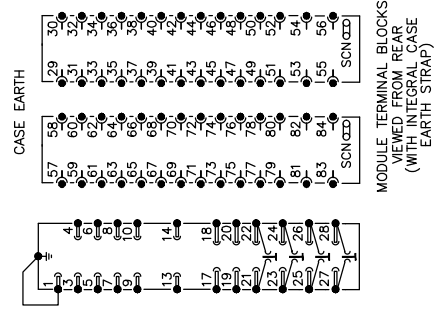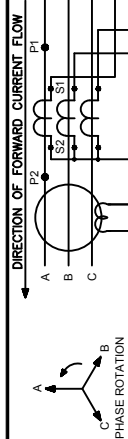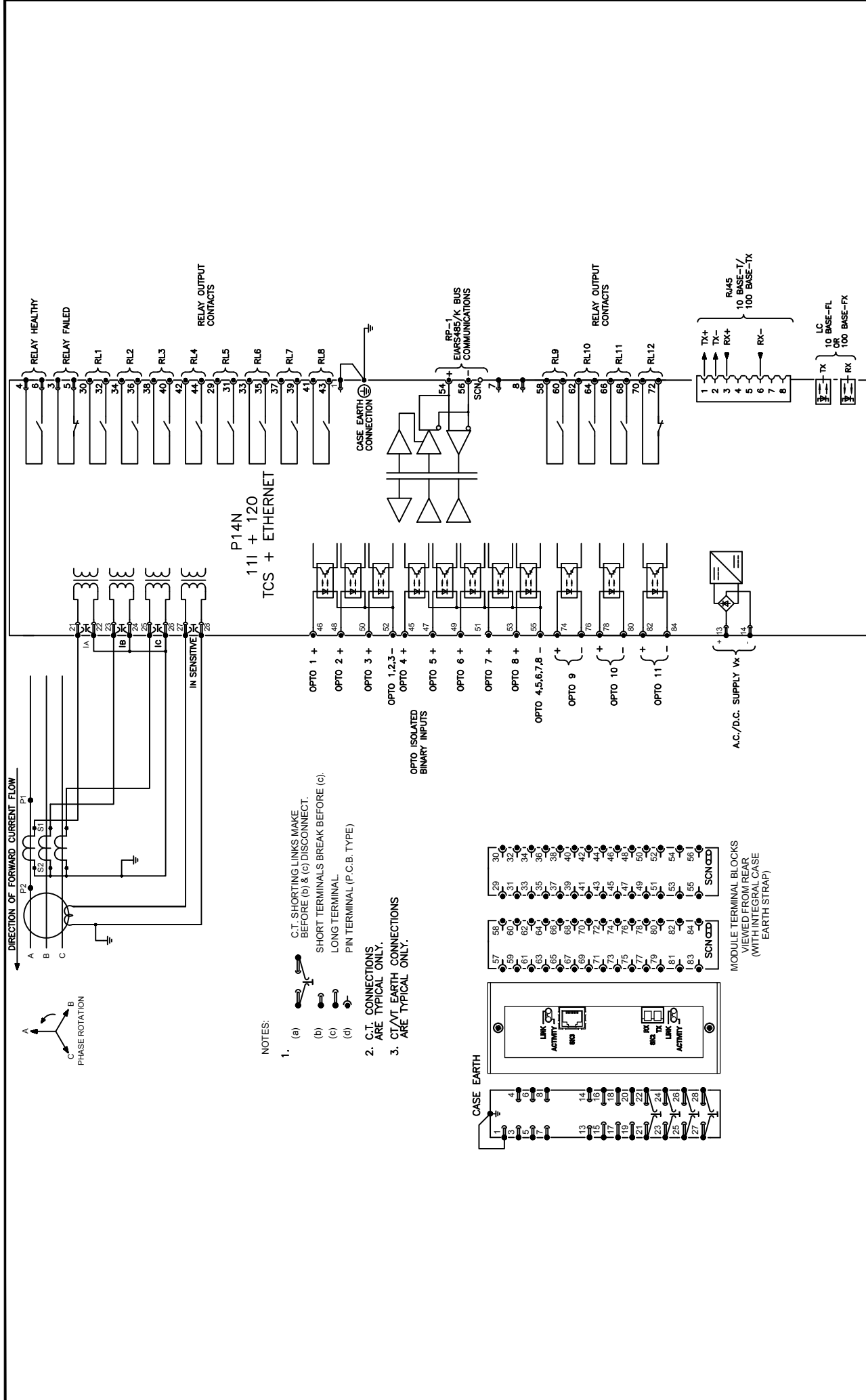
3. CT/VT EARTH CONNECTIONS ARE TYPICAL ONLY.

4. TERMINALS 9 & 10: OPTIONAL SHORTING LINK (ORDERING OPTION), ONLY AVAILABLE FOR THE 30TE MODEL VARIANTS. WHEN THESE TERMINALS ARE USED FOR CAPACITOR CONE APPLICATIONS PLEASE REFER TO ALSTOM GRID APPLICATION GUIDE AG013 FOR SAFETY PROCEDURE.

CASE EARTH

29 30
31 32
33 34
35 36
37 38
39 40
41 42
43 44
45 46
47 48
49 50
51 52
53 54
55 56
SCN

3 4
5 6
7 8
9 10
13 14
17 18
19 20
21 22
23 24
25 26
27 28

MODULE TERMINAL BLOCKS VIEWED FROM REAR (WITH INTEGRAL CASE EARTH STRAP)

Issue: C

Revision: CID006234 Outlines updated to GE Format

Date: 5/1/2020   Name: S.J.BURTON
Date:             Chkd: CP.TEOH

DIRECTION OF FORWARD CURRENT FLOW

PHASE ROTATION

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RL4
RELAY OUTPUT CONTACTS
RL5
RL6
RL7
RL8

CASE EARTH CONNECTION

RP-1 EIARS485/K BUS COMMUNICATIONS

A.C./D.C. SUPPLY Vx

RL9
RL10
RL11
RL12
RELAY OUTPUT CONTACTS

RP-2 EIARS485/K BUS COMMUNICATIONS

P14N
11I + 12O
+ 2 RS485

OPTO 1
OPTO 2
OPTO 3
OPTO 1,2,3
OPTO 4
OPTO 5
OPTO 6
OPTO 7
OPTO 8
OPTO 4,5,6,7,8
OPTO 9
OPTO 10
OPTO 11
OPTO 9,10,11

OPTO ISOLATED BINARY INPUTS

NOTES:

1. (a) C.T. SHORTING LINKS. MAKE BEFORE (b) & (c) DISCONNECT.
   (b) SHORT TERMINALS BREAK BEFORE (c).
   (c) LONG TERMINAL.
   (d) PIN TERMINAL (P.C.B. TYPE)

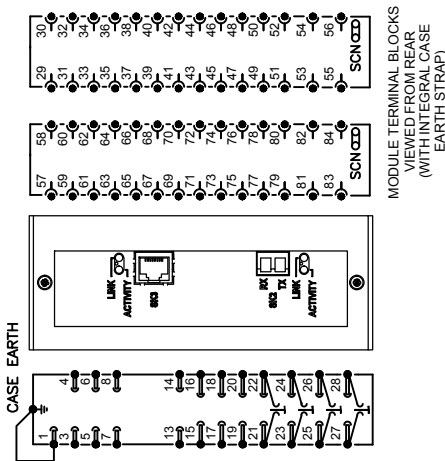2. C.T. CONNECTIONS ARE TYPICAL ONLY.

3. EARTH CONNECTIONS ARE TYPICAL ONLY.

CASE EARTH

MODULE TERMINAL BLOCKS
VIEWED FROM REAR
(WITH INTEGRAL CASE EARTH STRAP)

| Title: | P14N NON DIRECTIONAL PHASE OVERCURRENT AND EARTH FAULT (11 I/P & 12 O/P) WITH 2 RS485 | |
|---|---|---|
| Drg No: | 10P14N05 | Sht: 1 |
| | | Next Sht: - |

| Issue: C | Revision: CID006234 Outlines updated to GE Format | |
|---|---|---|
| Date: 5/1/2020 | Name: S.J.BURTON | |
| Date: 03/12/2011 | Chkd: K.VENKATARAMAN | |

P14N
11I + 120
+ 2 RS485
+ ETHERNET

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RL4
RELAY OUTPUT CONTACTS
RL5
RL6
RL7
RL8

CASE EARTH CONNECTION

RP-1
EIARS485/K BUS COMMUNICATIONS

RELAY OUTPUT CONTACTS
RL9
RL10
RL11
RL12

RP-2
EIARS485/K BUS COMMUNICATIONS

RJ45
10 BASE-T/
100 BASE-TX
TX+
TX-
RX+
RX-

LC
10 BASE-FL
OR
100 BASE-FX
TX
RX

DIRECTION OF FORWARD CURRENT FLOW

PHASE ROTATION

OPTO 1
OPTO 2
OPTO 3
OPTO 1,2,3
OPTO 4
OPTO 5
OPTO 6
OPTO 7
OPTO 8
OPTO 4,5,6,7,8
OPTO 9
OPTO 10
OPTO 11
OPTO 9,10,11

OPTO ISOLATED BINARY INPUTS

A.C./D.C. SUPPLY Vx
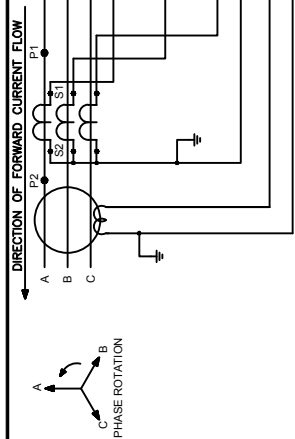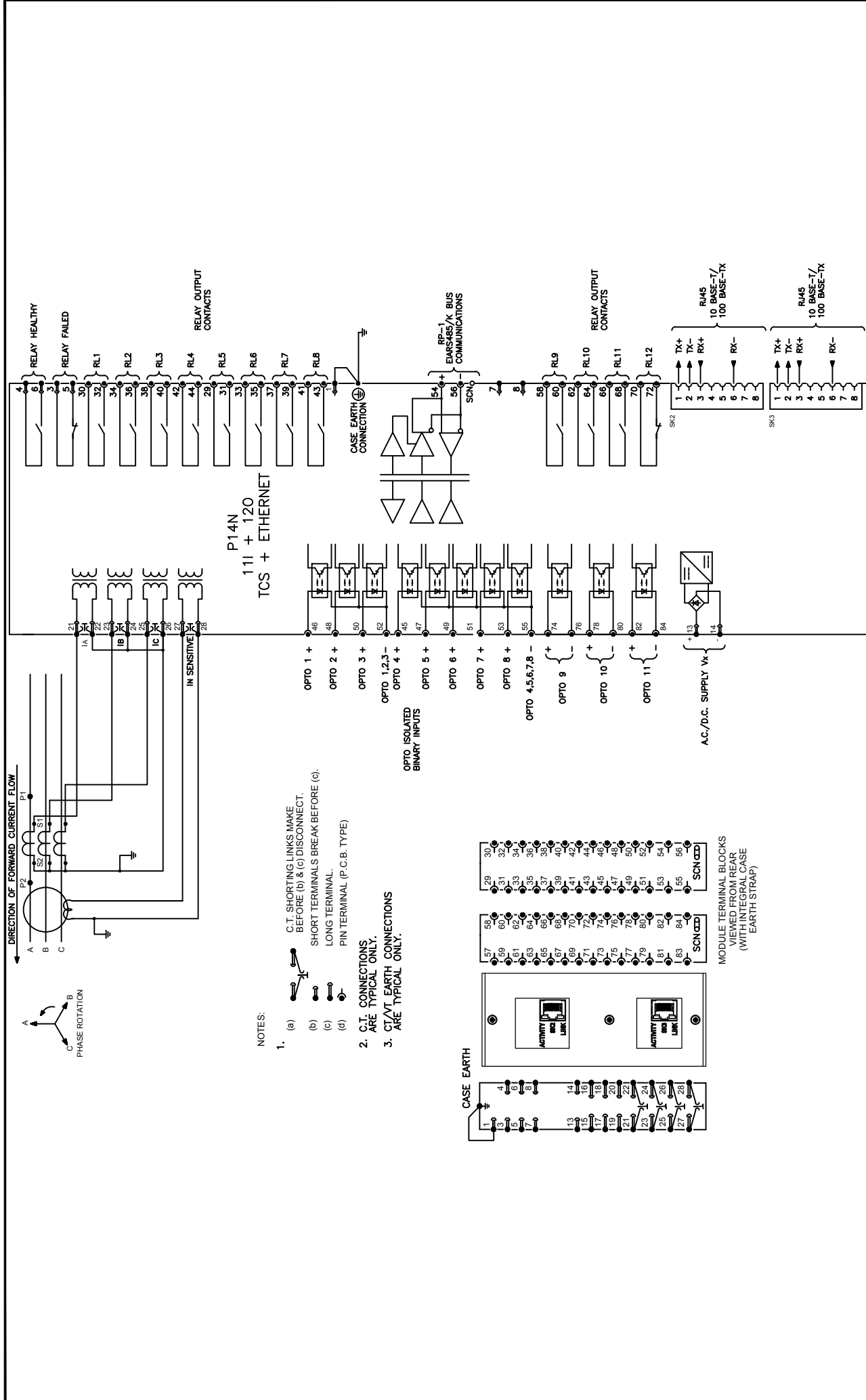
NOTES:

1. (a)  C.T. SHORTING LINKS MAKE
        BEFORE (b) & (c) DISCONNECT.
   (b)  SHORT TERMINALS BREAK BEFORE (c).
   (c)  LONG TERMINAL.
   (d)  PIN TERMINAL (P.C.B. TYPE)

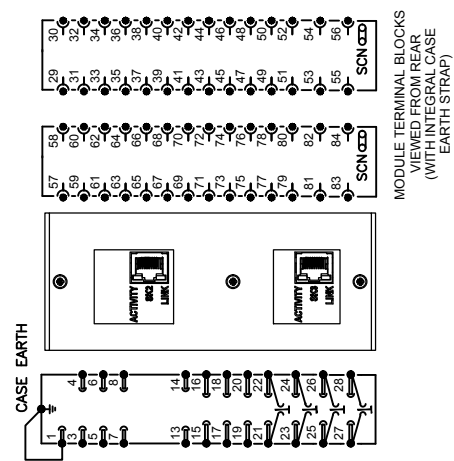2. C.T. CONNECTIONS ARE TYPICAL ONLY.

3. EARTH CONNECTIONS ARE TYPICAL ONLY.

CASE EARTH

MODULE TERMINAL BLOCKS
VIEWED FROM REAR
(WITH INTEGRAL CASE
EARTH STRAP)

| Issue: C | Revision: CID006234 Outlines updated to GE Format | | Title: | P14N NON DIRECTIONAL PHASE OVERCURRENT & EARTH FAULT (11 I/P & 12 O/P) WITH 2 RS485 ETHERNET | | © UK Grid Solutions Ltd St Leonards Building, Harry Kerr Drive, Stafford. ST16 1WT, UK | Sht: 2 |
| Date: 5/1/2020 | Name: S.J.BURTON | | | | | Next Sht: 3 |
| Date: | Chkd: TEOH C.P. | | Drg No: | 10P14N05 | | |

DIRECTION OF FORWARD CURRENT FLOW

PHASE ROTATION

P14N
11I + 12O
+ 2 RS485
+ ETHERNET

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RL4
RELAY OUTPUT CONTACTS
RL5
RL6
RL7
RL8

CASE EARTH CONNECTION

RP–1
EIA RS485/K BUS COMMUNICATIONS

RL9
RL10
RL11
RELAY OUTPUT CONTACTS
RL12

RP–2
EIA RS485/K BUS COMMUNICATIONS

RJ45
10 BASE–T/
100 BASE–TX

RJ45
10 BASE–T/
100 BASE–TX

OPTO 1
OPTO 2
OPTO 3
OPTO 1,2,3
OPTO 4
OPTO 5
OPTO 6
OPTO 7
OPTO 8
OPTO 4,5,6,7,8
OPTO 9
OPTO 10
OPTO 11
OPTO 9,10,11

OPTO ISOLATED BINARY INPUTS

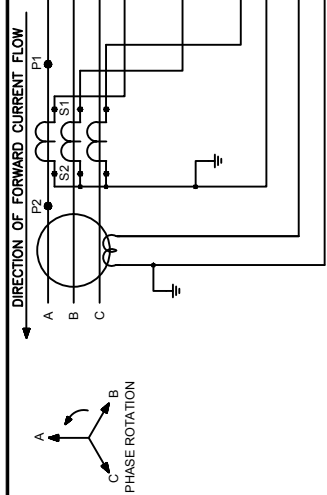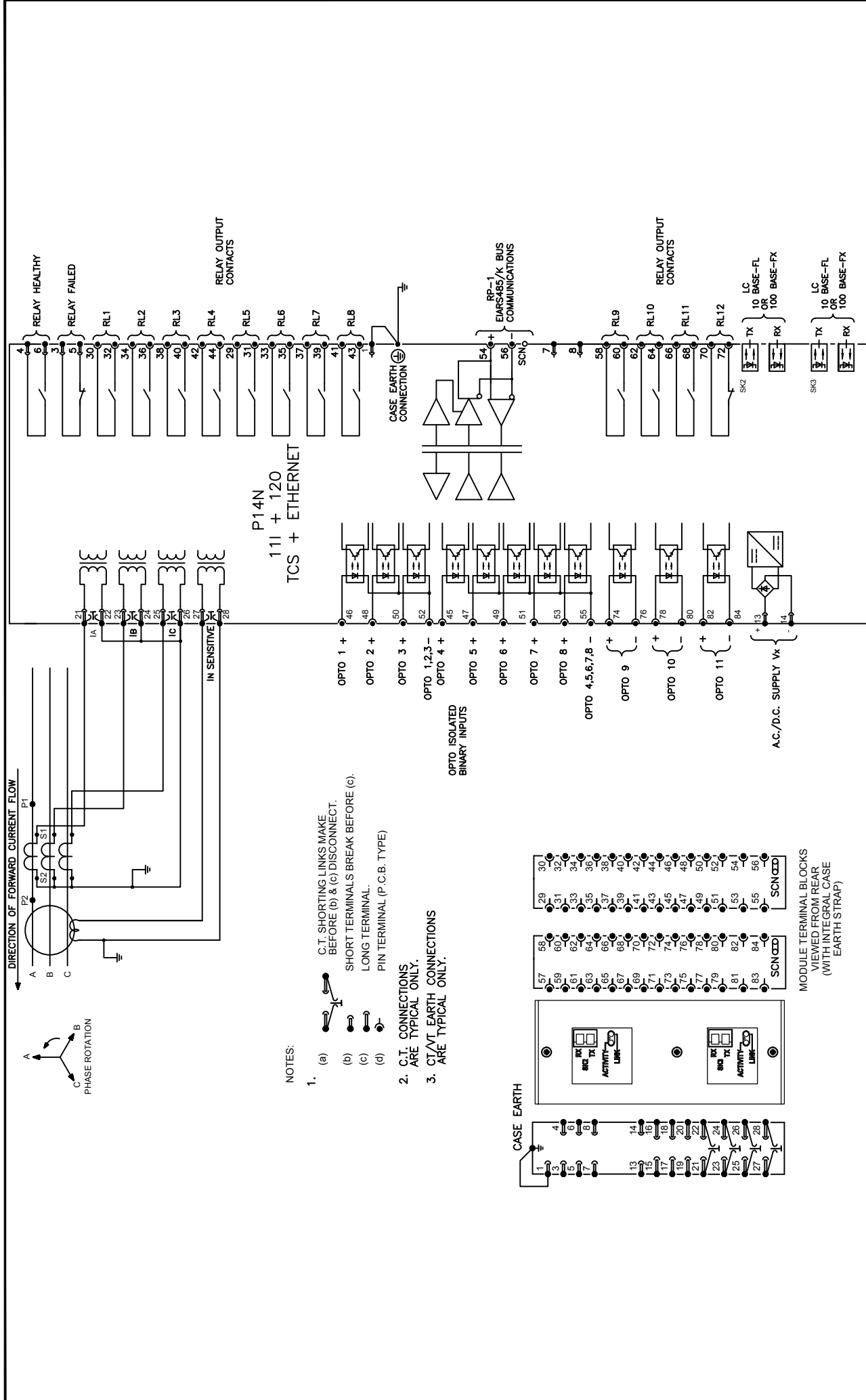A.C./D.C. SUPPLY Vx

NOTES:

1. (a)    C.T. SHORTING LINKS MAKE
            BEFORE (b) & (c) DISCONNECT.
   (b)    SHORT TERMINALS BREAK BEFORE (c).
   (c)    LONG TERMINAL.
   (d)    PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS
   ARE TYPICAL ONLY.

3. EARTH CONNECTIONS
   ARE TYPICAL ONLY.

CASE EARTH

MODULE TERMINAL BLOCKS
VIEWED FROM REAR
(WITH INTEGRAL CASE
EARTH STRAP)

Title: P14N NON DIRECTIONAL PHASE OVERCURRENT
& E/F (11 I/P & 12 O/P) WITH 2 RS485 DUAL COPPER ETHERNET

Drg No: 10P14N05

Sht: 3
Next Sht: 4

Issue: C

Revision:
CID006234 Outlines updated to GE Format

Date: 5/1/2020    Name: S.J.BURTON
Date:              Chkd: TEOH C.P.

DIRECTION OF FORWARD CURRENT FLOW

PHASE ROTATION

P14N
11I + 120
+ 2 RS485
+ ETHERNET

RELAY HEALTHY

RELAY FAILED

RL1
RL2
RL3
RL4
RL5
RL6
RL7
RL8

RELAY OUTPUT CONTACTS

CASE EARTH CONNECTION

RP-1
EIARS485/K BUS COMMUNICATIONS

RL9
RL10
RL11
RL12

RELAY OUTPUT CONTACTS

RP-2
EIARS485/K BUS COMMUNICATIONS

SK2   LC
10 BASE-FL
OR
100 BASE-FX
TX
RX

SK3   LC
10 BASE-FL
OR
100 BASE-FX
TX
RX

OPTO 1
OPTO 2
OPTO 3
OPTO 1,2,3
OPTO 4
OPTO 5
OPTO 6
OPTO 7
OPTO 8
OPTO 4,5,6,7,8
OPTO 9
OPTO 10
OPTO 11
OPTO 9,10,11

OPTO ISOLATED BINARY INPUTS

A.C./D.C. SUPPLY Vx

NOTES:

1.
(a)   C.T. SHORTING LINKS MAKE
      BEFORE (b) & (c) DISCONNECT.
      SHORT TERMINALS BREAK BEFORE (c).
(b)   LONG TERMINAL.
(c)   PIN TERMINAL (P.C.B. TYPE)
(d)

2.   C.T. CONNECTIONS
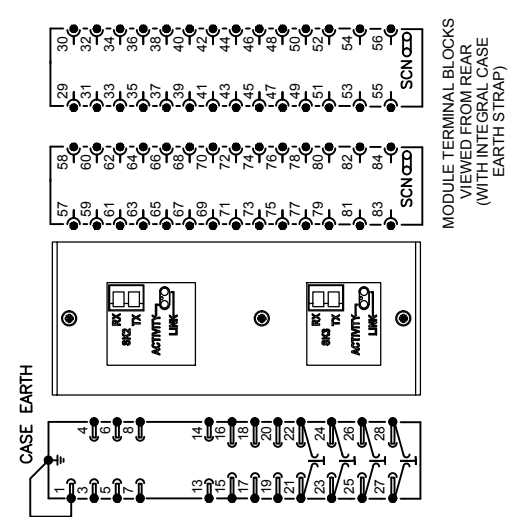     ARE TYPICAL ONLY.

3.   EARTH CONNECTIONS
     ARE TYPICAL ONLY.

CASE EARTH

MODULE TERMINAL BLOCKS
VIEWED FROM REAR
(WITH INTEGRAL CASE
EARTH STRAP)

| Title: | P14N NON DIRECTIONAL PHASE OVERCURRENT |
| --- | --- |
| | & E/F (11 I/P & 12 O/P) WITH 2 RS485 DUAL FIBRE ETHERNET |

Drg No:   10P14N05

Sht: 4
Next Sht: -

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Harry Kerr Drive, Stafford.
ST16 1WT, UK

| Issue: | Revision: |
| --- | --- |
| C | CID006234 Outlines updated to GE Format |

| Date: | 5/1/2020 | Name: | S.J.BURTON |
| --- | --- | --- | --- |
| Date: | | Chkd: | TEOH C.P. |

DIRECTION OF FORWARD CURRENT FLOW

PHASE ROTATION

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RL4
RELAY OUTPUT CONTACTS
RL5
RL6
RL7
RL8

CASE EARTH CONNECTION

RP-1
EIARS485/K BUS COMMUNICATIONS

A.C./D.C. SUPPLY Vx

RL9
RL10
RELAY OUTPUT CONTACTS
RL11
RL12

RP-2
EIARS485/K BUS COMMUNICATIONS

P14N
11I + 12O
+ 2 RS485

OPTO 1 +
OPTO 2 +
OPTO 3 +
OPTO 1,2,3 –
OPTO 4 +
OPTO 5 +
OPTO 6 +
OPTO 7 +
OPTO 8 +
OPTO 4,5,6,7,8 –
OPTO 9 +
OPTO 10+
OPTO 11 +
OPTO 9,10,11–

OPTO ISOLATED BINARY INPUTS

IN SENSITIVE

NOTES:

1. (a)         C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.
   (b)         SHORT TERMINALS BREAK BEFORE (c).
   (c)         LONG TERMINAL.
   (d)         PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS ARE TYPICAL ONLY.
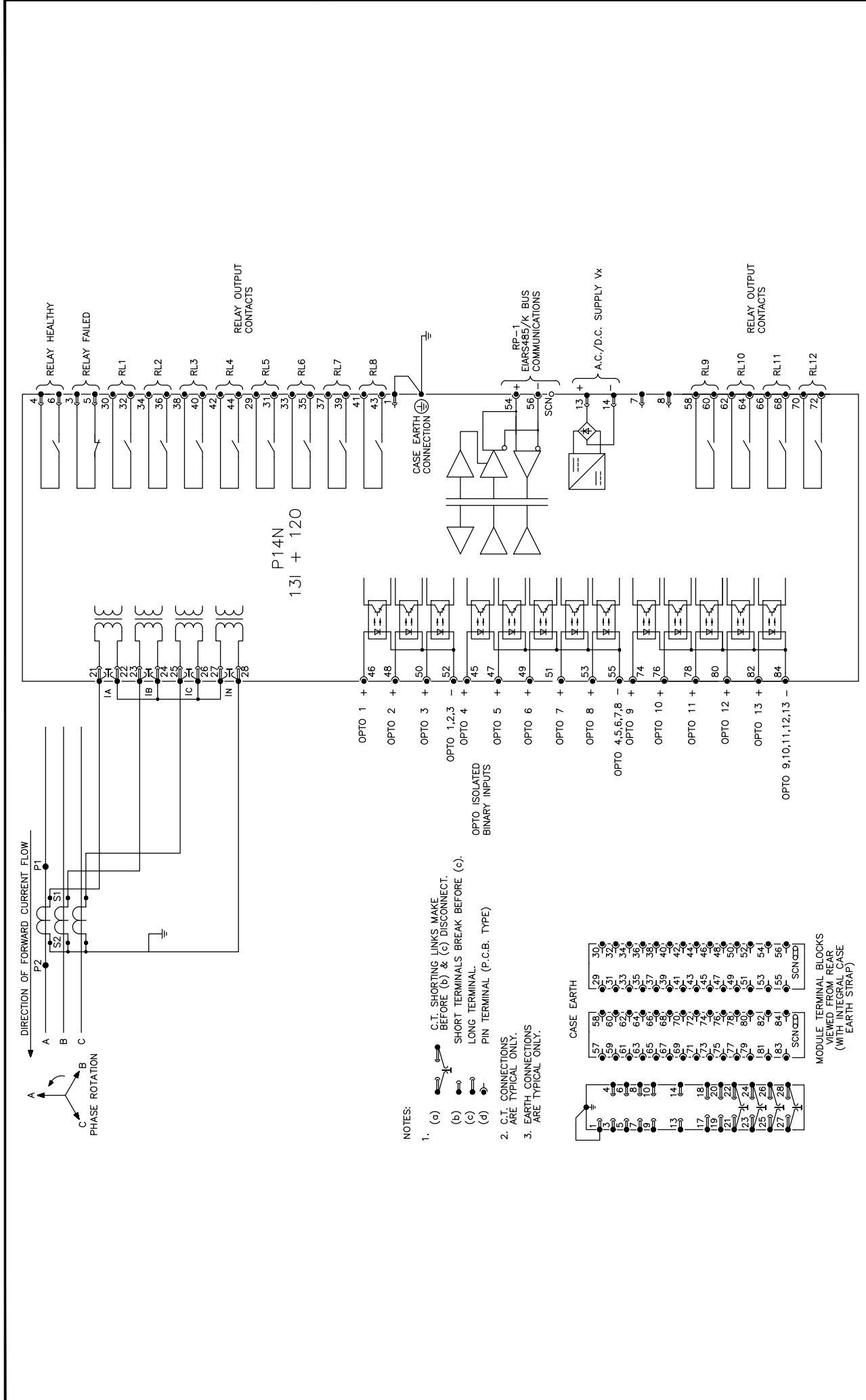
3. CT/VT EARTH CONNECTIONS ARE TYPICAL ONLY.

