GE
Grid Solutions

MiCOM P40 Agile

Px4x-92LE

Technical Manual
IEC 61850-9-2LE Interface

Hardware Version: A
Software Version: P441SV v80, (P442/P444 v71 & 82), (P446/P546 v74 & v80), (P645SV v12 & v20), P743 v60, P746 v12, P841B v74
Publication Reference: Px4x-92LE-TM-EN-4

Contents

CHAPTER 1

INTRODUCTION

1 CHAPTER OVERVIEW

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

This chapter contains the following sections:

2 FOREWORD

This technical manual provides a functional and technical description of GE's Px4x-92LE, as well as a comprehensive set of instructions for using the device. The level at which this manual is written assumes that you are already familiar with protection engineering and have experience in this discipline. The description of principles and theory is limited to that which is necessary to understand the product. For further details on general protection engineering theory, we refer you to GE's publication, Protection and Automation Application Guide, which is available online or from our Contact Centre.

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

All feedback should be sent to our contact centre via:

contact.centre@ge.com

3 PRODUCT SCOPE

The IEC 61850-9-2LE interface board assures communication with compliant Merging Units (MU). To order an IEC 61850-9-2LE version of the IED, see the relevant option in the IED's Cortec.

4 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.

CHAPTER 2

HARDWARE DESIGN

1 CHAPTER OVERVIEW

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

This chapter contains the following sections:

2 LIST OF BOARDS

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

Board	Use
Main Processor board - 40TE or smaller	Main Processor board – without support for function keys
Main Processor board - 60TE or larger	Main Processor board – with support for function keys
Power supply board - 24/54V DC	Power supply input. Accepts DC voltage between 24V and 54V
Power supply board - 48/125V DC	Power supply input. Accepts DC voltage between 48V and 125V
Power supply board - 110/250V DC	Power supply input. Accepts DC voltage between 110V and 125V
Transformer board	Contains the voltage and current transformers
Input board	Contains the A/D conversion circuitry
Input board with opto-inputs	Contains the A/D conversion circuitry + 8 digital opto-inputs
IRIG-B board - modulated input	Interface board for modulated IRIG-B timing signal
IRIG-B board - demodulated input	Interface board for demodulated IRIG-B timing signal
Fibre board	Interface board for fibre-based RS485 connection
Fibre board + IRIG-B	Interface board for fibre-based RS485 connection + demodulated IRIG-B
2nd rear communications board	Interface board for RS232 / RS485 connections
2nd rear communications board with IRIG-B input	Interface board for RS232 / RS485 + IRIG-B connections
High-break output relay board	Output relay board with high breaking capacity relays
Redundant Ethernet RSTP + PRP + HSR + Failover universal IRIG-B	Redundant Ethernet running RSTP + PRP + HSR + Failover (two fibre pairs), with on-board universal IRIG-B
Redundant Ethernet RSTP + PRP + HSR + Failover universal IRIG-B	Redundant Ethernet running RSTP + PRP + HSR + Failover (two copper pairs), with on-board universal IRIG-B
Redundant Ethernet RSTP + PRP + HSR + Failover universal IRIG-B	Redundant Ethernet running RSTP + PRP + HSR + Failover (one copper, one multi-mode fibre), with on-board universal IRIG-B
Output relay output board	Standard output relay board
Redundant Ethernet PRP + Failover IEC 61850-9-2LE	Redundant Ethernet for IEC 61850-9-2LE process bus running PRP + Failover (two multi-mode fibre)

3 REDUNDANT IEC61850-9-2LE BOARD

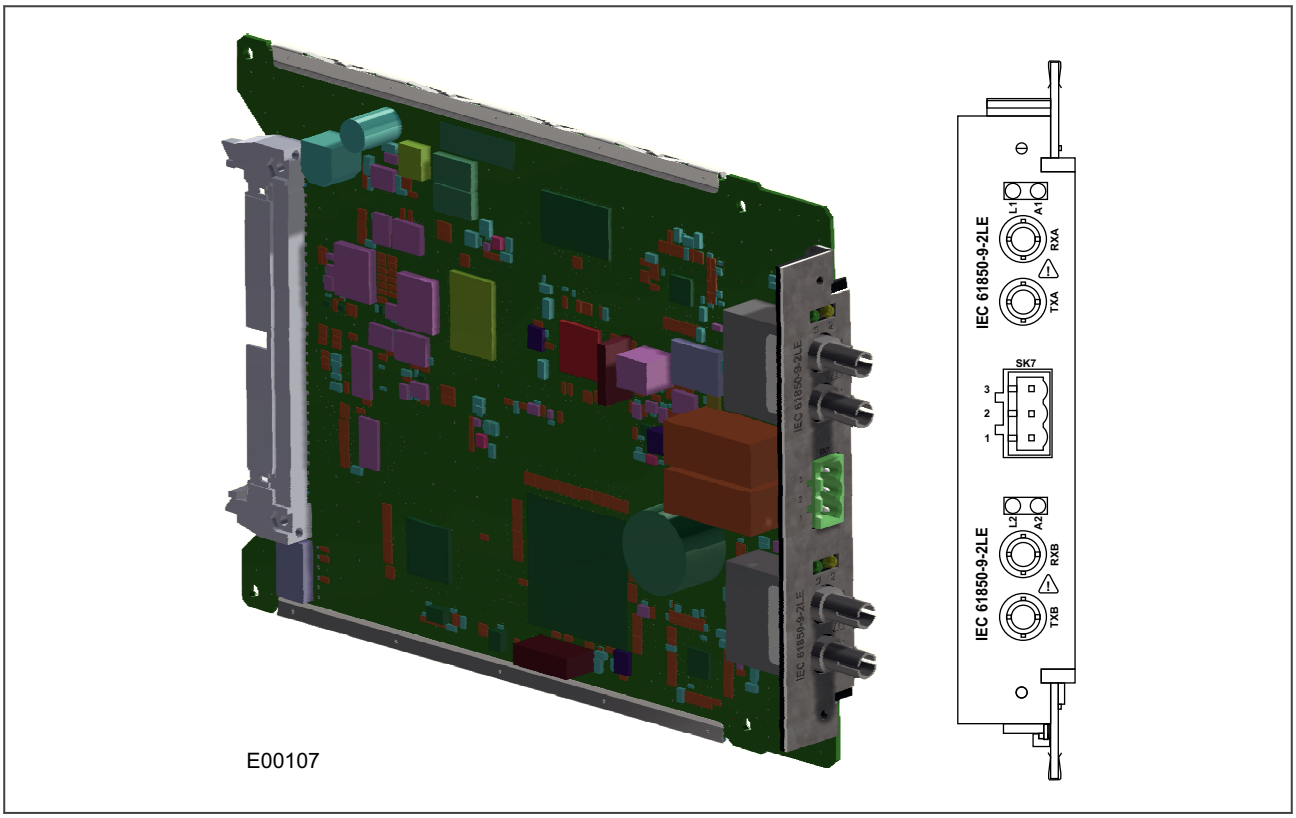


Figure 1: Redundant IEC 61850-9-2LE board

This board provides dual redundant Ethernet for IEC 61850-9-2LE process bus. The PRP and Failover redundancy protocols are supported.

Optical Fibre Connectors

The board uses 1300 nm multi mode 100BaseFx with ST connectors.

SK7 Connector

This is a service port for commissioning and testing only. Do not use this for permanent connections.

LEDs

LED	Function	On	Off	Flashing
Green	Link	Link ok	Link broken	
Yellow	Activity			Traffic

Note:
The 9-2LE interface fibre port does not support auto negotiation. Ensure the Ethernet port of the device connected to the 9-2 LE interface fibre port is set to 100Mbps full duplex.

4 REAR PANEL

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

The back panel cut-outs and slot allocations vary. This depends on the product, the type of boards and the terminal blocks needed to populate the case. The following diagram shows a typical rear view of a case populated with various boards. The IEC 61850-9-2LE interface is highlighted in grey.

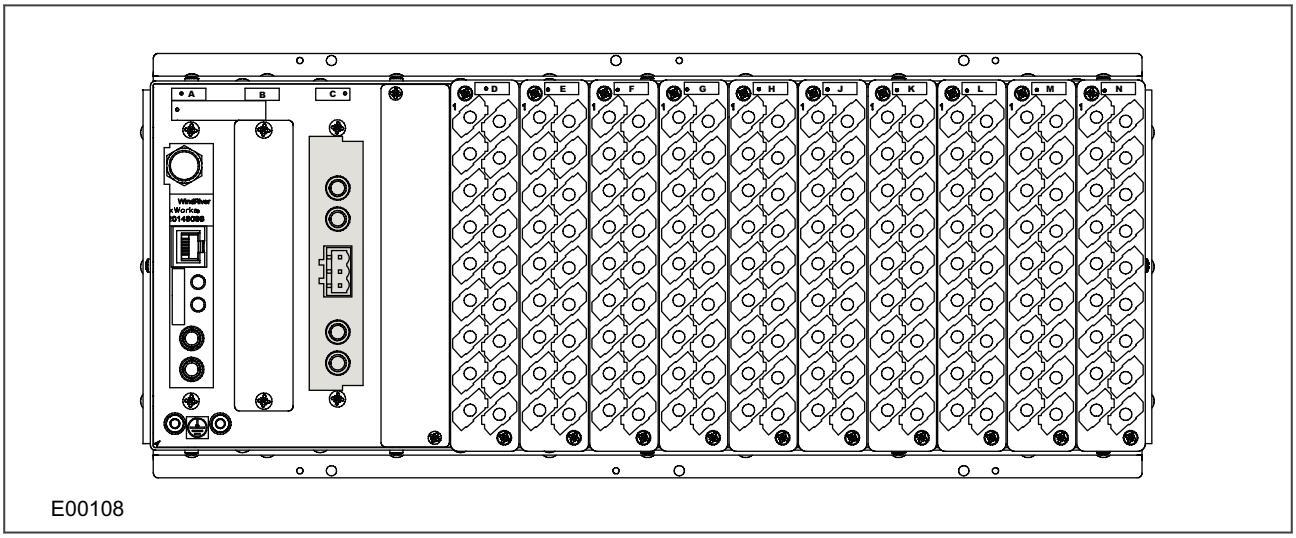


Figure 2: Rear view of populated case

Note:
This diagram is a typical example and may not show the exact same arrangement of boards as your particular model. Refer to the Cortec for product details.

CHAPTER 3

OPERATION

1 CHAPTER OVERVIEW

This chapter provides details of how the product functions.

This chapter contains the following sections:

2 IEC 61850

This section describes how the IEC 61850 standard is applied to GE products. It is not a description of the standard itself. The level at which this section is written assumes that the reader is already familiar with the IEC 61850 standard.

IEC 61850 is the international standard for Ethernet-based communication in substations. It enables integration of all protection, control, measurement and monitoring functions within a substation, and additionally provides the means for interlocking and inter-tripping. It combines the convenience of Ethernet with the security that is so essential in substations today.

There are two editions of most parts of the IEC 61850 standard; edition 1 and edition 2. The edition which this product supports depends on the Software Version.

From Software Version 90 onwards, it is possible to select between edition 1 and edition 2. Switching between edition 1 and edition 2 is described in the Selection of the IEC 61850 Edition section.

An additional section detailing the enhancements in edition 2 models is documented later in this chapter, if applicable.

2.1 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)

2.2 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.

2.3 INTRODUCTION TO IEC 61850-9-2LE

IEC 61850-9-2LE defines Process Bus communications between the different components of the substation automation system. MiCOM IEDs with an IEC 61850-9-2LE interface can communicate with the Process Bus and receive IEC 61850-9-2LE data from Merging Units. Analogue Merging Units digitise analogue values from

conventional CTs and VTs, replacing analogue inputs. This simplifies the installation by replacing low voltage analogue measurement wiring with the Process Bus Local Area Network. Using a fibre optic network instead of heavy copper cables between the measuring device and the IED provides safer and more economical cross-site cabling. It also allows IEDs to receive current and voltage sampled data through Digital Merging Units from non-conventional instrument transformers such as optical and Rogowski devices.

2.4 IEDS WITH AN IEC61850-9-2LE INTERFACE

The implementation has been designed to be especially resilient and reliable in the presence of interference, such as latency, jitter and missing or suspect data.

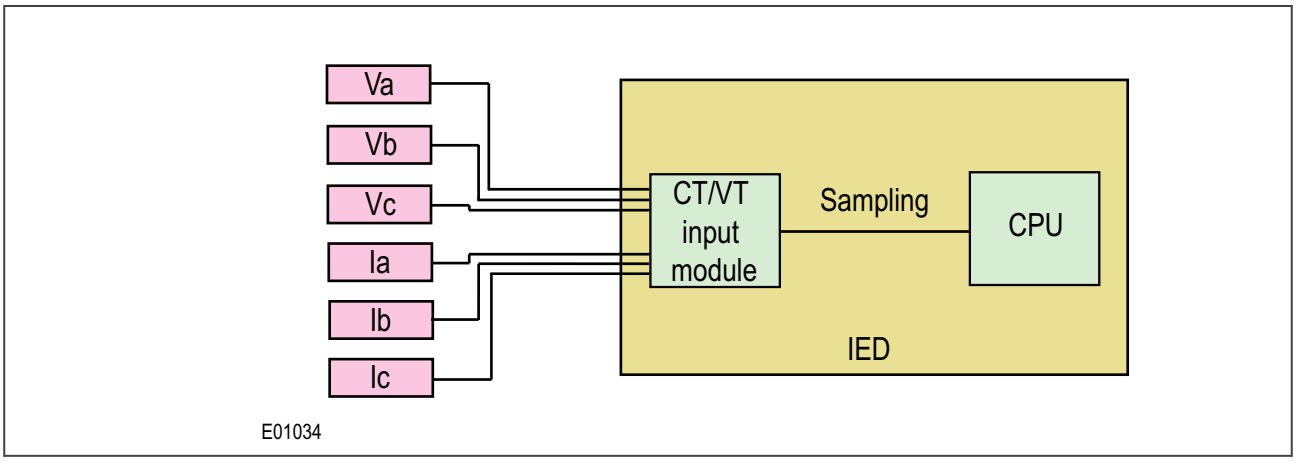


Figure 3: MiCOM IED with conventional CT and VT inputs

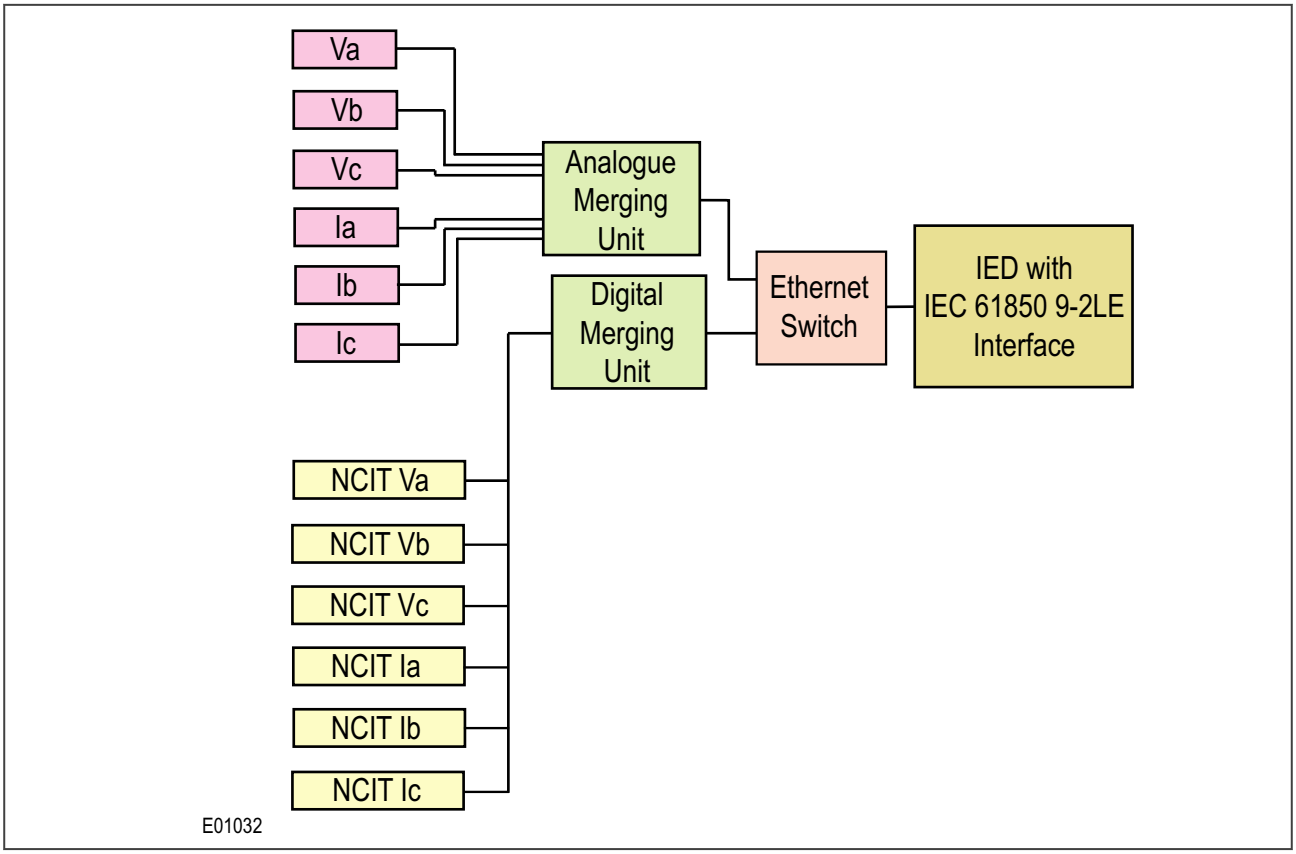


Figure 4: IED with IEC 61850 9-2LE inputs

3 DATA RESAMPLING

An IEC 61850-9-2LE SV interface receives 80 Sampled Values per cycle from the Process Bus. This is the same for both 50 and 60 Hz. The SV interface then resamples these Sampled Values to make the data appear the same to the IED as analogue signals would do on its normal inputs from CTs and VTs. The resampling frequency depends on the device.

The IEC 61850-9-2LE interface also tracks the supply frequency. This is because the Sampled Values from the Process Bus are fixed at 4000 samples/sec for 50 Hz and 4800 samples/sec at 60 Hz.

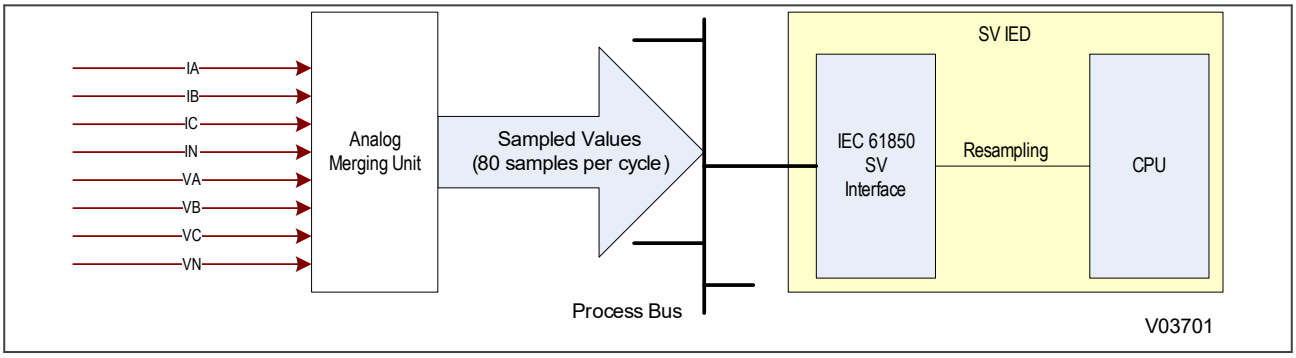


Figure 5: Data sampling using an IEC 61850-9-2LE interface

Note:
The resampling rate for the P743 is 48 samples/cycle.

4 SAMPLED VALUE ALIGNMENT

Sampled Value frames from different Merging Units on the Process Bus may not arrive at the same time at the IED. The transmission delay depends on the background Ethernet traffic and how many switches are used in the Process Bus network.

Transmission delays do not usually matter for functions such as three-phase overcurrent protection where current signals are all received in a single frame. However, a function such as distance protection uses voltage and current signals which may be from different merging units with different transmission delays. The SV interface synchronises the voltage and current samples that are sent to the IED's distance protection function. The IED then uses the ***Merge Unit Delay*** setting, which is set to the maximum expected delay between the first and last Sampled Value.

The following examples show how you would need to set the delay.

- If the IED receives one Logical Node only, no delay is needed so set the merging unit delay to `0 ms`.
- If the IED receives several Logical Nodes at the same time, no delay is needed so set the merging unit delay to `0 ms`.
- If the IED receives several Logical Nodes but not at the same time, set the merging unit delay to an appropriate non-zero value.

If all the Logical Nodes configured in the IED are not received during the merging unit delay time, an alarm is raised.

To set the merging unit delay during commissioning, set ***MUs Delay Search*** to `Yes`. The IED then monitors the Sampled Value frames received for the next two seconds and displays the maximum delay between identical samples.

4.1 CHANNEL MAPPINGS FOR SAV TEST, SAV QUESTIONABLE, SAV INVALID

These signals correspond to the analogue channels in a conventional MiCOM IED. The channel name appears on the IED display against each bit.

P441SV, P442, P444

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
VA	VB	VC	VSC1	IA1	IB1	IC1	IM	INSEN	IA2	IB2	IC2	VSC2											

P446, P546, P841B

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
VA	VB	VC	VSC1	IA1	IB1	IC1	IM	INSEN	IA2	IB2	IC2	VSC2											

4.2 CHANNEL MAPPINGS

Each sampled value that enters the device is assigned a channel number from 0 to 23 according to the table below:

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
VA	VB	IY1	IY2	IY3	IA2	IB2	IC2	IA1	IB1	IC1			VC	VFLUX	IA5	IB5	IC5	IA4	IB4	IC4	IA3	IB3	IC3

The cells ***SAV Test***, ***SAV Questionable*** and ***SAV Invalid***, are 24 bit registers which represent the corresponding Sampled Value according to the above table. For example, if the `VB` sampled value was questionable, bit 1 in the ***SAV Questionable*** register would be set to 1 and this would be displayed accordingly on the HMI panel.

P743

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
IA	IB	IC	IN																				

P746

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
VA	VB	IA3	IB3	IC3	IA2	IB2	IC2	IA1	IB1	IC1			VC		IA6	IB6	IC6	IA5	IB5	IC5	IA4	IB4	IC4

5 DATA QUALITY

Any degradation in the measurement or transmission of Sampled Values means that the protection function of the IED may not operate correctly. Data frames from a typical Logical Node have quality flags assigned to each of the channels. The device adapts the behaviour of protection functions according to these quality flags. The available quality flags are *Good*, *Invalid* and *Questionable*. A *Test* flag is also available for test purposes.

A protection function operates normally when all the necessary Sampled Value inputs are available and have a *Good* Quality flag. When the flag for one or more of the Sampled Value inputs changes to *Invalid*, the protection function is inhibited. When the flag for one or more of the Sampled Value inputs changes to *Questionable*, the protection function can either be inhibited or not, depending on the chosen options in the ***Trus Ques Data*** setting. The options are:

- Bit 0:Out of Range
- Bit 1:Bad Reference
- Bit 2:Oscillatory
- Bit 3:Old Data
- Bit 4:Inconsistent
- Bit 5:Inaccurate

The protection function will be trusted and NOT inhibited for questionable data for the items above which have been set.

The protection function returns to the *Normal* state when the quality flags for all the necessary Sampled Value inputs are *Good*. The quality flags can change with each sample, therefore there is a one-cycle transition delay between the *Normal* and *Inhibit* states for each protection function.

5.1 IMPACT OF DATA QUALITY ON PROTECTION FUNCTIONS

The following table shows how Sampled Value errors affect protection functions in the IED.

For example, overcurrent protection can be configured as directional, in which case the voltage inputs have an impact on the function. The quality of the voltage input is not important if the overcurrent is non-directional.

X means the SV input affects the Normal and Inhibit states of the protection function.

means the protection function is affected where configured to work with this input.

$ means that frequency protection operates if any one current or voltage phase is good quality.