CASE EARTH

MODULE TERMINAL BLOCKS VIEWED FROM REAR (WITH INTEGRAL CASE EARTH STRAP)

| Title: | P14N NON DIRECTIONAL PHASE OVERCURRENT AND SEF (11 I/P & 12 O/P) WITH 2 RS485 | | |
|---|---|---|---|
| Drg No: | 10P14N06 | Sht: 1 | Next Sht: - |

| Issue: D | Revision: CID006234 Outlines updated to GE Format | |
|---|---|---|
| Date: 5/1/2020 | Name: S.J.BURTON | |
| Date: 03/12/2011 | Chkd: K.VENKATARAMAN | |

**P14N NON DIRECTIONAL PHASE OVERCURRENT AND SEF (11 I/P & 12 O/P) WITH 2 RS485 & ETHERNET**

Title:

Drg No: **10P14N06**

Sht: 2

Next Sht: 3

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RL4
RELAY OUTPUT CONTACTS
RL5
RL6
RL7
RL8

CASE EARTH CONNECTION

RP-1 EIARS485/K BUS COMMUNICATIONS

RL9
RL10
RL11
RL12
RELAY OUTPUT CONTACTS

RP-2 EIARS485/K BUS COMMUNICATIONS

RJ45 10 BASE-T/ 100 BASE-TX

TX+
TX−
RX+
RX−

LC 10 BASE-FL OR 100 BASE-FX
TX
RX

P14N 11I + 12O + 2 RS485 + ETHERNET

DIRECTION OF FORWARD CURRENT FLOW

IA
IB
IC
IN SENSITIVE

OPTO 1 +
OPTO 2 +
OPTO 3 +
OPTO 1,2,3 −
OPTO 4 +
OPTO 5 +
OPTO 6 +
OPTO 7 +
OPTO 8 +
OPTO 4,5,6,7,8 −
OPTO 9 +
OPTO 9 −
OPTO 10 +
OPTO 10 −
OPTO 11 +
OPTO 11 −

OPTO ISOLATED BINARY INPUTS

A.C./D.C. SUPPLY Vx

B
A
C
PHASE ROTATION

NOTES:

1. (a) C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.
   (b) SHORT TERMINALS BREAK BEFORE (c).
   (c) LONG TERMINAL.
   (d) PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS ARE TYPICAL ONLY.

3. CT/VT EARTH CONNECTIONS ARE TYPICAL ONLY.

CASE EARTH

MODULE TERMINAL BLOCKS VIEWED FROM REAR (WITH INTEGRAL CASE EARTH STRAP)

LINK ACTIVITY
RX TX
LINK ACTIVITY

Issue: **C**

Revision: CID006234 Outlines updated to GE Format

Date: 5/1/2020   Name: S.J.BURTON

Chkd: TEOH C.P.

P14N NON DIRECTIONAL PHASE OVERCURRENT
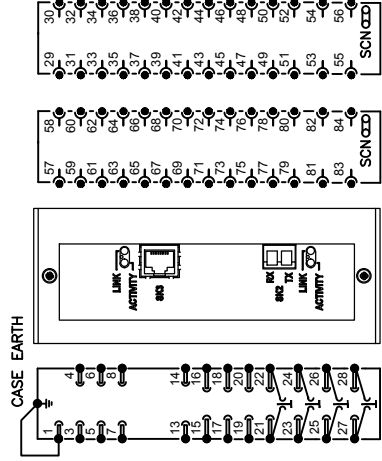& SEF (11 I/P & 12 O/P) WITH 2 RS485 & DUAL COPPER ETHERNET

Title:

Drg No: **10P14N06**

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Harry Kerr Drive, Stafford.
ST16 1WT, UK

Sht: 3
Next Sht: 4

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RL4
RL5
RL6
RL7
RL8

RELAY OUTPUT CONTACTS

CASE EARTH CONNECTION

RP-1
EIARS485/K BUS COMMUNICATIONS

RL9
RL10
RL11
RL12

RELAY OUTPUT CONTACTS

RP-2
EIARS485/K BUS COMMUNICATIONS

RJ45
10 BASE-T/
100 BASE-Tx
TX+
TX-
RX+
RX-

SK2

RJ45
10 BASE-T/
100 BASE-Tx
TX+
TX-
RX+
RX-

SK3

P14N
11I + 120
+ 2 RS485
+ ETHERNET

DIRECTION OF FORWARD CURRENT FLOW
P1
P2
S1
S2

IA
IB
IC
IN SENSITIVE

A
B
C

A
B
C
PHASE ROTATION

OPTO 1 +
OPTO 2 +
OPTO 3 +
OPTO 1,2,3 −
OPTO 4 +
OPTO 5 +
OPTO 6 +
OPTO 7 +
OPTO 8 +
OPTO 4,5,6,7,8 −
OPTO 9 +
OPTO 10+
OPTO 11 +
OPTO 9,10,11 −

OPTO ISOLATED BINARY INPUTS

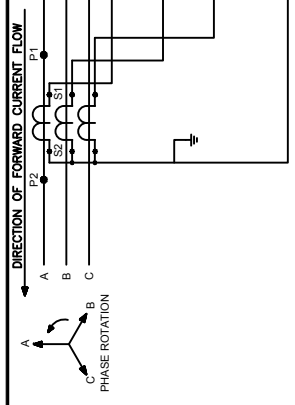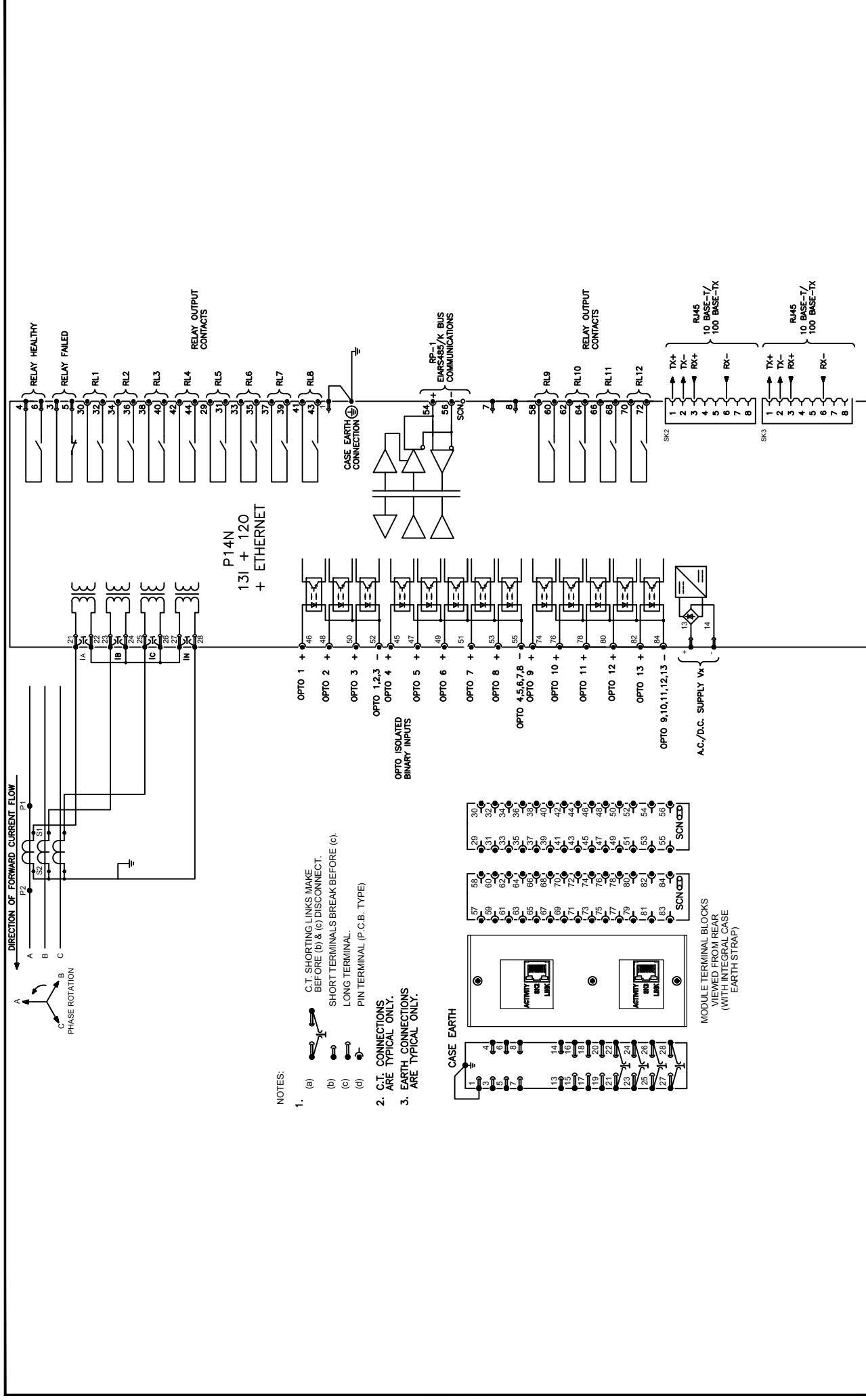A.C./D.C. SUPPLY Vx

NOTES:
1. (a)    C.T. SHORTING LINKS MAKE
         BEFORE (b) & (c) DISCONNECT.
   (b)    SHORT TERMINALS BREAK BEFORE (c).
   (c)    LONG TERMINAL.
   (d)    PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS ARE TYPICAL ONLY.

3. CT/VT EARTH CONNECTIONS ARE TYPICAL ONLY.

CASE EARTH

MODULE TERMINAL BLOCKS
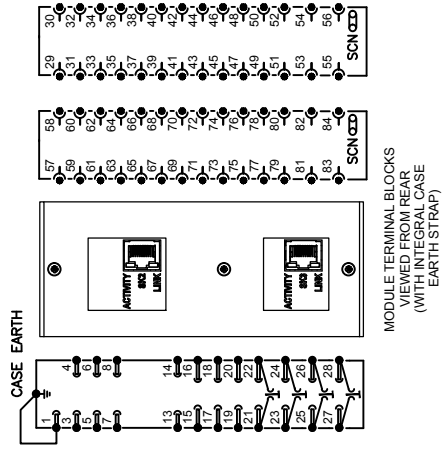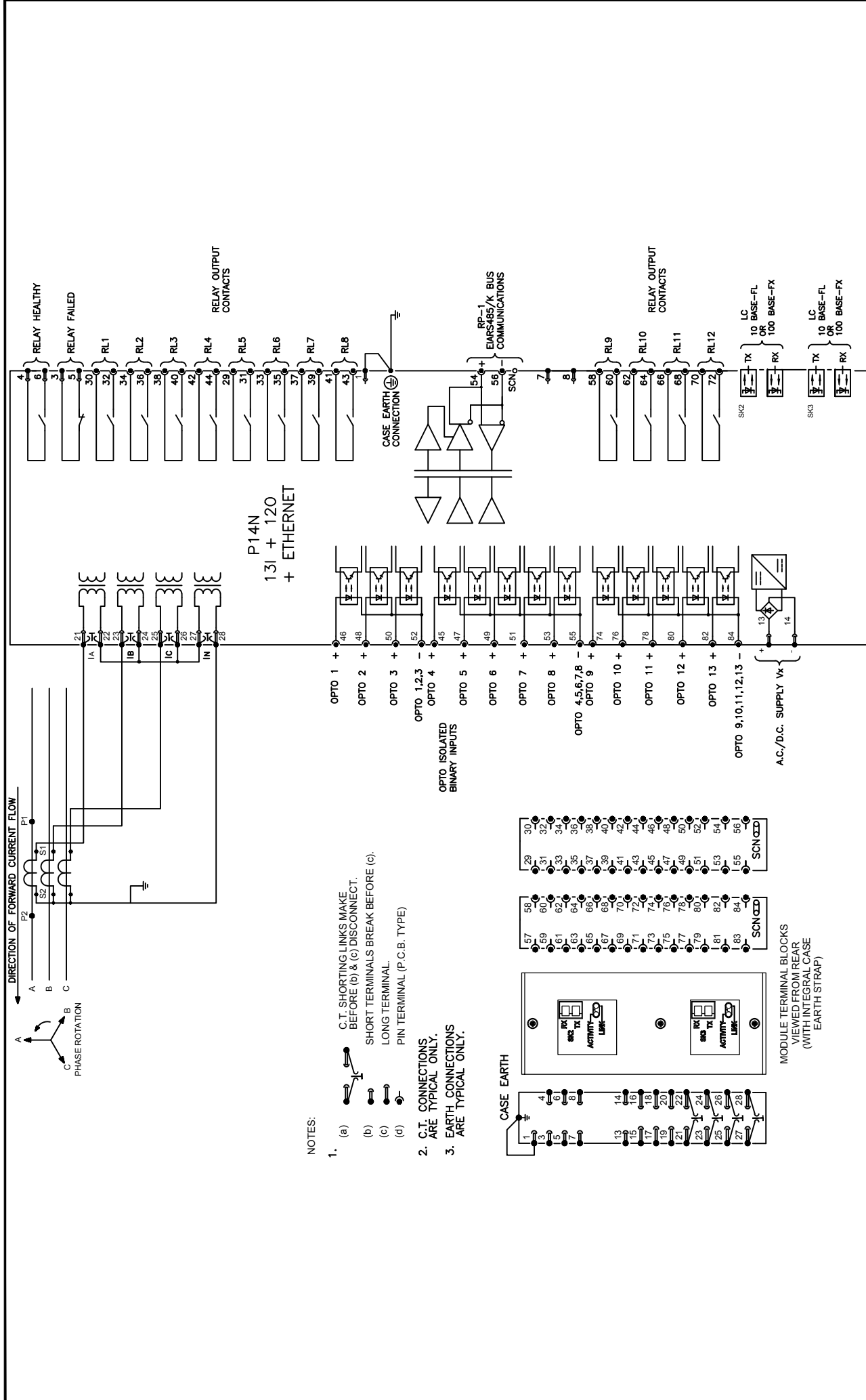VIEWED FROM REAR
(WITH INTEGRAL CASE
EARTH STRAP)

SCN
SCN

DIRECTION OF FORWARD CURRENT FLOW

P1
S1
S2
P2
A
B
C

PHASE ROTATION
A B C

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RL4
RELAY OUTPUT CONTACTS
RL5
RL6
RL7
RL8

CASE EARTH CONNECTION

RP-1 EARS485/K BUS COMMUNICATIONS
54 + 56 − SCN

RL9
RL10
RL11
RL12
RELAY OUTPUT CONTACTS

RP-2 EARS485/K BUS COMMUNICATIONS
82 + 84 − SCN

LC
10 BASE-FL
OR
100 BASE-FX
SK2 TX RX

LC
10 BASE-FL
OR
100 BASE-FX
SK3 TX RX

IA  21 22
IB  23 24
IC  25 26
IN SENSITIVE  27 28

P14N
11I + 12O
+ 2 RS485
+ ETHERNET

OPTO 1 +  46
OPTO 2 +  48
OPTO 3 +  50
OPTO 1,2,3 −  52
OPTO 4 +  45
OPTO 5 +  47
OPTO 6 +  49
OPTO 7 +  51
OPTO 8 +  53
OPTO 4,5,6,7,8 −  55
OPTO 9 +  74
OPTO 10+  76
OPTO 11+  78
OPTO 9,10,11 −  80

OPTO ISOLATED BINARY INPUTS

A.C./D.C. SUPPLY Vx
+ 13
− 14

NOTES:

1. (a) C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.
   (b) SHORT TERMINAL
   (c) TERMINALS BREAK BEFORE (c).
   LONG TERMINAL.
   (d) PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS ARE TYPICAL ONLY.
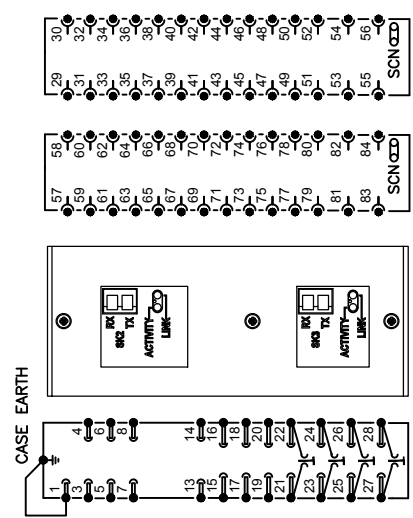
3. CT/VT EARTH CONNECTIONS ARE TYPICAL ONLY.

CASE EARTH

MODULE TERMINAL BLOCKS VIEWED FROM REAR (WITH INTEGRAL CASE EARTH STRAP)

Title: P14N NON DIRECTIONAL PHASE OVERCURRENT & SEF (11 I/P & 12 O/P) WITH 2 RS485 & DUAL FIBRE ETHERNET

Drg No: 10P14N06

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Harry Kerr Drive, Stafford.
ST16 1WT, UK

Sht: 4
Next Sht: −

Issue: C

Revision: CID006234 Outlines updated to GE Format

Date: 5/1/2020  Name: S.J.BURTON
Chkd: TEOH C.P.

DIRECTION OF FORWARD CURRENT FLOW

P1
P1
S1
S2
P2

A
B
C

A
B
C
PHASE ROTATION
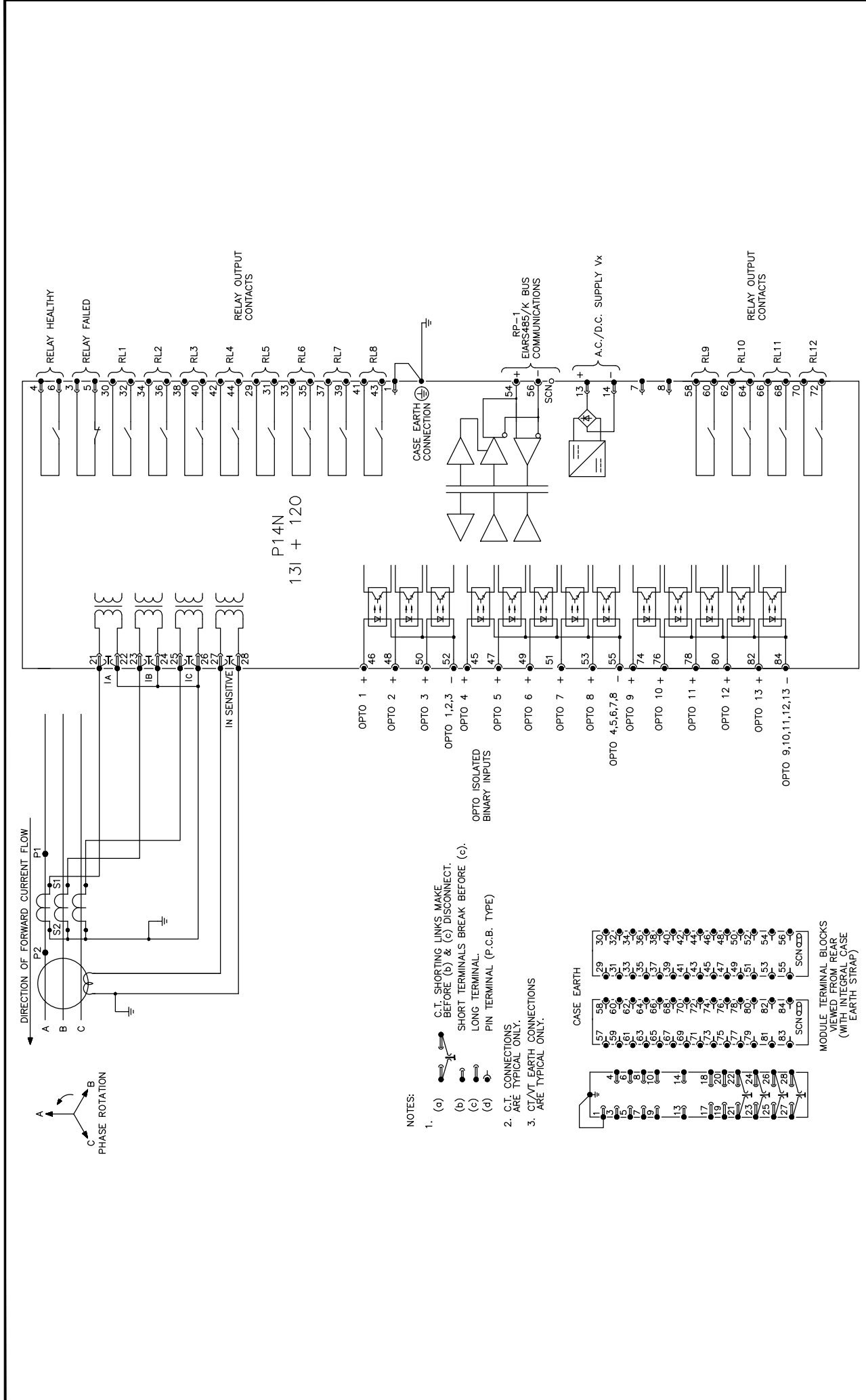
NOTES:

1. (a)   C.T. SHORTING LINKS MAKE
         BEFORE (b) & (c) DISCONNECT.
   (b)   SHORT TERMINALS BREAK BEFORE (c).
   (c)   LONG TERMINAL.
   (d)   PIN TERMINAL (P.C.B. TYPE).

2. C.T. CONNECTIONS
   ARE TYPICAL ONLY.

3. EARTH CONNECTIONS
   ARE TYPICAL ONLY.

CASE EARTH

29 30
31 32
33 34
35 36
37 38
39 40
41 42
43 44
45 46
47 48
49 50
51 52
53 54
55 56
SCN

57 58
59 60
61 62
63 64
65 66
67 68
69 70
71 72
73 74
75 76
77 78
79 80
81 82
83 84
SCN    SCN

1 2
3 4
5 6
7 8
9 10
13 14
17 18
19 20
21 22
23 24
25 26
27 28

MODULE TERMINAL BLOCKS
VIEWED FROM REAR
(WITH INTEGRAL CASE
EARTH STRAP)

RELAY HEALTHY       4 6
RELAY FAILED        3 5
RL1                 30 32
RL2                 34 36
RL3                 38 40
RL4                 42 44
RL5                 29 31
RL6                 33 35
RL7                 37 39
RL8                 41 43
                    1

RELAY OUTPUT
CONTACTS

CASE EARTH
CONNECTION

P14N
11I + 12O
TCS

54 56
SCN
RP-1
EIARS485/K BUS
COMMUNICATIONS

13 + 14 -
7 8
A.C./D.C. SUPPLY Vx

RL9    58 60
RL10   62 64
RL11   66 68
RL12   70 72

RELAY OUTPUT
CONTACTS

IA  21 1
IB  22 23 24
IC  25 26
IN  27 28

OPTO 1 +    46
OPTO 2 +    48
OPTO 3 +    50
OPTO 1,2,3 - 52
OPTO 4 +    45
OPTO 5 +    47
OPTO 6 +    49
OPTO 7 +    51
OPTO 8 +    53
OPTO 4,5,6,7,8 - 55

OPTO ISOLATED
BINARY INPUTS

OPTO 9   + 74 - 76
OPTO 10  + 78 - 80
OPTO 11  + 82 - 84

Title: P14N NON DIRECTIONAL PHASE OVERCURRENT AND EARTH FAULT (11 I/P & 12 O/P) WITH TCS

Drg No: 10P14N07

Sht: 1
Next Sht: -

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ST16 1WT, UK

Issue: C

Revision:
CID006234 Outlines updated to GE Format

Date: 5/1/2020   Name: S.J.BURTON
Date: 03/12/2011   Chkd: K.VENKATARAMAN

PHASE ROTATION

DIRECTION OF FORWARD CURRENT FLOW

P14N
11I + 12O
TCS+ETHERNET

RELAY HEALTHY

RELAY FAILED

RL1
RL2
RL3
RL4
RL5
RL6
RL7
RL8

RELAY OUTPUT CONTACTS

CASE EARTH CONNECTION

RP-1
EIARS485/K BUS COMMUNICATIONS

RL9
RL10
RL11
RL12

RELAY OUTPUT CONTACTS

RJ45
10 BASE-T/
100 BASE-TX

TX+
TX-
RX+
RX-

LC
10 BASE-FL
OR
100 BASE-FX

OPTO 1 +
OPTO 2 +
OPTO 3 +
OPTO 1,2,3 -
OPTO 4 +
OPTO 5 +
OPTO 6 +
OPTO 7 +
OPTO 8 +
OPTO 4,5,6,7,8 -
OPTO 9
OPTO 10
OPTO 11

OPTO ISOLATED BINARY INPUTS

A.C./D.C. SUPPLY Vx

NOTES:

1.
(a)  C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.
(b)  SHORT TERMINALS BREAK BEFORE (c).
(c)  LONG TERMINAL.
(d)  PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS ARE TYPICAL ONLY.
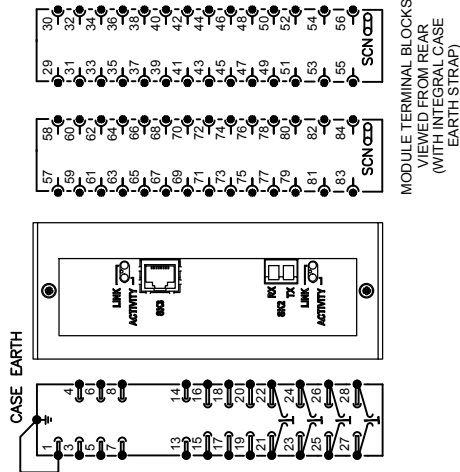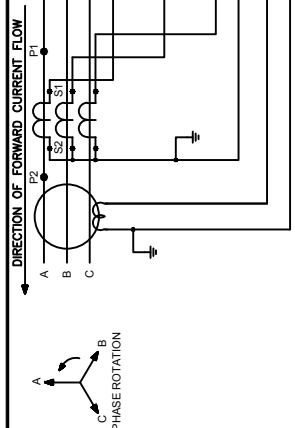
3. EARTH CONNECTIONS ARE TYPICAL ONLY.

ARE TYPICAL ONLY.

CASE EARTH

MODULE TERMINAL BLOCKS VIEWED FROM REAR
(WITH INTEGRAL CASE EARTH STRAP)

SCN
SCN
SCN

LINK
ACTIVITY
SK1
RX
SK2
TX
LINK
ACTIVITY

Issue: C

Revision: CID006234 Outlines updated to GE Format

Date: 5/1/2020    Name: S.J.BURTON

Date:    Chkd: TEOH C.P.

DIRECTION OF FORWARD CURRENT FLOW

PHASE ROTATION

NOTES:

1.

(a) C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.

(b) SHORT TERMINALS BREAK BEFORE (c).

(c) LONG TERMINAL.

(d) PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS ARE TYPICAL ONLY.
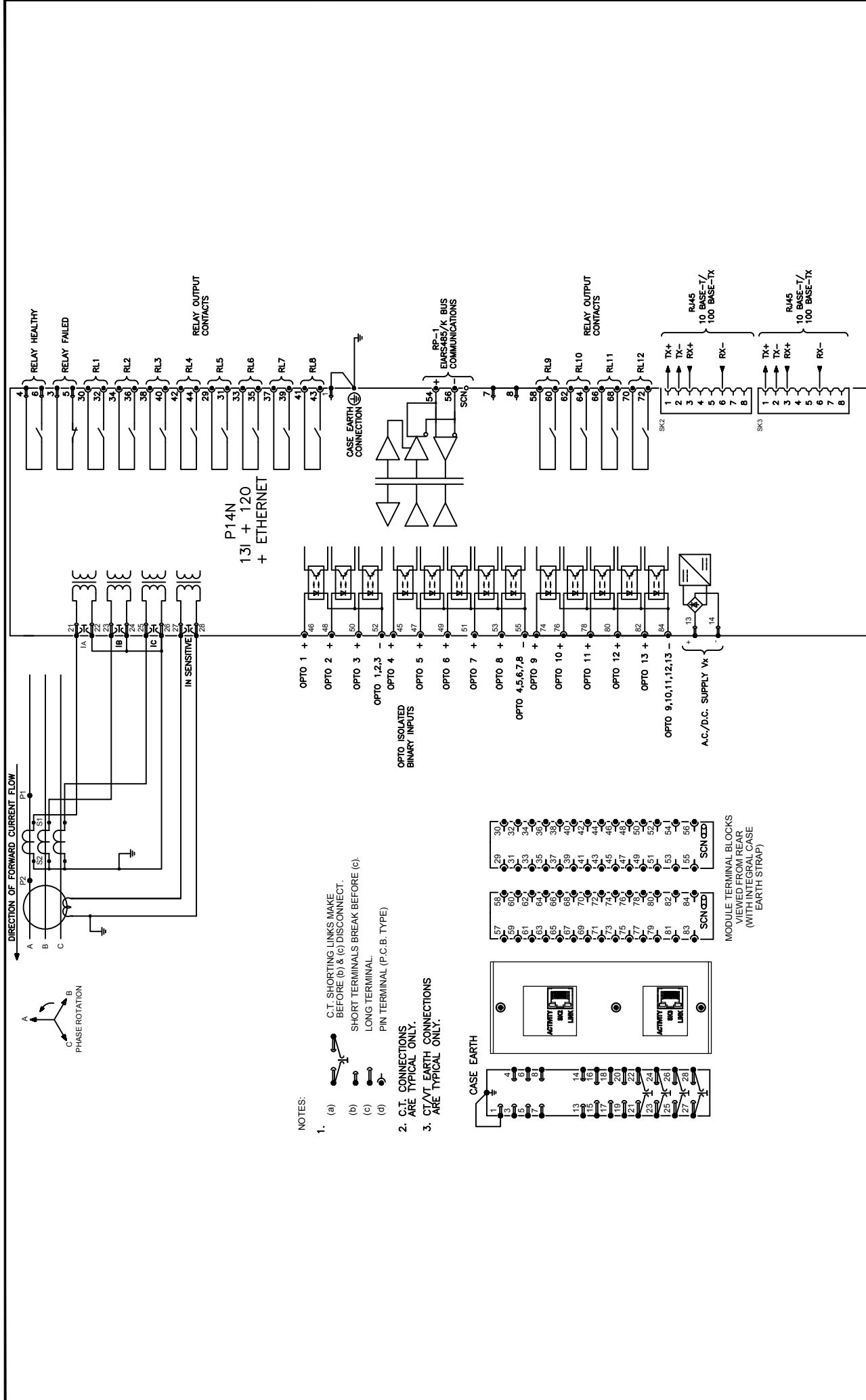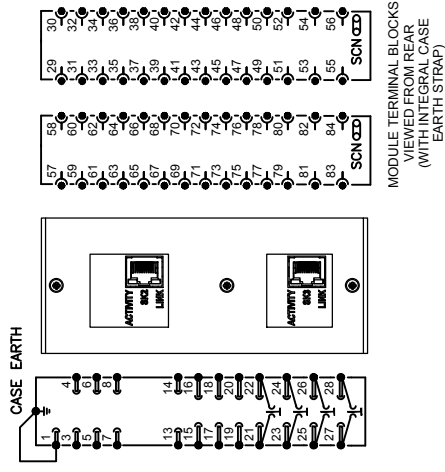
3. EARTH CONNECTIONS ARE TYPICAL ONLY.

CASE EARTH

MODULE TERMINAL BLOCKS
VIEWED FROM REAR
(WITH INTEGRAL CASE EARTH STRAP)

P14N
11I + 120
TCS+ETHERNET

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RL4
RL5
RL6
RL7
RL8

RELAY OUTPUT CONTACTS

CASE EARTH CONNECTION

RP-1
EIARS485/K BUS COMMUNICATIONS

RL9
RL10
RL11
RL12

RELAY OUTPUT CONTACTS

RJ45
10 BASE-T/
100 BASE-TX

TX+
TX-
RX+
RX-

SK2

RJ45
10 BASE-T/
100 BASE-TX

TX+
TX-
RX+
RX-

SK3

OPTO 1 +
OPTO 2 +
OPTO 3 +
OPTO 1,2,3 -
OPTO 4 +
OPTO 5 +
OPTO 6 +
OPTO 7 +
OPTO 8 +
OPTO 4,5,6,7,8 -
OPTO 9
OPTO 10
OPTO 11

OPTO ISOLATED BINARY INPUTS

A.C./D.C. SUPPLY Vx

Issue: C

Revision: CID006234 Outlines updated to GE Format

Title: P14N NON DIRECTIONAL PHASE OVERCURRENT & E/F (11 I/P & 12 O/P) WITH TCS & DUAL COPPER ETHERNET

Drg No: 10P14N07

Date: 5/1/2020

Name: S.J.BURTON

Chkd: TEOH C.P.

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ST16 1WT, UK

Sht: 3

Next Sht: 4

DIRECTION OF FORWARD CURRENT FLOW

P14N
11I + 12O
TCS+ETHERNET

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RL4
RL5
RL6
RL7
RL8

RELAY OUTPUT CONTACTS

CASE EARTH CONNECTION

RP-1
EIARS485/K BUS COMMUNICATIONS

RL9
RL10
RL11
RL12

RELAY OUTPUT CONTACTS

LC
10 BASE-FL
OR
100 BASE-FX
TX
RX
SK2

LC
10 BASE-FL
OR
100 BASE-FX
TX
RX
SK3

OPTO 1 +
OPTO 2 +
OPTO 3 +
OPTO 1,2,3 –
OPTO 4 +
OPTO 5 +
OPTO 6 +
OPTO 7 +
OPTO 8 +
OPTO 4,5,6,7,8 –
OPTO 9
OPTO 10
OPTO 11

OPTO ISOLATED BINARY INPUTS
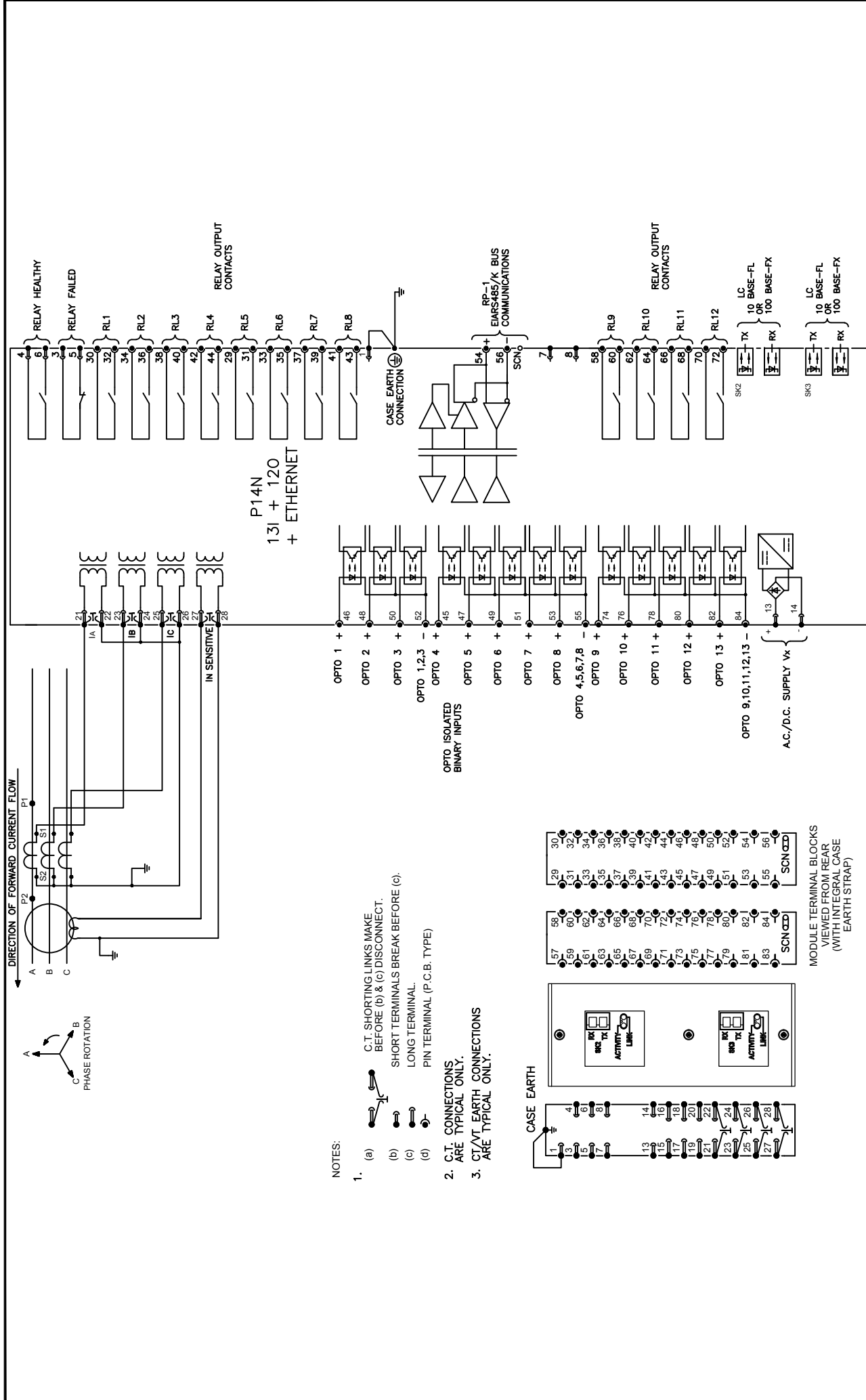
A.C./D.C. SUPPLY Vx

PHASE ROTATION

NOTES:

1.
(a) C.T. SHORTING LINKS MAKE
    BEFORE (b) & (c) DISCONNECT.
(b) SHORT TERMINALS BREAK BEFORE (c).
(c) LONG TERMINAL.
(d) PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS
   ARE TYPICAL ONLY.

3. EARTH CONNECTIONS
   ARE TYPICAL ONLY.

CASE EARTH

MODULE TERMINAL BLOCKS
VIEWED FROM REAR
(WITH INTEGRAL CASE
EARTH STRAP)

Title: P14N NON DIRECTIONAL PHASE OVERCURRENT & E/F (11 I/P & 12 O/P) WITH TCS & DUAL FIBRE ETHERNET

Drg No: 10P14N07

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Sht: 4
Next Sht: -

| Issue: | C | Revision: CID006234 Outlines updated to GE Format | |
|---|---|---|---|
| Date: | 5/1/2020 | Name: | S.J.BURTON |
| Date: | | Chkd: | TEOH C.P. |

DIRECTION OF FORWARD CURRENT FLOW

PHASE ROTATION

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RL4
RL5
RL6
RL7
RL8

RELAY OUTPUT CONTACTS

CASE EARTH CONNECTION

RP−1
EIARS485/K BUS COMMUNICATIONS

A.C./D.C. SUPPLY Vx

RL9
RL10
RL11
RL12

RELAY OUTPUT CONTACTS

P14N
11I + 12O
TCS

IA
IB
Ic
IN SENSITIVE

OPTO 1 +
OPTO 2 +
OPTO 3 +
OPTO 1,2,3 −
OPTO 4 +
OPTO 5 +
OPTO 6 +
OPTO 7 +
OPTO 8 +
OPTO 4,5,6,7,8 −
OPTO 9
OPTO 10
OPTO 11

OPTO ISOLATED BINARY INPUTS

NOTES:

1. (a)   C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.

   (b)   SHORT TERMINALS BREAK BEFORE (c).

   (c)   LONG TERMINAL.

   (d)   PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS ARE TYPICAL ONLY.

3. CT/VT EARTH CONNECTIONS ARE TYPICAL ONLY.

CASE EARTH

MODULE TERMINAL BLOCKS
VIEWED FROM REAR
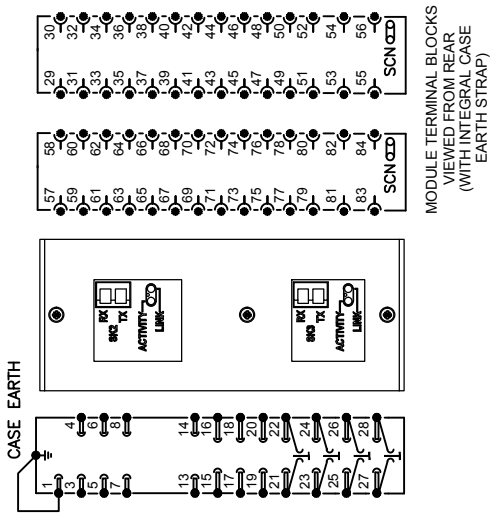(WITH INTEGRAL CASE
EARTH STRAP)

| Issue: | Revision: | | |
|---|---|---|---|
| D | CID006234 Outlines updated to GE Format | | |

Title: P14N NON DIRECTIONAL PHASE OVERCURRENT AND SEF (11 I/P & 12 O/P) WITH TCS

| Date: | 5/1/2020 | Name: | S.J.BURTON |
| Date: | 03/12/2011 | Chkd: | K.VENKATARAMAN |

Drg No: 10P14N08

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ST16 1WT, UK

Sht: 1
Next Sht: −

NOTES:

1. (a) C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.

   (b) SHORT TERMINALS BREAK BEFORE (c).

   (c) LONG TERMINAL.

   (d) PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS ARE TYPICAL ONLY.

3. CT/VT EARTH CONNECTIONS ARE TYPICAL ONLY.

DIRECTION OF FORWARD CURRENT FLOW

PHASE ROTATION

RELAY HEALTHY

RELAY FAILED

RELAY OUTPUT CONTACTS

P14N
11I + 120
TCS + ETHERNET

CASE EARTH CONNECTION

RP–1
EIARS485/K BUS COMMUNICATIONS

RELAY OUTPUT CONTACTS

RJ45
10 BASE–T/
100 BASE–TX

LC
10 BASE–FL
OR
100 BASE–FX

OPTO 1 +
OPTO 2 +
OPTO 3 +
OPTO 1,2,3 –
OPTO 4 +
OPTO 5 +
OPTO 6 +
OPTO 7 +
OPTO 8 +
OPTO 4,5,6,7,8 –

OPTO ISOLATED BINARY INPUTS

OPTO 9
OPTO 10
OPTO 11

A.C./D.C. SUPPLY Vx

CASE EARTH

MODULE TERMINAL BLOCKS VIEWED FROM REAR (WITH INTEGRAL CASE EARTH STRAP)

DIRECTION OF FORWARD CURRENT FLOW

PHASE ROTATION

RELAY HEALTHY
RELAY FAILED
RELAY OUTPUT CONTACTS

RL1
RL2
RL3
RL4
RL5
RL6
RL7
RL8

CASE EARTH CONNECTION

RP-1
EIARS485/K BUS COMMUNICATIONS

RELAY OUTPUT CONTACTS

RL9
RL10
RL11
RL12

RJ45
10 BASE-T/
100 BASE-TX

TX+
TX-
RX+
RX-

RJ45
10 BASE-T/
100 BASE-TX

TX+
TX-
RX+
RX-

P14N
11I + 12O
TCS + ETHERNET

IA
IB
IC
IN SENSITIVE

OPTO 1 +
OPTO 2 +
OPTO 3 +
OPTO 1,2,3 -
OPTO 4 +
OPTO 5 +
OPTO 6 +
OPTO 7 +
OPTO 8 +
OPTO 4,5,6,7,8 -
OPTO 9
OPTO 10
OPTO 11

OPTO ISOLATED BINARY INPUTS

A.C./D.C. SUPPLY Vx

NOTES:

1.
(a)   C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.
(b)   SHORT TERMINALS BREAK BEFORE (c).
(c)   LONG TERMINAL.
(d)   PIN TERMINAL. (P.C.B. TYPE)

2.   C.T. CONNECTIONS ARE TYPICAL ONLY.

3.   CT/VT EARTH CONNECTIONS ARE TYPICAL ONLY.

CASE EARTH

MODULE TERMINAL BLOCKS VIEWED FROM REAR (WITH INTEGRAL CASE EARTH STRAP)

Title: P14N NON DIRECTIONAL PHASE OVERCURRENT & SEF (11 I/P & 12 O/P) WITH TCS & DUAL COPPER ETHERNET

Drg No: 10P14N08

Sht: 3
Next Sht: 4

Issue: C

Revision: CID006234 Outlines updated to GE Format

Date: 5/1/2020   Name: S.J.BURTON
Date:             Chkd:

DIRECTION OF FORWARD CURRENT FLOW

PHASE ROTATION

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RL4 — RELAY OUTPUT CONTACTS
RL5
RL6
RL7
RL8

CASE EARTH CONNECTION

P14N
11I + 120
TCS + ETHERNET

RP-1
EIARS485/K BUS
COMMUNICATIONS

RL9
RL10
RL11
RL12 — RELAY OUTPUT CONTACTS

LC   10 BASE-FL
     OR
     100 BASE-FX
TX / RX   SK2

LC   10 BASE-FL
     OR
     100 BASE-FX
TX / RX   SK3

IA / IB / IC / IN SENSITIVE

OPTO 1 +
OPTO 2 +
OPTO 3 +
OPTO 1,2,3 –
OPTO 4 +
OPTO 5 +
OPTO 6 +
OPTO 7 +
OPTO 8 +
OPTO 4,5,6,7,8 –
OPTO 9
OPTO 10
OPTO 11
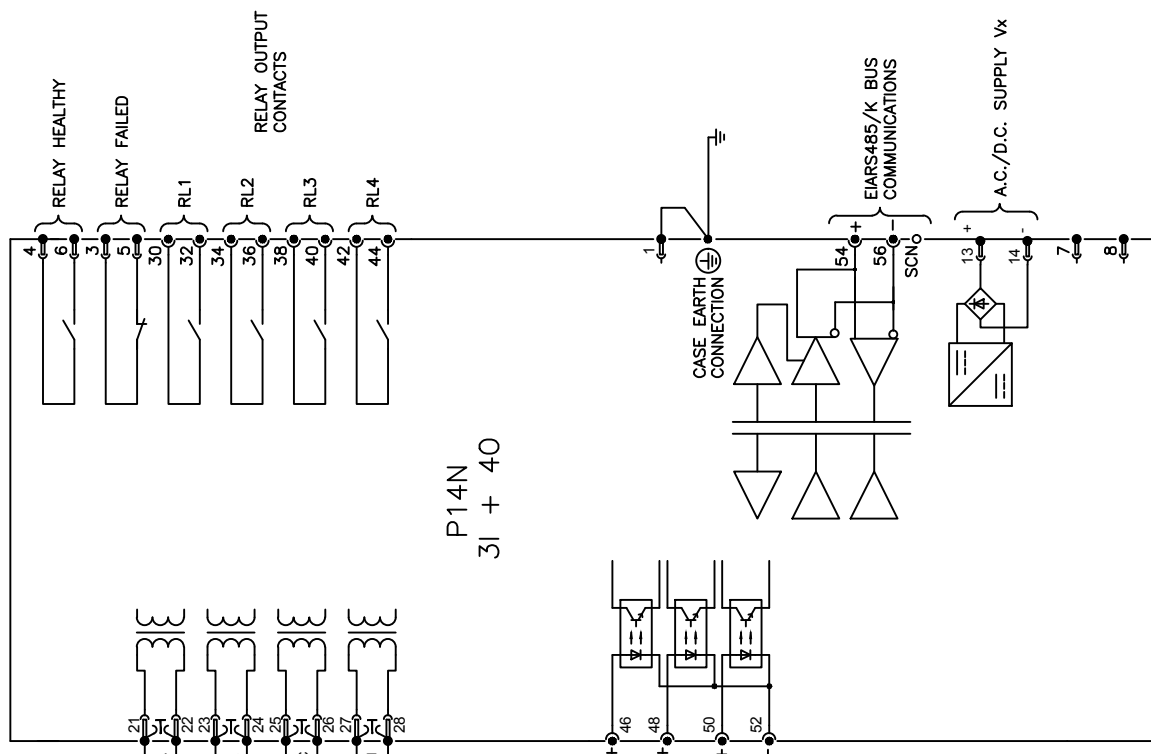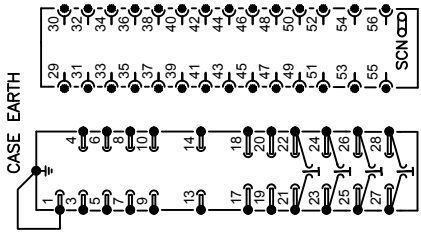OPTO ISOLATED BINARY INPUTS

A.C./D.C. SUPPLY Vx

NOTES:

1. (a)  C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.
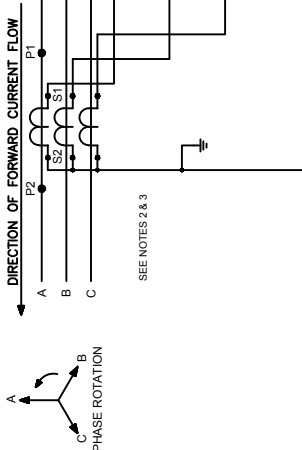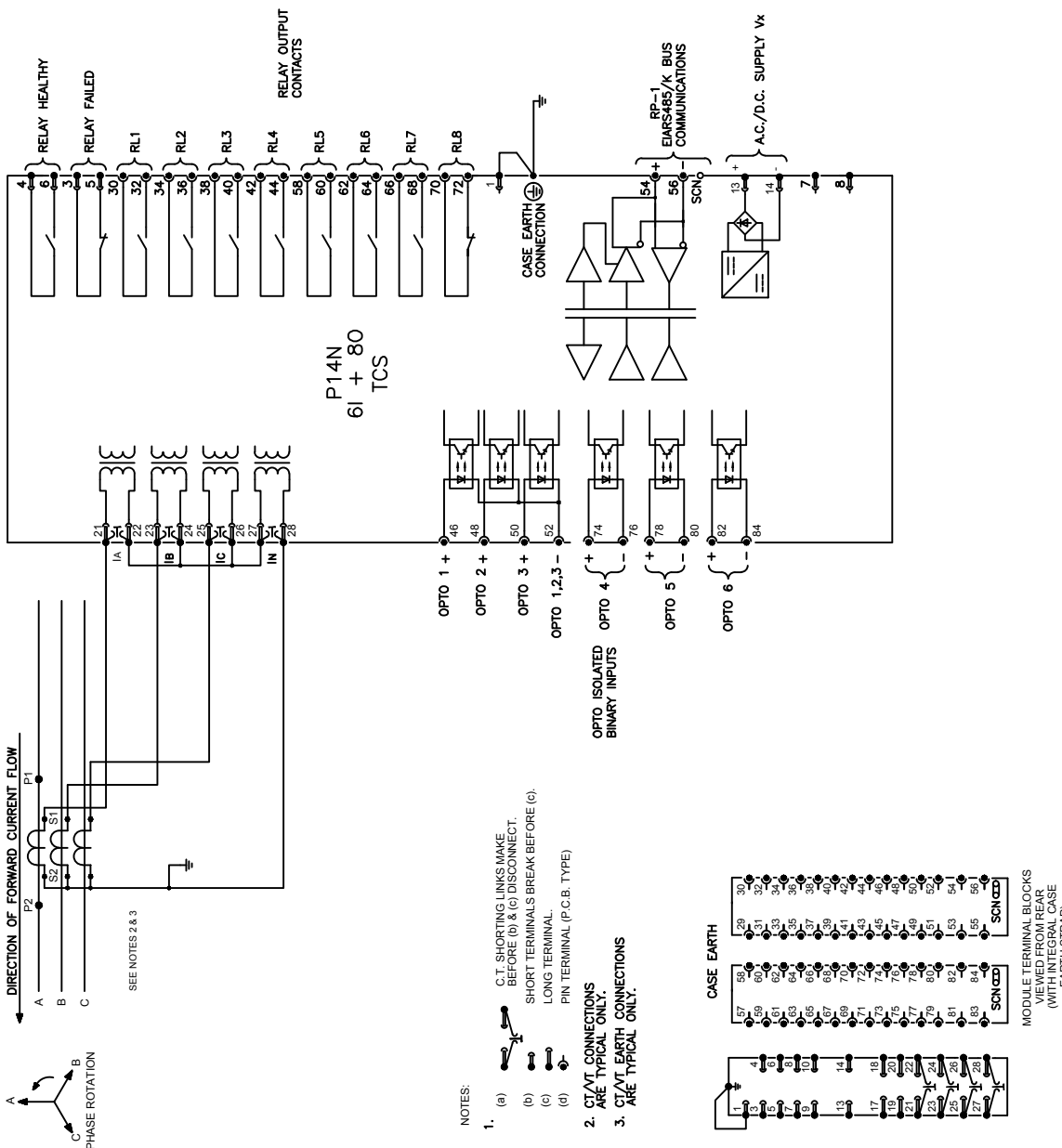   (b)  SHORT TERMINALS BREAK BEFORE (c).
   (c)  LONG TERMINAL.
   (d)  PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS ARE TYPICAL ONLY.

3. CT/VT EARTH CONNECTIONS ARE TYPICAL ONLY.

CASE EARTH

MODULE TERMINAL BLOCKS
VIEWED FROM REAR
(WITH INTEGRAL CASE EARTH STRAP)

| Title: | P14N NON DIRECTIONAL PHASE OVERCURRENT & SEF (11 I/P & 12 O/P) WITH TCS & DUAL FIBRE ETHERNET |
|---|---|
| Drg No: | 10P14N08 |

Sht: 4
Next Sht: –

| Issue: C | Revision: CID006234 Outlines updated to GE Format |
|---|---|
| Date: 5/1/2020 | Name: S.J.BURTON |
| Date: | Chkd: TEOH C.P. |

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RL4
RELAY OUTPUT CONTACTS
RL5
RL6
RL7
RL8

4
6
3
5
30
32
34
36
38
40
42
44
29
31
33
35
37
39
41
43
1

CASE EARTH CONNECTION

P14N
13I + 120

54
56
SCN

RP-1
EIARS485/K BUS
COMMUNICATIONS

13
14
7
8

A.C./D.C. SUPPLY Vx

58
60
62
64
66
68
70
72

RL9
RL10
RL11
RL12

RELAY OUTPUT CONTACTS

21
22
23
24
25
26
27
28

IA
IB
IC
IN

OPTO 1    46 +
           48 –
OPTO 2    48 +
OPTO 3    50 +
           52 –
OPTO 1,2,3
OPTO 4    45 +
           47 –
OPTO ISOLATED BINARY INPUTS
OPTO 5    49 +
           51 –
OPTO 6
OPTO 7    53 +
           55 –
OPTO 8
OPTO 4,5,6,7,8
OPTO 9    74 +
           76 –
OPTO 10   78 +
           80 –
OPTO 11
OPTO 12   82 +
           84 –
OPTO 13
OPTO 9,10,11,12,13 –

DIRECTION OF FORWARD CURRENT FLOW
A
B
C
P1
P2
S1
S2

PHASE ROTATION
A
B
C

NOTES:

1. (a)    C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.
   (b)    SHORT TERMINALS BREAK BEFORE (c).
   (c)    LONG TERMINAL.
   (d)    PIN TERMINAL (P.C.B. TYPE)

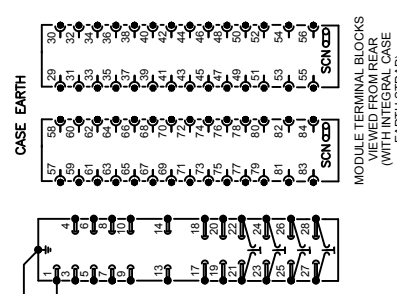2. C.T. CONNECTIONS ARE TYPICAL ONLY.
3. EARTH CONNECTIONS ARE TYPICAL ONLY.

CASE EARTH

29 30
31 32
33 34
35 36
37 38
39 40
41 42
43 44
45 46
47 48
49 50
51 52
53 54
55 56
57 58
59 60
61 62
63 64
65 66
67 68
69 70
71 72
73 74
75 76
77 78
79 80
81 82
83 84
SCN    SCN

1 2
3 4
5 6
7 8
9 10
13 14
17 18
19 20
21 22
23 24
25 26
27 28

MODULE TERMINAL BLOCKS
VIEWED FROM REAR
(WITH INTEGRAL CASE EARTH STRAP)

Title: P14N NON DIRECTIONAL PHASE OVERCURRENT AND EARTH FAULT (13 I/P & 12 O/P)

Drg No: 10P14N09

Sht: 1
Next Sht: -

Issue: C

Revision: CID006234 Outlines updated to GE Format

Date: 5/1/2020    Name: S.J.BURTON
Date: 03/12/2011  Chkd: K.VENKATARAMAN

DIRECTION OF FORWARD CURRENT FLOW

PHASE ROTATION

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RL4
RL5
RL6
RL7
RL8

RELAY OUTPUT CONTACTS

CASE EARTH CONNECTION

RP-1
EIA RS485/K BUS COMMUNICATIONS

RL9
RL10
RL11
RL12

RELAY OUTPUT CONTACTS

RJ45
10 BASE-T/
100 BASE-TX

TX+
TX-
RX+
RX-

LC
10 BASE-FL
OR
100 BASE-FX

TX
RX

P14N
13I + 12O
+ ETHERNET

OPTO 1
OPTO 2
OPTO 3
OPTO 1,2,3
OPTO 4
OPTO 5
OPTO 6
OPTO 7
OPTO 8
OPTO 4,5,6,7,8
OPTO 9
OPTO 10
OPTO 11
OPTO 12
OPTO 13
OPTO 9,10,11,12,13

OPTO ISOLATED BINARY INPUTS

A.C./D.C. SUPPLY Vx

NOTES:
1. (a)    C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.
   (b)    SHORT TERMINALS BREAK BEFORE (c).
   (c)    LONG TERMINAL.
   (d)    PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS ARE TYPICAL ONLY.

3. EARTH CONNECTIONS ARE TYPICAL ONLY.

CASE EARTH

MODULE TERMINAL BLOCKS
VIEWED FROM REAR
(WITH INTEGRAL CASE EARTH STRAP)

LINK ACTIVITY  SK3
RX TX  SK2  LINK ACTIVITY

SCN
SCN
SCN

Title: P14N NON DIRECTIONAL PHASE OVERCURRENT & EARTH FAULT (13 I/P & 12 O/P) & ETHERNET

Drg No: 10P14N09

Sht: 2
Next Sht: 3

Issue: C

Revision: CID006234 Outlines updated to GE Format

Date: 5/1/2020    Name: S.J.BURTON
Date:              Chkd: TEOH C.P.

DIRECTION OF FORWARD CURRENT FLOW

PHASE ROTATION

P14N
13I + 12O
+ ETHERNET

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RL4
RELAY OUTPUT CONTACTS
RL5
RL6
RL7
RL8

CASE EARTH CONNECTION

RP-1/
EIARS485/K BUS
COMMUNICATIONS

RL9
RL10
RL11
RELAY OUTPUT CONTACTS
RL12

RJ45
10 BASE-T/
100 BASE-TX
TX+
TX-
RX+
RX-
SK2

RJ45
10 BASE-T/
100 BASE-TX
TX+
TX-
RX+
RX-
SK3

OPTO 1
OPTO 2
OPTO 3
OPTO 1,2,3
OPTO 4
OPTO 5
OPTO 6
OPTO 7
OPTO 8
OPTO 4,5,6,7,8
OPTO 9
OPTO 10
OPTO 11
OPTO 12
OPTO 13
OPTO 9,10,11,12,13
OPTO ISOLATED BINARY INPUTS

A.C./D.C. SUPPLY Vx

CASE EARTH

MODULE TERMINAL BLOCKS
VIEWED FROM REAR
(WITH INTEGRAL CASE EARTH STRAP)

NOTES:

1.
(a)    C.T. SHORTING LINKS MAKE
       BEFORE (b) & (c) DISCONNECT.
(b)    SHORT TERMINALS BREAK BEFORE (c).
(c)    LONG TERMINAL.
(d)    PIN TERMINAL (P.C.B. TYPE)

2.    C.T. CONNECTIONS
      ARE TYPICAL ONLY.

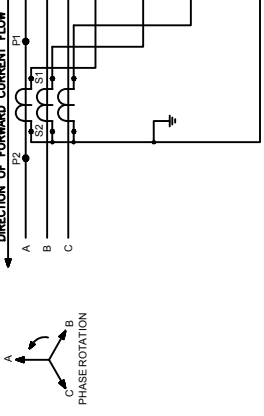3.    EARTH CONNECTIONS
      ARE TYPICAL ONLY.

| Issue: | | Revision: | | |
|--------|--|-----------|--|--|
| C | | CID006234 Outlines updated to GE Format | | |
| Date: | 5/1/2020 | Name: | S.J.BURTON | |
| Date: | | Chkd: | TEOH C.P. | |

Title: P14N NON DIRECTIONAL PHASE OVERCURRENT
& E/F (13 I/P & 12 O/P) & DUAL COPPER ETHERNET

Drg No: 10P14N09

Sht: 3
Next Sht: 4

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ST16 1WT, UK

DIRECTION OF FORWARD CURRENT FLOW
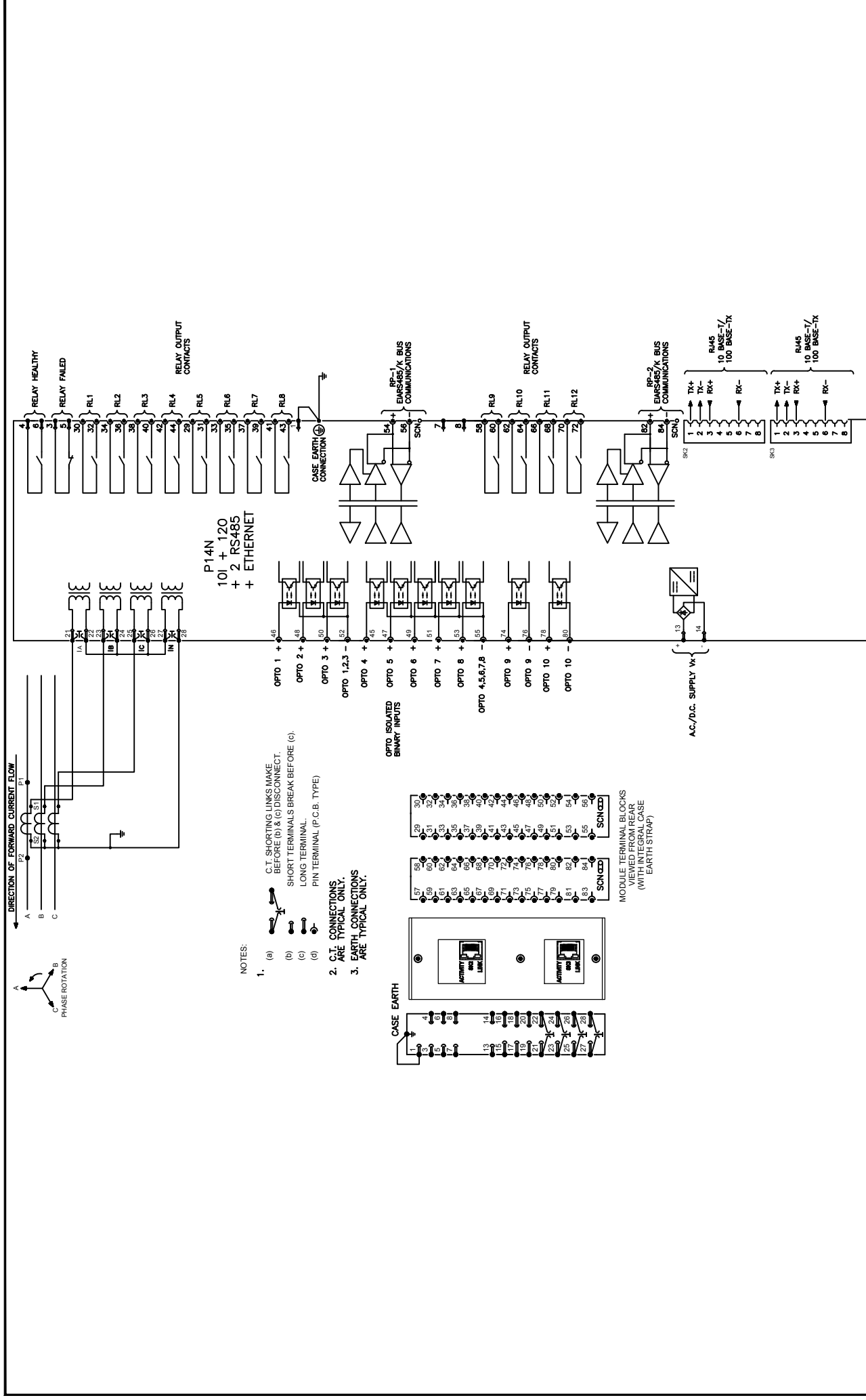
PHASE ROTATION

NOTES:

1. (a) C.T. SHORTING LINKS MAKE
       BEFORE (b) & (c) DISCONNECT.
   (b) SHORT TERMINALS BREAK BEFORE (c).
   (c) LONG TERMINAL.
   (d) PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS
   ARE TYPICAL ONLY.

3. EARTH CONNECTIONS
   ARE TYPICAL ONLY.

CASE EARTH

MODULE TERMINAL BLOCKS
VIEWED FROM REAR
(WITH INTEGRAL CASE
EARTH STRAP)

P14N
13I + 12O
+ ETHERNET

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RL4
RELAY OUTPUT CONTACTS
RL5
RL6
RL7
RL8

CASE EARTH CONNECTION

RP-1
EIARS485/K BUS
COMMUNICATIONS

RELAY OUTPUT CONTACTS
RL9
RL10
RL11
RL12

LC
10 BASE-FL
OR
100 BASE-FX
TX
RX
SK2

LC
10 BASE-FL
OR
100 BASE-FX
TX
RX
SK3

OPTO 1 +
OPTO 2 +
OPTO 3 +
OPTO 1,2,3 −
OPTO 4 +
OPTO 5 +
OPTO 6 +
OPTO 7 +
OPTO 8 +
OPTO 4,5,6,7,8 −
OPTO 9 +
OPTO 10 +
OPTO 11 +
OPTO 12 +
OPTO 13 +
OPTO 9,10,11,12,13 −

OPTO ISOLATED
BINARY INPUTS

A.c./D.C. SUPPLY Vx

Title: P14N NON DIRECTIONAL PHASE OVERCURRENT
& E/F (13 I/P & 12 O/P) & DUAL FIBRE ETHERNET

Drg No: 10P14N09

Sht: 4
Next Sht: −

Issue: C

Revision: CID006234 Outlines updated to GE Format

Date: 5/1/2020   Name: S.J.BURTON
Date:            Chkd: TEOH C.P.

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RELAY OUTPUT CONTACTS
RL4
RL5
RL6
RL7
RL8

CASE EARTH CONNECTION

RP-1
EIARS485/K BUS COMMUNICATIONS

A.C./D.C. SUPPLY Vx

RL9
RL10
RELAY OUTPUT CONTACTS
RL11
RL12

P14N
13I + 120

DIRECTION OF FORWARD CURRENT FLOW

IN SENSITIVE

OPTO 1 +
OPTO 2 +
OPTO 3 +
OPTO 1,2,3 −
OPTO 4 −
OPTO 5 +
OPTO 6 +
OPTO 7 +
OPTO 8 +
OPTO 4,5,6,7,8 −
OPTO 9 +
OPTO 10 +
OPTO 11 +
OPTO 12 +
OPTO 13 +
OPTO 9,10,11,12,13 −

OPTO ISOLATED BINARY INPUTS

PHASE ROTATION

NOTES:

1. (a) C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.
   (b) SHORT TERMINALS BREAK BEFORE (c).
   (c) LONG TERMINAL.
   (d) PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS ARE TYPICAL ONLY.

3. CT/VT EARTH CONNECTIONS ARE TYPICAL ONLY.

CASE EARTH

MODULE TERMINAL BLOCKS VIEWED FROM REAR (WITH INTEGRAL CASE EARTH STRAP)

Title: P14N NON DIRECTIONAL PHASE OVERCURRENT AND SEF (13 I/P & 12 O/P)

Drg No: 10P14N10

Sht: 1
Next Sht: −

Issue: D

Revision: CID006234 Outlines updated to GE Format

Date: 5/1/2020    Name: S.J.BURTON
Date: 03/12/2011    Chkd: K.VENKATARAMAN

DIRECTION OF FORWARD CURRENT FLOW

PHASE ROTATION

NOTES:

1.
(a) C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.

(b) SHORT TERMINALS BREAK BEFORE (c).

(c) LONG TERMINAL.

(d) PIN TERMINAL (P.C.B. TYPE).

2. C.T. CONNECTIONS ARE TYPICAL ONLY.

3. CT/VT EARTH CONNECTIONS ARE TYPICAL ONLY.

RELAY HEALTHY

RELAY FAILED

RL1
RL2
RL3
RL4

RELAY OUTPUT CONTACTS

RL5
RL6
RL7
RL8

CASE EARTH CONNECTION

P14N
13I + 12O
+ ETHERNET

RP-1 EIARS485/K BUS COMMUNICATIONS
SCN

RL9
RL10
RL11
RL12

RELAY OUTPUT CONTACTS

TX+
TX-
RX+
RX-

RJ45
10 BASE-T/
100 BASE-TX

LC
10 BASE-FL
OR
100 BASE-FX

TX
RX

IA
IB
Ic

IN SENSITIVE

OPTO 1 +
OPTO 2 +
OPTO 3 +
OPTO 1,2,3 -
OPTO 4 +
OPTO 5 +
OPTO 6 +
OPTO 7 +
OPTO 8 +
OPTO 4,5,6,7,8 -
OPTO 9 +
OPTO 10 +
OPTO 11 +
OPTO 12 +
OPTO 13 +
OPTO 9,10,11,12,13 -

OPTO ISOLATED BINARY INPUTS

A.C./D.C. SUPPLY Vx

CASE EARTH

MODULE TERMINAL BLOCKS
VIEWED FROM REAR
(WITH INTEGRAL CASE EARTH STRAP)

SCN
SCN

Title: P14N NON DIRECTIONAL PHASE OVERCURRENT AND SEF (13 I/P & 12 O/P) WITH ETHERNET

Drg No: 10P14N10

Sht: 2
Next Sht: 3

Issue: C

Revision: CID006234 Outlines updated to GE Format

Date: 5/1/2020
Name: S.J.BURTON
Chkd: TEOH C.P.

NOTES:

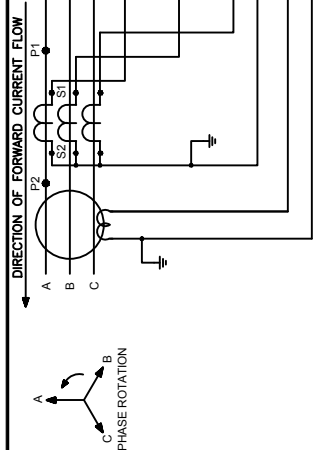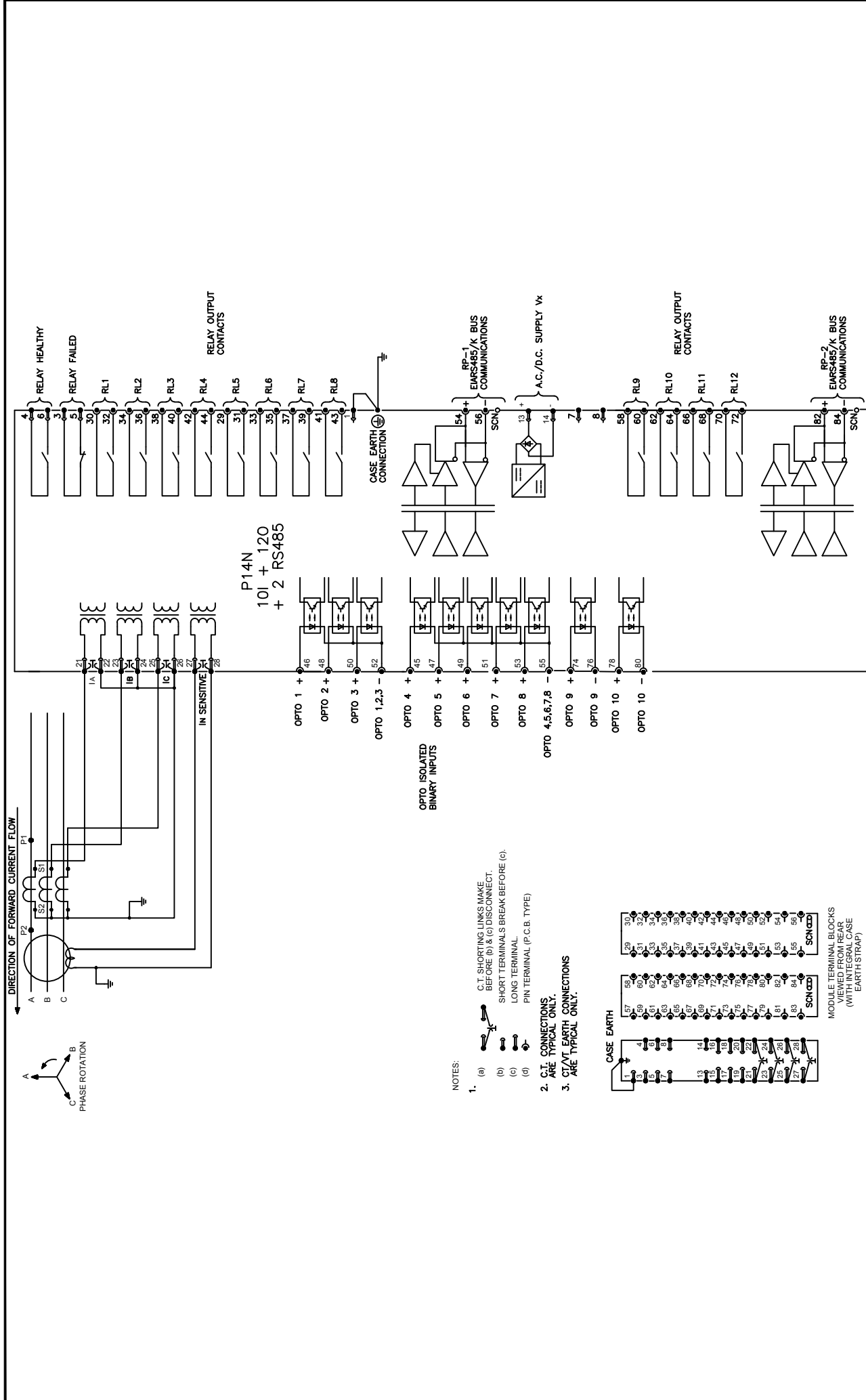1. (a) C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.
   (b) SHORT TERMINALS BREAK BEFORE (c).
   (c) LONG TERMINAL.
   (d) PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS ARE TYPICAL ONLY.
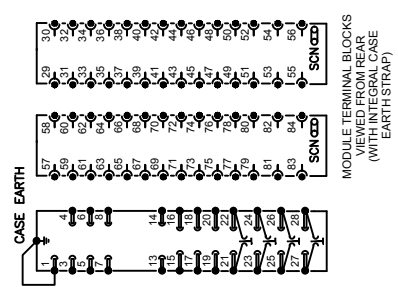
3. CT/VT EARTH CONNECTIONS ARE TYPICAL ONLY.