5.1.1 P441SV, P442, P444

	[IA1 IB1 IC1]	[IA2 IB2 IC2]	[VA VB VC]	VSC1	VSC2	IN SEN	IM
Distance Protection	X	#	X			#	
Overcurrent Protection	X	#	#				
Negative Sequence Overcurrent Protection	X	#	#				
Broken Conductor Protection	X	#				#	
Earth Fault Overcurrent Protection	#	#	#			#	
Directional Earth Fault Protection	X	#	X			#	
Residual Overvoltage Protection			X				
Zero Sequence Power Protection	#	#	X			#	
Undercurrent Protection	X	#					
Voltage Protection			X				

	[IA1 IB1 IC1]	[IA2 IB2 IC2]	[VA VB VC]	VSC1	VSC2	IN SEN	IM
Frequency Protection			X				

5.1.2 P446, P546, P841B

	$[I_{A1}\ I_{B1}\ I_{C1}]$	$[I_{A2}\ I_{B2}\ I_{C2}]$	$[V_A\ V_B\ V_C]$	V_{SC1}	V_{SC2}	$I_{N\ SEN}$	I_M
Differential Protection	X	#	#				
Distance Protection	X	#	X				
Directional Earth Fault	X	#	X				
Overcurrent Protection	X	#	#				
Negative Sequence	X	#	#				
Broken Conductor	X	#					
Earth Fault Protection	X	#	#				
REF Protection						X	
SEF Protection						X	
Residual Overvoltage			X				
Voltage Protection			X				
Frequency Protection	$	$	$				

5.1.3 P645

	$[I_{A1}\ I_{B1}\ I_{C1}]$	$[I_{A2}\ I_{B2}\ I_{C2}]$	$[I_{A3}\ I_{B3}\ I_{C3}]$	$[I_{A4}\ I_{B4}\ I_{C4}]$	$[I_{A5}\ I_{B5}\ I_{C5}]$	I_{Y1}	I_{Y2}	I_{Y3}	$[V_A\ V_B\ V_C]$	V_{FLUX}
Differential Protection	X	#	#	#	X					
REF HV Protection	X	#				X				
REF LV Protection				#	X		X			
REF TV Protection		#	X	#				X		
Overcurrent HV Protection	X	#							#	
Overcurrent LV Protection				#	X				#	
Overcurrent TV Protection		#	X	#					#	
NPS HV Protection	X	#							#	
NPS LV Protection				#	X				#	

	$[I_{A1}\ I_{B1}\ I_{C1}]$	$[I_{A2}\ I_{B2}\ I_{C2}]$	$[I_{A3}\ I_{B3}\ I_{C3}]$	$[I_{A4}\ I_{B4}\ I_{C4}]$	$[I_{A5}\ I_{B5}\ I_{C5}]$	I_{Y1}	I_{Y2}	I_{Y3}	$[V_A\ V_B\ V_C]$	V_{FLUX}
NPS TV Protection		#	X	#					#	
Earth Fault HV Protection	#	#				#			#	
Earth Fault LV Protection				#	#		#		#	
Earth Fault TV Protection		#	#	#				#	#	
Voltage Protection									X	
Residual Overvoltage NVD									X	
Overfluxing Volts/Hz W1									X	
Overfluxing Volts/Hz W2										X
Frequency Protection	$	$	$	$	$				$	$

5.1.4 P743

In most IEDs, Sampled Value frames that have an Invalid flag are ignored by the IED and are treated as missing. However, if the P743 receives an Invalid flag, it blocks its protection functions and generates alarms. The P743 works with direct samples, therefore the quality status needs to be monitored to prevent an unexpected trip.

	$[I_A\ I_B\ I_C\ I_N]$
Differential Protection	X
Dead Zone Protection	X
Circuit Breaker Failure	X
Three Phase Overcurrent	X
Earth Fault Current	X
CT Supervision	X

5.1.5 P746

	$[I_{A1}\ I_{B1}\ I_{C1}]$	$[I_{A2}\ I_{B2}\ I_{C2}]$	$[I_{A3}\ I_{B3}\ I_{C3}]$	$[I_{A4}\ I_{B4}\ I_{C4}]$	$[I_{A5}\ I_{B5}\ I_{C5}]$	$[I_{A6}\ I_{B6}\ I_{C6}]$	$[V_A\ V_B\ V_C]$
Differential Protection	#	#	#	#	#	#	#
Overcurrent Terminal 1	X						
Overcurrent Terminal 2		X					
Overcurrent Terminal 3			X				
Overcurrent Terminal 4				X			
Overcurrent Terminal 5					X		
Overcurrent Terminal 6						X	
Earth Fault Terminal 1	X						

	[I_{A1} I_{B1} I_{C1}]	[I_{A2} I_{B2} I_{C2}]	[I_{A3} I_{B3} I_{C3}]	[I_{A4} I_{B4} I_{C4}]	[I_{A5} I_{B5} I_{C5}]	[I_{A6} I_{B6} I_{C6}]	[V_A V_B V_C]
Earth Fault Terminal 2		X					
Earth Fault Terminal 3			X				
Earth Fault Terminal 4				X			
Earth Fault Terminal 5					X		
Earth Fault Terminal 6						X	
Dead Zone OC 1	X						
Dead Zone OC 2		X					
Dead Zone OC 3			X				
Dead Zone OC 4				X			
Dead Zone OC 5					X		
Dead Zone OC 6						X	

6 PROCESS BUS PERFORMANCE

Ethernet networks sometimes lose frames, so the IED tolerates some loss of samples to ensure availability of its protection functions. The IED calculates a ***Frame Loss Rate*** every cycle for each Merging Unit (Logical Node) with which it communicates. If the ***Frame Loss Rate*** is less than the ***Loss Rate Level*** setting (set in %), the IED tolerates network losses of up to three consecutive samples. If the ***Frame Loss Rate*** is greater than the ***Loss Rate Level*** setting (set in %), the protection functions are temporarily inhibited.

The IED display shows information about Sampled Analogue Value losses on the Process Bus for each Logical Node associated with the IED in the following cells in the *IEC 61850-9.2LE* column. This is useful during testing or commissioning to identify and resolve any network problems which could degrade the protection scheme.

The following data is provided:

LNx LossRate Sec: This is the percentage of SAV frames missing during the past second for LNx.

LNx FrmLoss Cuml: This is the number of frames lost since the last reset. The most recent reset time is listed in the IED menu.

LNx Error Second: The Frame Error Seconds is a cumulative value since the last reset. If the Frame Loss Rate exceeds 1.25% (one sample per cycle on average for one second), the IED records this as an Error Second.

where x is the number of the node (e.g. LN1)

The Sampled Analogue Values loss data can be reset manually with the ***LossRate Reset*** command in the *IEC61850-9.2LE* setting column.

6.1 SAMPLE LOSS DATA

The Sampled Value loss data can be reset manually. The following data is provided:

LNx LossRate Sec: This is the percentage of SV frames missing during the past second for LNx.

LNx FrmLoss Cuml: This is the number of frames lost since the last reset. The most recent reset time is listed in the IED menu.

LNx Error Second: The Frame Error Seconds is a cumulative value since the last reset. If the Frame Loss Rate exceeds 1.25% (one sample per cycle on average for one second), the IED records this as an Error Second.

where x is the number of the node (e.g. LN1)

7 VT SWITCHING

This function is used in the P442, P444, P446, P546 and P841B IEDs which have an IEC 61850-9-2LE interface. It allows the user to switch the three-phase voltage input between two independent Sampled Value frames while the IED is in service. This may correspond to two separate voltage transformers in the primary system. The VT Switch function also allows the single-phase check synchronising voltages to be selected from three independent Sampled Value frames.

The VT switching function is disabled by default. To enabled it, in the IED menu *IEC 61850-9-2LE*, select ***VT Switch Mode*** then `Enabled`.

Three-Phase Voltage Input Switching

The three-phase voltage can be switched between two Sampled Value frames. These are [VA1 VB1 VC1] and [VA2 VB2 VC2]. The switching is controlled by the status of the DDB VABC Select x. The logic is shown in the following table.

DDB VABC Select x	VA VB VC Selection
0	VA1 VB1 VC1
1	VA2 VB2 VC2

The change of VT input is accepted only if the DDB status change is effective for a minimum of 20 ms. The selected three-phase voltage is only displayed when VT Switch Mode is enabled.

Single-Phase Voltage Input Switching

There are two single-phase voltages associated with the System Check function. These are Vsc1 and Vsc2. The selection of voltage Vsc1 is controlled by the combined status of two DDBs, Vsc1 Select x1 and Vsc1 Select 1x as shown in the following table.

DDB Vsc1 Select x1	DDB Vsc1 Select 1x	Vsc1 Selection
0	0	Vcs1
0	1	Vcs2
1	0	Vcs3
1	1	Unused

The selection of voltage Vsc2 is controlled by the combined status of two DDBs, Vsc2 Select x1 and Vsc2 Select 1x as shown in the following table.

DDB Vsc2 Select x1	DDB Vsc2 Select 1x	Vsc2 Selection
0	0	Vcs2
0	1	Vcs3
1	0	Vcs1
1	1	Unused

The selected single-phase voltages are only displayed when VT Switch Mode is enabled.

8 VIRTUAL INPUTS AND OUTPUTS

Sampled Value IEDs have additional virtual inputs and virtual outputs. These are mapped as new DDBs in the IED's PSL and are used as triggers for GOOSE messages to and from the IED. The GOOSE Control Blocks can be configured using the IEC 61850 Configurator software tool, which is part of the Settings Application Software.

The additional inputs and outputs make it easier to apply the IEDs in full Digital Substations where switchgear status, controls and commands are exchanged as GOOSE messages between the IEDs and Merging Units.

8.1 P441SV, P442, P444 VIRTUAL INPUTS AND OUTPUTS DDBS

Ordinal	Signal Name	Source	Type	Response
Description				
512 to 543	GOOSEOUT_1-32	PSL	PFSI	Protection Event Log
Virtual outputs. These allow you to control binary signals which can be mapped using the SCADA protocol output to other devices.				
1224 to 1287	GOOSEIN_1-64	Software	PFSI	Protection Event Log
Virtual Input received from GOOSE message.				

8.2 P446, P546, P841B VIRTUAL INPUTS AND OUTPUTS DDBS

Ordinal	Signal Name	Source	Type	Response
Description				
1792 to 1823	GOOSEIN_33-64	Software	GOOSEIN	Protection Event
Virtual Input received from GOOSE message.				
1888 to 1919	GOOSEOUT_33-64	PSL	GOOSEOUT	Protection Event
Virtual outputs. These allow you to control binary signals which can be mapped using the SCADA protocol output to other devices.				

8.3 P645 VIRTUAL INPUTS AND OUTPUTS DDBS

Ordinal	Signal Name	Source	Type	Response
Description				
672-703	GOOSEOUT_1-32	PSL	GOOSEOUT	Protection event
Virtual outputs. These allow you to control binary signals which can be mapped using the SCADA protocol output to other devices.				
1754-1769	GOOSEOUT_33-48	PSL	GOOSEOUT	Protection event
Virtual outputs. These allow you to control binary signals which can be mapped using the SCADA protocol output to other devices.				
1856-1919	GOOSEIN_1-64	SW	GOOSEIN	Protection event
Virtual inputs received from GOOSE message.				

8.4 P743 VIRTUAL INPUTS AND OUTPUTS DDBS

Ordinal	Signal Name	Source	Type	Response
Description				
112 to 127	VIRTUAL_TC 1-16	PSL	PFSI	Protection Event Log
Virtual outputs. These allow you to control binary signals which can be mapped using the SCADA protocol output to other devices.				
368 to 383	VIRTUAL TS 1-16	Software	PFSI	Protection Event Log
Virtual Input received from GOOSE message.				

8.5 P746 VIRTUAL INPUTS AND OUTPUTS DDBS

Ordinal	Signal Name	Source	Type	Response
Description				
663-715	GOOSEIN_65-117	Software	GOOSEIN	Protection event
Virtual inputs received from GOOSE message.				
1044-1103	GOOSEOUT_33-92	PSL	GOOSEOUT	Protection event
Virtual outputs. These allow you to control binary signals which can be mapped using the SCADA protocol output to other devices.				
1484-1494	GOOSEIN_118-128	Software	GOOSEIN	Protection event
Virtual inputs received from GOOSE message.				
1592-1623	GOOSEOUT_1-32	PSL	GOOSEOUT	Protection event
Virtual outputs. These allow you to control binary signals which can be mapped using the SCADA protocol output to other devices.				
1678-1695	GOOSEOUT_93-110	PSL	GOOSEOUT	Protection event
Virtual outputs. These allow you to control binary signals which can be mapped using the SCADA protocol output to other devices.				
1722-1739	GOOSEOUT_111-128	PSL	GOOSEOUT	Protection event
Virtual outputs. These allow you to control binary signals which can be mapped using the SCADA protocol output to other devices.				
1856-1887	GOOSEIN_1-32	Software	GOOSEIN	Protection event
Virtual inputs received from GOOSE message.				
1888-1919	GOOSEIN_33-64	Software	GOOSEIN	Protection event
Virtual inputs received from GOOSE message.				

8.6 VIRTUAL CT AND VT RATIO SETTINGS

The Sampled Value frames are primary measurements. These come from Merging Units (MU) connected to conventional CTs and VTs or Non-Conventional Instrument Transformers (NCITs). Alternatively they may come directly from NCITs. The IED algorithms are typically based on secondary values. If primary values are needed, they are calculated by the IED based on set CT or VT ratios.

The amplitudes for 1A CT inputs are limited to 64 A secondary. The amplitudes for 5A CT inputs are limited to 320 A secondary. The VT secondary is limited to 200 V phase-to-earth. Therefore it is necessary to set appropriate CT and VT ratios for the protection functions to operate correctly. The instrument transformer ratios are set in the IED menu *CT AND VT RATIOS*, which is common to both conventional and Sampled Value IEDs.

Measurement from a Merging Unit connected to a CT

As this has a real CT ratio, set the real primary CT ratio.

Direct measurement from an NCIT

There is no physical CT ratio. Set the CT ratio high enough so the maximum primary current (maximum fault level) when converted to secondary is not clamped.

For example if the maximum primary current is 50 kA:

- If the CT ratio is set to 1000:1 the converted secondary current is up to 50 A. This is less than 64 A so is acceptable.
- If the CT ratio is set to 500:1 the converted secondary current is up to 100 A. This is above 64 A so is not acceptable.

9 IED ALARMS

Sampled Analogue Value IEDs have additional alarms.

9-2 Configuration Alarm (9-2LE Cfg Alarm)

This alarm is raised if analogue channels in the IED are assigned incorrectly (Illegal Channel Map). For example, if you assign two current inputs to the same Logical Node.

Sampled Analogue Values quality alarm (9-2LE SAV Alarm)

This alarm is raised if any of the following conditions exist:

- One or more of the Sampled Analogue Value frames received are not synchronised as required by the IED configuration.
- One or more of the Sampled Analogue Value frames expected are not received.
- One or more of the Sampled Analogue Value frames received are of *Invalid* quality.
- One or more of the Sampled Analogue Value frames received are of *Questionable* quality and the IED is configured not to accept such Sampled Analogue Value frames.
- One or more of the Sampled Analogue Value frames received has a test flag, and the IED is configured to inhibit protection functions when receiving frames with a test flag.
- One or more of the Sampled Analogue Value frames received does not have a test flag, and the IED is configured to receive only frames with a test flag.
- Sampled Analogue Values received have a nominal frequency different to that set in the IED.
- The secondary current or voltage exceeds the acceptable limit.

9.1 P441SV, P442, P444 ALARMS

9.1.1 ALARM SIGNALS SETTINGS TABLE

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
Process Bus Alarm*	18	45	Self Reset	Self-Reset, Alarm Latched
This alarm shows there is an error on the Process Bus.				
SAV Absence	18	51	00000000	
This is a data cell with 8 binary flags. It shows the presence or absence of Sampled Values from each of the Merging Units the IED is communicating with. There is a maximum of 8 Logical Nodes. The cell data for each Logical Node is continuously refreshed. 0: No Sampled Values being received from the Merging Unit. 1: Sampled Values being received from the Merging Unit.				
SAV No SmpSynch	18	52	00000000	
This is a data cell with 8 binary flags. It indicates the healthiness of the Sampled Values being received from each of the configured Merging Units. 0: Sampled Values received are synchronised and any loss of samples is within acceptable limits. 1: Sampled Values received are not synchronised (Setting :Synchro Alarm) or the Sampled Value delay exceeds the acceptable value (Merging Unit Delay setting). The IED raises a 9-2 Sample Alarm when any one of the binary flags is 1.				
SAV Questionable	18	54	00000000 00000000 00000000	
This is a data cell with 24 binary flags. It indicates the status of the IEC 61850 Quality attribute 'Questionable' in the Sampled Value frames for each of the analogue channels. The channel assignment depends on the IED.				
SAV Invalid	18	55	00000000 00000000 00000000	

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
This is a data cell with 24 binary flags. It indicates the status of the IEC 61850 Quality attribute 'Invalid' in the Sampled Value frames for each of the analogue channels. The channel assignment depends on the IED.				

*Setting not available on P441SV

9.1.2 ALARM SIGNALS DDB TABLE

Ordinal	Signal Name	Source	Type	Response
Description				
204	ALARM_9_2_SAV	Software	PFSO	Self reset alarm
Sampled Value error.				
205	9_2_SAV_CFG_ALARM	Software	PFSO	Self reset alarm
This alarm is triggered when the LN name is less than 10 characters or greater than 34 characters.				
206	QUALITY_BLOCK_ALARM	Software	PFSO	Self reset alarm
Due to a quality issue, this alarm indicates that protection functions are blocked on all phases.				
441	QUALITY_BLK_VA	Software	PFSO	No response
Due to a quality issue, this alarm indicates that VA protection functions are blocked.				
442	QUALITY_BLK_VB	Software	PFSO	No response
Due to a quality issue, this alarm indicates that VB protection functions are blocked.				
443	QUALITY_BLK_VC	Software	PFSO	No response
Due to a quality issue, this alarm indicates that VC protection functions are blocked.				
444	QUALITY_BLK_VSC1	Software	PFSO	No response
Due to a quality issue, this alarm indicates that VSC1 protection functions are blocked.				
445	QUALITY_BLK_IA1	Software	PFSO	No response
Due to a quality issue, this alarm indicates that IA1 protection functions are blocked.				
446	QUALITY_BLK_IB1	Software	PFSO	No response
Due to a quality issue, this alarm indicates that IB1 protection functions are blocked.				
447	QUALITY_BLK_IC1	Software	PFSO	No response
Due to a quality issue, this alarm indicates that IC1 protection functions are blocked.				
448	QUALITY_BLK_IM	Software	PFSO	No response
Due to a quality issue, this alarm indicates that IM protection functions are blocked.				
449	QUALITY_BLK_INSEN	Software	PFSO	No response
Due to a quality issue, this alarm indicates that INSEN protection functions are blocked.				
450	QUALITY_BLK_IA2	Software	PFSO	No response
Due to a quality issue, this alarm indicates that IA2 protection functions are blocked.				
451	QUALITY_BLK_IB2	Software	PFSO	No response
Due to a quality issue, this alarm indicates that IB2 protection functions are blocked.				
452	QUALITY_BLK_IC2	Software	PFSO	No response
Due to a quality issue, this alarm indicates that IC2 protection functions are blocked.				
453	QUALITY_BLK_VSC2	Software	PFSO	No response
Due to a quality issue, this alarm indicates that VSC2 protection functions are blocked.				

9.2 P446, P546, P841B ALARMS

Sampled Value global synchronisation alarm (GLOBALAV_SYN_FAIL)

This alarm is raised if the global synchronisation for Sampled Values has failed, inhibiting the current differential function.

Inverse settings alarm (ALARM_INV_SETTING_SAV)

This alarm is raised if ***Phase Diff*** is set to *Enabled* but ***GPS Sync*** is set to *GPS disabled*.

9.2.1 ALARM SIGNAL SETTINGS

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
Process Bus Alarm	18	45	Self Reset	Self-Reset, Alarm Latched
This alarm shows there is an error on the Process Bus.				
SAV Absence	18	51	00000000	
This is a data cell with 8 binary flags. It shows the presence or absence of Sampled Values from each of the Merging Units the IED is communicating with. There is a maximum of 8 Logical Nodes. The cell data for each Logical Node is continuously refreshed. 0: No Sampled Values being received from the Merging Unit. 1: Sampled Values being received from the Merging Unit.				
SAV No SmpSynch	18	52	00000000	
This is a data cell with 8 binary flags. It indicates the healthiness of the Sampled Values being received from each of the configured Merging Units. 0: Sampled Values received are synchronised and any loss of samples is within acceptable limits. 1: Sampled Values received are not synchronised (Setting :Synchro Alarm) or the Sampled Value delay exceeds the acceptable value (Merging Unit Delay setting). The IED raises a 9-2 Sample Alarm when any one of the binary flags is 1.				
SAV Questionable	18	54	00000000 00000000 00000000	
This is a data cell with 24 binary flags. It indicates the status of the IEC 61850 Quality attribute 'Questionable' in the Sampled Value frames for each of the analogue channels. The channel assignment depends on the IED.				
SAV Invalid	18	55	00000000 00000000 00000000	
This is a data cell with 24 binary flags. It indicates the status of the IEC 61850 Quality attribute 'Invalid' in the Sampled Value frames for each of the analogue channels. The channel assignment depends on the IED.				

9.2.2 ALARM SIGNALS DDB TABLE

Ordinal	Signal Name	Source	Type	Response
Description				
340	ALARM_9_2_SAV	Software	PFSO	Self reset alarm
Sampled Value error.				
341	GLOBAL_SYN_FAIL	Software	PFSO	Alarm latched with protection function
This alarm is raised if the global synchronisation for Sampled Values has failed, inhibiting the current differential function.				
342	9_2_SAV_CFG_ALARM	Software	PFSO	Self reset alarm
This alarm is triggered when the LN name is less than 10 characters or greater than 34 characters.				
343	ALARM_INV_SETTING_SAV	Software	PFSO	Self reset alarm
This alarm is raised if Phase Diff is set to Enabled but GPS Sync is set to GPS disabled.				

9.3 P645 ALARMS

9.3.1 ALARM SIGNAL SETTINGS

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
Trust Ques Data	18	43	000000	
This setting specifies how the Sampled Values are processed by the IED when the associated Quality tag is Questionable. There are six binary flags (0 = No, 1 = Yes) which you can set, corresponding to the data quality attributes Out of Range, Bad Reference, Oscillatory, Old Data, Inconsistent, and Inaccurate. Questionable data is treated as invalid if the flag is 0. To process the data as good samples, the flag is changed to 1. The setting is common to all Logical Nodes in service.				
SAV Absence	18	51	00000000	
This is a data cell with 8 binary flags. It shows the presence or absence of Sampled Values from each of the Merging Units the IED is communicating with. There is a maximum of 8 Logical Nodes. The cell data for each Logical Node is continuously refreshed. 0: No Sampled Values being received from the Merging Unit. 1: Sampled Values being received from the Merging Unit.				
SAV No SmpSynch	18	52	00000000	
This is a data cell with 8 binary flags. It indicates the healthiness of the Sampled Values being received from each of the configured Merging Units. 0: Sampled Values received are synchronised and any loss of samples is within acceptable limits. 1: Sampled Values received are not synchronised (Setting :Synchro Alarm) or the Sampled Value delay exceeds the acceptable value (Merging Unit Delay setting). The IED raises a 9-2 Sample Alarm when any one of the binary flags is 1.				
SAV Questionable	18	54	00000000 00000000 00000000	
This is a data cell with 24 binary flags. It indicates the status of the IEC 61850 Quality attribute 'Questionable' in the Sampled Value frames for each of the analogue channels. The channel assignment depends on the IED.				
SAV Invalid	18	55	00000000 00000000 00000000	
This is a data cell with 24 binary flags. It indicates the status of the IEC 61850 Quality attribute 'Invalid' in the Sampled Value frames for each of the analogue channels. The channel assignment depends on the IED.				

9.3.2 ALARM SIGNALS DDB TABLE

Ordinal	Signal Name	Source	Type	Response
Description				
472	ALARM_9_2_SAV	Software	PFSO	Self reset alarm
Sampled Value error.				
473	9_2_SAV_CFG_ALARM	Software	PFSO	Self reset alarm
This alarm is triggered when the LN name is less than 10 characters or greater than 34 characters.				

9.4 P743 ALARMS

Sampled Value Synchronisation Alarm (SAV_SYNC_ALARM)

This alarm is raised if there is an error in Sampled Value synchronisation.

Merging Unit Quality Alarm (SAV_MU_ALARM)

This alarm is raised if any of the following conditions exist:

- One or more of the received Sampled Value frames are of 'invalid' quality.
- One or more of the receivedSampled Value frames are of 'questionable' quality and the IED is configured not to accept such Sampled Value frames.
- One or more of the received Sampled Value frames have a test flag and the IED is configured to inhibit protection functions when receiving frames with a test flag.
- One or more of the received Sampled Value frames does not have a test flag, and the IED is configured to receive only frames with a test flag.
- Sampled Values received have a nominal frequency different to that set in the IED.

Process Bus Alarm (PROCESS_BUS_ALARM)

This alarm is raised if any of the following conditions exist:

- One or more of the expected Sampled Value frames are not received (absence of samples).
- One or more of the expected Sampled Value frames have reached the skew threshold.
- One or more of the expected Sampled Value frames have reached the jitter threshold (+/-10 microseconds).
- Loss Rate Level reached.