DIRECTION OF FORWARD CURRENT FLOW

PHASE ROTATION

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RL4
RELAY OUTPUT CONTACTS
RL5
RL6
RL7
RL8

CASE EARTH CONNECTION

P14N 13I + 12O + ETHERNET

RP-1, EIARS485/K BUS COMMUNICATIONS

RL9
RL10
RELAY OUTPUT CONTACTS
RL11
RL12

SK2
RJ45 10 BASE-T/ 100 BASE-TX
TX+ 1
TX- 2
RX+ 3
4
5
RX- 6
7
8

SK3
RJ45 10 BASE-T/ 100 BASE-TX
TX+ 1
TX- 2
RX+ 3
4
5
RX- 6
7
8

OPTO 1 +
OPTO 2 +
OPTO 3 +
OPTO 1,2,3 −
OPTO 4 +
OPTO 5 +
OPTO 6 +
OPTO 7 +
OPTO 8 +
OPTO 4,5,6,7,8 −
OPTO 9 +
OPTO 10 +
OPTO 11 +
OPTO 12 +
OPTO 13 +
OPTO 9,10,11,12,13 −

OPTO ISOLATED BINARY INPUTS

A.C./D.C. SUPPLY Vx

CASE EARTH

MODULE TERMINAL BLOCKS VIEWED FROM REAR (WITH INTEGRAL CASE EARTH STRAP)

SCN
SCN
SCN

ACTIVITY LINK 10/3
ACTIVITY LINK 10/3

DIRECTION OF FORWARD CURRENT FLOW

P1
P2
S1
S2
A
B
C

PHASE ROTATION
A
B
C

IA
IB
IC
IN SENSITIVE

21 22 23 24 25 26 27 28

P14N
13I + 12O
+ ETHERNET

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RL4
RL5
RL6
RL7
RL8

RELAY OUTPUT CONTACTS

4 6
3 5
30 32
34 36
38 40
42 44
29 31
33 35
37 39
41 43

CASE EARTH CONNECTION

RP-1
EIARS485/K BUS COMMUNICATIONS
54 +
56 −
SCN

7
8

RL9
RL10
RL11
RL12

RELAY OUTPUT CONTACTS

58 60
62 64
66 68
70 72

LC
10 BASE-FL
OR
100 BASE-FX
SK2
TX
RX

LC
10 BASE-FL
OR
100 BASE-FX
SK3
TX
RX

OPTO 1 + 46
OPTO 2 + 48
OPTO 3 + 50
OPTO 1,2,3 − 52
OPTO 4 + 45
OPTO 5 + 47
OPTO 6 + 49
OPTO 7 + 51
OPTO 8 + 53
OPTO 4,5,6,7,8 − 55
OPTO 9 + 74
OPTO 10 + 76
OPTO 11 + 78
OPTO 12 + 80
OPTO 13 + 82
OPTO 9,10,11,12,13 − 84

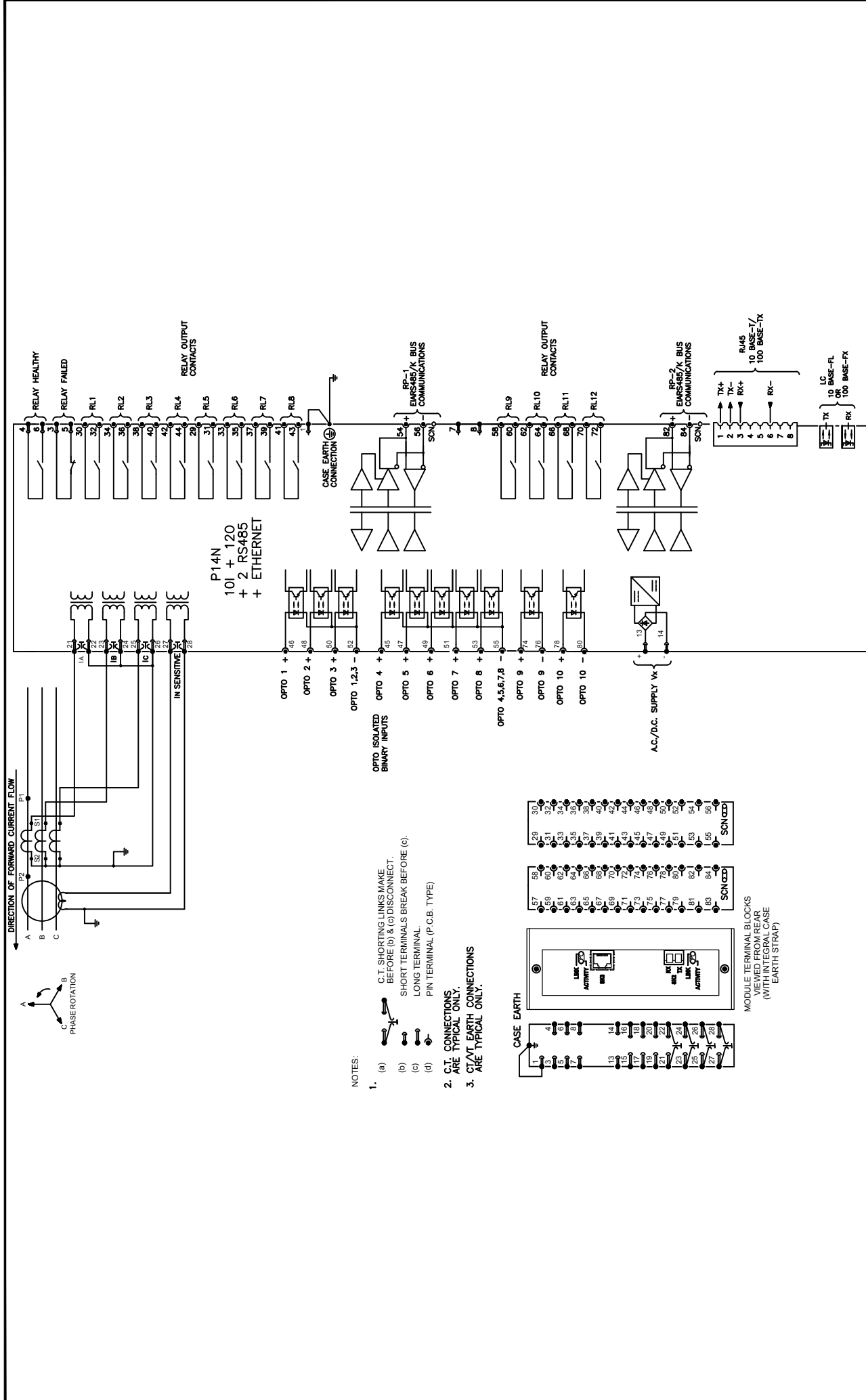OPTO ISOLATED BINARY INPUTS

13 +
14 −
A.C./D.C. SUPPLY Vx

NOTES:

1.
(a) C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.
(b) SHORT TERMINALS BREAK BEFORE (c).
(c) LONG TERMINAL.
(d) PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS ARE TYPICAL ONLY.

3. CT/VT EARTH CONNECTIONS ARE TYPICAL ONLY.

CASE EARTH

RX
SK2 TX
ACTIVITY
LINK

RX
SK3 TX
ACTIVITY
LINK

MODULE TERMINAL BLOCKS
VIEWED FROM REAR
(WITH INTEGRAL CASE EARTH STRAP)

29 30
31 32
33 34
35 36
37 38
39 40
41 42
43 44
45 46
47 48
49 50
51 52
53 54
55 56
SCN

57 58
59 60
61 62
63 64
65 66
67 68
69 70
71 72
73 74
75 76
77 78
79 80
81 82
83 84
SCN

1 2
3 4
5 6
7 8
13 14
15 16
17 18
19 20
21 22
23 24
25 26
27 28

RELAY HEALTHY

RELAY FAILED

RL1
RL2
RL3
RL4
RL5
RL6
RL7
RL8

RELAY OUTPUT CONTACTS

CASE EARTH CONNECTION

RP-1
EIARS485/K BUS COMMUNICATIONS

A.C./D.C. SUPPLY Vx

WIRING CAN BE INTERNAL OR EXTERNAL

NOTE 4.

P14N
KCGG142
RETROFIT

DIRECTION OF FORWARD CURRENT FLOW

P1
S1
S2
P2

A
B
C

PHASE ROTATION

OPTO 1 +
OPTO 2 +
OPTO 3 +
OPTO 1,2,3 −
OPTO 4 +
OPTO 5 +
OPTO 6 +
OPTO 7 +
OPTO 8 +
OPTO 4,5,6,7,8 −

OPTO ISOLATED BINARY INPUTS

IA
IB
IC
IN

NOTES:

1. (a)    C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.
   (b)    SHORT TERMINALS BREAK BEFORE (c).
   (c)    LONG TERMINAL.
   (d)    PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS ARE TYPICAL ONLY.

3. EARTH CONNECTIONS ARE TYPICAL ONLY.

4. SEPARATE ORDER OPTION AVAILABLE FOR INTERNAL LOOPING, LOAD ON TERMINALS 7&8 SHALL NOT EXCEED 5A

CASE EARTH

MODULE TERMINAL BLOCKS VIEWED FROM REAR (WITH INTEGRAL CASE EARTH STRAP)

| Title: | P14N NON DIRECTIONAL PHASE OVERCURRENT AND EARTH FAULT (8 I/P & 8 O/P) FOR KCGG 140/142 RETROFIT | | |
|---|---|---|---|
| Drg No: | 10P14N11 | | |

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| Sht: | 1 |
|---|---|
| Next Sht: | − |

| Issue: C | Revision: CID006234 Outlines updated to GE Format | | |
|---|---|---|---|
| Date: | 5/1/2020 | Name: | S.J.BURTON |
| Date: | 13/12/2011 | Chkd: | K.VENKATARAMAN |

RELAY HEALTHY

RELAY FAILED

RELAY OUTPUT
CONTACTS

RL1
RL2
RL3
RL4

4
6
3
5
30
32
34
36
38
40
42
44

P14N
3I + 40

IA  21 22
IB  23 24
IC  25 26
IN  27 28

DIRECTION OF FORWARD CURRENT FLOW

P1
S1
S2
P2

A
B
C

SEE NOTES 2 & 3

B
A
C
PHASE ROTATION

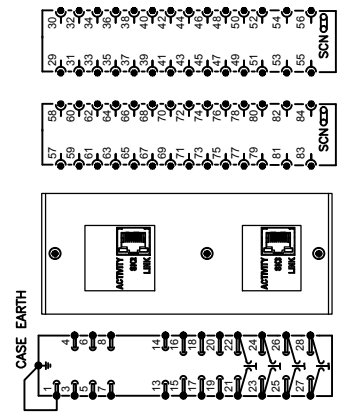NOTES:

1. (a)    C.T. SHORTING LINKS MAKE
          BEFORE (b) & (c) DISCONNECT.
   (b)    SHORT TERMINALS BREAK BEFORE (c).
   (c)    LONG TERMINAL.
   (d)    PIN TERMINAL (P.C.B. TYPE)

2. CT/VT CONNECTIONS
   ARE TYPICAL ONLY.

3. CT/VT EARTH CONNECTIONS
   ARE TYPICAL ONLY.

OPTO 1+  46
OPTO 2+  48
OPTO 3+  50
OPTO 1,2,3 – 52

OPTO ISOLATED
BINARY INPUTS

CASE EARTH
CONNECTION ⏚

1

EIARS485/K BUS
COMMUNICATIONS

54 +
56 –
SCN o

A.C./D.C. SUPPLY Vx

13 +
14 –
7
8

CASE EARTH

30
29
32
31
34
33
36
35
38
37
40
39
42
41
44
43
46
45
48
47
50
49
52
51
54
53
56
55
SCN

4
2
6
8
10
14
18
20
22
24
26
28
1
3
5
7
9
13
17
19
21
23
25
27
SCN

MODULE TERMINAL BLOCKS
VIEWED FROM REAR
(WITH INTEGRAL CASE
EARTH STRAP)

Title: P14D NON DIRECTIONAL PHASE OVER CURRENT AND
EARTH FAULT (3 I/P & 4 O/P)

Drg No: **10P14N12**

Sht: 1
Next Sht: -

Issue: C

Revision: CID006234 Outlines updated to GE Format

Date: 5/1/2020
Name: S.J.BURTON
Chkd:
Date:

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RL4
RL5
RL6
RL7
RL8

RELAY OUTPUT CONTACTS

P14N
6I + 8O
TCS

CASE EARTH CONNECTION

RP-1
EIARS485/K BUS COMMUNICATIONS
SCN

A.C./D.C. SUPPLY Vx

OPTO 1 +
OPTO 2 +
OPTO 3 +
OPTO 1,2,3 –
OPTO 4 +
OPTO 5 +
OPTO 6 +

OPTO ISOLATED BINARY INPUTS

DIRECTION OF FORWARD CURRENT FLOW

P1
S1
S2
P2
IA
IB
IC
IN

A
B
C

SEE NOTES 2 & 3

A
B
C
PHASE ROTATION

NOTES:

1. (a) C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.
   (b) SHORT TERMINALS BREAK BEFORE (c).
   (c) LONG TERMINAL.
   (d) PIN TERMINAL (P.C.B. TYPE)

2. CT/VT CONNECTIONS ARE TYPICAL ONLY.
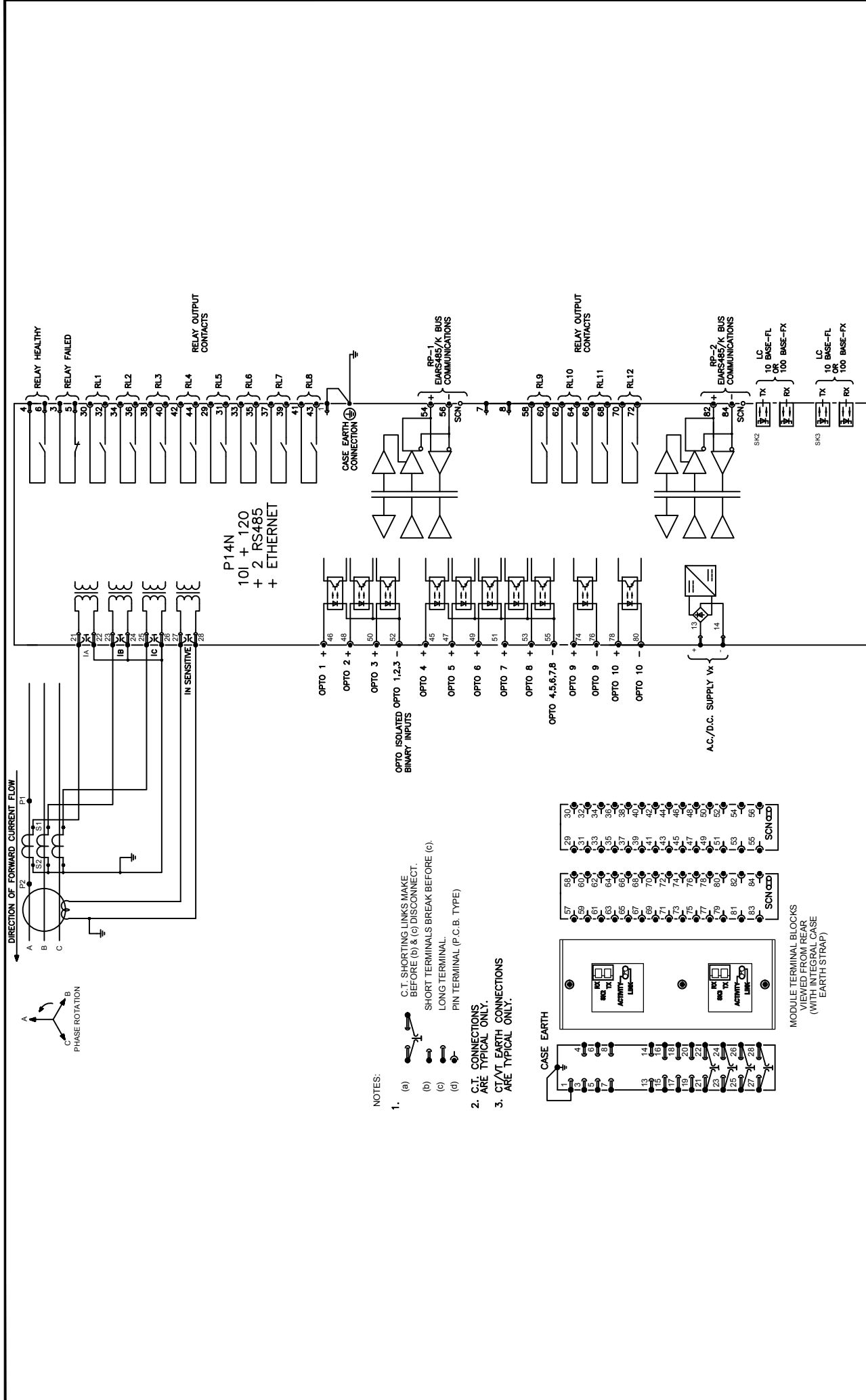
3. CT/VT EARTH CONNECTIONS ARE TYPICAL ONLY.

CASE EARTH

MODULE TERMINAL BLOCKS
VIEWED FROM REAR
(WITH INTEGRAL CASE EARTH STRAP)

Issue: C

Revision:
CID006234 Outlines updated to GE Format

Date: 5/1/2020   Name: S.J.BURTON
Chkd:
Date:

Title: P14D NON DIRECTIONAL PHASE OVER CURRENT AND EARTH FAULT (6 I/P & 8 O/P) WITH TCS

Drg No: 10P14N13

Sht: 1
Next Sht: –

Title: P14N NON DIRECTIONAL PHASE OVERCURRENT & EARTH FAULT (10 I/P & 12 O/P) WITH 2 RS485

Drg No: 10P14N14

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RL4
RL5
RL6
RL7
RL8

RELAY OUTPUT CONTACTS

CASE EARTH CONNECTION

RP-1, EIARS485/K BUS COMMUNICATIONS

A.C./D.C. SUPPLY Vx

RL9
RL10
RL11
RL12

RELAY OUTPUT CONTACTS

RP-2, EIARS485/K BUS COMMUNICATIONS

P14N 10I + 120 + 2 RS485

DIRECTION OF FORWARD CURRENT FLOW
P1
P2
S1
S2

IA
IB
IC
IN

A
B
C

PHASE ROTATION

OPTO 1 +
OPTO 2 +
OPTO 3 +
OPTO 1,2,3 -
OPTO 4 +
OPTO 5 +
OPTO 6 +
OPTO 7 +
OPTO 8 +
OPTO 4,5,6,7,8 -
OPTO 9 +
OPTO 9 -
OPTO 10 +
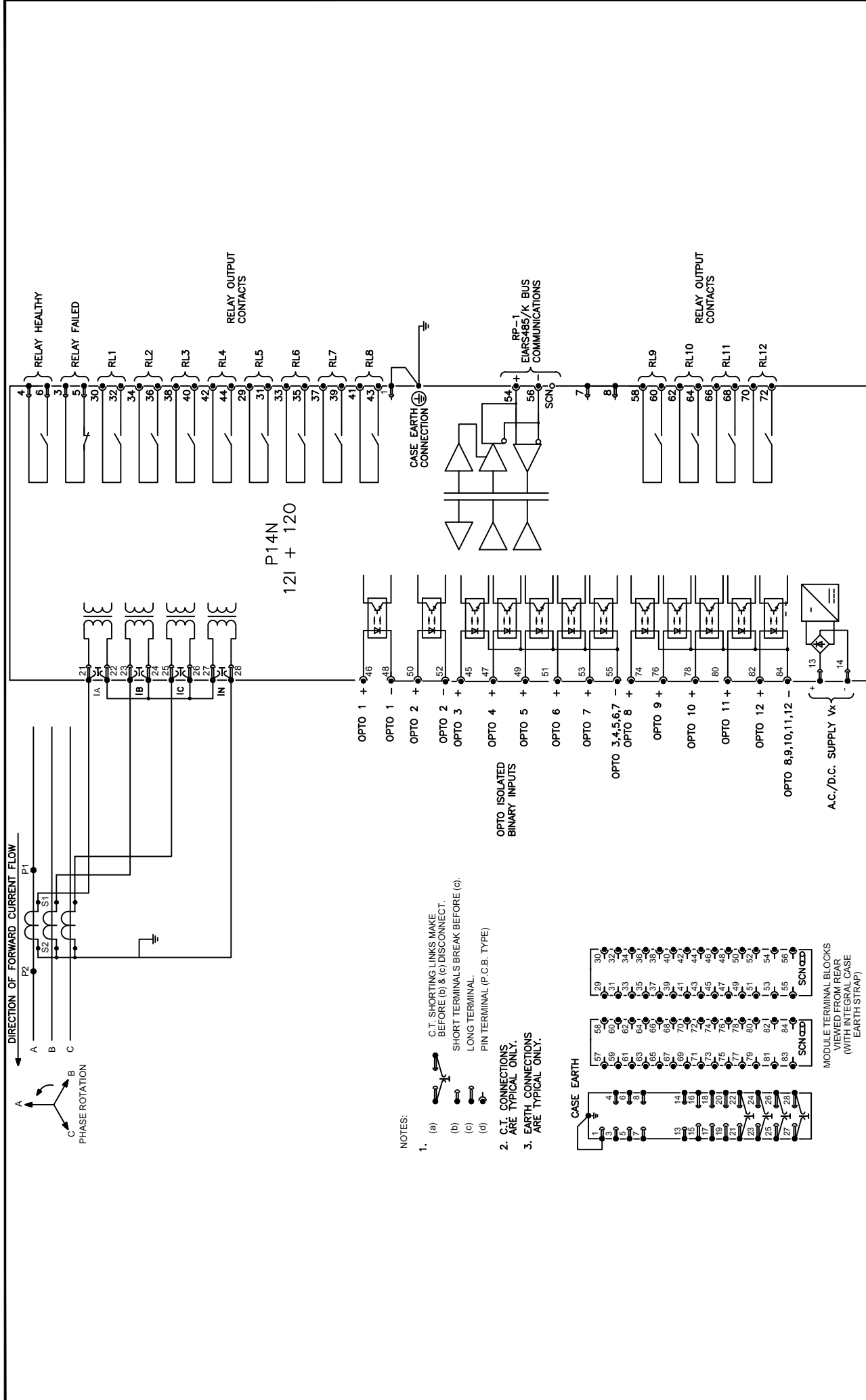OPTO 10 -

OPTO ISOLATED BINARY INPUTS

NOTES:

1. (a) C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.
   (b) SHORT TERMINALS BREAK BEFORE (c).
   (c) LONG TERMINAL.
   (d) PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS ARE TYPICAL ONLY.

3. EARTH CONNECTIONS ARE TYPICAL ONLY.

CASE EARTH

MODULE TERMINAL BLOCKS VIEWED FROM REAR (WITH INTEGRAL CASE EARTH STRAP)

Issue: C

Revision: CID006234 Outlines updated to GE Format

Date: 5/1/2020    Name: S.J.BURTON
Chkd: TEOH C.P.

Sht: 1
Next Sht: 2

DIRECTION OF FORWARD CURRENT FLOW

PHASE ROTATION

P14N
10I + 120
+ 2  RS485
+ ETHERNET

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RL4
RELAY OUTPUT CONTACTS
RL5
RL6
RL7
RL8

CASE EARTH CONNECTION

RP-1
EIARS485/K BUS COMMUNICATIONS

RELAY OUTPUT CONTACTS
RL9
RL10
RL11
RL12

RP-2
EIARS485/K BUS COMMUNICATIONS

RJ45
10 BASE-T/
100 BASE-TX
TX+
TX-
RX+
RX-

LC
10 BASE-FL
OR 100 BASE-FX
TX
RX

OPTO 1 +
OPTO 2 +
OPTO 3 +
OPTO 1,2,3 −
OPTO 4 +
OPTO 5 +
OPTO 6 +
OPTO 7 +
OPTO 8 +
OPTO 4,5,6,7,8 −
OPTO 9 +
OPTO 9 −
OPTO 10 +
OPTO 10 −
OPTO ISOLATED BINARY INPUTS

A.C./D.C. SUPPLY Vx

NOTES:
1. (a)  C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.
   (b)  SHORT TERMINALS BREAK BEFORE (c).
   (c)  LONG TERMINAL.
   (d)  PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS ARE TYPICAL ONLY.

3. EARTH CONNECTIONS ARE TYPICAL ONLY.

CASE EARTH

MODULE TERMINAL BLOCKS VIEWED FROM REAR
(WITH INTEGRAL CASE EARTH STRAP)

Title: 10P14N NON-DIRECTIONAL PHASE OVERCURRENT & EARTH FAULT (10 I/P & 12 O/P) +2 x RS485 & ETHERNET

Drg No: 10P14N14

Sht: 2    Next Sht: 3

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ST16 1WT, UK

Issue: C

Revision: CID006234 Outlines updated to GE Format

Date: 5/1/2020    Name: S.J.BURTON
Date:              Chkd: TEOH C.P.

PHASE ROTATION

DIRECTION OF FORWARD CURRENT FLOW

P14N
10I + 12O
+ 2 RS485
+ ETHERNET

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RL4
RELAY OUTPUT CONTACTS
RL5
RL6
RL7
RL8

CASE EARTH CONNECTION

RP–1,
EIARS485/K BUS COMMUNICATIONS

RL9
RL10
RL11
RL12
RELAY OUTPUT CONTACTS

RP–2,
EIARS485/K BUS COMMUNICATIONS

RJ45
10 BASE–T/
100 BASE–Tx

RJ45
10 BASE–T/
100 BASE–Tx

OPTO 1 +
OPTO 2 +
OPTO 3 –
OPTO 1,2,3 –
OPTO 4 +
OPTO 5 +
OPTO 6 +
OPTO 7 +
OPTO 8 +
OPTO 4,5,6,7,8 –
OPTO 9 +
OPTO 9 –
OPTO 10 +
OPTO 10 –

OPTO ISOLATED BINARY INPUTS
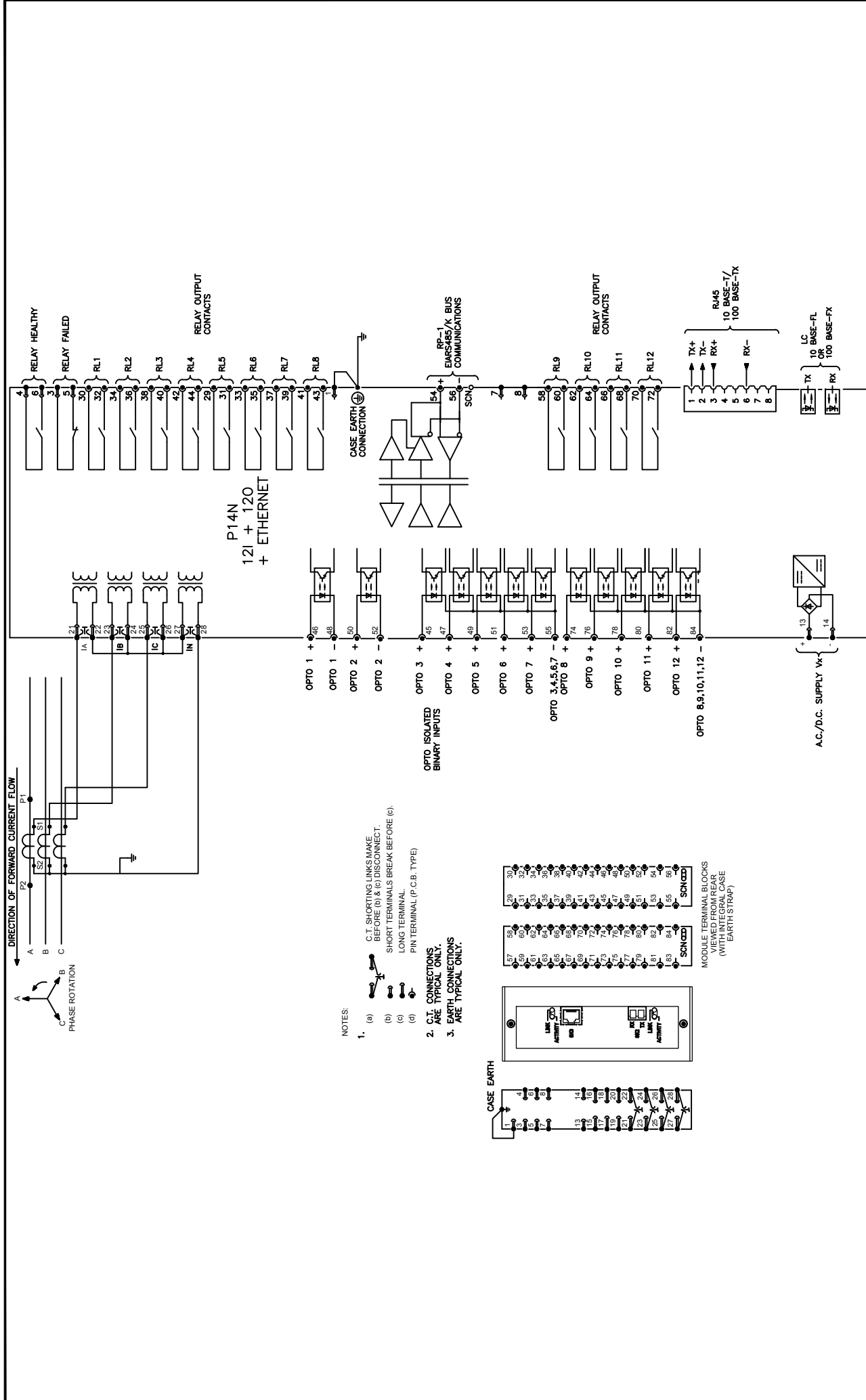
A.C./D.C. SUPPLY Vx

NOTES:

1. (a) C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.
   (b) SHORT TERMINALS BREAK BEFORE (c).
   (c) LONG TERMINAL.
   (d) PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS ARE TYPICAL ONLY.
3. EARTH CONNECTIONS ARE TYPICAL ONLY.

MODULE TERMINAL BLOCKS VIEWED FROM REAR (WITH INTEGRAL CASE EARTH STRAP)

CASE EARTH

| Title: | 10P14N NON-DIRECTIONAL PHASE OVERCURRENT& EARTH FAULT (10 I/P & 12 O/P) + 2xRS485 & DUAL COPPER ETHERNET |
|---|---|

Drg No: **10P14N14**

Sht: 3
Next Sht: 4

| Issue: C | Revision: CID006234 Outlines updated to GE Format | | |
|---|---|---|---|
| Date: 5/1/2020 | Name: S.J.BURTON | | |
| Date: | Chkd: TEOH C.P. | | |

P14N NON DIRECTIONAL PHASE OVERCURRENT & EARTH FAULT
(10 I/P & 12 O/P) WITH 2 RS485 & DUAL FIBRE ETHERNET

Title:

Drg No: **10P14N14**

Sht: 4
Next Sht: –

P14N
10I + 120
+ 2 RS485
+ ETHERNET

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RL4
RL5
RL6
RL7
RL8
RELAY OUTPUT CONTACTS

CASE EARTH CONNECTION

RP–1 EIARS485/K BUS COMMUNICATIONS

RL9
RL10
RL11
RL12
RELAY OUTPUT CONTACTS

RP–2 EIARS485/K BUS COMMUNICATIONS

SK2
LC 10 BASE–FL
OR 100 BASE–FX
TX
RX

SK3
LC 10 BASE–FL
OR 100 BASE–FX
TX
RX

DIRECTION OF FORWARD CURRENT FLOW

PHASE ROTATION

OPTO 1 +
OPTO 2 +
OPTO 3 +
OPTO 1,2,3 –
OPTO 4 +
OPTO 5
OPTO 6 +
OPTO 7
OPTO 8 +
OPTO 4,5,6,7,8 –
OPTO 9 +
OPTO 9 –
OPTO 10 +
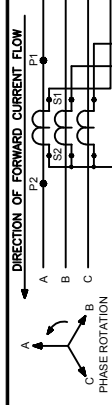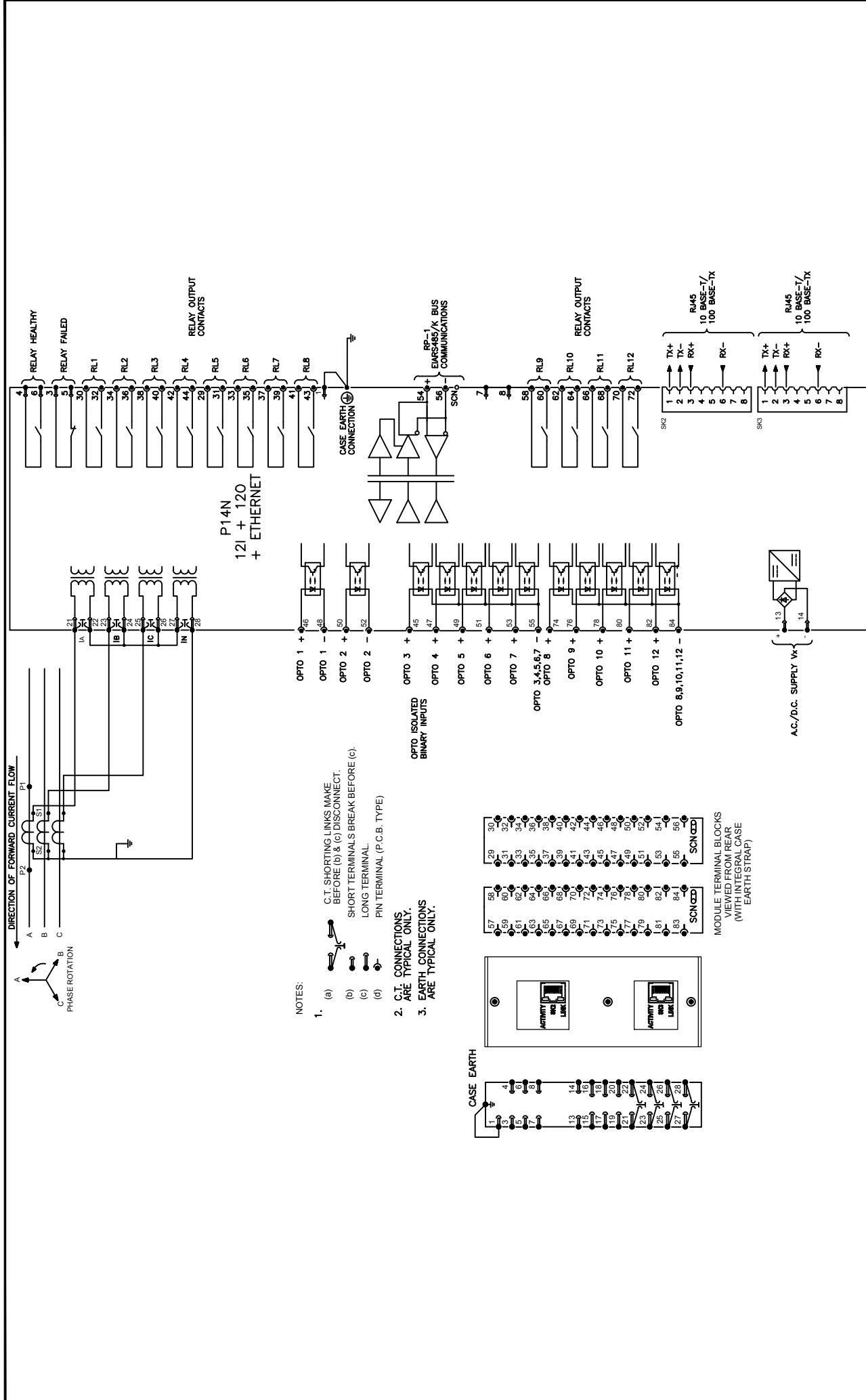OPTO 10 –
OPTO ISOLATED BINARY INPUTS

A.C./D.C. SUPPLY Vx

NOTES:
1.
(a) C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.
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(c) LONG TERMINAL.
(d) PIN TERMINAL (P.C.B. TYPE).

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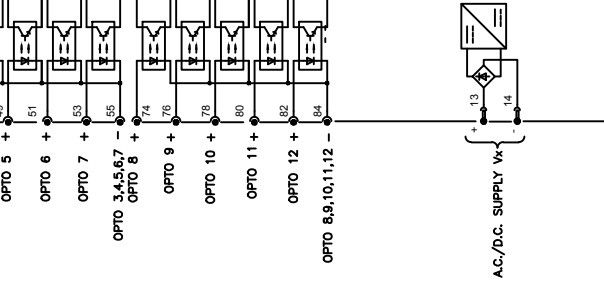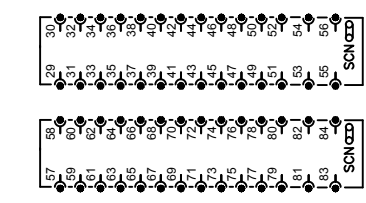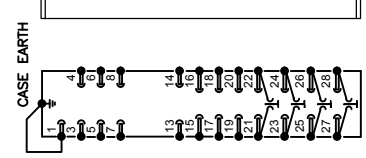
3. EARTH CONNECTIONS ARE TYPICAL ONLY.

CASE EARTH

MODULE TERMINAL BLOCKS VIEWED FROM REAR (WITH INTEGRAL CASE EARTH STRAP)

Issue: C

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Date: 5/1/2020
Name: S.J.BURTON
Chkd: TEOH C.P.

P14N NON DIRECTIONAL PHASE OVERCURRENT AND SEF (10 I/P & 12 O/P) WITH 2 RS485

Title:

Drg No: **10P14N15**

P14N
10I + 12O
+ 2 RS485

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RL4
RELAY OUTPUT CONTACTS
RL5
RL6
RL7
RL8

CASE EARTH CONNECTION

RP-1
EIARS485/K BUS COMMUNICATIONS
SCN

A.C./D.C. SUPPLY Vx

RL9
RL10
RL11
RL12
RELAY OUTPUT CONTACTS

RP-2
EIARS485/K BUS COMMUNICATIONS
SCN

OPTO 1 +
OPTO 2 +
OPTO 3 +
OPTO 1,2,3 –
OPTO 4 +
OPTO 5 +
OPTO 6 +
OPTO 7 +
OPTO 8 +
OPTO 4,5,6,7,8 –
OPTO 9 +
OPTO 9 –
OPTO 10 +
OPTO 10 –

OPTO ISOLATED BINARY INPUTS

IA
IB
IC
IN SENSITIVE

DIRECTION OF FORWARD CURRENT FLOW

P1
P2
S1
S2

A
B
C

A
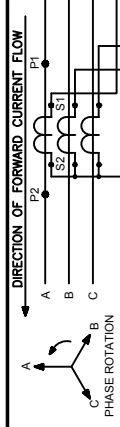B
C
PHASE ROTATION

NOTES:
1. (a)   C.T. SHORTING LINKS MAKE
         BEFORE (b) & (c) DISCONNECT.
   (b)   SHORT TERMINALS BREAK BEFORE (c).
   (c)   LONG TERMINAL.
   (d)   PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS ARE TYPICAL ONLY.
3. CT/VT EARTH CONNECTIONS ARE TYPICAL ONLY.

CASE EARTH

MODULE TERMINAL BLOCKS
VIEWED FROM REAR
(WITH INTEGRAL CASE EARTH STRAP)

SCN
SCN

Issue: **C**

Revision: CID006234 Outlines updated to GE Format

Date: 5/1/2020   Name: S.J.BURTON
Date:             Chkd: TEOH C.P.

Sht: 1
Next Sht: 2

RELAY HEALTHY — 4, 6

RELAY FAILED — 3, 5

RL1 — 30
RL2 — 32, 34
RL3 — 36, 38
RL4 — 40, 42 — RELAY OUTPUT CONTACTS
RL5 — 44, 29
RL6 — 31, 33, 35
RL7 — 37, 39
RL8 — 41, 43

CASE EARTH CONNECTION

RP-1 / EIARS485/K BUS COMMUNICATIONS — 54, 56, SCN — 7, 8

RL9 — 58, 60
RL10 — 62, 64 — RELAY OUTPUT CONTACTS
RL11 — 66, 68
RL12 — 70, 72

RP-2 / EIARS485/K BUS COMMUNICATIONS — 82, 84, SCN

RJ45 — 10 BASE-T / 100 BASE-TX
1 TX+
2 TX−
3 RX+
6 RX−
4, 5, 7, 8

LC — 10 BASE-FL OR 100 BASE-FX
TX, RX

P14N
10I + 12O
+ 2 RS485
+ ETHERNET

DIRECTION OF FORWARD CURRENT FLOW

P1, P2, S1, S2
IA — 21, 22
IB — 23, 24
IC — 25, 26
IN SENSITIVE — 27, 28

OPTO 1 + — 46
OPTO 2 + — 48
OPTO 3 + — 50
OPTO 1,2,3 − — 52

OPTO 4 + — 45
OPTO 5 + — 47
OPTO 6 + — 49
OPTO 7 + — 51
OPTO 8 + — 53
OPTO 4,5,6,7,8 − — 55

OPTO 9 + — 74
OPTO 9 − — 76
OPTO 10 + — 78
OPTO 10 − — 80

OPTO ISOLATED BINARY INPUTS

A.C./D.C. SUPPLY Vx — 13 +, 14 −
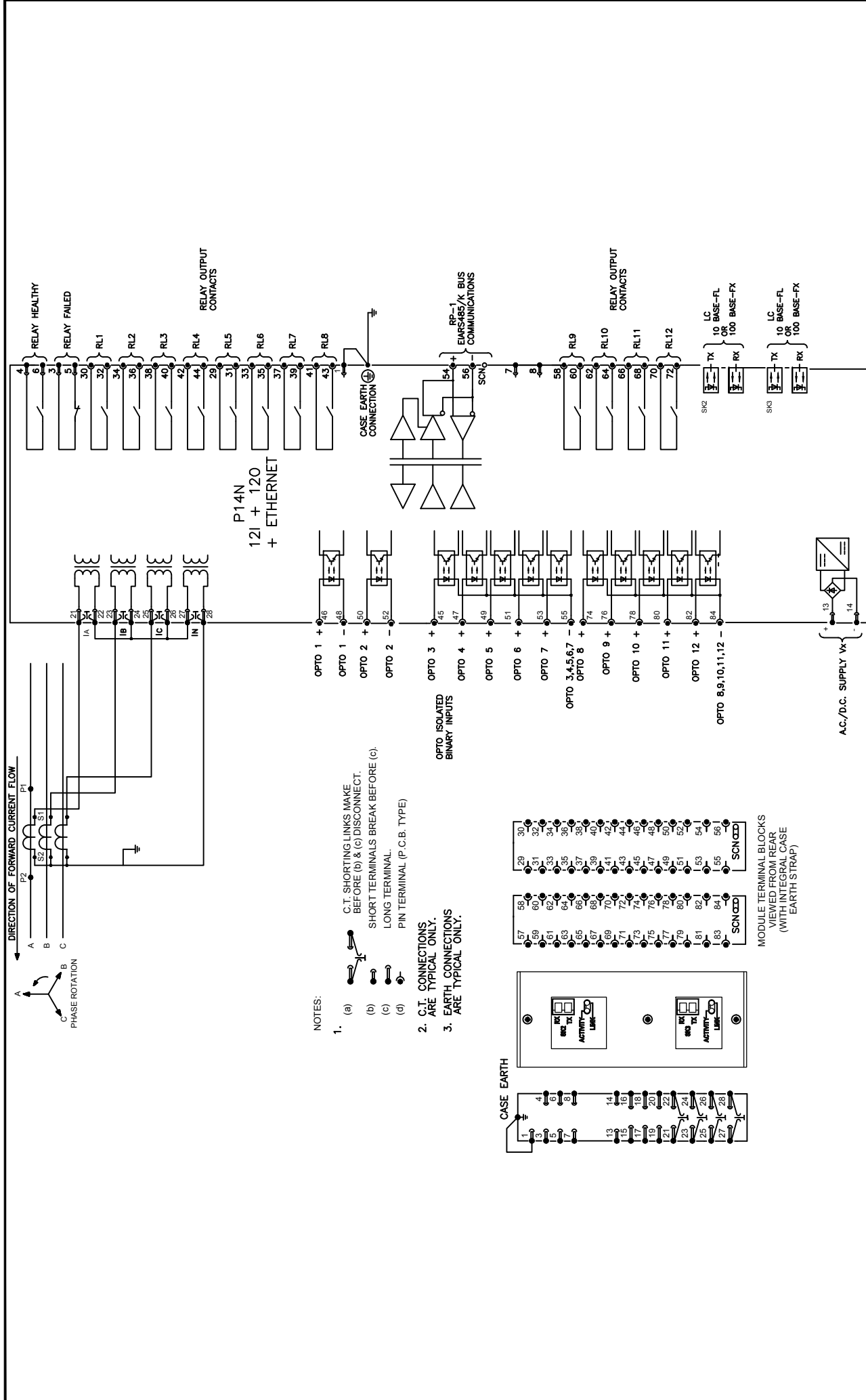
PHASE ROTATION — A, B, C

NOTES:
1. (a) C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.
   (b) SHORT TERMINALS BREAK BEFORE (c).
   (c) LONG TERMINAL.
   (d) PIN TERMINAL (P.C.B. TYPE)
2. C.T. CONNECTIONS ARE TYPICAL ONLY.
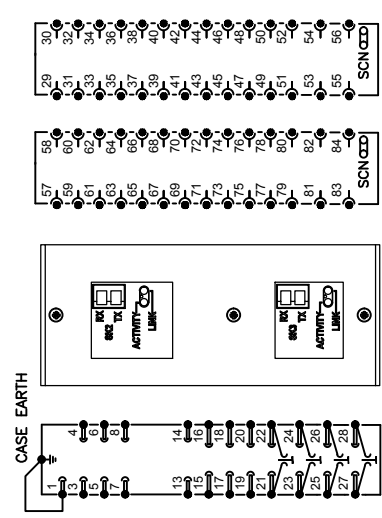3. CT/VT EARTH CONNECTIONS ARE TYPICAL ONLY.

CASE EARTH

MODULE TERMINAL BLOCKS
VIEWED FROM REAR
(WITH INTEGRAL CASE EARTH STRAP)

LINK, ACTIVITY, RX, TX, SK3

Title: 10P14N NON-DIRECTIONAL PHASE OVERCURRENT & SEF (10 I/P & 12 O/P) + RS485 & ETHERNET

Drg No: 10P14N15

Sht: 2
Next Sht: 3

Issue: C

Revision: CID006234 Outlines updated to GE Format

Date: 5/1/2020    Name: S.J.BURTON
Date:              Chkd: TEOH C.P.

# P14N NON DIRECTIONAL PHASE OVERCURRENT & SEF (10 I/P & 12 O/P) + 2 x RS485 & DUAL COPPER ETHERNET

10P14N15

RELAY HEALTHY
RELAY FAILED

RL1
RL2
RL3
RL4
RL5
RL6
RL7
RL8

RELAY OUTPUT CONTACTS

RP-1/ EIAR5485/K BUS COMMUNICATIONS
SCN

RL9
RL10
RL11
RL12

RELAY OUTPUT CONTACTS

RP-2/ EIAR5485/K BUS COMMUNICATIONS
SCN

CASE EARTH CONNECTION

RJ45
10 BASE-T/
100 BASE-TX

Tx+
Tx-
Rx+
Rx-
SK2

RJ45
10 BASE-T/
100 BASE-TX

Tx+
Tx-
Rx+
Rx-
SK3

P14N
10I + 120
+ 2 RS485
+ ETHERNET

DIRECTION OF FORWARD CURRENT FLOW
P1
P2
S1
S2

IA
IB
IC

IN SENSITIVE

A
B
C

PHASE ROTATION

OPTO 1 +
OPTO 2 +
OPTO 3 +
OPTO 1,2,3 –

OPTO 4 +
OPTO 5 +
OPTO 6 +
OPTO 7 +
OPTO 8 +
OPTO 4,5,6,7,8 –

OPTO 9 +
OPTO 9 –
OPTO 10 +
OPTO 10 –

OPTO ISOLATED BINARY INPUTS
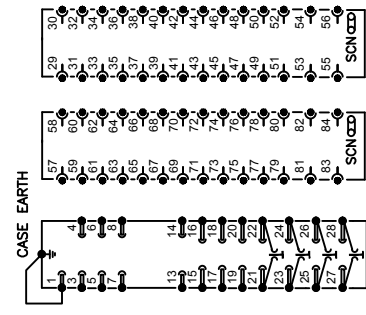
A.C./D.C. SUPPLY Vx

NOTES:

1.
   (a)  C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.
   (b)  SHORT TERMINALS BREAK BEFORE (c).
   (c)  LONG TERMINAL.
   (d)  PIN TERMINAL (P.C.B. TYPE)

2.  C.T. CONNECTIONS ARE TYPICAL ONLY.

3.  CT/VT EARTH CONNECTIONS ARE TYPICAL ONLY.

CASE EARTH

MODULE TERMINAL BLOCKS VIEWED FROM REAR (WITH INTEGRAL CASE EARTH STRAP)

ACTIVITY
LINK

SCN
SCN

Title: P14N NON DIRECTIONAL PHASE OVERCURRENT & SEF (10 I/P & 12 O/P) + 2 x RS485 & DUAL COPPER ETHERNET

Drg No: 10P14N15

Sht: 3
Next Sht: 4

Issue: C

Revision: CID006234 Outlines updated to GE Format

Date: 5/1/2020    Name: S.J.BURTON
Chkd: TEOH C.P.