Quality Blocked Alarm (QUALITY_BLK_ALARM, QUALITY_BLK_PHASE_A, B and C)

These alarms are raised to indicate that protection functions are blocked. The P743 is a segregated Low busbar protection IED, therefore if Phase A is marked with an 'invalid' quality flag, protection functions are blocked only on that phase.

9-2 Configuration Alarm (9_2_SAV_CFG_ALARM)

This alarm is triggered when the LN1 name is less than 10 characters or greater than 34 characters.

9.4.1 ALARM SIGNAL SETTINGS

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
IEC 61850-9.2LE	18	00		
This column contains all the configure/setting measurement parameters relative to IEC 61850-9-2LE.				
Process Bus Alarm	18	45	Self Reset	Self-Reset, Alarm Latched
This alarm shows there is an error on the Process Bus.				
SAV Absence	18	51	00000000	
This is a data cell with 8 binary flags. It indicates the presence or absence of Sampled Values from each of the Merging Units the IED is communicating with. There is a maximum of 8 Logical Nodes. The cell data for each Logical Node is continuously refreshed. The P743 only uses bit 0 for LN 1 0: No Sampled Values being received from the Merging Unit. 1: Sampled Values being received from the Merging Unit.				
SAV No SmpSynch	18	52	00000000	
This is a data cell with 8 binary flags. It indicates the healthiness of the Sampled Values being received from each of the Merging Units configured. The P743 only uses bit 0 for LN 1. 0: Sampled Values received are synchronised and any loss of samples is within acceptable limits. 1: Sampled Values received are not synchronised (Setting :Synchro Alarm) or the Sampled Value delay exceeds the acceptable value (Merging Unit Delay setting). The IED raises a 9-2 Sample Alarm when any one of the binary flags is 1.				

9.4.2 ALARM SIGNALS DDB TABLE

Ordinal	Signal Name	Source	Type	Response
Description				
272	SAV_SYNC_ALARM	Software	PFSO	Self reset alarm event
Error in Sampled Value synchronisation.				
273	SAV_MU_ALARM	Software	PFSO	Self reset alarm event
Error in Sampled Value from Merging Unit.				
274	PROCESS_BUS_ALARM	Software	PFSO	Self reset alarm event
Process Bus error.				
275	QUALITY_BLK_ALARM	Software	PFSO	Self reset alarm event
Due to a quality issue, this alarm indicates that protection functions are blocked on all phases.				
276	QUALITY_BLK_PHASE_A	Software	PFSO	No response
Due to a quality issue on Phase A, this alarm indicates that protection functions are blocked on Phase A.				
277	QUALITY_BLK_PHASE_B	Software	PFSO	No response
Due to a quality issue on Phase B, this alarm indicates that protection functions are blocked on Phase B.				
278	QUALITY_BLK_PHASE_C	Software	PFSO	No response
Due to a quality issue on Phase C, this alarm indicates that protection functions are blocked on Phase C.				
279	QUALITY_BLK_PHASE_N	Software	PFSO	No response
Due to a quality issue on the Neutral phase, this alarm indicates that protection functions are blocked on the Neutral phase.				
365	9_2_SAV_CFG_ALARM	Software	PFSO	Self reset alarm event
This alarm is triggered when the LN1 name is less than 10 characters or greater than 34 characters.				

9.5 P746 ALARMS

Sampled Value Synchronisation Alarm (SAV_SYNC_ALARM)

This alarm is raised if there is an error in Sampled Value synchronisation.

Merging Unit Quality Alarm (SAV_MU_ALARM)

This alarm is raised if any of the following conditions exist:

- One or more of the received Sampled Value frames are of 'invalid' quality.
- One or more of the receivedSampled Value frames are of 'questionable' quality and the IED is configured not to accept such Sampled Value frames.
- One or more of the received Sampled Value frames have a test flag and the IED is configured to inhibit protection functions when receiving frames with a test flag.
- One or more of the received Sampled Value frames does not have a test flag, and the IED is configured to receive only frames with a test flag.
- Sampled Values received have a nominal frequency different to that set in the IED.

Process Bus Alarm (PROCESS_BUS_ALARM)

This alarm is raised if any of the following conditions exist:

- One or more of the expected Sampled Value frames are not received (absence of samples).
- One or more of the expected Sampled Value frames have reached the skew threshold.
- One or more of the expected Sampled Value frames have reached the jitter threshold (+/-10 microseconds).
- Loss Rate Level reached.

Quality Blocked Alarm (QUALITY_BLK_ALARM, QUALITY_BLK_PHASE_A, B and C)

These alarms are raised to indicate that protection functions are blocked. If Phase A is marked with an 'invalid' quality flag, protection functions are blocked only on that phase.

9-2 Configuration Alarm (9_2_SAV_CFG_ALARM)

This alarm is triggered when the LN1 name is less than 10 characters or greater than 34 characters.

9.5.1 ALARM SIGNAL SETTINGS

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
IEC 61850-9.2LE	18	00		
This column contains all the configure/setting measurement parameters relative to IEC 61850-9-2LE.				
Synchro Alarm	18	03	Local 1 PPS	No SYNC CLK, Local 1PPS, Global 1PPS
This setting is used for processing Sampled Value frames with an IEC 61850 Test mode flag. This setting is common to all Logical Nodes configured in the IED. Test Blocked: all channel data frames received with an IEC 61850 Test flag are treated as invalid. The IED blocks relevant protection functions and issues a 9-2Sample Alarm. Test Ignored: all channel data frames received with an IEC 61850 Test flag are treated as good so all protection functions remain active. Test Only: all channel data received with an IEC 61850 Test flag are treated as good. Any channel data received without the Test flag are treated as invalid. The IED blocks relevant protection functions and issues a 9-2 Sample Alarm.				
Trust Ques Data	18	43	000000	
This setting specifies how the Sampled Values are processed by the IED when the associated Quality tag is Questionable. There are six binary flags (0 = No, 1 = Yes) which you can set, corresponding to the data quality attributes Out of Range, Bad Reference, Oscillatory, Old Data, Inconsistent, and Inaccurate. Questionable data is treated as invalid if the flag is 0. To process the data as good samples, the flag is changed to 1. The setting is common to all Logical Nodes in service.				
SAV Absence	18	51	000000	0 or 1 for each flag
This is a data cell with 8 binary flags. It shows the presence or absence of Sampled Values from each of the Merging Units the IED is communicating with. There is a maximum of 8 Logical Nodes. The cell data for each Logical Node is continuously refreshed. 0: No Sampled Values being received from the Merging Unit. 1: Sampled Values being received from the Merging Unit.				
SAV No SmpSynch	18	52	000000	
This is a data cell with 8 binary flags. It indicates the healthiness of the Sampled Values being received from each of the configured Merging Units.. 0: Sampled Values received are synchronised and any loss of samples is within acceptable limits. 1: Sampled Values received are not synchronised (Setting :Synchro Alarm) or the Sampled Value delay exceeds the acceptable value (Merging Unit Delay setting). The IED raises a 9-2 Sample Alarm when any one of the binary flags is 1				
SAV Test	18	53	00000000 00000000 00000000	
This is a data cell with 24 binary flags. It indicates the status of the IEC 61850 Test mode flag for each analogue channel processed by the IED (eg: VA, the A-phase voltage). The channel assignment depends on the IED.				
SAV Questionable	18	54	00000000 00000000 00000000	
This is a data cell with 24 binary flags. It indicates the status of the IEC 61850 Quality attribute 'Questionable' in the Sampled Value frames for each of the analogue channels. The channel assignment depends on the IED.				
SAV Invalid	18	55	00000000 00000000 00000000	
This is a data cell with 24 binary flags. It indicates the status of the IEC 61850 Quality attribute 'Invalid' in the Sampled Value frames for each of the analogue channels. The channel assignment depends on the IED.				

9.5.2 ALARM SIGNALS DDB TABLE

Ordinal	Signal Name	Source	Type	Response
Description				
508	9_2_SAV_CFG_ALARM	Software	PFSO	Self reset alarm

Ordinal	Signal Name	Source	Type	Response
Description				
This alarm is triggered when the LN name is less than 10 characters or greater than 34 characters.				
511	ALARM_9_2_SAV	Software	PFSO	Self reset alarm
Sampled Value error.				

10 P546

10.1 CURRENT DIFFERENTIAL FUNCTION

The feeder differential function uses a P546 at each end of the protected circuit. It can be configured in two-ended or three-ended schemes depending on the application. The IEDs send local current information to the remote ends. The decisions whether to trip are made locally after calculating the bias and differential currents based on the received currents.

For the current differential function to work correctly, Sampled Values from each end of the feeder must be synchronised to correspond to the same time instant. This also applies to any other quantities derived from samples such as Fourier values. This is essential to properly evaluate bias and differential currents. Otherwise it could result in false differential currents and unwanted operation of the differential scheme.

In a differential scheme with conventional P546 IEDs, either:

- time stamps plus current information are exchanged between the IEDs
- all the IEDs in the scheme are synchronised to 1 PPS GPS inputs.

When the IEDs in the scheme have an IEC 61850-9-2LE interface, the synchronisation must account for delays in receiving Sampled Values over the Process Bus network. This is not important for conventional IEDs where the primary CTs are directly wired to the IED's analogue inputs. The following diagram shows P546 IEDs at both line ends of the Process Bus. The Merging Units and the Sampled Value distribution networks at End A and End B are independent of each other. Therefore the Sampled Values may arrive at the P546 IEDs with different delays.

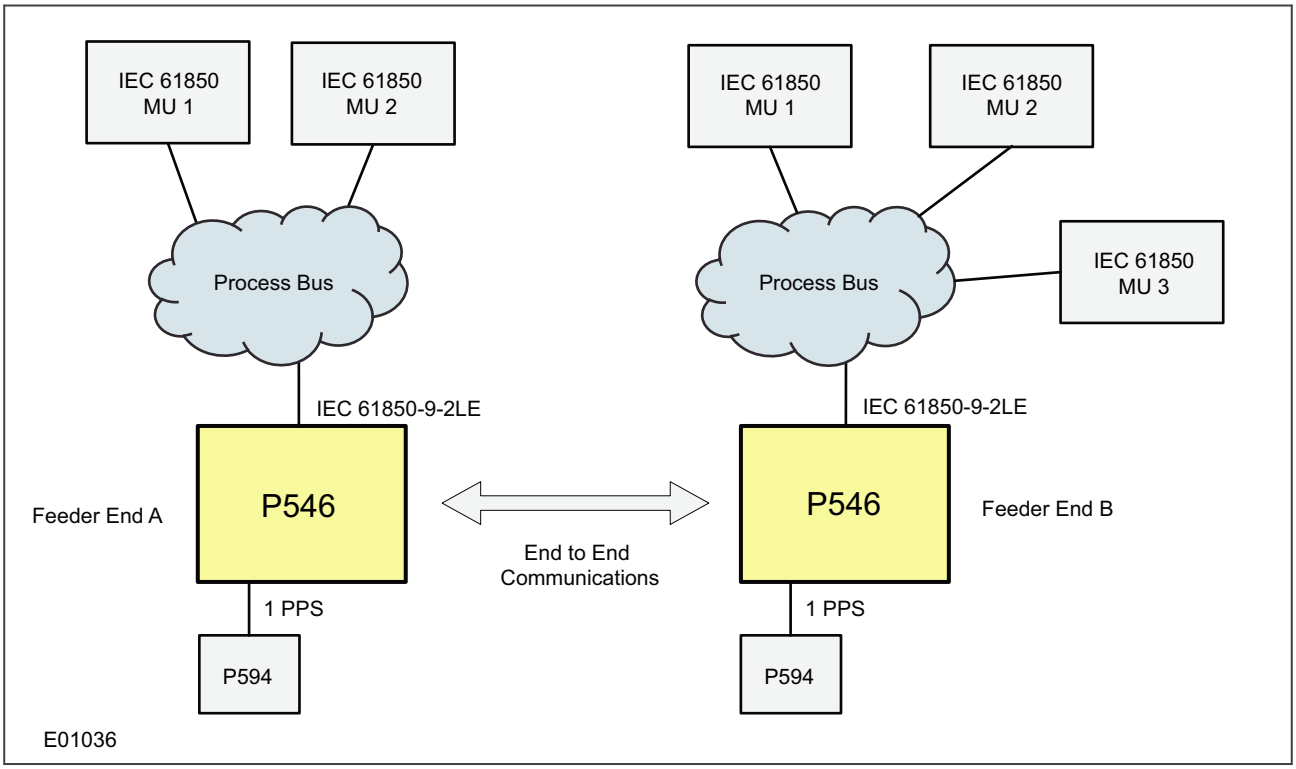


Figure 6: Two-ended P546 scheme with IEC 61850-9-2LE IEDs at both feeder ends

To synchronise the Sampled Values across multiple P546 IEDs with IEC 61850-9-2LE interfaces, all must be synchronised using a 1 PPS GPS signal from a P594/RT430. This applies for all IEDs in the scheme when one or more of the feeder ends uses Sampled Value inputs.

The following conditions are also necessary for the feeder differential function to work correctly:

- All P546 IEDs in the scheme must work in GPS Synchronised mode and must have 1 PPS GPS inputs from the P594/RT430.
- At all line ends, the Merging Units in the feeder differential scheme must use a reference time clock for synchronisation. For example, IEEE 1588 or GPS synchronised 1PPS.
- The GPS sources for the P546 IEDs and the Merging Units must be synchronised as they may not be common.
- The first Sampled Value frame from the Merging Units for each second has a sequence count of 0. This corresponds to a zero time offset from the start of the second.

The P546 uses the sample count in the Sampled Value frames, plus its own 1PPS GPS synchronisation input, to calculate delays in the Process Bus. The P546 then phase shifts the current vectors to time-align them before performing bias and differential currents calculations. The delay is recalculated every second to adapt to any changes in the Process Bus, enhancing the security of the protection scheme.

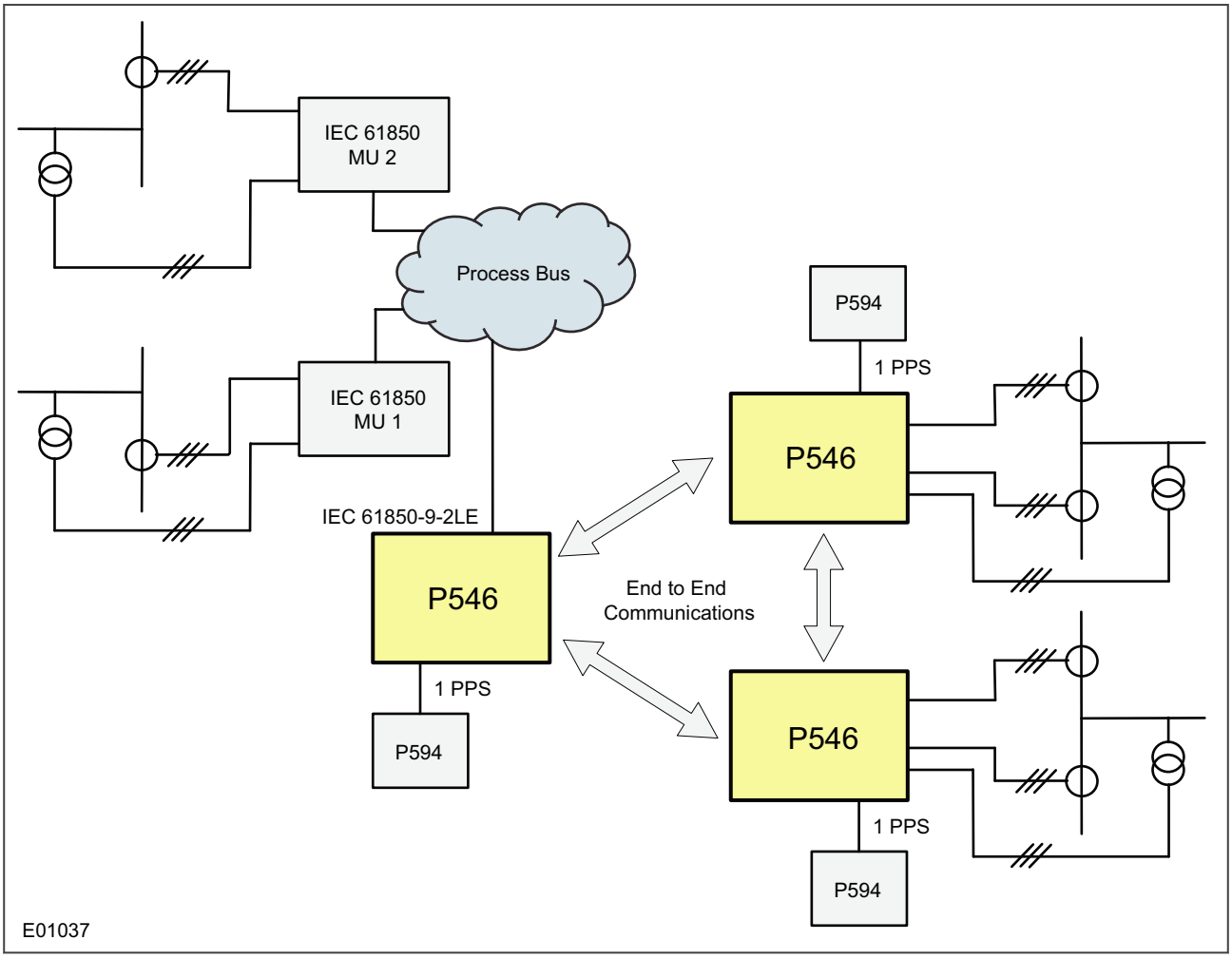


Figure 7: Conventional and non-conventional P546 IEDs combined in a current differential scheme

The current differential scheme is inhibited at all feeder ends if any of the following conditions occur:

- The Sampled Value frames received at the P546 are not 1 PPS GPS synchronised.
- The 1PPS input to the P546 is not GPS synchronised.
- There is a delay of 100 ms or more between the receipt of a Sampled Value frame with SmpCnt 0, and the 1 PPS input pulse to the P546 indicating the start of the second.

When the GPS synchronisation recovers in any of these cases, the current differential scheme inhibit is removed on the next occurrence of the ‘SmpCnt 0’ in the Sampled Value frames.

The P546 uses a special setting for commissioning tests with IEC 61850-9-2LE using local 1 PPS synchronisation. See the Configuration chapter.

CHAPTER 4

APPLICATION EXAMPLES

1 APPLICATION EXAMPLES

This chapter provides typical examples of applications for the product.

This chapter contains the following sections:

2 OVERVIEW

The IEC 61850-9-2LE interface allows measurement signals to be transferred on a common bus, known as the Process Bus. These signals may originate from standard CTs and VTs, or from NCITs. Information from both types of measurement devices is sampled by merging units and is transferred on the Process Bus.

In a fully digital substation, digital interfaces are used for all items of primary plant. This includes the switchgear such as circuit breakers, isolators and earth switches, in addition to the CTs and VTs. In the present MiCOM implementation, IEC 61850-8-1 GOOSE messages on the Station Bus port can be used to receive binary status information from the switchgear and send controls or commands. Additional IEC 61850-8-1 GOOSE messages can be configured in the MiCOM IEDs which use the IEC 61850-9-2LE interface.

3 BAY ARCHITECTURE

The following diagram shows an example of substation Ethernet architecture adapted to a substation Process Bus.

IED 1 and IED 2 are used for protection BCU is the Bay Controller. This would be typical of transmission bays. In this example, each IED receives Sampled Values from a separate Analogue Merging Unit (AMU). Each Merging Unit is connected to a separate CT. The IEDs and AMUs are connected point-to-point. Point-to-point connections do not need switches but need one Merging Unit for each IED. Alternatively Sampled Values could be shared from one Merging Unit to several IEDs using an Ethernet Switch.

The diagram also shows a network architecture for digital signals. The IEDs and Switchgear Control Units (SCU) have redundant interfaces such as the IEC 62439 Parallel Redundancy Protocol. The network uses two Ethernet switches to create two independent LANs. For example, a trip signal or control command from IED 1 reaches SCU 1 through both LANs. This ensures redundancy to trip or control the CB.

In this example, the Sampled Value network is completely independent of the network for IEC 61850-8-1 GOOSE. This is analogous to conventional protection schemes where the AC wiring between CTs, VTs and IED inputs is fully independent from DC wiring for binary inputs or outputs, and interlocks.

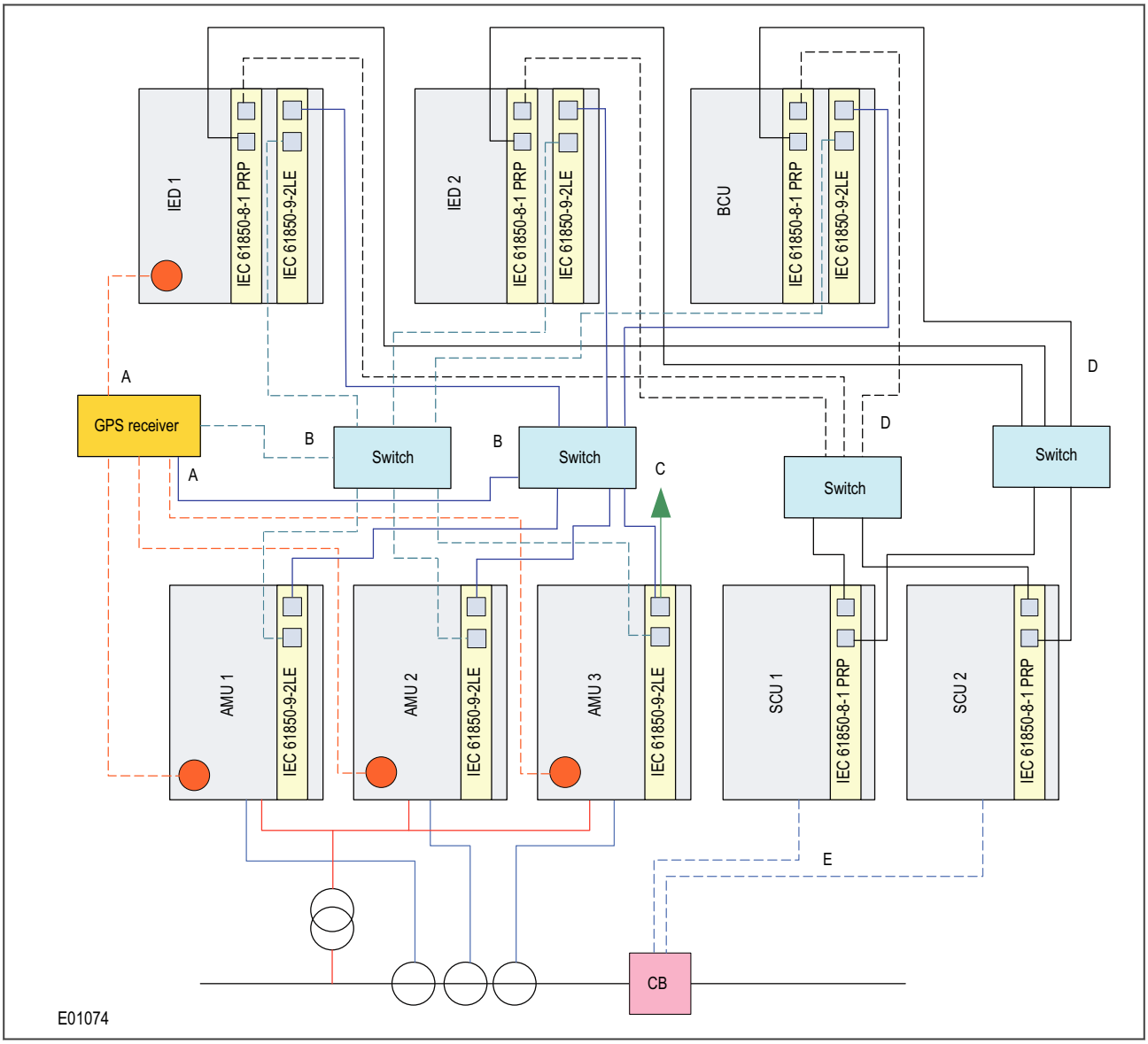


Figure 8: Example of Bay Architecture with IEC 61850-9-2LE IEDs

Key:

A: 1 PPS distribution to IED 1 and Analogue Merging Units.

B: Point-to-point connections for Sampled Values.

C: Sampled values for other bay functions such as busbar protection or bay control units.

D: Network with redundancy for tripping or control signals.

E: Status and trips, physical signals.

AMU: Analogue Merging Unit with CT and VT inputs, and an IEC 61850-9-2LE output.

SCU: Switchgear Control Unit with binary inputs and outputs, and a redundant IEC 61850-8-1 GOOSE interface.