P14N
10I + 120
+ 2 RS485
+ ETHERNET

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RL4
RELAY OUTPUT CONTACTS
RL5
RL6
RL7
RL8

CASE EARTH CONNECTION

RP–1
EIARS485/K BUS COMMUNICATIONS

RL9
RL10
RL11
RL12
RELAY OUTPUT CONTACTS

RP–2
EIARS485/K BUS COMMUNICATIONS

LC
10 BASE–FL
OR
100 BASE–FX

LC
10 BASE–FL
OR
100 BASE–FX

DIRECTION OF FORWARD CURRENT FLOW

PHASE ROTATION

IN SENSITIVE

OPTO 1 +
OPTO 2 +
OPTO 3 +
OPTO ISOLATED OPTO 1,2,3 –
BINARY INPUTS
OPTO 4 +
OPTO 5 +
OPTO 6 +
OPTO 7 +
OPTO 8 +
OPTO 4,5,6,7,8 –
OPTO 9 +
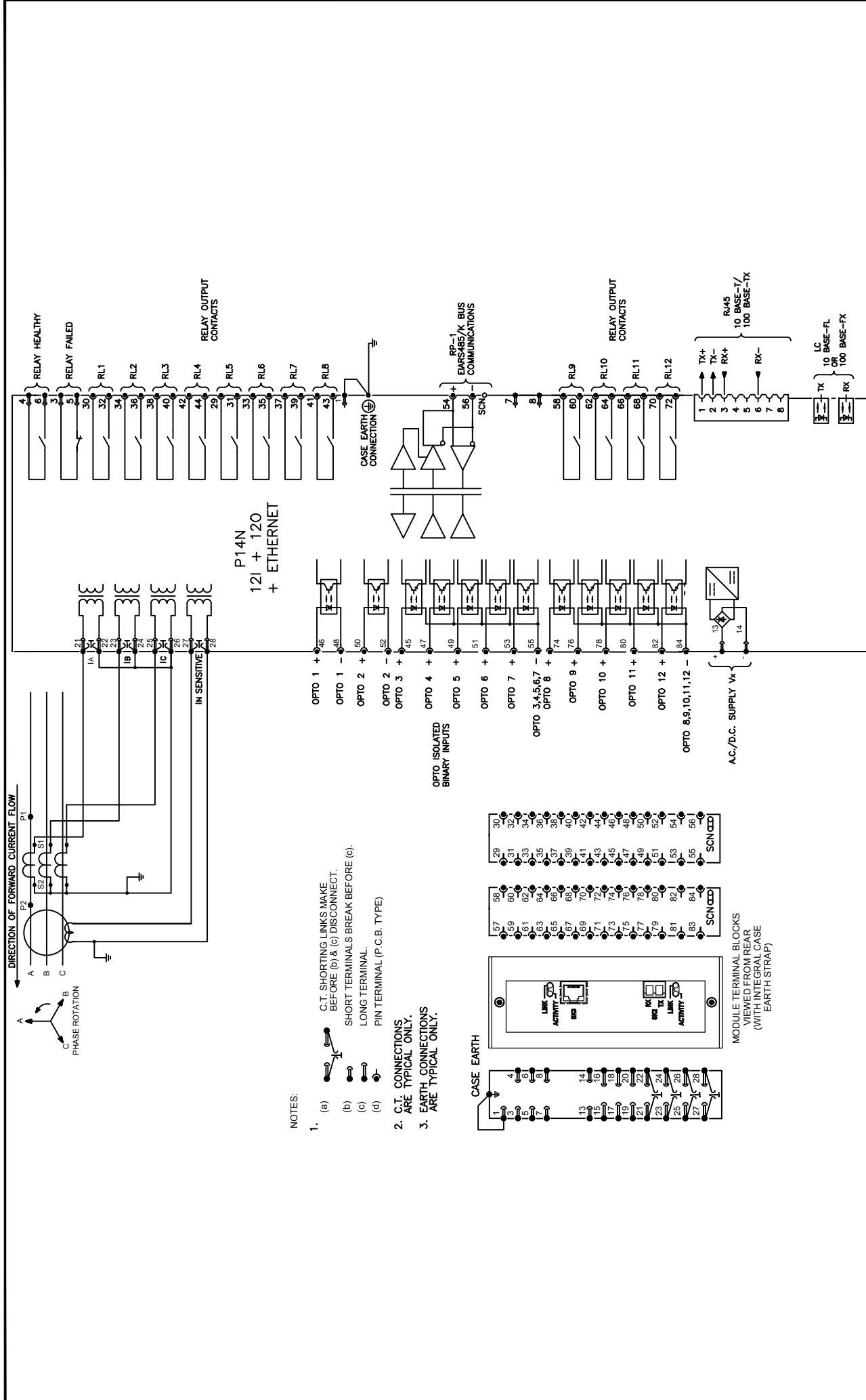OPTO 9 –
OPTO 10 +
OPTO 10 –

A.C./D.C. SUPPLY Vx

NOTES:

1. (a)   C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.
   (b)   SHORT TERMINALS BREAK BEFORE (c).
   (c)   LONG TERMINAL.
   (d)   PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS ARE TYPICAL ONLY.

3. CT/VT EARTH CONNECTIONS ARE TYPICAL ONLY.

CASE EARTH

MODULE TERMINAL BLOCKS
VIEWED FROM REAR
(WITH INTEGRAL CASE
EARTH STRAP)

SCN
SCN
SCN

Title: P14N NON DIRECTIONAL PHASE OVERCURRENT & SEF (10 I/P & 12 O/P) WITH 2 RS485 & DUAL FIBRE ETHERNET

Drg No: 10P14N15

Sht: 4
Next Sht: –

Issue: C

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Date: 5/1/2020    Name: S.J.BURTON
Date:              Chkd: TEOH C.P.

PHASE ROTATION

DIRECTION OF FORWARD CURRENT FLOW

P14N
12I + 12O

RELAY HEALTHY

RELAY FAILED

RL1
RL2
RL3
RL4
RL5
RL6
RL7
RL8

RELAY OUTPUT CONTACTS

CASE EARTH CONNECTION

RP-1
EIARS485/K BUS COMMUNICATIONS

SCN

RL9
RL10
RL11
RL12

RELAY OUTPUT CONTACTS

OPTO 1 +
OPTO 1 –
OPTO 2 +
OPTO 2 –
OPTO 3 +
OPTO 4 +
OPTO 5 +
OPTO 6 +
OPTO 7 +
OPTO 3,4,5,6,7 –
OPTO 8 +
OPTO 9 +
OPTO 10 +
OPTO 11 +
OPTO 12 +
OPTO 8,9,10,11,12 –

OPTO ISOLATED BINARY INPUTS

A.C./D.C. SUPPLY Vx

NOTES:

1. (a) C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.
   (b) SHORT TERMINALS BREAK BEFORE (c).
   (c) LONG TERMINAL.
   (d) PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS ARE TYPICAL ONLY.

3. EARTH CONNECTIONS ARE TYPICAL ONLY.

CASE EARTH

SCN
SCN
SCN

MODULE TERMINAL BLOCKS VIEWED FROM REAR (WITH INTEGRAL CASE EARTH STRAP)

Title: P14N NON DIRECTIONAL PHASE OVERCURRENT & EARTH FAULT (12 I/P & 12 O/P)

Drg No: 10P14N16

Sht: 1
Next Sht: 2

© UK Grid Solutions Ltd
St Leonards Building
Harry Kerr Drive, Stafford,
ST16 1WT, UK

Issue: C

Revision: CID006234 Outlines updated to GE Format

Date: 5/1/2020    Name: S.J.BURTON

Date:              Chkd: TEOH C.P.

DIRECTION OF FORWARD CURRENT FLOW

PHASE ROTATION

RELAY HEALTHY

RELAY FAILED

RL1
RL2
RL3
RL4
RL5
RL6
RL7
RL8

RELAY OUTPUT CONTACTS

CASE EARTH CONNECTION

P14N
12I + 12O
+ ETHERNET

RP-1
EIA RS485/K BUS
COMMUNICATIONS

SCN

RL9
RL10
RL11
RL12

RELAY OUTPUT CONTACTS

RJ45
10 BASE-T/
100 BASE-TX

TX+
TX-
RX+
RX-

LC
10 BASE-FL
OR
100 BASE-FX

TX
RX

OPTO 1 +
OPTO 1 -
OPTO 2 +
OPTO 2 -
OPTO 3 +
OPTO 4 +
OPTO 5 +
OPTO 6 +
OPTO 7 +
OPTO 3,4,5,6,7
OPTO 8 -
OPTO 9 +
OPTO 10 +
OPTO 11 +
OPTO 12 +
OPTO 8,9,10,11,12 -

OPTO ISOLATED BINARY INPUTS

A.C./D.C. SUPPLY Vx

NOTES:

1.
(a)   C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.
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3.   EARTH CONNECTIONS ARE TYPICAL ONLY.

MODULE TERMINAL BLOCKS
VIEWED FROM REAR
(WITH INTEGRAL CASE
EARTH STRAP)

CASE EARTH

LINK
ACTIVITY
RXD
RXD TX
LINK
ACTIVITY

Sht: 2
Next Sht: 3

Title: P14N NON DIRECTIONAL PHASE OVERCURRENT & EARTH FAULT (12 I/P & 12 O/P) & ETHERNET

Drg No: 10P14N16

Issue: C

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Date:              Chkd: TEOH C.P.

DIRECTION OF FORWARD CURRENT FLOW

PHASE ROTATION

P14N
12I + 12O
+ ETHERNET

RELAY HEALTHY

RELAY FAILED

RL1
RL2
RL3
RL4

RELAY OUTPUT
CONTACTS

RL5
RL6
RL7
RL8

CASE EARTH
CONNECTION

RP-1,
EIA RS485/K BUS
COMMUNICATIONS

SCN

RL9
RL10
RL11
RL12

RELAY OUTPUT
CONTACTS

RJ45
10 BASE-T/
100 BASE-TX

TX+
TX-
RX+
RX-

SK2

RJ45
10 BASE-T/
100 BASE-TX

TX+
TX-
RX+
RX-

SK3

OPTO 1 +
OPTO 1 -
OPTO 2 +
OPTO 2 -
OPTO 3 +
OPTO 4 +
OPTO 5 +
OPTO 6 +
OPTO 7 +
OPTO 3,4,5,6,7 -
OPTO 8 +
OPTO 9 +
OPTO 10 +
OPTO 11 +
OPTO 12 +
OPTO 8,9,10,11,12 -

OPTO ISOLATED
BINARY INPUTS

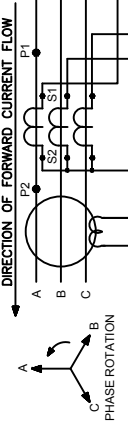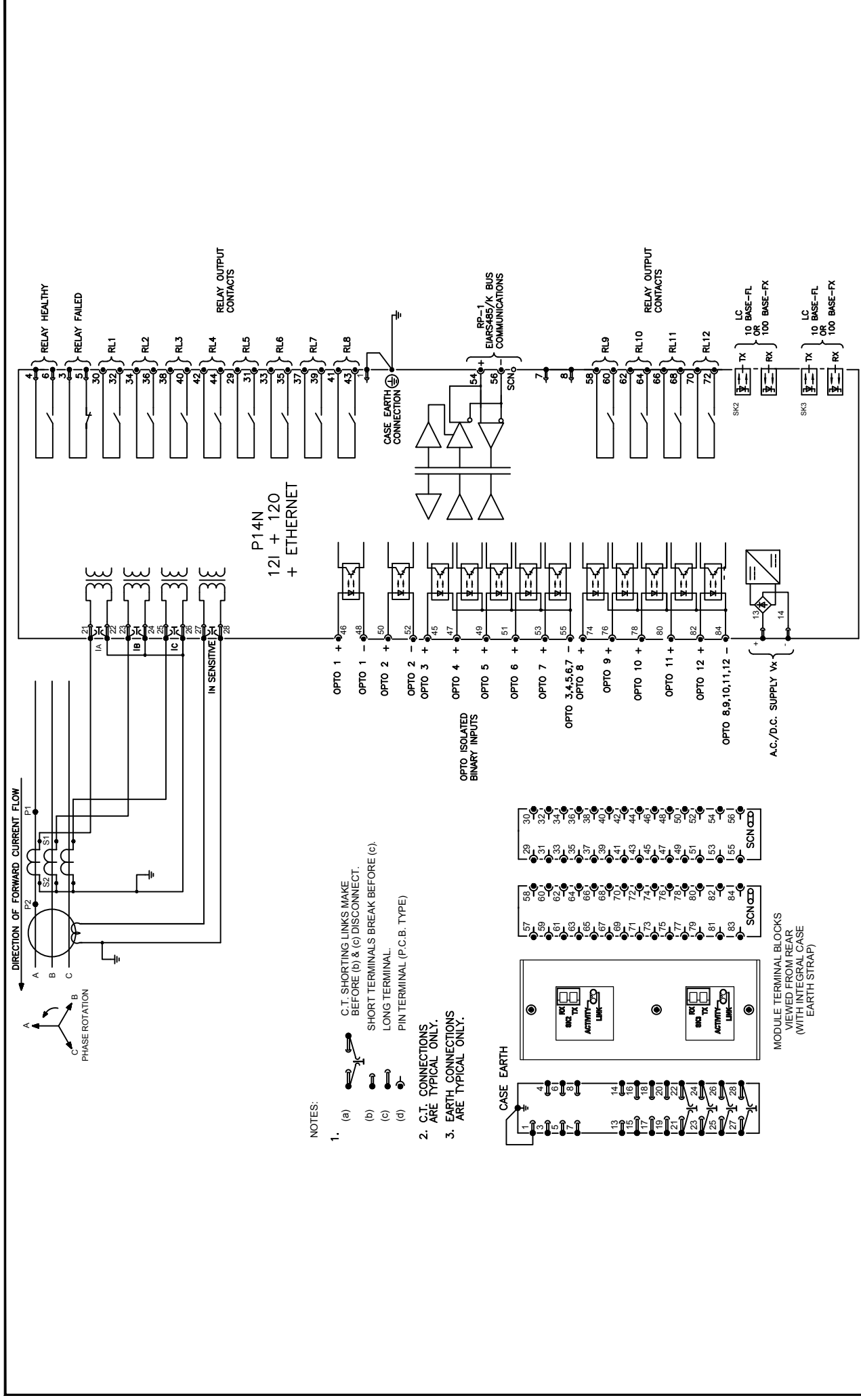A.C./D.C. SUPPLY Vx

NOTES:

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    (b)  SHORT TERMINALS BREAK BEFORE (c).
    (c)  LONG TERMINAL.
    (d)  PIN TERMINAL (P.C.B. TYPE)

2.  C.T. CONNECTIONS
    ARE TYPICAL ONLY.

3.  EARTH CONNECTIONS
    ARE TYPICAL ONLY.

MODULE TERMINAL BLOCKS
VIEWED FROM REAR
(WITH INTEGRAL CASE
EARTH STRAP)

SCN

CASE EARTH

Title: P14N NON DIRECTIONAL PHASE OVERCURRENT & EARTH FAULT (12 I/P & 12 O/P) & DUAL COPPER ETHERNET

Drg No: 10P14N16

Issue: C

Revision:
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Chkd: TEOH C.P.
Date:

DIRECTION OF FORWARD CURRENT FLOW

PHASE ROTATION

P14N
12I + 12O
+ ETHERNET

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RL4
RL5
RL6
RL7
RL8

RELAY OUTPUT CONTACTS

CASE EARTH CONNECTION

RP-1/
EIARS485/K BUS
COMMUNICATIONS
SCNo

RL9
RL10
RL11
RL12

RELAY OUTPUT CONTACTS

LC
10 BASE-FL
OR
100 BASE-FX
TX
RX
SK2

LC
10 BASE-FL
OR
100 BASE-FX
TX
RX
SK3

OPTO 1 +
OPTO 1 –
OPTO 2 +
OPTO 2 –
OPTO 3 +
OPTO 4 +
OPTO 5 +
OPTO 6 +
OPTO 7 +
OPTO 3,4,5,6,7 –
OPTO 8 +
OPTO 9 +
OPTO 10 +
OPTO 11 +
OPTO 12 +
OPTO 8,9,10,11,12 –

OPTO ISOLATED
BINARY INPUTS

A.C./D.C. SUPPLY Vx

NOTES:

1.
(a)    C.T. SHORTING LINKS MAKE
       BEFORE (b) & (c) DISCONNECT.
(b)    SHORT TERMINALS BREAK BEFORE (c).
(c)    LONG TERMINAL.
(d)    PIN TERMINAL (P.C.B. TYPE)

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    ARE TYPICAL ONLY.

3.  EARTH CONNECTIONS
    ARE TYPICAL ONLY.

MODULE TERMINAL BLOCKS
VIEWED FROM REAR
(WITH INTEGRAL CASE
EARTH STRAP)

CASE EARTH

Issue: C

Revision:
CID006234 Outlines updated to GE Format

Title: P14N NON DIRECTIONAL PHASE OVERCURRENT & EARTH
FAULT (12 I/P & 12 O/P) & DUAL FIBRE ETHERNET

Drg No: 10P14N16

Sht: 4
Next Sht: –

Date: 5/1/2020    Name: S.J.BURTON
Chkd: TEOH C.P.
Date:

P14N NON DIRECTIONAL PHASE OVERCURRENT & SEF (12 I/P & 12 O/P)

**Title:** P14N NON DIRECTIONAL PHASE OVERCURRENT & SEF (12 I/P & 12 O/P)

**Drg No:** 10P14N17

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RL4
RELAY OUTPUT CONTACTS
RL5
RL6
RL7
RL8

CASE EARTH CONNECTION

RP-1
EIARS485/K BUS COMMUNICATIONS
SCN

A.C./D.C. SUPPLY Vx

RL9
RL10
RL11
RL12
RELAY OUTPUT CONTACTS

P14N
12I + 12O

OPTO 1 +
OPTO 1 −
OPTO 2 +
OPTO 2 −
OPTO 3 +
OPTO 4 +
OPTO 5 +
OPTO 6 +
OPTO 7 +
OPTO 3,4,5,6,7 −
OPTO 8 +
OPTO 9 +
OPTO 10 +
OPTO 11 +
OPTO 12 +
OPTO 8,9,10,11,12 −

OPTO ISOLATED BINARY INPUTS

DIRECTION OF FORWARD CURRENT FLOW

IA
IB
IC
IN SENSITIVE

P1
S1
S2
P2
A
B
C

PHASE ROTATION

NOTES:
1. (a)  C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.
   (b)  SHORT TERMINALS BREAK BEFORE (c).
   (c)  LONG TERMINAL.
   (d)  PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS ARE TYPICAL ONLY.
3. CT/VT EARTH CONNECTIONS ARE TYPICAL ONLY.

CASE EARTH

MODULE TERMINAL BLOCKS VIEWED FROM REAR (WITH INTEGRAL CASE EARTH STRAP)

SCN

**Issue:** C

**Revision:** CID006234 Outlines updated to GE Format

**Date:** 5/1/2020  **Name:** S.J.BURTON

**Date:**  **Chkd:** TEOH C.P.

**Sht:** 1
**Next Sht:** 2

DIRECTION OF FORWARD CURRENT FLOW

PHASE ROTATION

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RL4
RL5
RL6
RL7
RL8

RELAY OUTPUT CONTACTS

CASE EARTH CONNECTION

RP-1
EIARS485/K BUS COMMUNICATIONS

RL9
RL10
RL11
RL12

RELAY OUTPUT CONTACTS

RJ45
10 BASE-T/
100 BASE-TX

TX+
TX-
RX+
RX-

LC
10 BASE-FL
OR
100 BASE-FX

TX
RX

P14N
12I + 12O
+ ETHERNET

IN SENSITIVE

OPTO 1 +
OPTO 1 -
OPTO 2 +
OPTO 2 -
OPTO 3 +
OPTO 4 +
OPTO 5 +
OPTO 6 +
OPTO 7 +
OPTO 3,4,5,6,7
OPTO 8 +
OPTO 9 +
OPTO 10 +
OPTO 11 +
OPTO 12 +
OPTO 8,9,10,11,12 -

OPTO ISOLATED BINARY INPUTS

A.C./D.C. SUPPLY Vx

NOTES:

1. (a)   C.T. SHORTING LINKS MAKE
    BEFORE (b) & (c) DISCONNECT.

(b)   SHORT TERMINALS BREAK BEFORE (c).

(c)   LONG TERMINAL.

(d)   PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS
  ARE TYPICAL ONLY.

3. EARTH CONNECTIONS
  ARE TYPICAL ONLY.

CASE EARTH

MODULE TERMINAL BLOCKS
VIEWED FROM REAR
(WITH INTEGRAL CASE
EARTH STRAP)

LINK
ACTIVITY
SIG
RX
SIG
TX
LINK
ACTIVITY

SCN
SCN

Title: P14N NON DIRECTIONAL PHASE OVERCURRENT
& SEF (12 I/P & 12 O/P) & ETHERNET

Drg No: 10P14N17

Sht: 2
Next Sht: 3

Issue: C

Revision: CID006234 Outlines updated to GE Format

Date: 5/1/2020   Name: S.J.BURTON
Date:   Chkd: TEOH C.P.

# P14N NON DIRECTIONAL PHASE OVERCURRENT & SEF (12 I/P & 12 O/P) & DUAL COPPER ETHERNET

**Title:** P14N NON DIRECTIONAL PHASE OVERCURRENT & SEF (12 I/P & 12 O/P) & DUAL COPPER ETHERNET

**Drg No:** 10P14N17

DIRECTION OF FORWARD CURRENT FLOW

PHASE ROTATION

P14N 12I + 12O + ETHERNET

RELAY HEALTHY
RELAY FAILED
RL1
RL2
RL3
RL4
RL5
RL6
RL7
RL8

RELAY OUTPUT CONTACTS

CASE EARTH CONNECTION

RP-1 / EIARS485/K BUS COMMUNICATIONS

RL9
RL10
RL11
RL12

RELAY OUTPUT CONTACTS

RJ45 10 BASE-T/ 100 BASE-TX
TX+ TX- RX+ RX-
SK2

RJ45 10 BASE-T/ 100 BASE-TX
TX+ TX- RX+ RX-
SK3

IA  IB  IC  IN SENSITIVE

OPTO ISOLATED BINARY INPUTS
OPTO 1 +
OPTO 1 –
OPTO 2 +
OPTO 2 –
OPTO 3 +
OPTO 4 +
OPTO 5 +
OPTO 6 +
OPTO 7 +
OPTO 3,4,5,6,7
OPTO 8 +
OPTO 9 +
OPTO 10 +
OPTO 11 +
OPTO 12 +
OPTO 8,9,10,11,12

A.C./D.C. SUPPLY Vx

MODULE TERMINAL BLOCKS VIEWED FROM REAR (WITH INTEGRAL CASE EARTH STRAP)

CASE EARTH

ACTIVITY / LINK

NOTES:

1.
(a) C.T. SHORTING LINKS MAKE BEFORE (b) & (c) DISCONNECT.
(b) SHORT TERMINALS BREAK BEFORE (c).
(c) LONG TERMINAL.
(d) PIN TERMINAL (P.C.B. TYPE)

2. C.T. CONNECTIONS ARE TYPICAL ONLY.

3. EARTH CONNECTIONS ARE TYPICAL ONLY.

**Issue:** C

**Revision:** CID006234 Outlines updated to GE Format

**Date:** 5/1/2020 **Name:** S.J.BURTON
**Chkd:** TEOH C.P.

Sht: 3 Next Sht: 4

DIRECTION OF FORWARD CURRENT FLOW

PHASE ROTATION

RELAY HEALTHY
RELAY FAILED

RELAY OUTPUT CONTACTS

RL1
RL2
RL3
RL4
RL5
RL6
RL7
RL8

CASE EARTH CONNECTION

RP-1 / K BUS
EIARS485/K BUS COMMUNICATIONS

SCNo

RELAY OUTPUT CONTACTS

RL9
RL10
RL11
RL12

SK2
LC
TX    10 BASE-FL
       OR
RX    100 BASE-FX

SK3
LC
TX    10 BASE-FL
       OR
RX    100 BASE-FX

P14N
12I + 12O
+ ETHERNET

IA
IB
IC
IN SENSITIVE

OPTO 1   +   46
OPTO 1   –   48
OPTO 2   +   50
OPTO 2   –   52
OPTO 3   +   45
OPTO 4   +   47
OPTO 5   +   49
OPTO 6   +   51
OPTO 7   +   53
OPTO 3,4,5,6,7   –   55
OPTO 8   +   74
OPTO 9   +   76
OPTO 10  +   78
OPTO 11  +   80
OPTO 12  +   82
OPTO 8,9,10,11,12  –   84

OPTO ISOLATED
BINARY INPUTS

A.c.,/D.C.  SUPPLY Vx

NOTES:

1.
(a)    C.T. SHORTING LINKS MAKE
       BEFORE (b) & (c) DISCONNECT.

(b)    SHORT TERMINALS BREAK BEFORE (c).

(c)    LONG TERMINAL.

(d)    PIN TERMINAL (P.C.B. TYPE)

2.  C.T. CONNECTIONS
    ARE TYPICAL ONLY.

3.  EARTH CONNECTIONS
    ARE TYPICAL ONLY.

CASE EARTH

MODULE TERMINAL BLOCKS
VIEWED FROM REAR
(WITH INTEGRAL CASE
EARTH STRAP)

SCN

SCN

Title: P14N NON DIRECTIONAL PHASE OVERCURRENT
& SEF (12 I/P & 12 O/P) & DUAL FIBRE ETHERNET

Drg No: 10P14N17

Sht: 4    Next Sht: –

Issue: C

Revision: CID006234 Outlines updated to GE Format

Date: 5/1/2020    Name: S.J.BURTON
Date:              Chkd: TEOH C.P.

# APPENDIX D

# VERSION HISTORY

# 1 HARDWARE AND SOFTWARE VERSION HISTORY

| S/W Version Major | S/W Version Minor | H/W Version | Original Date of Issue | Description of Changes | Technical Documentation |
|---|---|---|---|---|---|
| 50 | H | A | April 2013 | • Original Issue | TG8612C |
| 50 | J | A | June 2015 | • Fix for Error/Lockout 7104:2000/reboot<br>• IEC 61850 - Connection/Disconnection issues<br>• DNP3oE Versions - Courier Tunnelling does not work (AGP140-46)<br>• Ethernet application (IEC61850 + DNP3oe) crashes if a Courier tunnel is continuously opened/closed<br>• Object 0 variations: 219, 222, 245 and 247 are incorrect<br>• QNX kernel can delay user threads for up to 10ms<br>• IEC61850 Select Before Operate Incorrect Behaviour<br>• With e-terra SCADA system, the P40 Agile data model extraction stops at Measurements/PriFouMMXU1$CF<br>• Unextracted events are lost on RP1, following relay reboot, using a DNPOE build<br>• Incorrect response to Object 2 Variation 3 request for Binary Input Event with Relative Time<br>• IEEE Floats are wrong at MODBUS interface<br>• Downloading a settings file reverts settings temporarily to setting group 1<br>• P94V operation on UF<br>• DNP3OE Versions - Command management during IED disconnection/connection<br>• CB Fail trip may fail to operate under faults with DC transient offsets<br>• IEC 61850 Client disassociation while reading PloGGIO1$CO block in P14D IEDs<br>• IEC61850 Measurements negative values rounding error<br>• Agile latch reset when setting group is changed<br>• Undervoltage programmable curve not using standard template used by other Px4x relays<br>• The VCO Status, cell [3582], for the Voltage Controlled Overcurrent isn't updated after a change. The change takes effect after a power cycle or change to V Dep OC V<1 Set<br>• ISEF, IEF and anything related are not scaled properly when the CT ratio is 5A<br>• EF directional function failed to trip<br>• Fix for P14DH 53A IEC61850-8-1 Level B Conformance Issue | P14D-B/G/L/Z-TM-EN-1<br>P14N-B/Z-TM-EN-1<br>P94V-B/P-TM-EN-1 |
| 50 | K | A | April 2016 | • DNPoE Application stops running after many days of Polling<br>• DNPOE: After multiple DI and AI events at the same time, the relay Ethernet board seems locked<br>• FA Steady Fault - Incorrect Assertion<br>• P14DZ HiF Function asserting incorrectly (CHA HiF)<br>• Incorrect Burst Count - HiF Detection<br>• High Impedance Fault maloperation<br>• HIF CHA Hysteresis is not correctly set<br>• HIF Burst Threshold is not reset after the adaptive threshold is disabled | |

| S/W Version Major | S/W Version Minor | H/W Version | Original Date of Issue | Description of Changes | Technical Documentation |
|---|---|---|---|---|---|
| 50 | L | A | April 2017 | • Permanent ethernet communication loss in P40 Agile relays<br>• Maintenance record generated every time Gateway is configured in DNP configuration<br>• CS1 and CS2 does not work independently when CB Comp enabled for CS2 | |
| 50 | M | A | March 2018 | • Flash change due to obsolescence | |
| 51 | A | A | September 2013 | • Ethernet Enhancements for the P94V<br>• New model P14DA<br>• Neutral Admittance Protection for the P14DL and P14DZ<br>• Selectable Measured/Derived NVD<br>• Undervoltage programmable curve not using standard template used by other Px4x relays<br>• With e-terra SCADA system, the P40 Agile data model extraction stops at Measurements/PriFouMMXU1$CF<br>• When using SBOns control model for the data 'Control/XCBR1$CO$Lock' and both Check Conditions are set the Agile relay is dropping the connection to the client<br>• DNP ALSTOM rebranding in dnpev_devattr.h<br>• Unextracted events are lost on RP1, following relay reboot, using a DNPoE build<br>• Incorrect response to Object 2 Variation 3 request for Binary Input Event with Relative Time<br>• ISEF, IEF and anything related are not scaled properly when the CT ratio is 5A<br>• IEEE Floats are wrong at MODBUS interface<br>• Ethernet application (IEC61850 + DNP3oE) stops running if a Courier tunnel is continuously opened/closed (as done by S1 Agile Measurements viewer) | P14D-TM-EN-1<br>P14N-TM-EN-1<br>P94V-TM-EN-1 |
| 51 | B | A | November 2013 | • EF directional function fail to trip<br>• The VCO Status, cell [3582], for the Voltage Controlled Overcurrent isn't updated after a change. The change takes effect after a power cycle or change to V Dep<br>• Object 0 variations: 219, 222, 245 & 247 are incorrect | P14D-TM-EN-1<br>P14N-TM-EN-1<br>P94V-TM-EN-1 |
| 51 | C | A | June 2014 | • PWM duty cycle change for opto input drive circuit | |
| 51 | D | A | March 2018 | • Flash change due to obsolescence | |
| 52 | B | A | November 2013 | • Chinese HMI added<br>• The DDB 1599-1798 display "PSL internal 001-200", but DDB 923-1022 still display "PSL internal 001- 100". Have duplicate content.<br>• The VCO Status isn't updated after a change. The edited change does take effect after a power-cycle or a change to "V Dep OC V<1 Set" cell 3583<br>• Object 0 variations: 219, 222, 245 and 247 are incorrect | P14D-TM-EN-1<br>P14N-TM-EN-1<br>P94V-TM-EN-1 |
| 52 | C | A | March 2018 | • Flash change due to obsolescence | |
| 53 | A | A | April 2014 | • Add P14DH variant with Wattmetric Directional Earthfault protection<br>• The .lng files generated by building and the .LNG files used by S1 Agile are inconsistent<br>• Incorrect Russian translations for DDB_CONTROL_TRIP & DDB_CONTROL_CLOSE | P14D-TM-EN-3<br>P14N-TM-EN-3<br>P94V-TM-EN-3 |

| S/W Version Major | S/W Version Minor | H/W Version | Original Date of Issue | Description of Changes | Technical Documentation |
|---|---|---|---|---|---|
| 53 | A | A | April 2014 | ▪ Fix for P14DH 53A IEC61850-8-1 Level B Conformance Issue<br>▪ Inconsistent language text strings between P40Agile and P14x | P14D-TM-EN-3<br>P14N-TM-EN-3<br>P94V-TM-EN-3 |
| 53 | B | A | April 2014 | ▪ CB Fail trip may fail to operate under faults with DC transient offsets<br>▪ Integrate new FPGA version | P14D-TM-EN-3<br>P14N-TM-EN-3<br>P94V-TM-EN-3 |
| 53 | C | A | April 2014 | ▪ Fix for Error/Lockout 7104:2000/reboot<br>▪ The LCD display year is 2080 but in the disturbance and event records it is 1980<br>▪ Using S1 Agile changing values to the Voltage Transformer does not change the corresponding values in Residual O/V NVD column<br>▪ Line length mismatch between value sent from S1 Agile and the value received in the relay<br>▪ DNP3oE Setting Files - GoEna is visible<br>▪ Values under High impedance menu do not show values in primary when relay is set to primary in S1 | P14D-TM-EN-3<br>P14N-TM-EN-3<br>P94V-TM-EN-3 |
| 53 | D | A | August 2015 | ▪ Very sharp pick current level lead relay tripping on IREF | |
| 53 | E | A | April 2017 | ▪ IEC 61850 - Connection/Disconnection issues<br>▪ DNP3oE Versions - Courier Tunnelling does not work<br>▪ DNPOE: After multiple DI and AI events at the same time, the relay Ethernet board seems locked<br>▪ DNPoE Application stops running after many days of Polling<br>▪ Permanent ethernet communication loss in P40 Agile relays<br>▪ TCP disrupts after around 206 days of continuous use<br>▪ P14DZ HiZ Function asserting incorrectly (CHA HiF)<br>▪ Incorrect Burst Count - HiF Detection<br>▪ HiF FA Steady Fault - Incorrect Assertion<br>▪ HIF CHA Hysteresis is not correctly set<br>▪ HIF Burst Threshold is not reset after the adaptive threshold is disabled<br>▪ Maintenance Record generated everytime Gateway is configured in DNP configuration<br>▪ CS1 and CS2 does not work independently whey CB Comp enabled for CS2 | |
| 53 | F | A | April 2018 | ▪ Flash change due to obsolescence | |
| 54 | A | A | December 2014 | ▪ New opto threshold for Russian requirement<br>▪ New reduced I/O option (3I/4O in 20TE and 6I/8O in 30TE)<br>▪ IEC 61850 client disassociation while reading PloGGIO1$CO block in P14D IEDs<br>▪ IEC 61850 incorrect Courier cell mapping to TotWh and TotVArh in MMTR LNs<br>▪ IEC61850 measurements negative values rounding error | P14D-TM-EN-4.1<br>P14N-TM-EN-4.1<br>P94V-TM-EN-4.1 |

| S/W Version Major | S/W Version Minor | H/W Version | Original Date of Issue | Description of Changes | Technical Documentation |
|---|---|---|---|---|---|
| 54 | B | A | April 2015 | ▪ Agile Relay failure: Error/Lockout 7104:2000/reboot<br>▪ The LCD display year is 2080 but in the disturbance and event records it is 1980<br>▪ Using S1 Agile changing values to the Voltage Transformer does not change the corresponding values in Residual<br>▪ O/V NVD column<br>▪ Line length mismatch between value sent from S1 Agile and the value received in the relay<br>▪ DNP3oE Setting Files - GoEna is visible<br>▪ Values under high impedance menu do not show values in primary when relay is set to primary in S1 | P14D-TM-EN-4.1<br>P14N-TM-EN-4.1<br>P94V-TM-EN-4.1 |
| 54 | C | A | April 2017 | ▪ IEC 61850 - Connection/Disconnection issues<br>▪ DNP3oE Versions - Courier Tunnelling does not work<br>▪ DNPoE: After multiple DI and AI events at the same time, the relay Ethernet board seems locked<br>▪ Permanent Ethernet communication loss in P40 Agile relays<br>▪ TCP disrupts after around 206 days of continuous use<br>▪ P14DZ HiZ Function asserting incorrectly (CHA HiF)<br>▪ Incorrect Burst Count - HiF Detection<br>▪ FA Steady Fault - Incorrect Assertion<br>▪ HIF CHA Hysteresis is not correctly set<br>▪ HIF Burst Threshold is not reset after the adaptive threshold is disabled<br>▪ Maintenance Record generated every time Gateway is configured in DNP configuration | |
| 54 | D | A | April 2018 | ▪ Flash change due to obsolescence | |
| 55 | A | A | November 2015 | ▪ CS1 and CS2 does not work independently whey CB Comp enabled for CS2<br>▪ To retrofit legacy products KAVR100, KAVS and KVTR<br>▪ Pin to pin retrofit solution for KMPC130<br>▪ Compliance to CEI 0-16 requirements in P14D/P94V<br>▪ New communication protocol options - 1) IEC61850 over Ethernet + MODBUS via RS485, 2) IEC 61850 over Ethernet + DNP3.0 via RS485<br>▪ Settable k factor in Thermal overload<br>▪ Fault locator setting improvements<br>▪ Earth Fault (EF1) setting 10mA minimum threshold<br>▪ DNP3.0 Unsolicited message reporting<br>▪ PSL timer setting<br>▪ New extra shorting link ordering option – for capacitor cone NVD application & alarm on IED removal<br>▪ Compliance to Russian Rosseti requirements<br>▪ NCIT column visibility incorrect.<br>▪ Write 'AAAA' into cell 0x0002 failed with a reply code 05(CS103_GRC_SETTING_OUT_OF_RANGE)<br>▪ Generated MICS document for IEC 61850 protocol contains 'IEC61850' instead of 'IEC 61850'. | P14D-TM-EN-5<br>P14N-TM-EN-5<br>P94V-TM-EN-5 |

| S/W Version Major | S/W Version Minor | H/W Version | Original Date of Issue | Description of Changes | Technical Documentation |
|---|---|---|---|---|---|
| 55 | A | A | November 2015 | • Status report over IEC61850 not in line with DDB signals<br>• actVal Data Attribute now finalised as INT32 requirement in SCL (Edition 1 Only)<br>• Values under High impedance menu do not show values in primary when relay is set to primary in S1<br>• Pending Reports when BufTm>0? Ed1<br>• Agile latch reset when setting group is changed<br>• Connection/Disconnection issues<br>• Class 0 should be configurable to select either Counter or corresponding Frozen Counter<br>• DNP3oE Versions - Courier Tunnelling does not work<br>• For DNPOE build, the frozen counter always keeps the same value with the static counter without accepting a Freeze command<br>• The behaviour of frozen counter is different between DNP3 and DNPOE before the freeze command is sent<br>• DNPoE: After multiple DI and AI events at the same time, the relay Ethernet board seems locked<br>• IEC 61850 Interoperability problem when a client writes to any/all unsupported Trigger Options<br>• ICD file corrections<br>• 8.333Hz is displayed in the first generated Fault Record after relay reboot<br>• Underfrequency function enhancements and fixes<br>• SecRmsMMXU1 showing values in primary, not secondary<br>• IEC 61850: incorrect Courier cell mapping to TotWh and TotVArh in MMTR LNs<br>• CB Fail trip may fail to operate under faults with DC transient offsets<br>• "FUNCTION KEYS" column is visible for 20TE devices in P14 Agile data model<br>• Default GOOSE "Min Cycle Time" is wrong<br>• Visibility of setting "I>1 TMS" and "I>1 Time Dial" is wrong in Group 2<br>• EPATR-B curve<br>• High Impedance Fault issue<br>• DNP3OE Versions - Command management during IED disconnection/connection<br>• Freq Avg Cycles & df/dt Avg Cycles should use power cycle instead of PCON calls cycles<br>• The unit of Records/RFLO1/CF/FltDiskm is incorrect<br>• Very sharp pick current level lead relay tripping on IREF<br>• The error message" Runtime Error C991:3011" appears on P14N relay when viewing the cells in overcurrent column from HMI<br>• Column [4E00] PSL TIMERS is invisible from relay<br>• Default Setting of Relay is in-consistent to Look & Feel<br>• P94VR Look & Feel consistency check issues via courier interface<br>• "Ethernet failover" option displays in IED Configurator<br>• New settings Moving average cells ([42 41] -> [42 2D]) are not working in MODBUS<br>• When downloading firmware to the P14DZ relay and power cycling, error message - "Runtime Error 2e0b:0101" appears and relay reboots | P14D-TM-EN-5<br>P14N-TM-EN-5<br>P94V-TM-EN-5 |

| S/W Version Major | S/W Version Minor | H/W Version | Original Date of Issue | Description of Changes | Technical Documentation |
|---|---|---|---|---|---|
| 55 | A | A | November 2015 | ▪ Language translations of all new DDBs and settings are in English apart from French<br>▪ The display of the cell [0341][0345][0347][0343] misses a sign minus on MODBUS protocol, and the value of new adding cells can't be taken<br>▪ SecAvgMSTA.Volts4.rang.max.f is not configurable<br>▪ The IEC61850 communication disconnect when BRCB with special configuration is Enabled<br>▪ Trip elements 5 is missing in fault record of DNP protocol<br>▪ CTS operations when [4609] CTS VN< Inhibit is not satisfied<br>▪ Command "Reset Total Autoreclosures" is missing for P94VR DNP Object 10<br>▪ DNP Binary Input 42 and Binary Input 299 could not be set when DDB 167 "UV Block" is ON<br>▪ Wrong DDB mapping for DA VtpAvgPTOV2.Str.PhsC<br>▪ When browsing Fault Record from HMI, Avg O/V Start operates unexpectedly when AVG OVER VOLT protection is disabled<br>▪ FUN number should be 164 instead of 162 for DDB #549 "dv/dt2 StartA/AB" in L & F "IEC60870-5-103" spread sheet<br>▪ MODBUS address of all DDBs in "Alarm status 2" and "Alarm status 3" are incorrect<br>▪ Menu text errors in 55A version<br>▪ Look & Feel Start Elements, Trip Elements available options, "Fault Record" spread sheet need update<br>▪ Data Group MODBUS missing, MODBUS Number of steps shift from cell [420D] V<3 Function to [4211] V<3 Poledead Inh in Look & Feel<br>▪ Max value 10Hz could not be set to cells f+Df/Dt x Dfreq(x=1 to 9) via MODBUS protocol<br>▪ The mapping "Measurements/SecMSTA1$MX$AvVAr3$mag$f" was wrong, mapping corrected to the cell [0342]("+3Ph VAr Fix Dem")<br>▪ The new Average voltage protections keep running even if 091D is disabled<br>▪ FAULT RECORD Start CN and Trip CN are missing from UI when two stages of average voltage protections are both enabled in case of three phase faults<br>▪ BRCB - Wrong response when client sets an unknow EntryID value before enable it<br>▪ DO sequence error in ICD file<br>▪ MODBUS Start, Data Group MODBUS, MODBUS Number of steps, MODBUS registers are incorrect for Frequency Protection Stage 9 cells in L&F<br>▪ In Unsolicited mode, the measured unsolicited response time is 5s greater than the setting [1B 04] - "Unso Response" value<br>▪ The cell text of these cells [4201][4220][4240][4250] are not consistent with look&feel file<br>▪ The cell [30 11] Dir Char Setting exist in P94VR<br>▪ MODBUS address error in L&F for cell [03 28] ~ [03 2D]<br>▪ Missing translation for DDB (ordinal:1799-1842) in Look & Feel file<br>▪ The "ASDU Type" in "Fault Record" that's extracted by Px40VDEW is not consistent with look & feel file<br>▪ The format of Build Date&Time is not correct | P14D-TM-EN-5<br>P14N-TM-EN-5<br>P94V-TM-EN-5 |

| S/W Version Major | S/W Version Minor | H/W Version | Original Date of Issue | Description of Changes | Technical Documentation |
|---|---|---|---|---|---|
| 55 | B | A | October 2016 | ▪ The values of DDBs (1717~1720) read via IEC61850 cannot be updated after downloading the new PSL<br>▪ The fault record can't be extracted via CS103 protocol if the previous fault record terminated by "Reset CU"<br>▪ DNPoE Application crash after many days of Polling<br>▪ Ethernet communication loss in P40 Agile relays<br>▪ After enabling the BRCB, the first integrity report comes out around 10s when the integrity time is set to be 3s under certain pre-steps<br>▪ Incorrect Burst Count - HiF Detection<br>▪ FA Steady Fault - Incorrect Assertion<br>▪ HIF CHA Hysteresis is not correctly set<br>▪ HIF Burst Threshold is not reset after the adaptive threshold is disabled | |
| 55 | C | A | April 2018 | ▪ Flash change due to obsolescence | |
| 56 | A | A | February 2016 | ▪ PRP/HSR/FailOver redundancy (new hardware boards) Configurable Fail-over in DNP3<br>▪ DDB 781/782 doesn't show the real status when the alarm "Port A Link Fail" or "Port B Link Fail" show in HMI<br>▪ The status of DDB 783 is "OFF" issue | P14D-TM-EN-6.1<br>P14N-TM-EN-6.1<br>P94V-TM-EN-6.1 |
| 56 | B | A | October 2016 | ▪ Ethernet communication lost after some time when deadbands for reporting set very small<br>▪ Maintenance record generated every time gateway is configured in DNP3.0 configuration<br>▪ CS1 and CS2 does not work independently whey CB Comp enabled for CS2 | |
| 56 | C | A | June 2017 | ▪ HiF Function enhancements<br>▪ DNP3oE enhancements | |
| 56 | D | A | March 2018 | ▪ Flash change due to obsolescence | |
| 57 | A | A | May 2015 | ▪ RSTP redundancy (new hardware boards)<br>▪ PCCN/Electre features<br>▪ Enhancements for Italy CEI 0-16<br>▪ Fix for DNP3 memory leak<br>▪ The values of DDBs (1717~1720) read via IEC61850 cannot be updated after downloading the new PSL<br>▪ The fault record can't be extracted via CS103 protocol if the previous fault record terminated by "Reset CU"<br>▪ DNP Over Ethernet Application stops running after many days of Polling<br>▪ DDB #146 "Prot'n Disabled" events are read as "test mode" via CS103 protocol.<br>▪ The new under voltage Average voltage protections doesn't use POLEDEAD similar to the standard under voltage<br>▪ Ext AR SEF Trip could not block AR when [493F] SEF Ext Prot is set to "Block AR".<br>▪ The VTS Fast Block can not block the AVG undervoltage;AVG overvoltage;AVG ZERO SEQ O/V;AVG POS SEQ O/V and AVG NEG SEQ O/V<br>▪ DDB #167 UV Block should not be visible on P14DA | P14D-TM-EN-7<br>P14N-TM-EN-7<br>P94V-TM-EN-7 |

| S/W Version Major | S/W Version Minor | H/W Version | Original Date of Issue | Description of Changes | Technical Documentation |
|---|---|---|---|---|---|
| 57 | A | A | May 2015 | ▪ After enabling the BRCB, the first integrity report comes out around 10s when the integrity time is set to be 3s under certain pre-steps<br>▪ IEC 61850 client sets unsupported TrgOps must have response+ (Tissue 780)<br>▪ Incorrect Burst Count - HiF Detection<br>▪ FA Steady Fault - Incorrect Assertion<br>▪ HIF CHA Hysteresis is not correctly set<br>▪ HIF Burst Threshold is not reset after the adaptive threshold is disabled | |
| 57 | B | A | April 2017 | ▪ Ethernet communication loss in P40 Agile relays<br>▪ Maintenance Record Generated every time Gateway is configured in DNP configuration | |
| 57 | C | A | March 2018 | ▪ Flash change due to obsolescence | |
| 60 | A | A | December 2016 | CLONE - CS1 and CS2 does not work independently whey CB Comp enabled for CS2<br>▪ Voltage vector shift<br>▪ Switch Status and control<br>▪ IEC61850 Fault Records<br>▪ Code Review Report - Bad task priority change in DSP DTC transmit task<br>▪ Permanent ethernet communication loss in P40 Agile relays<br>▪ DDB #146 ""Prot'n Disabled"" events are read as ""test mode"" via CS103 protocol<br>▪ No events read from CS103 protocol for DDB #441 ""Test Mode"", DDB #771 ""GOOSE IED Absent"", DDB #780<br>▪ ""IP Addr Conflict"", DDB #1200 ""Monitor bit 1"" to DDB #1207 ""Monitor bit 8""<br>▪ RSTP is non-responsive at 10Mbps<br>▪ Output relay RL1 contact does not persist on P14DH model after reboot | P14D-TM-EN-8<br>P14N-TM-EN-8<br>P94V-TM-EN-8 |
| 60 | B | A | March 2018 | ▪ Flash change due to obsolescence | |
| 61 | A | A | April 2017 | Introduction of 40TE models<br>▪ TEFD new algorithm<br>▪ Vn input implementation change<br>▪ New In RMS measurement<br>▪ 64 Virtual Inputs<br>▪ Editable user alarms<br>▪ Maintenance Record Generated Every time Gateway is configured in DNP configuration<br>▪ CS1 and CS2 does not work independently whey CB Comp enabled for CS2 | P14D-TM-EN-9 |
| 61 | B | A | November 2017 | P40 Agile Motor release<br>▪ Fix for SEF Directional protection working when multiple stages activated | P14D-TM-EN-9<br>P14N-TM-EN-9<br>P94V-TM-EN-9<br>P24xM-TM-EN-1 |

| S/W Version Major | S/W Version Minor | H/W Version | Original Date of Issue | Description of Changes | Technical Documentation |
|---|---|---|---|---|---|
| 61 | C | A | March 2018 | Flash change due to obsolescence | |
| 61 | D | A | February 2019 | ▪ DDR clock synchronization activation<br>▪ Fix for communication loss in DNPoE<br>▪ Fix for IEC103 communication stops and relay reboot<br>▪ Fix for DNP3 memory leak | |
| 62 | A | A | September 2018 | ▪ Concurrent Ethernet protocol support: IEC61850 and DNPoE in Feeder and Motor models<br>▪ Fix for unexpected behaviour when 103 communication is active and a protection function is triggered<br>▪ Fix for DNP3 memory leak | P14D-TM-EN-10.1<br>P14N-TM-EN-10.1<br>P94V-TM-EN-10.1<br>P24xM-TM-EN-2 |
| 62 | B | A | February 2019 | ▪ DDR clock synchronization activation | |
| 62 | C | A | April 2019 | ▪ Fix for overfrequency element - Maloperation with normal frequency when specific harmonics are present<br>▪ Fix for frequency protection element - zero crossing algorithm weakness | |
| 62 | D | A | October 2019 | ▪ Fix for reboots/lockouts caused by I/O maintenance records<br>▪ Fix for DNP3.0 Communication: When sending an Assign Class request immediately followed by a Class poll relay reboots | P14D-TM-EN-10.2<br>P14N-TM-EN-10.2<br>P94V-TM-EN-10.2 |
| 62 | F | A | January 2021 | ▪ Enhancement: All models updated to meet new IEC61850 Ed1 certification requirements<br>▪ Fix for manual reset latches causing logic to remain high after power cycle<br>▪ Fix for IRIG-B status: DNP3 Data point not updating & relay Event Missing for "No Signal"<br>▪ When self-test routine detects an internal power failure, a restart happens and output relays will be disabled-fixed<br>▪ Fix for Events corruption involving S1 Agile crash when trying to extract events<br>▪ Fix for corrupted RSTP FPGA bin file replaced with the correct one<br>▪ Fix for DNPoE counters issue<br>▪ IEC61850 stack resized (was producing errors 0x0B0903BB & 0xFFF2) | |
| 62 | G | A | January 2022 | ▪ Fix for Cyber security vulnerability on TMW Library for DNP3.0<br>▪ Fix for P14DL- Out of Service flag Set in RP1 Courier Communication when Relay is Healthy<br>▪ Fix for Cold Load Pick-up when enabled, it's blocking "inhibiting" PWH<br>▪ NAND Flash change due to obsolescence | |
| 64 | A | A | October 21 | ▪ Enhancement: PTP Time synchronization support<br>▪ Enhancement: Max fault current data in fault records<br>▪ Enhancement: PWH In derived option<br>▪ Enhancement: SNTP fail alarm in Alarms and IEC61850<br>▪ Enhancement: Adding password level control for HMI default screens<br>▪ Goose enhancement & optimized Goose configuration<br>▪ Improvement in DT timer hysteresis behaviour | P14D-TM-EN-12<br>P14N-TM-EN-12<br>P94V-TM-EN-12<br>P24xM-TM-EN-2.1 |

| S/W Version Major | S/W Version Minor | H/W Version | Original Date of Issue | Description of Changes | Technical Documentation |
|---|---|---|---|---|---|
| 64 | A | A | October 21 | ▪ Fix for Low impedance REF tripping incorrectly<br>▪ Fix for Cold Load Pick-up when enabled, it's blocking "inhibiting" PWH<br>▪ Fix for DNPOE communication which fails when Counter points are configured<br>▪ Fix for Cyber security vulnerability on TMW Library for DNP3.0 | P14D-TM-EN-12<br>P14N-TM-EN-12<br>P94V-TM-EN-12<br>P24xM-TM-EN-2.1 |
| 64 | B | A | January 22 | ▪ NAND Flash change due to obsolescence | |
| 70 | B | A | March 2021 | ▪ Enhancement: P14DL compliance with IEC61850 Ed2 for 2 communication protocols: 61850 & 61850 + IEC103<br>▪ Enhancement: RcdMade as Transient data point<br>▪ Fix for manual reset latches cause logic to remain high after power cycle<br>▪ Fix for incorrect values reported to MODBUS Master Station<br>▪ Fix for Low impedance REF trips incorrectly when phase CT saturates heavily<br>▪ Fix for GOOSE schemes which do not work with more than 32 APPID | P14DEd2-TM-EN-11 |
| 70 | C | A | June 2023 | ▪ Enhancement: P14NB and P94VR compliance with IEC61850 Ed2 for 2 communication protocols: 61850 & 61850 + IEC103<br>▪ Enhancement: Additional communication option support in P14DL model<br>▪ New NAND Flash driver due to obsolescence<br>▪ Fix for IRIG-B status not updating correctly in DNP3.0<br>▪ Fix for DNPOE communication, which fails when counter points are configured<br>▪ Fix for Out of Service flag Set in RP1 Courier Communication when Relay is Healthy<br>▪ Fix for RSTP communication issues<br>▪ Fix for relay reboot caused while modifying UI settings | P14DEd2-TM-EN-11.2<br>P14NEd2-TM-EN-13<br>P94VEd2-TM-EN-13 |

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