BCU: Bay Controller Unit (E.g. C264)

4 STATION AND PROCESS BUS ARRANGEMENT

The system architecture can be arranged so that different types of information are organised into groups. For example, GOOSE messages can be sent to one segment (Process Bus) and reports to another (Station Bus). Separating Process Bus data from Station Bus data prevents them from interfering with each other so the bandwidth can be optimised.

The following diagram shows an Ethernet switch which routes the reports received from the IED to the clients on the Station Bus. The reports are not present on the Process Bus segment of the network. The switch filters out the IEC 61850 GOOSE messages that are not relevant for the Station Bus, such as the switchgear status from the SCU, or trip commands from the IED to the SCU.

For further information on how to filter MAC multicast addresses, see the switch documentation.

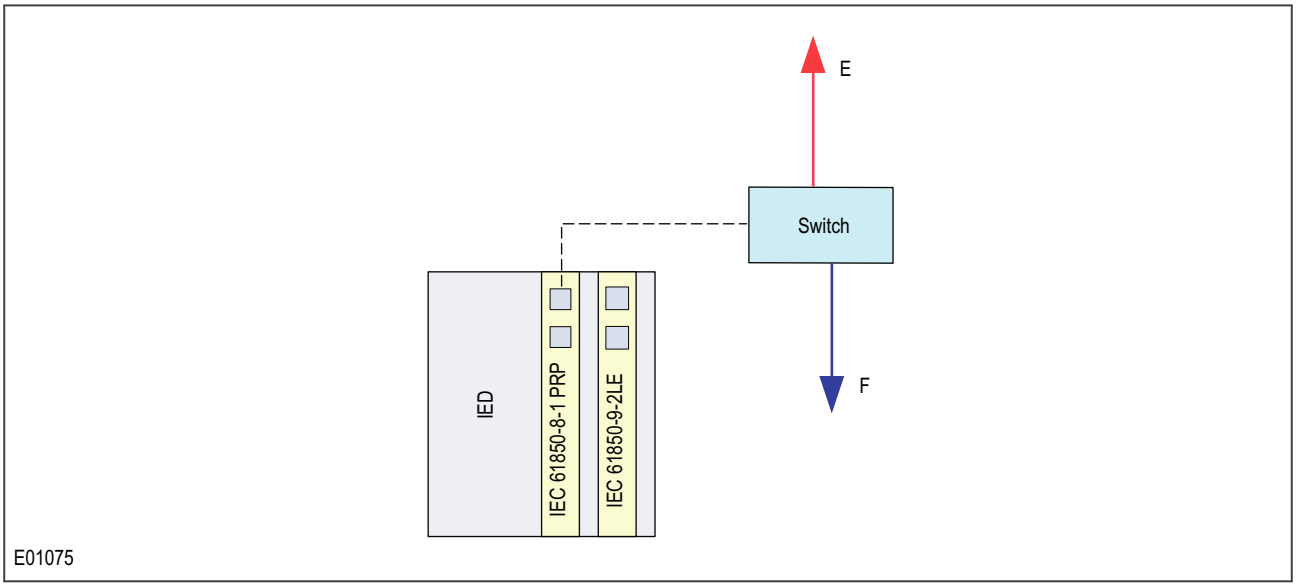


Figure 9: Integration of an IED with the Station Bus

Key:

E: Station Bus. Reports, waveform records.

F: Process Bus. IEC 61850 GOOSE.

5 VOLTAGE INPUT SWITCHING

The following diagram shows an example of three-phase voltage switching. In this case the feeders do not have individual voltage transformers. Therefore the feeder protection uses the voltage available from busbar voltage transformers for distance protection and other voltage-dependent functions.

Merging Units convert Voltages VT1 and VT2 to Sampled Values. Protection devices can then use the two independent IEC 61850-9.2LE Sampled Value data streams. In the example, the P446 is configured to receive both data streams. This is set in the IEC 61850-9.2LE setting menu, with the VT Switch Mode enabled. By default the IED uses VA1 VB1 VC1 for voltage-dependent functions. If VT1 fails, the operator can switch the voltage input to VA2 VB2 VC2 (VT2). This is done by changing the status of the DDB VABC Select x.

The check synchronising voltages can be switched. This is useful in breaker-and-a-half schemes or other busbar arrangements where the VT is used for a voltage check. A feeder may not be on the busbar and may be on one of the other bays in service when the synchronizing check is needed.

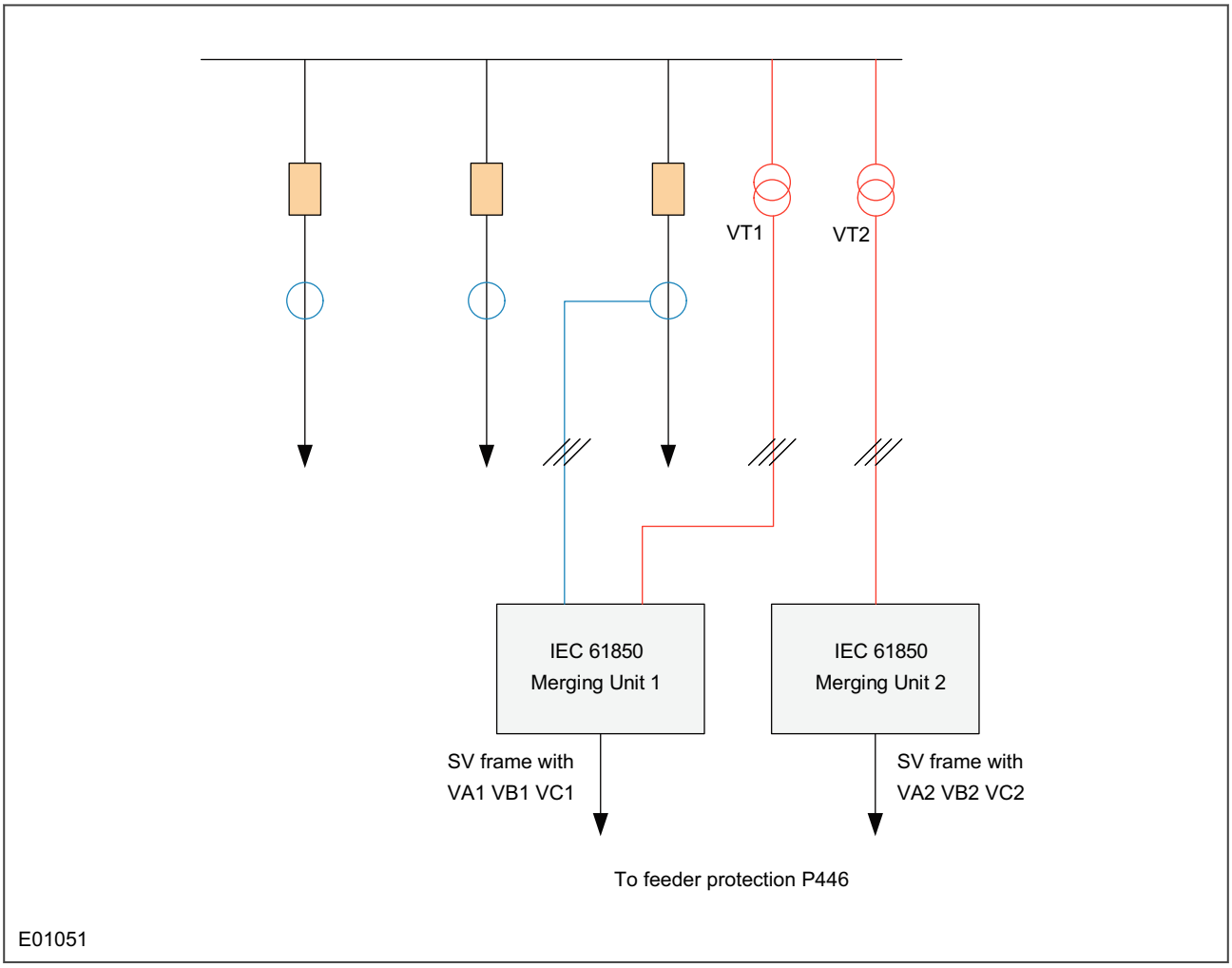


Figure 10: Example of three-phase voltage switching

The following diagram shows an application of switching the check synchronizing voltage. VT1 provides the main three-phase voltage VA VB VC for Feeder 1. The VTs on feeders on the busbar VT2, VT3 and VT4 can be configured as Vcs1, Vcs2 and Vcs3 respectively. These can be made available to the Feeder 1 protection as Vsc1/Vsc2 using the appropriate DDBs.

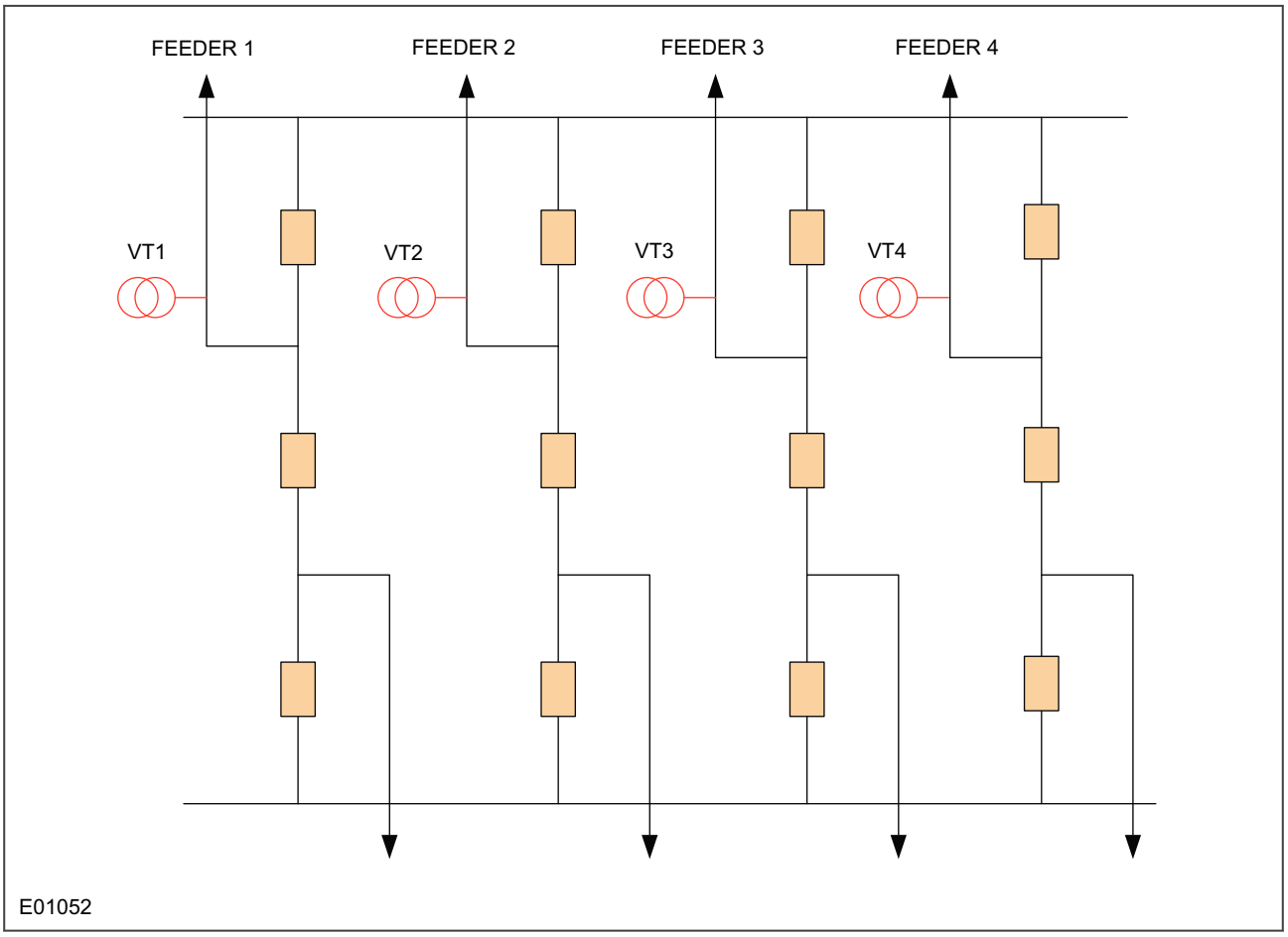


Figure 11: Application of switching the check synchronizing voltage

6 P441SV, P442, P444

An IED which has an IEC 61850-9-2LE interface is intended for use in applications where CT and VT measurements have been converted to Sampled Values. See the Ordering Options for the hardware and software versions of the IED. Also see the IED's technical manual for descriptions of its protection and non protection functions.

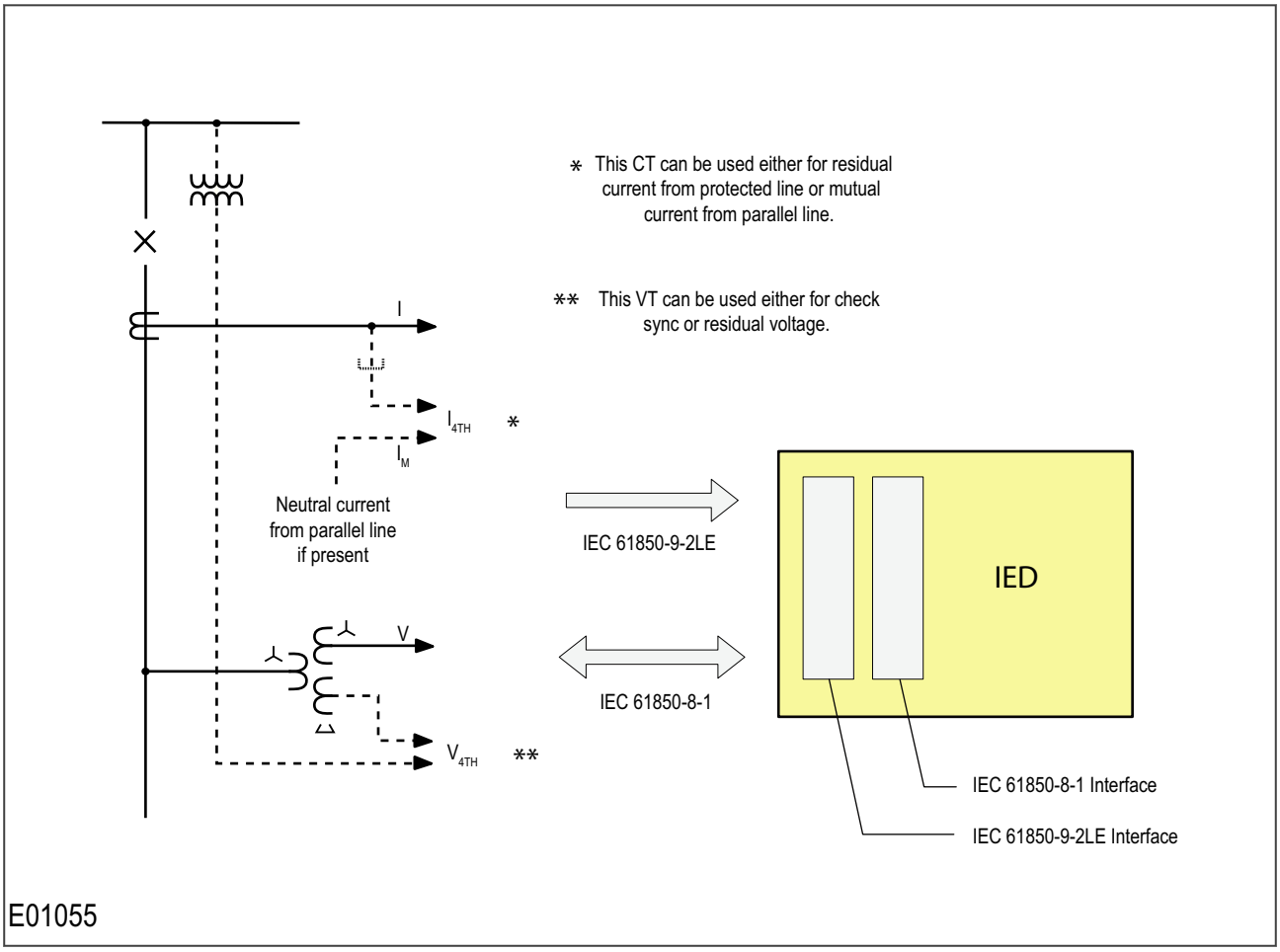


Figure 12: Overview of functionality

6.1 SAMPLED VALUE DISTRIBUTION

The IED provides up to eight Logical Nodes for receiving the Sampled Values. This allows several different arrangements of Merging Units in the substation. There are seven analogue input groups on the IED. These are:

[IA1 IB1 IC1] [IA2 IB2 IC2] [VA VB VC] [INSEN] [IM] [Vsc1] [Vsc2]

In the following diagram, the IED receives Sampled Values from two merging units. The IED has two Logical Nodes, one receiving the analogue input groups [IA1 IB1 IC1] and [VA VB VC], the other receiving input groups [IA2 IB2 IC2] and [Vsc1].

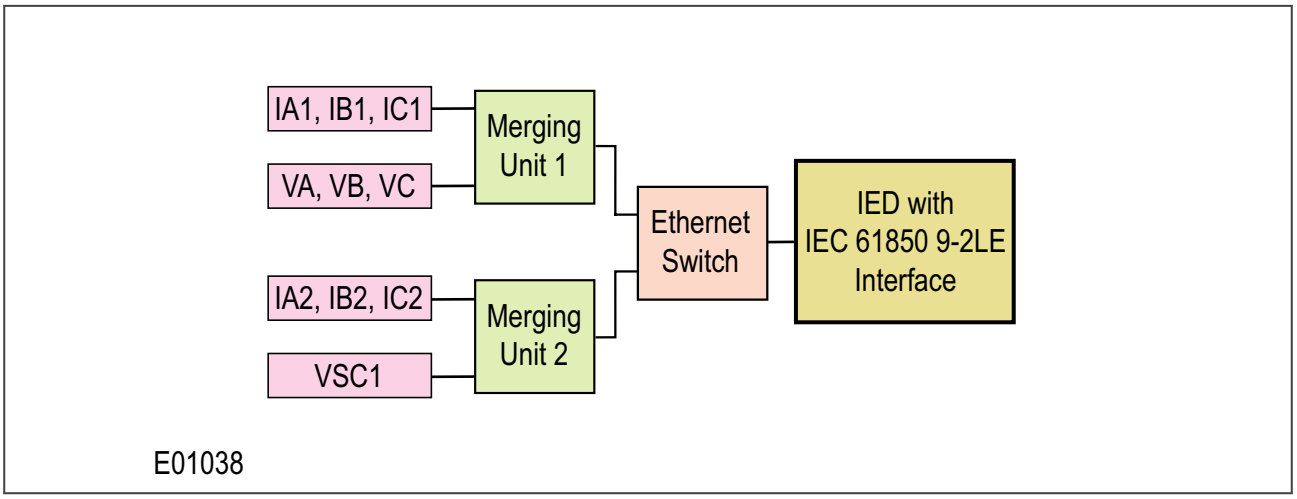


Figure 13: IED receiving Sampled Values from two merging units

In the following diagram, the IED receives Sampled Values from four merging units. The number of merging units can vary depending on application requirements, such as the substation layout and the inputs required by the IED.

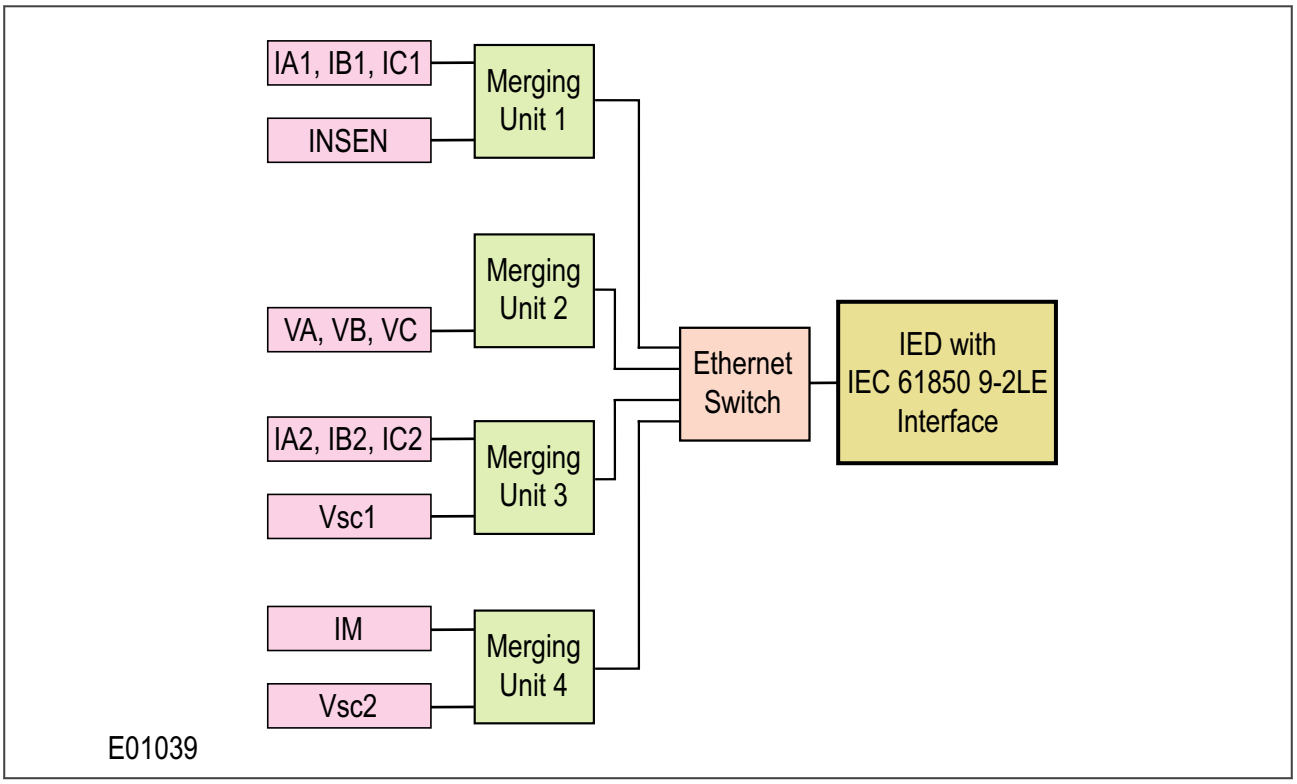


Figure 14: IED receiving Sampled Values from four merging units

7 P446

An IED which has an IEC 61850-9-2LE interface is intended for use in applications where CT and VT measurements have been converted to Sampled Values. In this way the P546 with an IEC 61850-9-2LE interface can be used as a P543, P544, P545 or P546 in applications using Sampled Values. However, unlike the P543 and P545, the P546 can be used on plain feeders only and does not cover transformer feeder applications.

See the Ordering Options for the hardware and software versions of the IED. Also see the IED's technical manual for descriptions of its protection and non protection functions.

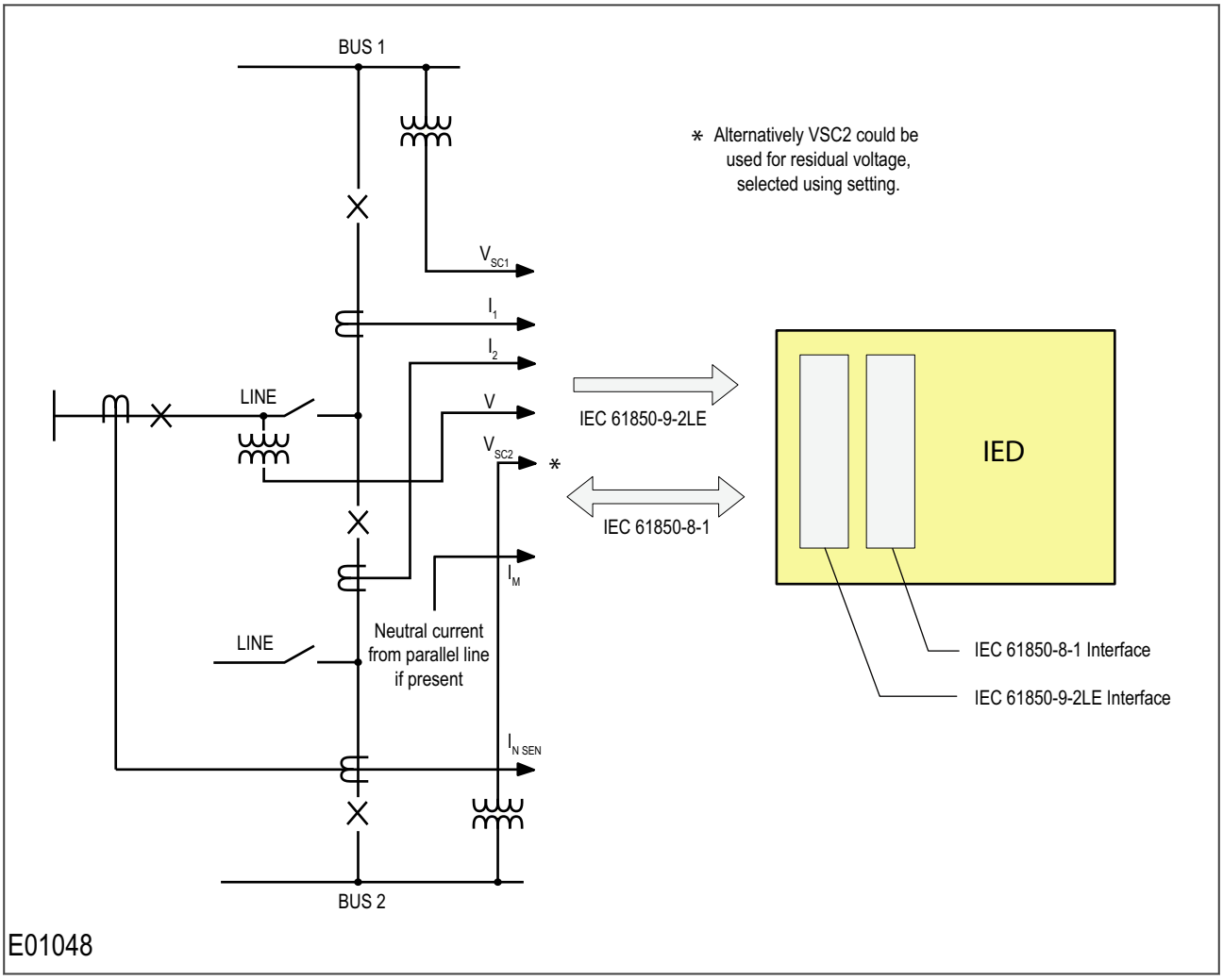


Figure 15: Overview of P546 functionality

7.1 SAMPLED VALUE DISTRIBUTION

The IED provides up to eight Logical Nodes for receiving the Sampled Values. This allows several different arrangements of Merging Units in the substation. There are seven analogue input groups on the IED. These are:

[IA1 IB1 IC1] [IA2 IB2 IC2] [VA VB VC] [INSEN] [IM] [Vsc1] [Vsc2]

In the following diagram, the IED receives Sampled Values from two merging units. The IED has two Logical Nodes, one receiving the analogue input groups [IA1 IB1 IC1] and [VA VB VC], the other receiving input groups [IA2 IB2 IC2] and [Vsc1].

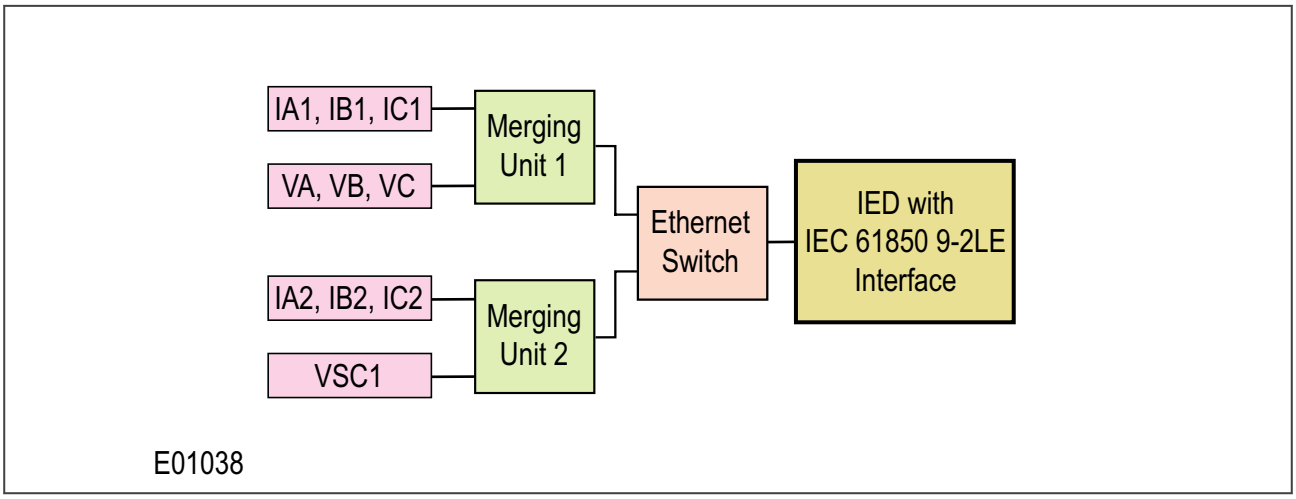


Figure 16: IED receiving Sampled Values from two merging units

In the following diagram, the IED receives Sampled Values from four merging units. The number of merging units can vary depending on application requirements, such as the substation layout and the inputs required by the IED.

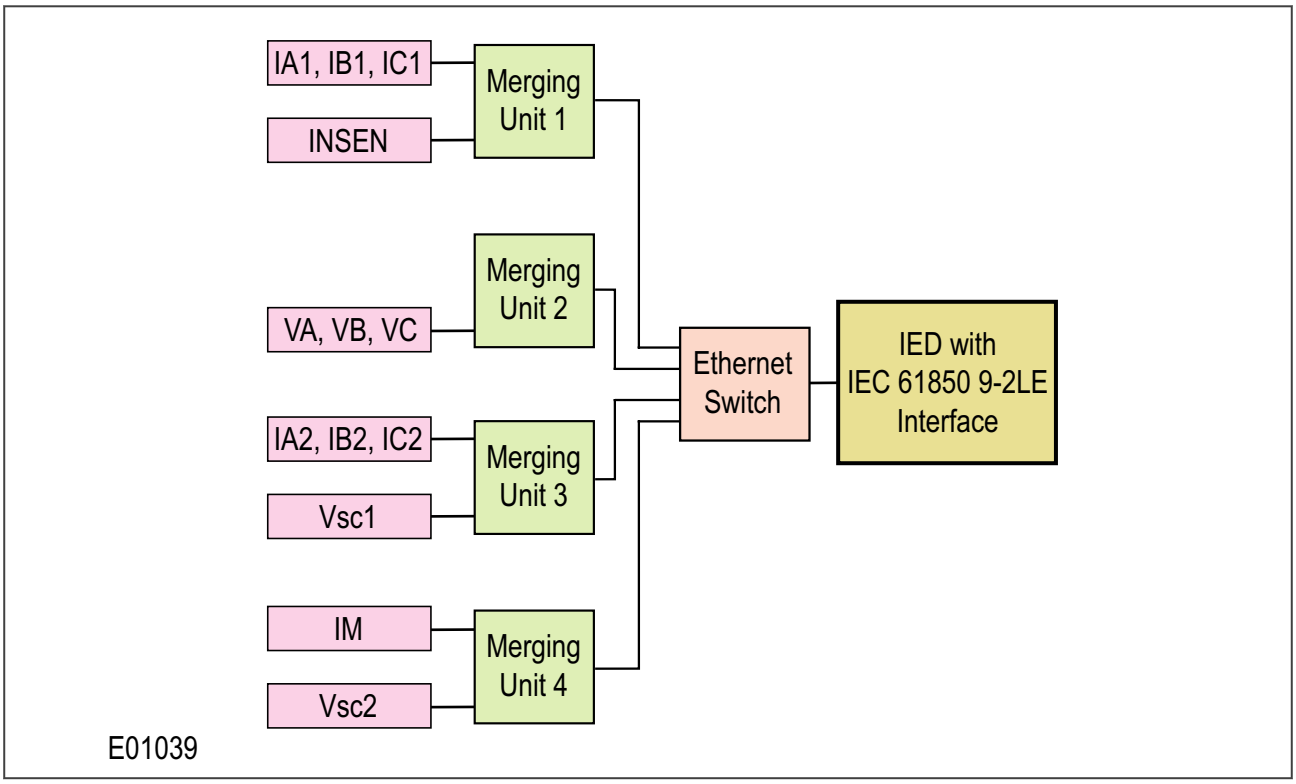


Figure 17: IED receiving Sampled Values from four merging units

8 P546

An IED which has an IEC 61850-9-2LE interface is intended for use in applications where CT and VT measurements have been converted to Sampled Values. In this way the P446 with an IEC 61850-9-2LE interface can be used as a P443 or P446 in applications using Sampled Values.

See the Ordering Options for the hardware and software versions of the IED. Also see the IED's technical manual for descriptions of its protection and non protection functions.

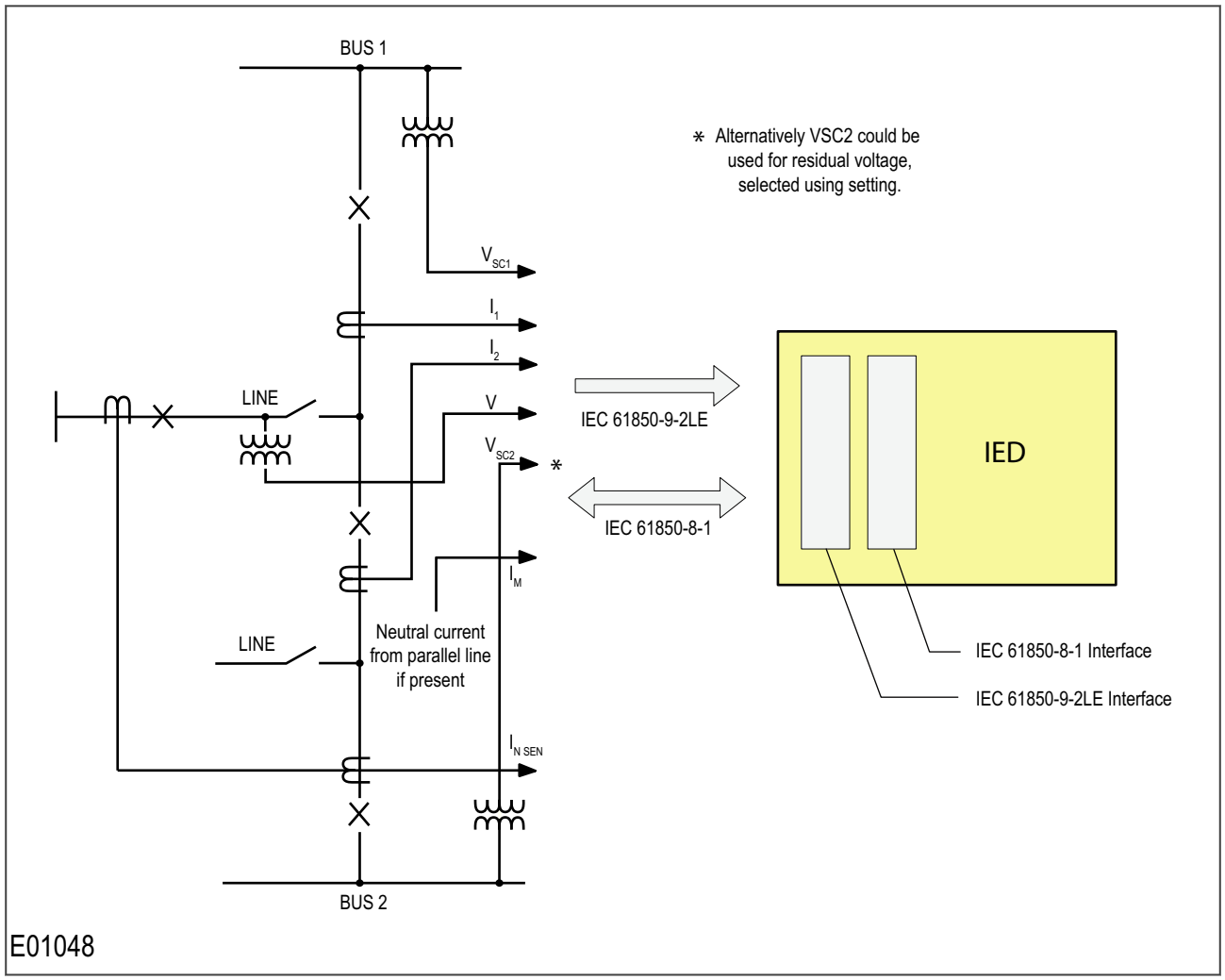


Figure 18: Overview of P546 functionality

8.1 SAMPLED VALUE DISTRIBUTION

The IED provides up to eight Logical Nodes for receiving the Sampled Values. This allows several different arrangements of Merging Units in the substation. There are seven analogue input groups on the IED. These are:

[IA1 IB1 IC1] [IA2 IB2 IC2] [VA VB VC] [INSEN] [IM] [Vsc1] [Vsc2]

In the following diagram, the IED receives Sampled Values from two merging units. The IED has two Logical Nodes, one receiving the analogue input groups [IA1 IB1 IC1] and [VA VB VC], the other receiving input groups [IA2 IB2 IC2] and [Vsc1].

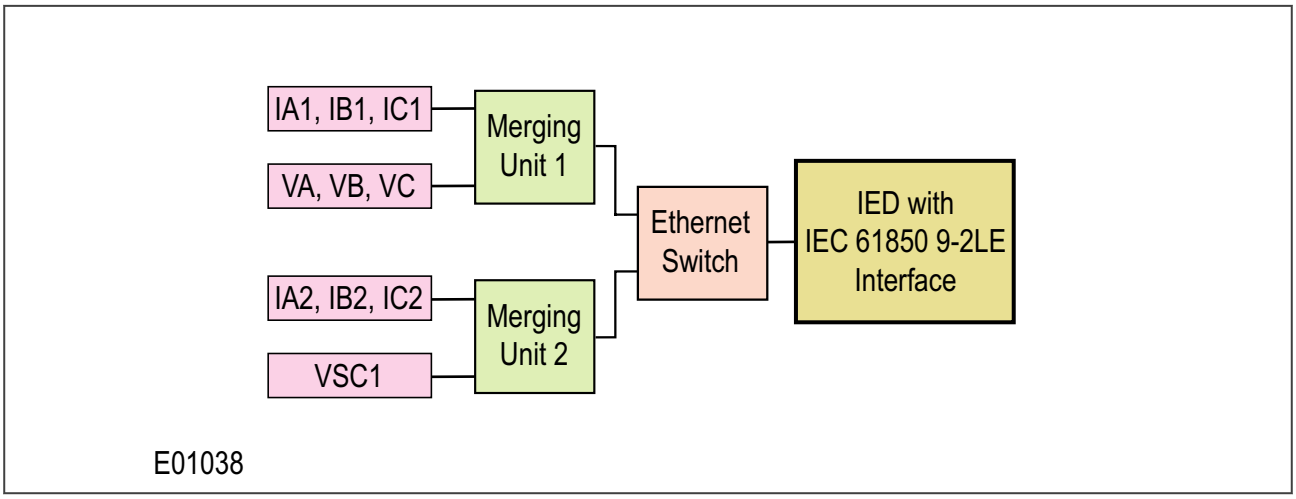


Figure 19: IED receiving Sampled Values from two merging units

In the following diagram, the IED receives Sampled Values from four merging units. The number of merging units can vary depending on application requirements, such as the substation layout and the inputs required by the IED.

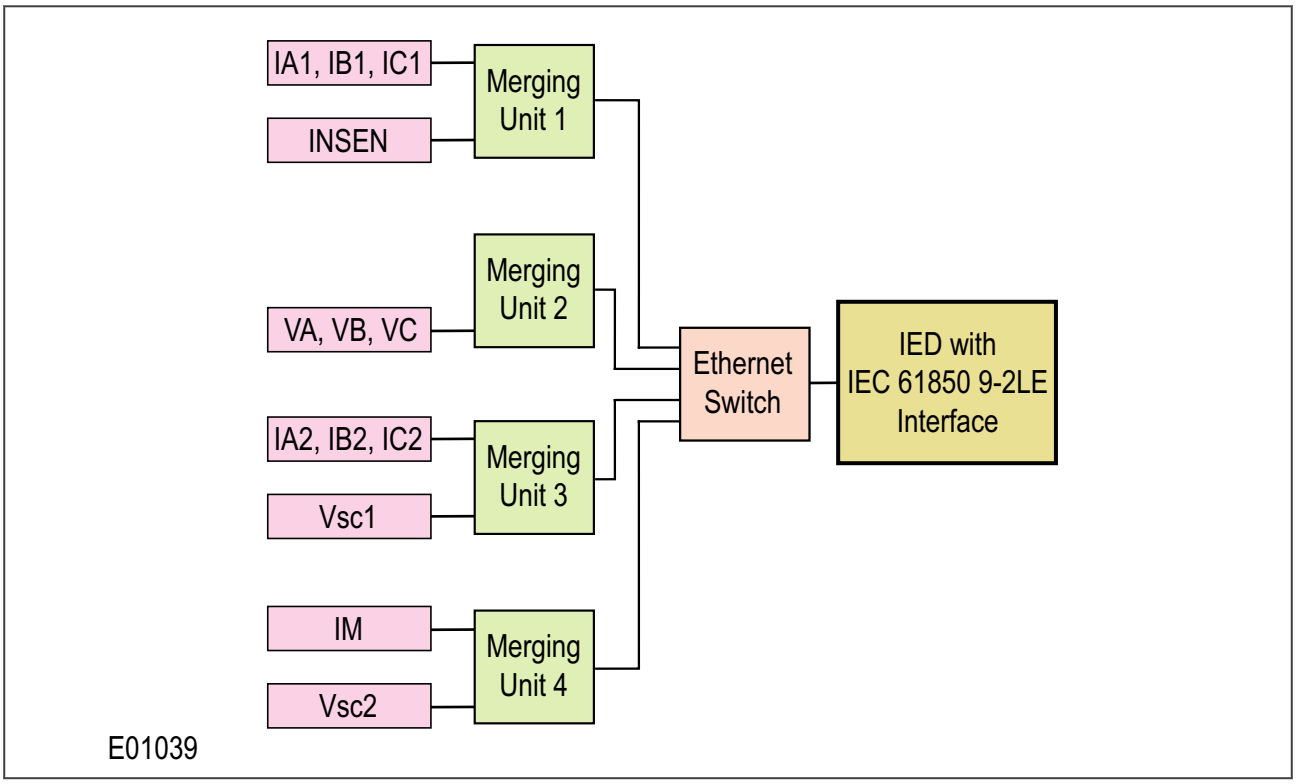


Figure 20: IED receiving Sampled Values from four merging units

8.2 CURRENT DIFFERENTIAL SCHEMES

Schemes with IEDs which use the IEC 61850-9-2LE interface can be two or three-ended. This is the same as with conventional P546 relays. The schemes always require GPS synchronisation with 1 PPS inputs from P594/RT430s to IEDs at all feeder ends.

The IEC 61850-9-2LE standard allows IEDs with Sampled Value inputs to be mixed with IEDs with conventional inputs. This allows protected feeders to link an existing substation which has conventional equipment with a substation where the current transformers are all non-conventional or the relays have Sampled Value inputs.

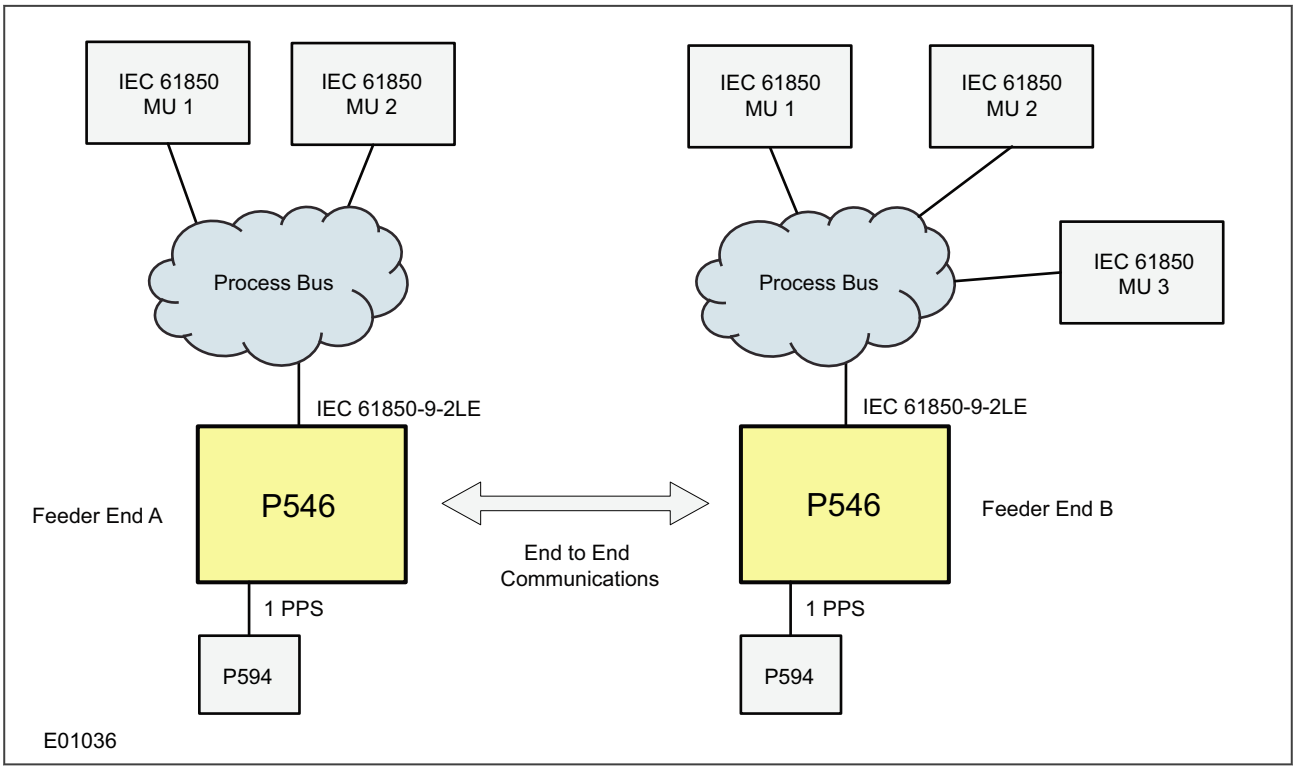


Figure 21: Two-ended scheme with Sampled Value unputs

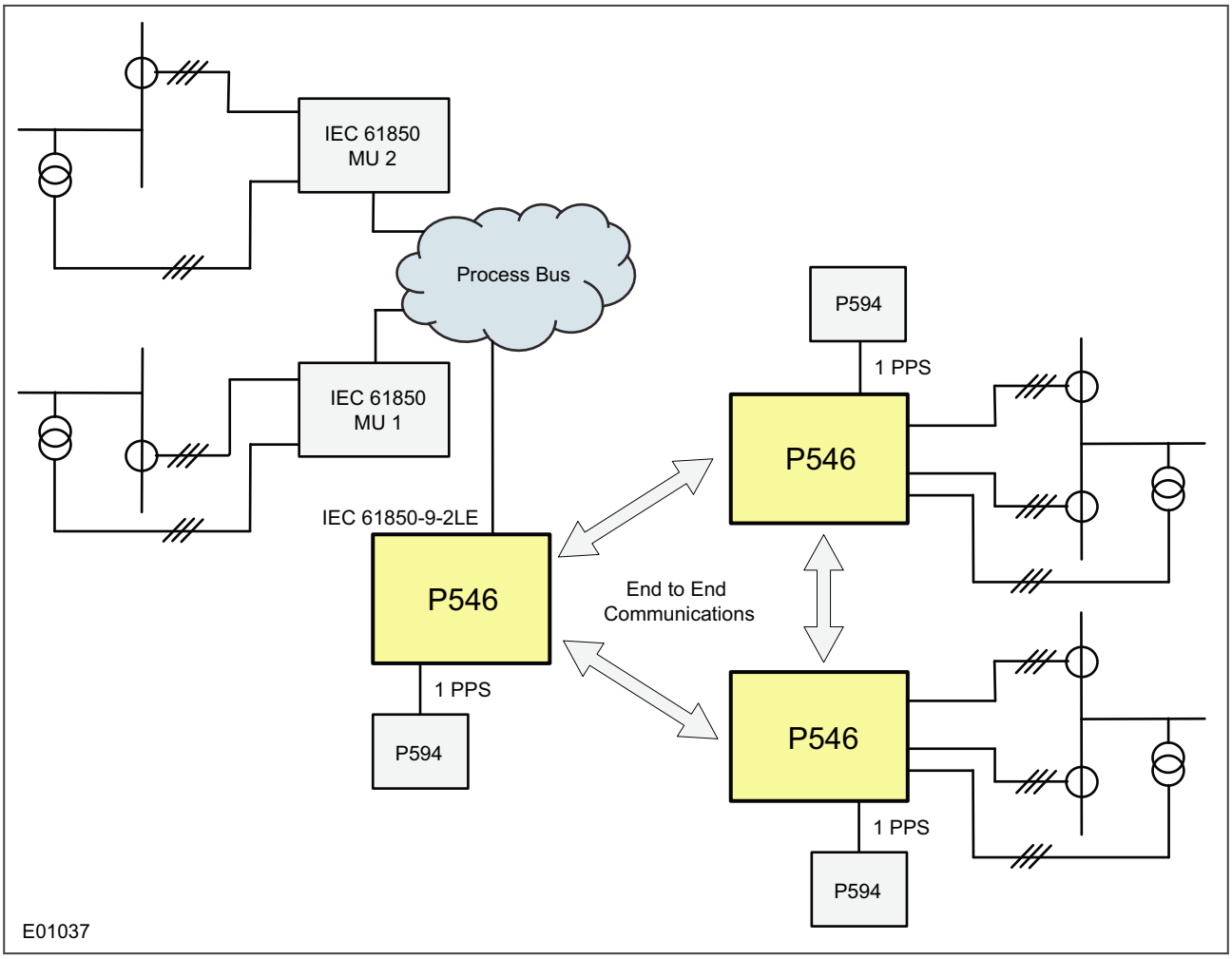


Figure 22: Three-ended scheme with analogue and Sampled Value unputs

The current differential protection requires GPS 1 PPS synchronisation and is inhibited if synchronisation is lost at any one feeder end. Therefore we recommend you enable appropriate backup protection in the IEDs to ensure faults are covered if the GPS signal fails. This backup protection should use only Local 1 PPS synchronisation of the Sampled Value inputs.

Note:
Use a P594 with version D firmware to meet the requirements of Local 1 PPS and Global 1 PPS signals for sample synchronisation.

9 P645

An IED which has an IEC 61850-9-2LE interface is intended for use in applications where CT and VT measurements have been converted to Sampled Values. In this way the P645 with an IEC 61850-9-2LE interface can be used as a P642, P643 or P645 in applications using Sampled Values.

See the Ordering Options for the hardware and software versions of the IED. Also see the IED's technical manual for descriptions of its protection and non protection functions.

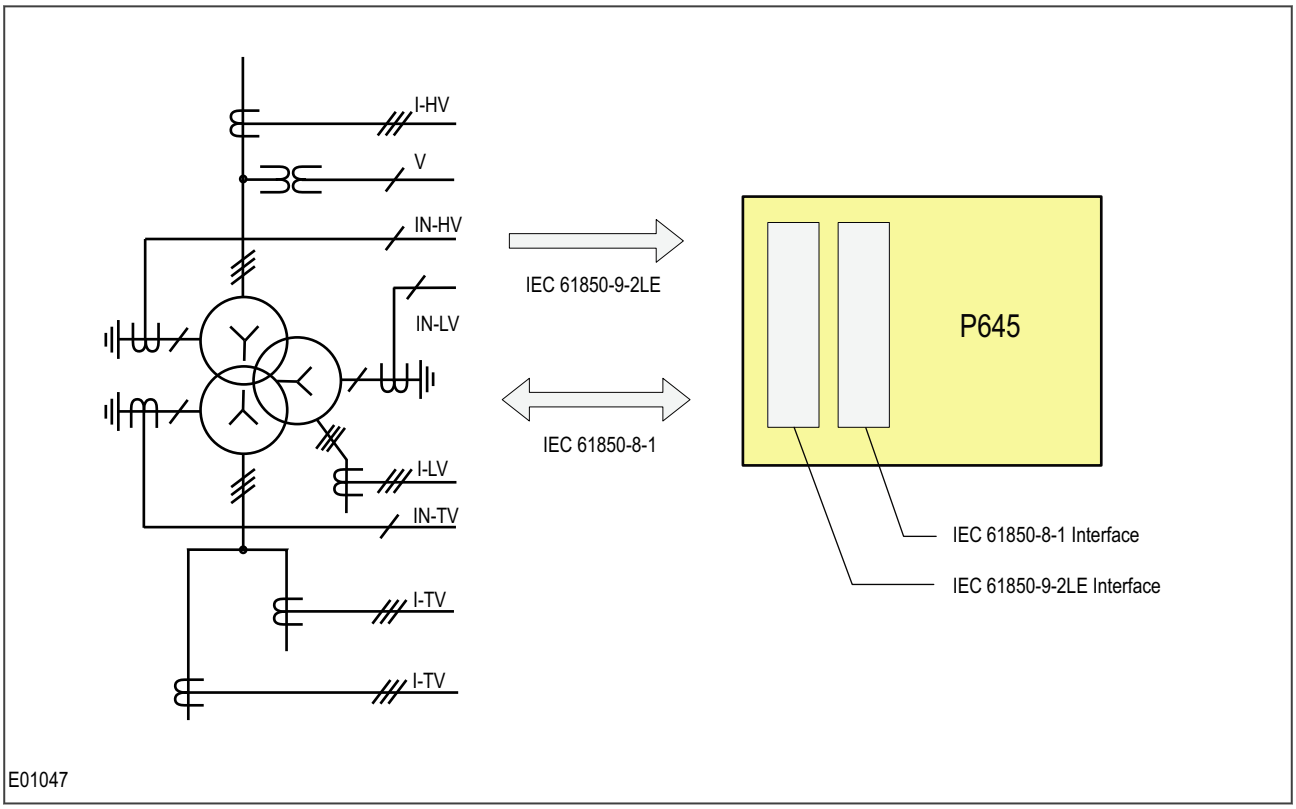


Figure 23: Overview of P645 functionality

9.1 SAMPLED VALUE DISTRIBUTION

The IED provides up to eight Logical Nodes for receiving the Sampled Values. This allows several different arrangements of Merging Units in the substation. There are ten analogue input groups on the IED. These are:

[IA1 IB1 IC1] [IA2 IB2 IC2] [IA3 IB3 IC3] [IA4 IB4 IC4] [IA5 IB5 IC5] [IY1] [IY2] [IY3] [VA VB VC] [V_{FLUX}]

The following diagrams show two possible arrangements for the P645. In the first diagram, the IED receives Sampled Values from three different merging units. The HV winding currents and the optional three-phase voltage input are received from MU1, the LV winding currents from MU2 and the tertiary currents from MU3. The winding neutral currents, where required for functions such as restricted earth fault, can also be received through the same merging units. In the second diagram, the IED receives Sampled Values from five different merging units.

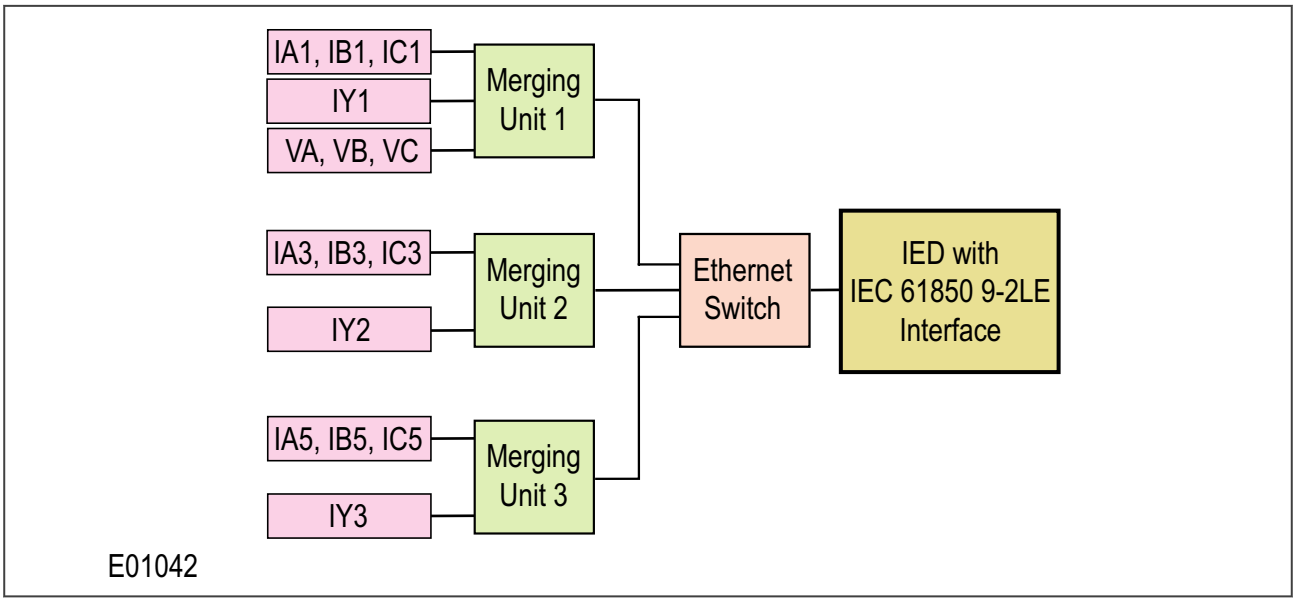


Figure 24: IED receiving sampled from three merging units

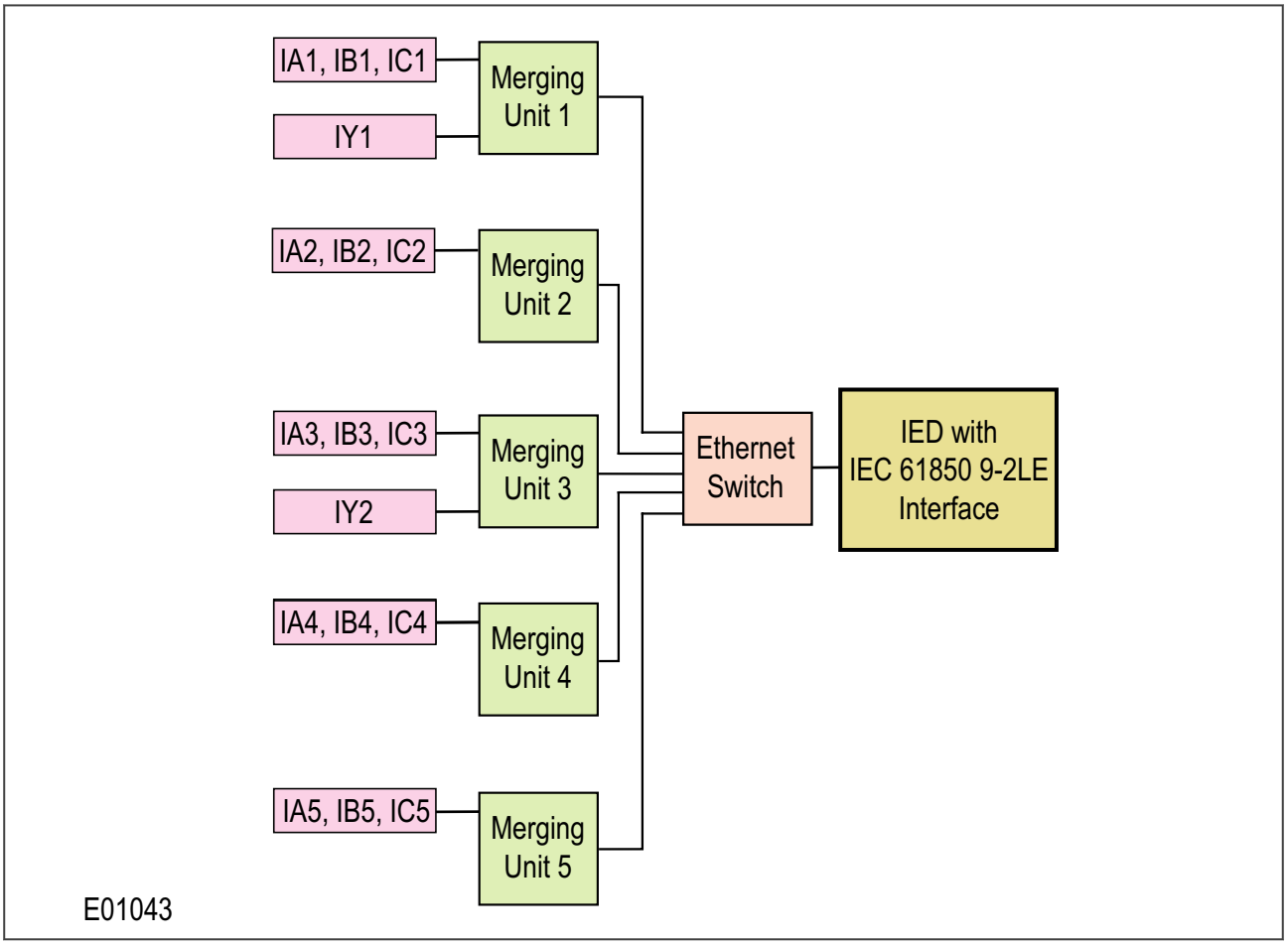


Figure 25: IED receiving Sampled Values from five merging units

10 P743

The P743 with the IEC 61850 interface board is intended for low impedance decentralised busbar protection schemes using a P741. In this type of scheme the P743 is commonly named the Peripheral Unit and the P741 is named the Central Unit Protection.

See the Ordering Options for the hardware and software versions of the IED. Also see the IED's technical manual for descriptions of its protection and non protection functions.

10.1 SAMPLED VALUE DISTRIBUTION

Caution:
The following requirements are mandatory to maintain performance of the protection functions and to reduce risks of maloperation.

- The Ethernet connection between the Merging Unit and the P743 must be point to point (no external switch between Merging Units and the P743).
- The Merging Unit must acquire the measurement [IA, IB, IC, IN].
- The Merging Unit must be connected to a GLOBAL 1 PPS signal.
- Each P743 is connected to a separate Merging Unit. The time difference between signals from each Merging Unit must not exceed 10 microseconds.
- At 50 Hz the Merging Unit acquires values every 250 microseconds +/-10 microseconds and transmits Sampled Value frames on the Process Bus every 250 microseconds +/-10 microseconds.
- At 60 Hz the Merging Unit acquires values every 208.3 microseconds +/-10 microseconds and transmits Sampled Value frames on the Process Bus every 208.3 microseconds +/-10 microseconds.

The following diagram shows a typical application where all P743 IEDs are Peripheral Units. IEDs can also be connected to a dedicated IEC 61850 8.1 network.

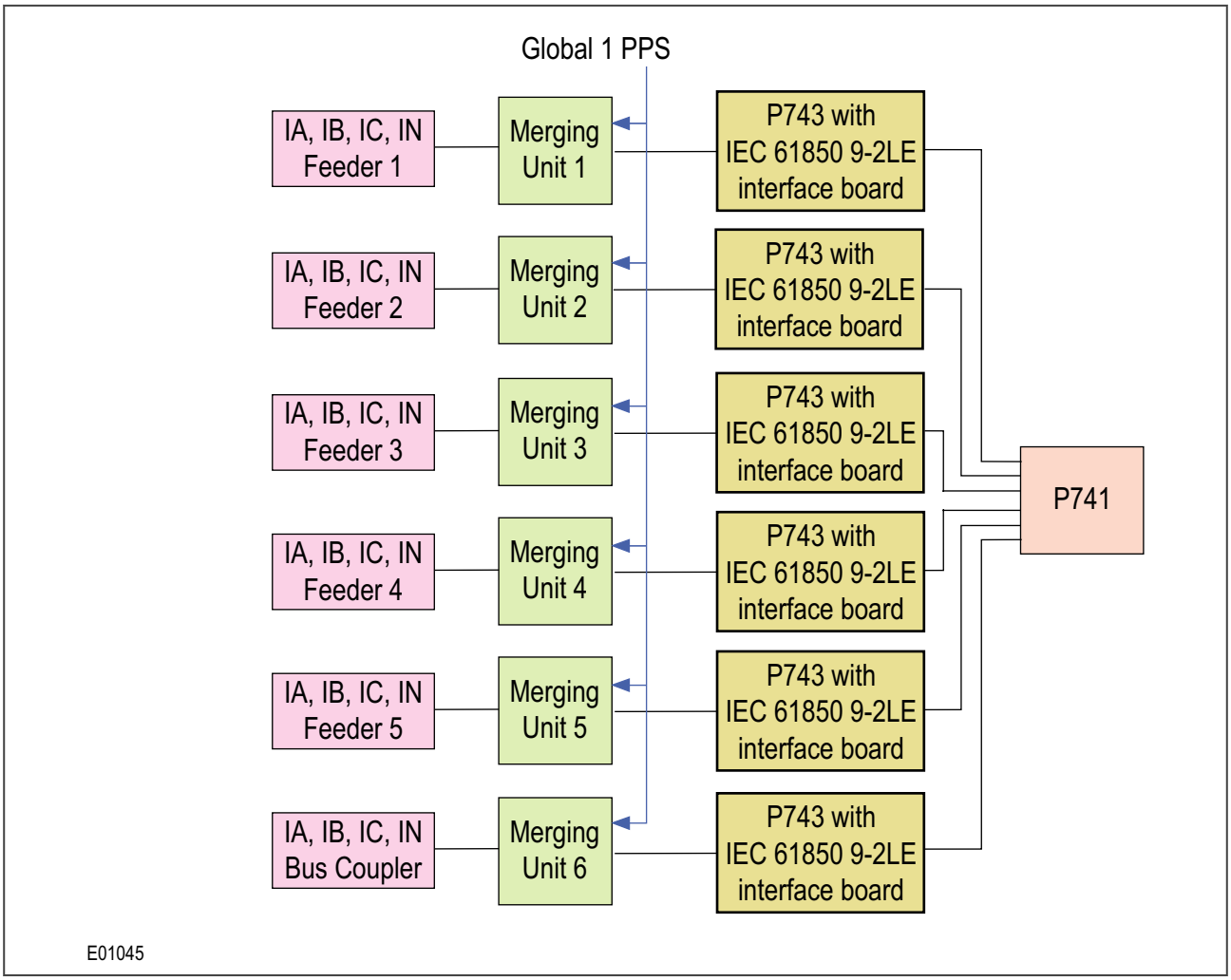


Figure 26: Typical application of P743 with P741

11 P746

The P746 with the IEC 61850-9-2LE interface is intended for applications where a Sampled Value interface is required. The IED only supports applications with a maximum of six CT inputs. This is the one-box mode. The P746 with the IEC 61850-9-2LE interface does not support the three-box mode. The IED is based on P746 firmware version 03 with MiCOM P40 Cyber-security. See the relevant relay's technical manual for descriptions of its protection and non-protection functions.

11.1 SAMPLED VALUE DISTRIBUTION

The following diagram shows a typical P746 application where all six three-phase current inputs are used. Where required, the optional voltage input can be combined in one of the six merging units shown or it can use a separate dedicated merging unit.

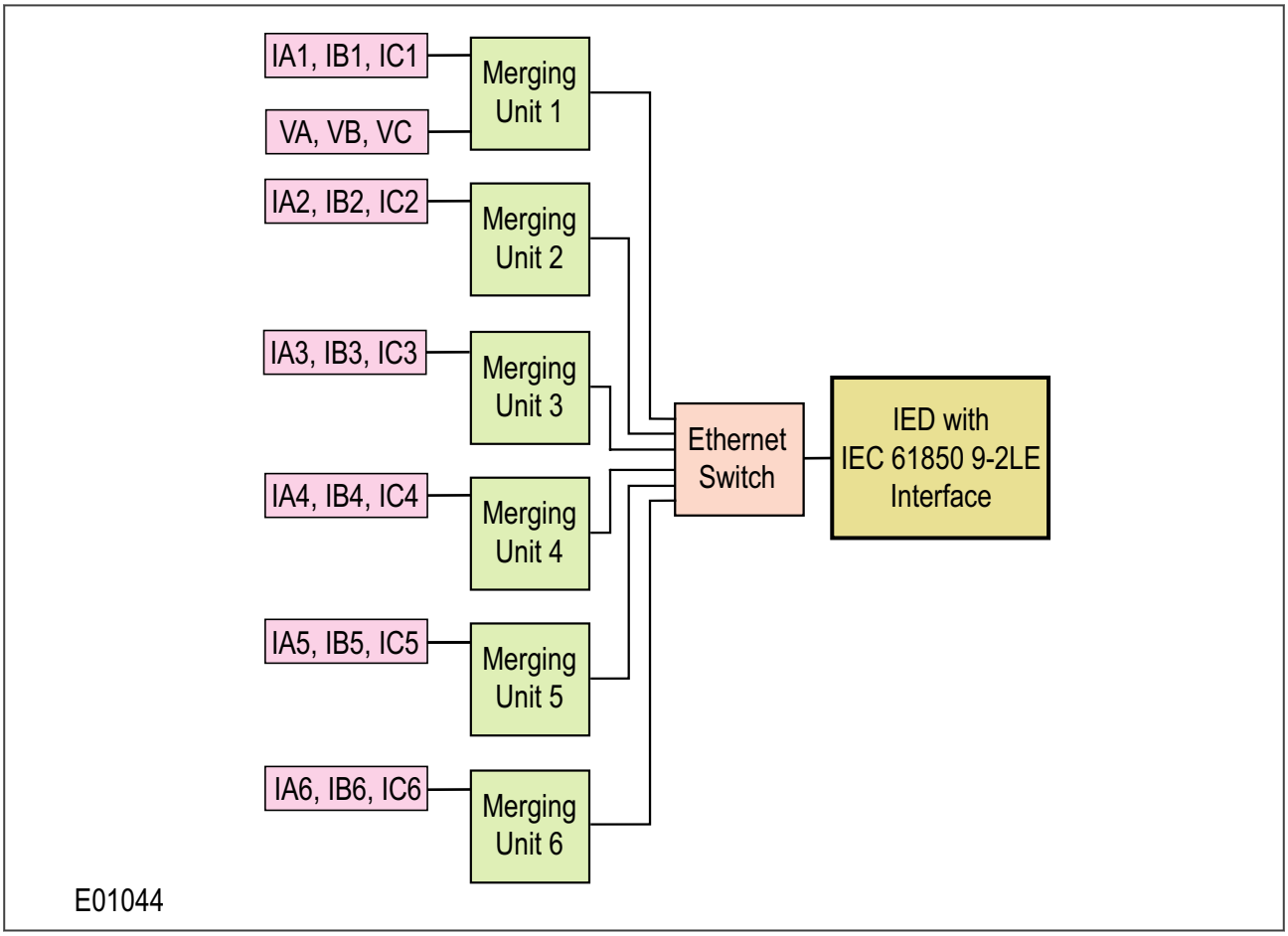


Figure 27: IED receiving sampled from six merging units

12 P841B

An IED which has an IEC 61850-9-2LE interface is intended for use in applications where CT and VT measurements have been converted to Sampled Values. In this way the P841B with an IEC 61850-9-2LE interface can be used as a P841A in applications using Sampled Values.

See the Ordering Options for the hardware and software versions of the IED. Also see the IED's technical manual for descriptions of its protection and non protection functions.

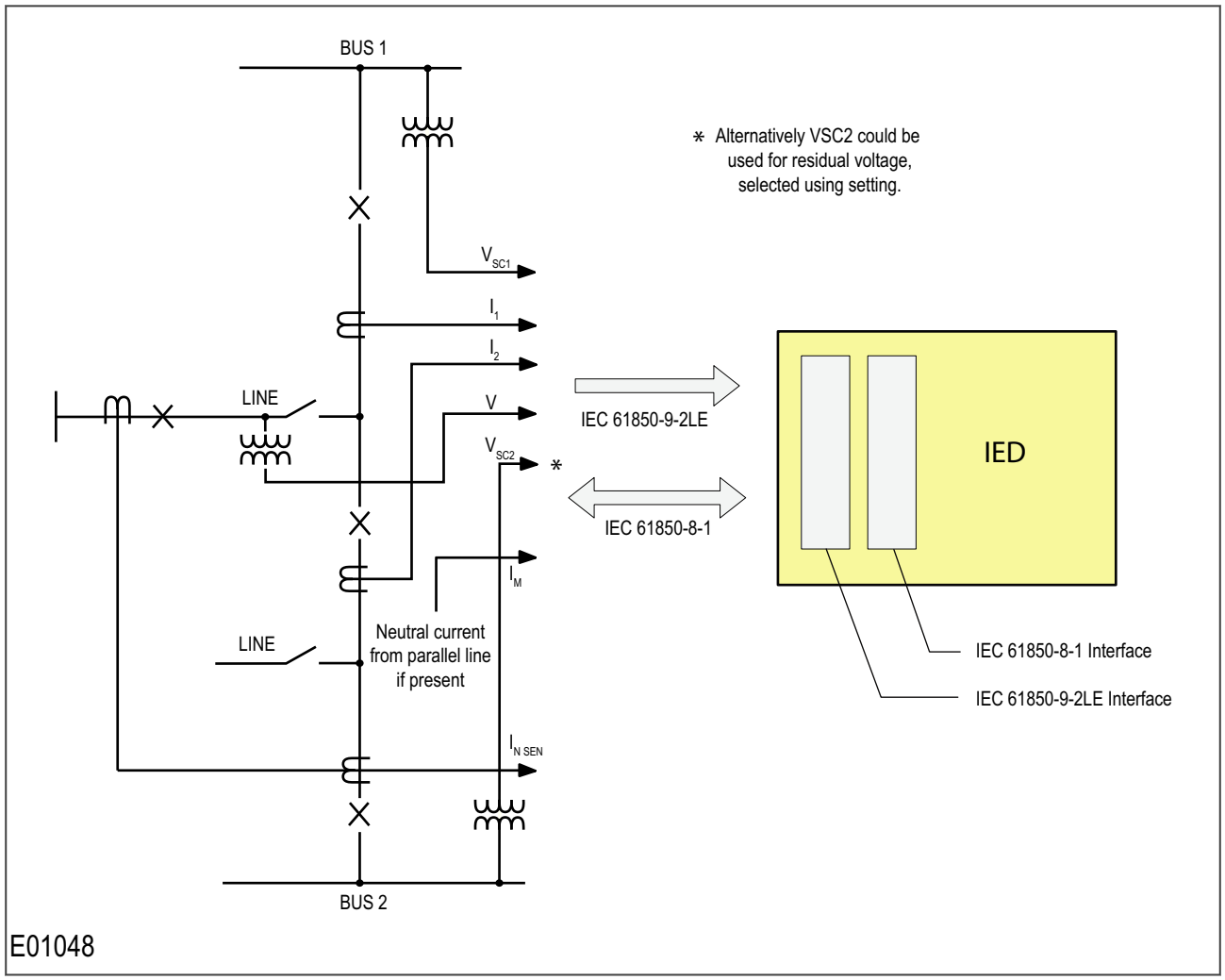


Figure 28: Overview of P546 functionality

12.1 SAMPLED VALUE DISTRIBUTION

The IED provides up to eight Logical Nodes for receiving the Sampled Values. This allows several different arrangements of Merging Units in the substation. There are seven analogue input groups on the IED. These are:

[IA1 IB1 IC1] [IA2 IB2 IC2] [VA VB VC] [INSEN] [IM] [Vsc1] [Vsc2]

In the following diagram, the IED receives Sampled Values from two merging units. The IED has two Logical Nodes, one receiving the analogue input groups [IA1 IB1 IC1] and [VA VB VC], the other receiving input groups [IA2 IB2 IC2] and [Vsc1].

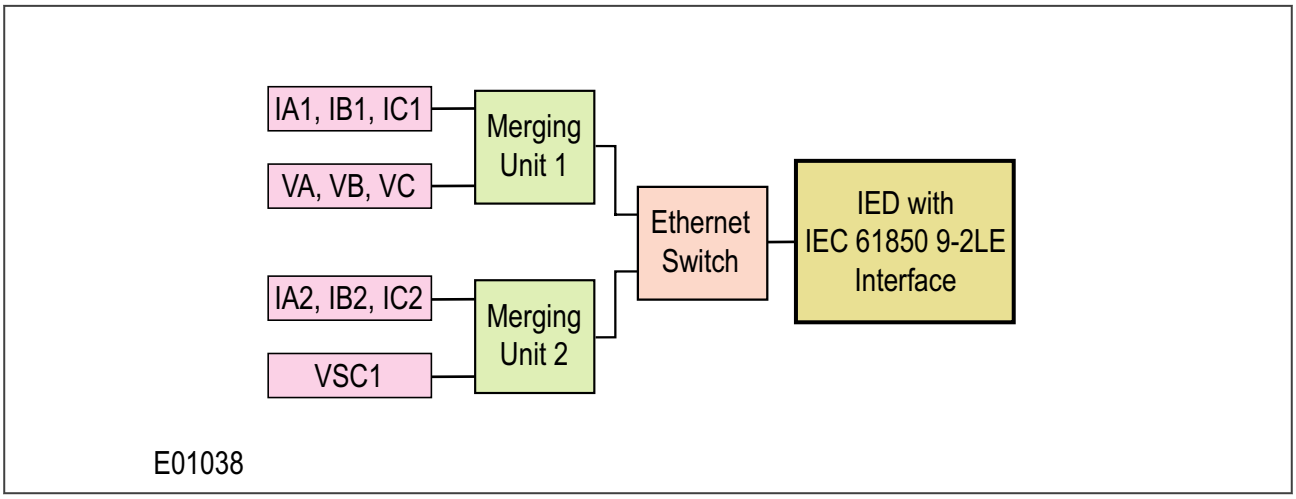


Figure 29: IED receiving Sampled Values from two merging units

In the following diagram, the IED receives Sampled Values from four merging units. The number of merging units can vary depending on application requirements, such as the substation layout and the inputs required by the IED.

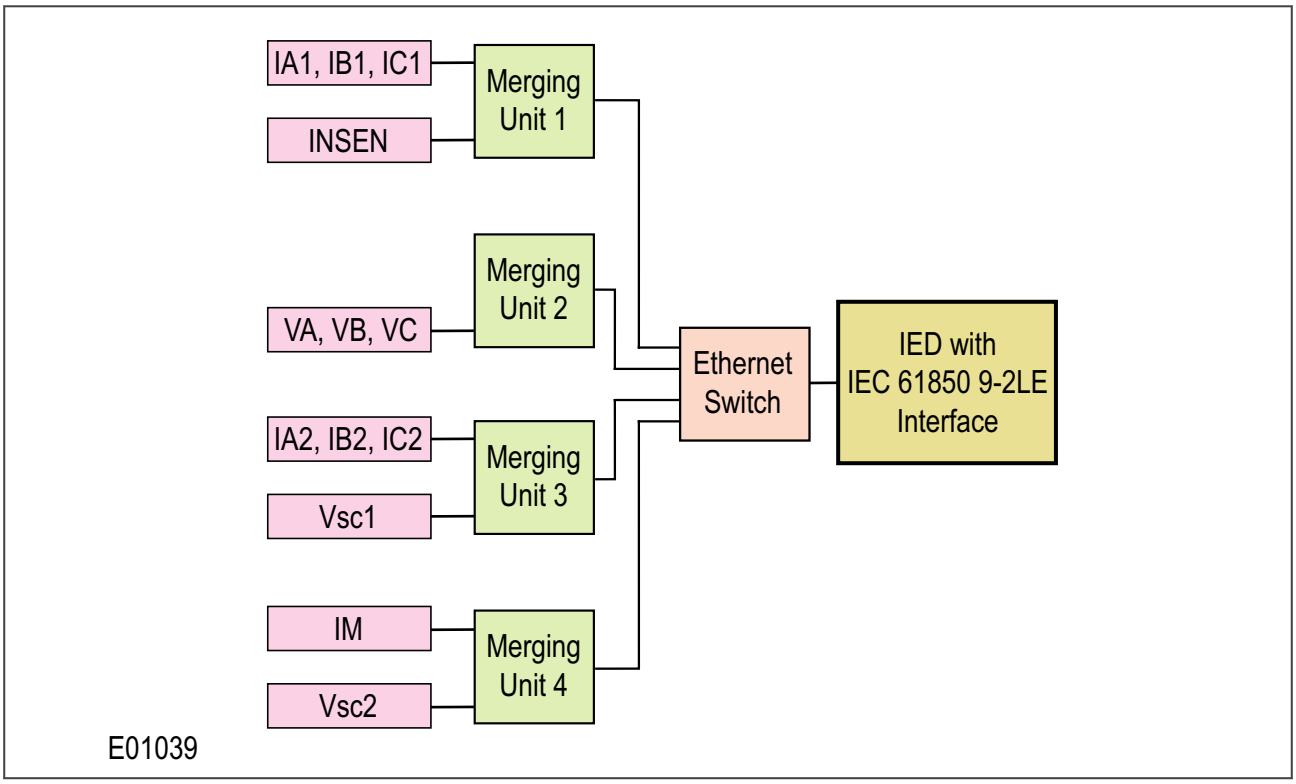


Figure 30: IED receiving Sampled Values from four merging units

CHAPTER 5

COMMISSIONING INSTRUCTIONS

1 CHAPTER OVERVIEW

This chapter contains the following sections:

2 GENERAL GUIDELINES

Warning:
Before working on the equipment, check the device ratings and read the appropriate Safety Information chapter.

Connect the device to the network. Check the Link and Activity LEDs are functioning. Check the IP address is correct.

This section shows typical network connections.

3 COMMISSIONING TEST EQUIPMENT

This is a typical list of equipment required for testing the IEC 61850-9-2LE interface in the IED.

- IED test kit capable of generating 2 or 3 sets of IEC 61850-9-2LE Sampled Values and GOOSE data sets. Or conventional current or voltage source with Merging Unit to generate Sampled Values
- Ethernet switch(es)
- Fibre optic cables

4 CHECK CONNECTIONS

1. De-energise the IED.
2. Visually inspect the connectors, and check the external wiring is correct.

5 IED CONFIGURED WITH ONE LOGICAL NODE

The settings for the IEC 61850-9-2LE interface are in the IED menu IEC 61850-9-2LE. See the Settings chapter.

1. If necessary, isolate or block any outgoing trips from the IED. If physical contacts from the IED are wired in the scheme, from the main IED menu select ***Test Mode***.
2. Connect the IED's IEC 61850-9-2LE port to the Sampled Value source. If necessary this can be routed through an Ethernet switch.
3. In the IED menu setting IEC 61850-9-2LE > ***Physical Link***, select `Fibre Optic` for receiving Sampled Values.
4. Check that the Logical Node name in the IED matches the name in the Sampled Value source (test kit or Merging Unit). Make any changes in the source Logical Node names. This prevents mismatches in Logical Node names when the IED is put into service when testing existing schemes.
5. Set the IED ***Synchro Alarm*** to `No SYNC CLK` so the IED accepts Sampled Value frames with or without synchronisation.
6. Generate Sampled Value frames with the rated current and voltage as required in the IED's Logical Node configuration.
7. In the *MEASUREMENTS* menu, check the magnitudes and phase angles are displayed correctly. The display may be in primary or secondary values. Also the IED's CT ratio or VT ratio settings affect the display. A typical accuracy of 1% can be expected for magnitudes.
8. Change the Logical Node name configured in the test kit. Check the data cell ***SAV Absence*** displays '0' for the Logical Node configured in the IED. Check that all *MEASUREMENTS* displays for voltage or current are zero.
9. Depending on the scheme, use the ***Synchro Alarm*** setting to return the IED to service. Re-enable the IED trip outputs.

6 IED CONFIGURED WITH TWO OR MORE LOGICAL NODES

The settings for the IEC 61850-9-2LE interface are in the IED menu IEC 61850-9-2LE.

1. If necessary, isolate or block any outgoing trips from the IED. If physical contacts from the IED are wired in the scheme, from the main IED menu select ***Test Mode***.
2. Connect the IED's IEC 61850-9-2LE port to an Ethernet switch, which is connected to the Sampled Value sources. In the IED menu setting *IEC 61850-9-2LE* then ***Physical Link***, select `Fibre Optic` for receiving Sampled Values.
3. Check that the Logical Node name in the IED matches the name in the Sampled Value source (test kit or Merging Unit). Make any changes in the source Logical Node names. This prevents mismatches in Logical Node names when the IED is put into service when testing existing schemes.
4. Set the IED ***Synchro Alarm*** to `Local 1PPS` so the IED accepts Sampled Value frames with local or global synchronisation.
5. Check that the Sampled Value source (test kit or Merging Unit) is GPS synchronised.
6. Check the receipt of Sampled Value frames one by one for each Logical Node configured in the IED.

Repeat the following steps for each Logical Node, configuring them one by one in the Sampled Value source(s).

1. Generate Sampled Value frames with the rated current and voltage as required in the IED's Logical Node configuration. You can check the receipt of Sampled Value frames for the configured Logical Node.
2. In the *MEASUREMENTS* menu, check the magnitudes and phase angles are displayed correctly. The display may be in primary or secondary values. Also the IED's CT ratio or VT ratio settings affect the display. A typical accuracy of 1% can be expected for magnitudes.
3. Change the Logical Node name configured in the test kit. Check the data cell ***SAV Absence*** displays '0' for the Logical Node configured in the IED. Check that all *MEASUREMENTS* displays for voltage or current are zero.

If the GPS signal is lost, repeat the following steps for each Logical Node.

1. Check the data cell ***9-2 Sample Alarm***.
2. Turn off the GPS to the Sampled Value source and turn it on again. Binary flags for respective Logical Node should indicate '1' for loss of GPS and return to '0' when the GPS is healthy.
3. Depending on the scheme, use the ***Synchro Alarm*** setting to return the IED to service. Re-enable the IED trip outputs. If the RJ45 port was used for testing, change the setting *IEC 61850-9-2LE* then ***Physical Link*** to `Fibre Optic`.

7 LOGICAL NODE NAMES

Each Logical Node must be identified by a unique name that allows it to receive Sampled Values from a specific Merging Unit.

Rename the Logical Nodes used for the application. Use between 10 and 34 characters for each Merging Unit Logical Node name. Each Logical Node name must be exactly the same as the one set in the Merging Unit that broadcasts it.

8 P546

8.1 COMISSIONING THE GPS FUNCTIONALITY

The P546 needs a 1PPS GPS input to function correctly. See the IED manual for GPS synchronisation tests. Use a P594 with version D firmware to comply with IEC 61850-9-2LE requirements for Local 1PPS and Global 1PPS signals.

8.1.1 STRENGTH OF P594 OPTICAL SIGNAL AT IED

1. Put the P594 in ***Test Cycle Mode***. See the P594 manual.
2. Check the optical fibre cable to the P594 transmitter is connected corrrectly.
3. Disconnect the other end of the cable from the IED and measure the received signal strength.
4. Record the value. It should be -16.8 dBm to -25.4 dBm.
5. Reconnect the optical fibre to the IED.

8.1.2 CHECKING THE GPS SYNCHRONISATION SIGNAL AT THE IED

1. In the P594 menu, set ***Test Cycle Mode*** to `Disable`.
2. Connect the transmit fibre from the P594 to the IED's GPS port.
3. At the IED, set *PROT COMMS/IM64* > ***GPS Sync Enabled*** to `Enable`. This enables GPS synchronisation.
4. Select *MEASUREMENTS 4* > ***Channel Status***. If the IED receives the GPS synchronisation signal, the display reads ****11********** (where ***** is a don't care state for this test). This means both the Local GPS and Remote GPS are received.
5. To check the GPS failure condition, disconnect the fibre from the P594 and check the display reverts to ****00**********.
6. Reconnect the fibre and check the display reads ****11**********.

8.1.3 COMMISSIONING MODE

Global synchronisation is needed for a current differential scheme to function correctly. The protection function is blocked if global synchronisation is not present. As IED test kits may not be able to generate Sampled Value frames with global synchronisation, the IED has a commissioning mode which allows the differential function to be tested with local synchronisation alone.

1. In the *COMMISSIONING* menu, set ***SAV Test Mode*** to `Local Sync Only`. The current differential protection function then operates for Sampled Value frames received with both Local 1 PPS and Global 1 PPS synchronisation.
2. Test the current differential protection function using a test kit synchronised to GPS, sending Sampled Value frames with Local 1 PPS synchronisation.
3. When the commissioning tests are complete, set the ***SAV Test Mode*** to `Disabled` before the IED is returned to service. The current differential protection operates only with Global 1 PPS synchronisation.
4. Check the Merging Unit's maximum delay and if necessary adjust the Merging Unit's delay setting.

9 P645, P746

9.1 DIFFERENTIAL PROTECTION FUNCTION TESTING

In conventional IEDs, differential protection such as transformer differential protection can be tested using a single three-phase current source. When testing IEDs with an IEC 61850-9-2LE interface, the test equipment should be able to generate at least two Logical Nodes. If the IEDs receive Sampled Value frames corresponding to one configured Logical Node only, a ***9-2 Sample Alarm*** is raised. Single end infeed cases can be simulated by making the current magnitudes zero in one of the Logical Nodes.

10 P743

10.1 CURRENT DIFFERENTIAL COMMISSIONING MODE

Global synchronisation is needed for a current differential scheme to function correctly. The protection function is blocked if global synchronisation is not present. As IED test kits may not be able to generate Sampled Value frames with global synchronisation, the IED has a commissioning mode which allows the differential function to be tested with local synchronisation alone.

1. In the *COMMISSION TESTS* menu, set ***SAV SynTst*** to `Local Sync Only`. The current differential protection function then operates for Sampled Value frames received with both Local 1 PPS and Global 1 PPS synchronisation.
2. Test the current differential protection function using a test kit synchronised to GPS, sending Sampled Value frames with Local 1 PPS synchronisation.
3. When the commissioning tests are complete, set the ***SAV SynTst*** to `Disabled` before the IED is returned to service. The current differential protection operates only with Global 1 PPS synchronisation.
4. Check the Merging Unit's maximum delay and if necessary adjust the Merging Unit's delay setting.

CHAPTER 6

TECHNICAL SPECIFICATIONS

1 CHAPTER OVERVIEW

This chapter describes the technical specifications of the product.

This chapter contains the following sections:

2 INTERFACES

2.1 100 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

2.2 100 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

CHAPTER 7

SETTINGS AND RECORDS

1 CHAPTER OVERVIEW

IEDs which use the IEC 61850-9-2LE interface have additional settings, each depending on the IED.

This chapter contains the following sections:

2 P441SV, P442, P444

2.1 SETTINGS TABLE

IEDs which have the IEC 61850-9-2LE interface have additional settings in the ***IEC 61850-9.2LE*** submenu. This allows them to be configured to the system and application.

To display the primary values whether CTs, VTs or NCITs are used, set ***Remote Values*** in the *MEASURE'T SET UP* column to `Primary`.

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
IEC 61850-9.2LE	18	00		
This column contains all the configure/setting measurement parameters relative to IEC61850-9-2LE.				
Physical Link	18	01	Fibre Optic	Copper, Fibre Optic
This setting specifies the physical connection between the IED and the Process Bus network. The RJ45 copper port is for service use only and should not be used as a permanent connection.				
AntiAias Filter	18	02	Enabled	Disabled, Enabled
This setting activates or deactivates the anti-aliasing filter, which conditions the Sampled Values from the Process Bus network.				
Synchro Alarm	18	03	Local 1PPS	No SYNC CLK, Local 1PPS, Global 1PPS
This setting specifies the type of Sampled Value synchronisation expected by the IED, depending on the application. Global 1PPS: the Sampled Values are synchronised with a global area clock (GPS like clock). The IED issues an alarm ('9-2 Sample Alarm') when it receives Sampled Value frames without Global 1PPS. Local 1PPS: the Sampled Values are synchronised with a local area clock signal at the substation. Sampled Value frames received with Global or Local synchronisation are acceptable with this setting. The IED issues the alarm '9-2 Sample Alarm' if the Sampled Value frames received have no synchronisation. No SYNC CLK: the Sampled Values do not need to be synchronised. With this setting the IED ignores the synchronisation flag in the Sampled Value frames.				
9.2 Test Mode	18	04	Test Blocked	Test Blocked, Test Ignored, Test Only
This setting is used for processing Sampled Value frames with an IEC 61850 Test mode flag. This setting is common to all Logical Nodes configured in the IED. Test Blocked: all channel data frames received with an IEC 61850 Test flag are treated as invalid. The IED blocks relevant protection functions and issues a '9-2 Sample Alarm'. Test Ignored: all channel data frames received with an IEC 61850 Test flag are treated as good so all protection functions remain active. Test Only: all channel data received with an IEC 61850 Test flag are treated as good. Any channel data received without the Test flag are treated as invalid. The IED blocks relevant protection functions and issues a '9-2 Sample Alarm'.				
Merge Unit Delay	18	05	1 ms	
When Sampled Values are received at the IED from different Merging Units, they may not arrive simultaneously due to differences in Merging Unit performance or different network path delays. This setting specifies the maximum time delay expected, starting at the reception of the Sampled Value frame from the first Merging Unit to the reception of the Sampled Value frame from the last Merging Unit for each sample count. Signal processing starts at the end of the Merging Unit delay and if a frame is not received in that specified time, an alarm appears. (9-2 Sample Alarm). The IED has a search command to measure and display the maximum Sampled Value frame delay. The Merging Unit Delay can be set based on the result of the search, which is displayed on the IED.				
VT Switch Mode	18	06	Disabled	Disabled, Enabled
If VT Switching Mode is enabled, you can configure the IED to switch between different VT inputs. These can be single-phase or three-phase inputs and are received as Sampled Values. The corresponding setting cells are visible when VT Switching Mode is enabled. Switching is controlled either using opto or virtual inputs. These can be assigned in the IED's Programmable Scheme Logic. If you do not need to use VT switching for voltage based protection functions or check synchronising, disable it.				
LN Count	18	11	1	
This setting specifies the number of Logical Nodes in use for receiving the Sampled Values required by the IED. The default value varies with the product. Modify the LN Count to match the number of Merging Units relevant for the IED in each specific application. The default LN Count is model dependent.				

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
LN1 Name to LN9 Name	18	12	MiCOM Logical Node 1 to 9	
Each Logical Node must be identified by a unique name that allows it to receive Sampled Values from a specific Merging Unit. The default name for LN1 is 'MiCOM Logical Node 1'. You can edit this ASCII text string using between 10 and 34 characters to match the Merging Unit's Logical Node (sample value identifier) name . The same applies for LN2 to 9. The Logical Node name is the system-wide unique identification 'MsvID' defined in the Merging Unit control block MSVCB according to IEC 61850-9-2 Ed 1.0. The number of Logical Nodes available is variable, as set in LN Count. For example, with an LN Count of 3, LN1 Name, LN2 Name and LN3 Name should be set to match those of the corresponding Merging Units. Rename the Logical Nodes used for the application. Use between 10 and 34 characters to match each MU Logical Node name. Each Logical Node name must be exactly the same as the one set in the Merging Unit that broadcasts it.				
IA1 IB1 IC1	18	31	LN1	Unused, LN1, LN2, LN3,...,LN 9
Three-phase current inputs to the IED.				
IA2 IB2 IC2	18	32	Unused	Unused,LN1, LN2, LN3,...,LN 9
Three-phase current inputs to the IED.				
INsen	18	33	Unused	Unused,LN1, LN2, LN3,...,LN 9
Current input with sensitive range for SEF/REF functions. This single-phase current signal is recovered from the neutral current in the IEC 61850-9-2LE frame of the LN assigned.				
IM	18	34	Unused	Unused,LN1, LN2, LN3,...,LN 9
Current input for neutral current from a parallel feeder. This single-phase current signal is recovered from the neutral current in the IEC 61850-9-2LE frame of the LN assigned.				
VA VB VC	18	35	LN1	Unused,LN1, LN2, LN3,...,LN 9
Three-phase voltage inputs to the IED. The default setting Logical Node 1 indicates that only one LN is configured. This cell is visible only when VT Switch Mode [18 06] is disabled.				
Vsc1	18	36	Unused	Unused,LN1, LN2, LN3,...,LN 9
This single-phase voltage is recovered from the phase(s) assigned in the IED setting. It may be assigned to Van, Vbn, Vcn, Vab, Vbc or Vca in the settings. The IEC 61850-9-2LE interface uses the appropriate phase(s) from the Sampled Value frame received on the Logical Node configured for Vsc1. The IED raises an Illegal Channel Map alarm if the same Logical Node is assigned to both [VA VB VC] and Vsc1. This cell is visible only when VT Switch Mode is disabled.				
Vsc2	18	37	Unused	Unused, LN1, LN2, LN3,...,LN 9
This single-phase voltage is recovered from the phase(s) assigned in the IED setting. It may be assigned to Van, Vbn, Vcn, Vab, Vbc or Vca in the settings. The IEC 61850-9-2LE interface uses the appropriate phase(s) from the Sampled Value frame received on the Logical Node configured for Vsc2. The IED raises an Illegal Channel Map alarm if the same Logical Node is assigned to both [VA VB VC] and Vsc2. This cell is visible only when VT Switch Mode is disabled.				
VA1 VB1 VC1	18	38	LN1	Unused, LN1, LN2, LN3,...,LN 9
One of the two Sampled Value inputs for selection of three-phase voltage for use by functions in the relay, such as distance protection or overvoltage protection. This cell is visible only when VT Switch Mode is enabled.				
VA2 VB2 VC2	18	39	Unused	Unused, LN1, LN2, LN3,...,LN 9
The second of the two Sampled Value inputs for selection of three-phase voltage for use by functions in the relay, such as distance protection or overvoltage protection. This cell is visible only when VT Switch Mode is enabled.				
Vcs1	18	3A	Unused	Unused, LN1, LN2, LN3,...,LN 9
The first of the three Sampled Value inputs for selection of single-phase voltage for check synchronising function. This cell is visible only when VT Switch Mode is enabled. This single-phase voltage is recovered from the phase(s) assigned in the IED setting. It can be assigned to Van, Vbn, Vcn, Vab, Vbc or Vca in the settings. The IEC 61850-9-2LE interface uses the appropriate phase(s) from the Sampled Value frame. These are received on the Logical Node which is configured for Vcs1.				
Vcs2	18	3B	Unused	Unused, LN1, LN2, LN3,...,LN 9

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
The second of the three Sampled Value inputs for selection of single-phase voltage for check synchronising function. This cell is visible only when VT Switch Mode is enabled. This single-phase voltage is recovered from the phase(s) assigned in the IED setting. It can be assigned to Van, Vbn, Vcn, Vab, Vbc or Vca in the settings. The IEC 61850-9-2LE interface uses the appropriate phase(s) from the Sampled Value frame. These are received on the Logical Node which is configured for Vcs2.				
Vcs3	18	3C	Unused	Unused, LN1, LN2, LN3,...,LN 9
The third Sampled Value inputs for selection of single-phase voltage for check synchronising function. This cell is visible only when VT Switch Mode is enabled. This single-phase voltage is recovered from the phase(s) assigned in the IED setting. It can be assigned to Van, Vbn, Vcn, Vab, Vbc or Vca in the settings. The IEC 61850-9-2LE interface uses the appropriate phase(s) from the Sampled Value frame. These are received on the Logical Node which is configured for Vcs3.				
MUs Delay Search	18	41	No	No, Yes
The IED has a search command to measure and display the maximum Sampled Value frame delay. The Merging Unit Delay can be set based on the result of the search, which is displayed on the IED.				
MUs Delay Max	18	42	0	
When sampled values are received at the IED from different Merging Units, they may not arrive simultaneously due to differences in Merging Unit performance or different network path delays. This setting specifies the maximum time-delay expected, starting at the reception of the sampled value frame from the "first" Merging Unit to the reception of the sampled value frame from the last Merging Unit for each sample count. Signal processing starts at the end of the Merging Unit delay and if a frame is not received in that specified time, a synchronisation alarm appears.				
Trust Ques Data	18	43	000000	0 or 1 for each flag
This setting specifies how the Sampled Values are processed by the IED when the associated Quality tag is 'Questionable'. There are six binary flags (0 = No, 1 = Yes) which can be set by the user, corresponding to the data quality attributes 'Out of Range', 'Bad Reference', 'Oscillatory', 'Old Data', 'Inconsistent' and 'Inaccurate'. Questionable data is treated as invalid if the flag is '0'. To process the data as good samples, the flag is changed to '1'. The setting is common to all Logical Nodes in service.				
Loss Rate Level	18	44	10%	
This setting is related to Process Bus network performance, in particular, the possibility of loss of samples. The set threshold is an upper limit for the loss of Sampled Values from any of the Logical Nodes configured in the IED, calculated every cycle. If the loss rate level exceeds the set value, the IED generates the '9-2 Sample Alarm' and the related protection functions are inhibited. 1.25% corresponds to the loss of 1 out of the 80 samples expected every cycle, averaged over one second. The loss rate calculation and threshold check is performed independently for each Logical Node configured.				
SAV Absence	18	51	000000000	0 or 1 for each flag
This is a data cell with 9 binary flags. It indicates the presence or absence of Sampled Values from each of the Merging Units the IED is communicating with. There is a maximum of 9 Logical Nodes. The cell data for each Logical Node is continuously refreshed. 0: Sampled Values being received from the Merging Unit. 1: No Sampled Values being received from the Merging Unit.				
SAV No SmpSynch	18	52	000000000	0 or 1 for each flag
This is a data cell with 9 binary flags. It indicates the healthiness of the Sampled Values being received from each of the configured Merging Units: 0: Sampled Values received are synchronised and any loss of samples is within acceptable limits. 1: Sampled Values received are not synchronised (Setting : Synchro Alarm) or the Sampled Value delay exceeds the acceptable value (Merging Unit Delay setting). The IED raises a 'SAV No SmpSynch' when any one of the binary flags is '1'.				
SAV Test	18	53	00000000 00000000 00000000	0 or 1 for each flag
This is a data cell with 24 binary flags. It indicates the status of the IEC 61850 Test mode flag for each analogue channel processed by the IED (eg: VA, the A-phase voltage). The channel assignment depends on the IED.				
SAV Questionable	18	54	00000000 00000000 00000000	0 or 1 for each flag
This is a data cell with 24 binary flags. It indicates the status of the IEC 61850 Quality attribute 'Questionable' in the Sampled Value frames for each of the analogue channels. The channel assignment depends on the IED.				

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
SAV Invalid	18	55	00000000 00000000 00000000	0 or 1 for each flag
This is a data cell with 24 binary flags. It indicates the status of the IEC 61850 Quality attribute 'Invalid' in the Sampled Value frames for each of the analogue channels. The channel assignment depends on the IED.				
Frame Loss Data	18	70		
This column contains all the configure/setting measurement parameters relative to frame loss data.				
Frame Loss Rate	18	71	Enabled	Disabled, Enabled
Enables the frame loss rate counter				
LN1 – LN9 Loss Rate Sec	18	72 – 7A	0	
These data cells indicate the percentage of SV frames missing during the past second, for LNx				
LossRate Reset	18	90	No	No, Yes
Resets the frame loss rate counter				
Reset Time	18	91	0	
This data cell is the time stamp of the most recent instance of Frame Loss Rate counter				
LN1 – LN9 FrmLoss Cuml	18	92 – 9A	0	
These data cells indicate the number of frames lost since last reset for LN 1...9; the most recent reset time available in the IED menu.				
LN1 - LN9 Error Second	18	B1 to 9	0	
Frame Error Seconds is a cumulative value since the last reset per LN. If the Frame Loss Rate exceeds 1.25% (one sample per cycle on average for one second) the IED records this as an Error Second.				
VA VB VC	18	D1		VA1 VB1 VC1, VA2 VB2 VC2
This data cell displays the three-phase voltage input in use by the relay. This cell is visible only when VT Switch Mode is enabled.				
Vsc1	18	D2		Vcs1, Vcs2, Vcs3
This data cell displays the single-phase voltage in use by the System Check function as Vsc1. This cell is visible only when VT Switch Mode is enabled.				
Vsc2	18	D3		Vcs1, Vcs2, Vcs3
This data cell displays the single-phase voltage in use by the System Check function as Vsc2. This cell is visible only when VT Switch Mode is enabled.				

2.2 DDB TABLE

IEDs which have the IEC 61850-9-2LE interface have additional DDBs so they can be configured to the system and application.

Ordinal	Signal Name	Source	Type	Response
Description				
204	ALARM_9_2_SAV	Software	PFSO	Self reset alarm
Sampled Value error.				
205	9_2_SAV_CFG_ALARM	Software	PFSO	Self reset alarm
This alarm is triggered when the LN name is less than 10 characters or greater than 34 characters.				
206	QUALITY_BLOCK_ALARM	Software	PFSO	Self reset alarm
Due to a quality issue, this alarm indicates that protection functions are blocked on all phases.				
441	QUALITY_BLK_VA	Software	PFSO	No response
Due to a quality issue, this alarm indicates that VA protection functions are blocked.				

Ordinal	Signal Name	Source	Type	Response
Description				
442	QUALITY_BLK_VB	Software	PFSO	No response
Due to a quality issue, this alarm indicates that VB protection functions are blocked.				
443	QUALITY_BLK_VC	Software	PFSO	No response
Due to a quality issue, this alarm indicates that VC protection functions are blocked.				
444	QUALITY_BLK_VSC1	Software	PFSO	No response
Due to a quality issue, this alarm indicates that VSC1 protection functions are blocked.				
445	QUALITY_BLK_IA1	Software	PFSO	No response
Due to a quality issue, this alarm indicates that IA1 protection functions are blocked.				
446	QUALITY_BLK_IB1	Software	PFSO	No response
Due to a quality issue, this alarm indicates that IB1 protection functions are blocked.				
447	QUALITY_BLK_IC1	Software	PFSO	No response
Due to a quality issue, this alarm indicates that IC1 protection functions are blocked.				
448	QUALITY_BLK_IM	Software	PFSO	No response
Due to a quality issue, this alarm indicates that IM protection functions are blocked.				
449	QUALITY_BLK_INSEN	Software	PFSO	No response
Due to a quality issue, this alarm indicates that INSEN protection functions are blocked.				
450	QUALITY_BLK_IA2	Software	PFSO	No response
Due to a quality issue, this alarm indicates that IA2 protection functions are blocked.				
451	QUALITY_BLK_IB2	Software	PFSO	No response
Due to a quality issue, this alarm indicates that IB2 protection functions are blocked.				
452	QUALITY_BLK_IC2	Software	PFSO	No response
Due to a quality issue, this alarm indicates that IC2 protection functions are blocked.				
453	QUALITY_BLK_VSC2	Software	PFSO	No response
Due to a quality issue, this alarm indicates that VSC2 protection functions are blocked.				
1133	9_2_VABC_SELECT_X	PSL	PFSI	VT Switch
Switches 3 phase voltage between 2 Sampled Value frames.				
1134	9_2_VSC1_SELECT_X1	PSL	PFSI	VT Switch
Used to select single phase voltage VSC1 associated with System Check function.				
1135	9_2_VSC1_SELECT_1X	PSL	PFSI	VT Switch
Used to select single phase voltage VSC1 associated with System Check function.				
1136	9_2_VSC2_SELECT_X1	PSL	PFSI	VT Switch
Used to select single phase voltage VSC2 associated with System Check function.				
1137	9_2_VSC2_SELECT_1X	PSL	PFSI	VT Switch
Used to select single phase voltage VSC2 associated with System Check function.				

3 P446, P546, P841B

3.1 SETTINGS TABLE

IEDs which have the IEC 61850-9-2LE interface have additional settings in the ***IEC 61850-9.2LE*** submenu. This allows them to be configured to the system and application.

To display the primary values whether CTs, VTs or NCITs are used, set ***Remote Values*** in the *MEASURE'T SET UP* column to `Primary`.

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
IEC 61850-9.2LE	18	00		
This column contains all the configure/setting measurement parameters relative to IEC61850-9-2LE.				
Physical Link	18	01	Fibre Optic	Copper, Fibre Optic
This setting specifies the physical connection between the IED and the Process Bus network. The RJ45 copper port is for service use only and should not be used as a permanent connection.				
AntiAias Filter	18	02	Enabled	Disabled, Enabled
This setting activates or deactivates the anti-aliasing filter, which conditions the Sampled Values from the Process Bus network.				
Synchro Alarm	18	03	Local 1PPS	No SYNC CLK, Local 1PPS, Global 1PPS
This setting specifies the type of Sampled Value synchronisation expected by the IED, depending on the application. Global 1PPS: the Sampled Values are synchronised with a global area clock (GPS like clock). The IED issues an alarm ('9-2 Sample Alarm') when it receives Sampled Value frames without Global 1PPS. Local 1PPS: the Sampled Values are synchronised with a local area clock signal at the substation. Sampled Value frames received with Global or Local synchronisation are acceptable with this setting. The IED issues the alarm '9-2 Sample Alarm' if the Sampled Value frames received have no synchronisation. No SYNC CLK: the Sampled Values do not need to be synchronised. With this setting the IED ignores the synchronisation flag in the Sampled Value frames.				
9.2 Test Mode	18	04	Test Blocked	Test Blocked, Test Ignored, Test Only
This setting is used for processing Sampled Value frames with an IEC 61850 Test mode flag. This setting is common to all Logical Nodes configured in the IED. Test Blocked: all channel data frames received with an IEC 61850 Test flag are treated as invalid. The IED blocks relevant protection functions and issues a '9-2 Sample Alarm'. Test Ignored: all channel data frames received with an IEC 61850 Test flag are treated as good so all protection functions remain active. Test Only: all channel data received with an IEC 61850 Test flag are treated as good. Any channel data received without the Test flag are treated as invalid. The IED blocks relevant protection functions and issues a '9-2 Sample Alarm'.				
Merge Unit Delay	18	05	1 ms	
When Sampled Values are received at the IED from different Merging Units, they may not arrive simultaneously due to differences in Merging Unit performance or different network path delays. This setting specifies the maximum time delay expected, starting at the reception of the Sampled Value frame from the first Merging Unit to the reception of the Sampled Value frame from the last Merging Unit for each sample count. Signal processing starts at the end of the Merging Unit delay and if a frame is not received in that specified time, an alarm appears. (9-2 Sample Alarm). The IED has a search command to measure and display the maximum Sampled Value frame delay. The Merging Unit Delay can be set based on the result of the search, which is displayed on the IED.				
VT Switch Mode	18	06	Disabled	Disabled, Enabled
If VT Switching Mode is enabled, you can configure the IED to switch between different VT inputs. These can be single-phase or three-phase inputs and are received as Sampled Values. The corresponding setting cells are visible when VT Switching Mode is enabled. Switching is controlled either using opto or virtual inputs. These can be assigned in the IED's Programmable Scheme Logic. If you do not need to use VT switching for voltage based protection functions or check synchronising, disable it.				
LN Count	18	11	1	
This setting specifies the number of Logical Nodes in use for receiving the Sampled Values required by the IED. The default value varies with the product. Modify the LN Count to match the number of Merging Units relevant for the IED in each specific application. The default LN Count is model dependent.				

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
LN1 Name to LN9 Name	18	12	MiCOM Logical Node 1 to 9	
Each Logical Node must be identified by a unique name that allows it to receive Sampled Values from a specific Merging Unit. The default name for LN1 is 'MiCOM Logical Node 1'. You can edit this ASCII text string using between 10 and 34 characters to match the Merging Unit's Logical Node (sample value identifier) name . The same applies for LN2 to 9. The Logical Node name is the system-wide unique identification 'MsvID' defined in the Merging Unit control block MSVCB according to IEC 61850-9-2 Ed 1.0. The number of Logical Nodes available is variable, as set in LN Count. For example, with an LN Count of 3, LN1 Name, LN2 Name and LN3 Name should be set to match those of the corresponding Merging Units. Rename the Logical Nodes used for the application. Use between 10 and 34 characters to match each MU Logical Node name. Each Logical Node name must be exactly the same as the one set in the Merging Unit that broadcasts it.				
IA1 IB1 IC1	18	31	LN1	Unused, LN1, LN2, LN3,...,LN 9
Three-phase current inputs to the IED.				
IA2 IB2 IC2	18	32	Unused	Unused,LN1, LN2, LN3,...,LN 9
Three-phase current inputs to the IED.				
INsen	18	33	Unused	Unused,LN1, LN2, LN3,...,LN 9
Current input with sensitive range for SEF/REF functions. This single-phase current signal is recovered from the neutral current in the IEC 61850-9-2LE frame of the LN assigned.				
IM	18	34	Unused	Unused,LN1, LN2, LN3,...,LN 9
Current input for neutral current from a parallel feeder. This single-phase current signal is recovered from the neutral current in the IEC 61850-9-2LE frame of the LN assigned.				
VA VB VC	18	35	LN1	Unused,LN1, LN2, LN3,...,LN 9
Three-phase voltage inputs to the IED. The default setting Logical Node 1 indicates that only one LN is configured. This cell is visible only when VT Switch Mode [18 06] is disabled.				
Vsc1	18	36	Unused	Unused,LN1, LN2, LN3,...,LN 9
This single-phase voltage is recovered from the phase(s) assigned in the IED setting. It may be assigned to Van, Vbn, Vcn, Vab, Vbc or Vca in the settings. The IEC 61850-9-2LE interface uses the appropriate phase(s) from the Sampled Value frame received on the Logical Node configured for Vsc1. The IED raises an Illegal Channel Map alarm if the same Logical Node is assigned to both [VA VB VC] and Vsc1. This cell is visible only when VT Switch Mode is disabled.				
Vsc2	18	37	Unused	Unused, LN1, LN2, LN3,...,LN 9
This single-phase voltage is recovered from the phase(s) assigned in the IED setting. It may be assigned to Van, Vbn, Vcn, Vab, Vbc or Vca in the settings. The IEC 61850-9-2LE interface uses the appropriate phase(s) from the Sampled Value frame received on the Logical Node configured for Vsc2. The IED raises an Illegal Channel Map alarm if the same Logical Node is assigned to both [VA VB VC] and Vsc2. This cell is visible only when VT Switch Mode is disabled.				
VA1 VB1 VC1	18	38	LN1	Unused, LN1, LN2, LN3,...,LN 9
One of the two Sampled Value inputs for selection of three-phase voltage for use by functions in the relay, such as distance protection or overvoltage protection. This cell is visible only when VT Switch Mode is enabled.				
VA2 VB2 VC2	18	39	Unused	Unused, LN1, LN2, LN3,...,LN 9
The second of the two Sampled Value inputs for selection of three-phase voltage for use by functions in the relay, such as distance protection or overvoltage protection. This cell is visible only when VT Switch Mode is enabled.				
Vcs1	18	3A	Unused	Unused, LN1, LN2, LN3,...,LN 9
The first of the three Sampled Value inputs for selection of single-phase voltage for check synchronising function. This cell is visible only when VT Switch Mode is enabled. This single-phase voltage is recovered from the phase(s) assigned in the IED setting. It can be assigned to Van, Vbn, Vcn, Vab, Vbc or Vca in the settings. The IEC 61850-9-2LE interface uses the appropriate phase(s) from the Sampled Value frame. These are received on the Logical Node which is configured for Vcs1.				
Vcs2	18	3B	Unused	Unused, LN1, LN2, LN3,...,LN 9

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
The second of the three Sampled Value inputs for selection of single-phase voltage for check synchronising function. This cell is visible only when VT Switch Mode is enabled. This single-phase voltage is recovered from the phase(s) assigned in the IED setting. It can be assigned to Van, Vbn, Vcn, Vab, Vbc or Vca in the settings. The IEC 61850-9-2LE interface uses the appropriate phase(s) from the Sampled Value frame. These are received on the Logical Node which is configured for Vcs2.				
Vcs3	18	3C	Unused	Unused, LN1, LN2, LN3,...,LN 9
The third Sampled Value inputs for selection of single-phase voltage for check synchronising function. This cell is visible only when VT Switch Mode is enabled. This single-phase voltage is recovered from the phase(s) assigned in the IED setting. It can be assigned to Van, Vbn, Vcn, Vab, Vbc or Vca in the settings. The IEC 61850-9-2LE interface uses the appropriate phase(s) from the Sampled Value frame. These are received on the Logical Node which is configured for Vcs3.				
MUs Delay Search	18	41	No	No, Yes
The IED has a search command to measure and display the maximum Sampled Value frame delay. The Merging Unit Delay can be set based on the result of the search, which is displayed on the IED.				
MUs Delay Max	18	42	0	
When sampled values are received at the IED from different Merging Units, they may not arrive simultaneously due to differences in Merging Unit performance or different network path delays. This setting specifies the maximum time-delay expected, starting at the reception of the sampled value frame from the "first" Merging Unit to the reception of the sampled value frame from the last Merging Unit for each sample count. Signal processing starts at the end of the Merging Unit delay and if a frame is not received in that specified time, a synchronisation alarm appears.				
Trust Ques Data	18	43	000000	0 or 1 for each flag
This setting specifies how the Sampled Values are processed by the IED when the associated Quality tag is 'Questionable'. There are six binary flags (0 = No, 1 = Yes) which can be set by the user, corresponding to the data quality attributes 'Out of Range', 'Bad Reference', 'Oscillatory', 'Old Data', 'Inconsistent' and 'Inaccurate'. Questionable data is treated as invalid if the flag is '0'. To process the data as good samples, the flag is changed to '1'. The setting is common to all Logical Nodes in service.				
Loss Rate Level	18	44	10%	
This setting is related to Process Bus network performance, in particular, the possibility of loss of samples. The set threshold is an upper limit for the loss of Sampled Values from any of the Logical Nodes configured in the IED, calculated every cycle. If the loss rate level exceeds the set value, the IED generates the '9-2 Sample Alarm' and the related protection functions are inhibited. 1.25% corresponds to the loss of 1 out of the 80 samples expected every cycle, averaged over one second. The loss rate calculation and threshold check is performed independently for each Logical Node configured.				
SAV Absence	18	51	000000000	0 or 1 for each flag
This is a data cell with 9 binary flags. It indicates the presence or absence of Sampled Values from each of the Merging Units the IED is communicating with. There is a maximum of 9 Logical Nodes. The cell data for each Logical Node is continuously refreshed. 0: Sampled Values being received from the Merging Unit. 1: No Sampled Values being received from the Merging Unit.				
SAV No SmpSynch	18	52	000000000	0 or 1 for each flag
This is a data cell with 9 binary flags. It indicates the healthiness of the Sampled Values being received from each of the configured Merging Units: 0: Sampled Values received are synchronised and any loss of samples is within acceptable limits. 1: Sampled Values received are not synchronised (Setting : Synchro Alarm) or the Sampled Value delay exceeds the acceptable value (Merging Unit Delay setting). The IED raises a 'SAV No SmpSynch' when any one of the binary flags is '1'.				
SAV Test	18	53	00000000 00000000 00000000	0 or 1 for each flag
This is a data cell with 24 binary flags. It indicates the status of the IEC 61850 Test mode flag for each analogue channel processed by the IED (eg: VA, the A-phase voltage). The channel assignment depends on the IED.				
SAV Questionable	18	54	00000000 00000000 00000000	0 or 1 for each flag
This is a data cell with 24 binary flags. It indicates the status of the IEC 61850 Quality attribute 'Questionable' in the Sampled Value frames for each of the analogue channels. The channel assignment depends on the IED.				

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
SAV Invalid	18	55	00000000 00000000 00000000	0 or 1 for each flag
This is a data cell with 24 binary flags. It indicates the status of the IEC 61850 Quality attribute 'Invalid' in the Sampled Value frames for each of the analogue channels. The channel assignment depends on the IED.				
Frame Loss Data	18	70		
This column contains all the configure/setting measurement parameters relative to frame loss data.				
Frame Loss Rate	18	71	Enabled	Disabled, Enabled
Enables the frame loss rate counter				
LN1 – LN9 Loss Rate Sec	18	72 – 7A	0	
These data cells indicate the percentage of SV frames missing during the past second, for LNx				
LossRate Reset	18	90	No	No, Yes
Resets the frame loss rate counter				
Reset Time	18	91	0	
This data cell is the time stamp of the most recent instance of Frame Loss Rate counter				
LN1 – LN9 FrmLoss Cuml	18	92 – 9A	0	
These data cells indicate the number of frames lost since last reset for LN 1...9; the most recent reset time available in the IED menu.				
LN1 - LN9 Error Second	18	B1 to 9	0	
Frame Error Seconds is a cumulative value since the last reset per LN. If the Frame Loss Rate exceeds 1.25% (one sample per cycle on average for one second) the IED records this as an Error Second.				
VA VB VC	18	D1		VA1 VB1 VC1, VA2 VB2 VC2
This data cell displays the three-phase voltage input in use by the relay. This cell is visible only when VT Switch Mode is enabled.				
Vsc1	18	D2		Vcs1, Vcs2, Vcs3
This data cell displays the single-phase voltage in use by the System Check function as Vsc1. This cell is visible only when VT Switch Mode is enabled.				
Vsc2	18	D3		Vcs1, Vcs2, Vcs3
This data cell displays the single-phase voltage in use by the System Check function as Vsc2. This cell is visible only when VT Switch Mode is enabled.				

3.2 DDB SIGNALS TABLE

IEDs which have the IEC 61850-9-2LE interface have additional DDBs so they can be configured to the system and application.

Ordinal	English Text	Source	Description
340	9-2 Sample Alarm	Software	Abnormal state of IEC 61850-9-2LE sample.
341	C Diff Sync Fail	Software	The IEC 61850-9-2LE sample Global sync has failed, inhibiting the current differential function.
342	9-2LE Cfg Alarm	Software	This alarm highlights discrepancies in assignments of analogue channels in the IED. For example, if you assign two current inputs to the same Logical Node, the IED raises an Illegal Channel Map alarm.
343	Invalid Setting	Software	This DDB issues an alarm when Phase Diff is set to 'Enabled' but GPS Sync is set to 'GPS Disabled'.
991	VABC Select x	PSL	Switch three-phase voltage between two designated LNs
992	Vsc1 Select x1	PSL	Switch Vsc1 between three designated LN – Bit 1

Ordinal	English Text	Source	Description
993	Vsc1 Select 1x	PSL	Switch Vsc1 between three designated LN – Bit 0
994	Vsc2 Select x1	PSL	Switch Vsc2 between three designated LN – Bit 1
995	Vsc2 Select 1x	PSL	Switch Vsc2 between three designated LN – Bit 0
1792-1823	Virtual Input 33-64	Software	These are additional virtual Inputs.
1824-1855	Quality VIP 33 -64	Software	These are additional virtual inputs that provide Quality attributes.
1856-1887	PubPres VIP 33 -64	Software	These are are additional virtual inputs that indicate if the publisher is present.
1888-1919	Virtual Output33-64	PSL	These are additional GOOSE outputs.

4 P645

4.1 SETTINGS TABLE

IEDs which have the IEC 61850-9-2LE interface have additional settings in the ***IEC 61850-9.2LE*** submenu. This allows them to be configured to the system and application.

To display the primary values whether CTs, VTs or NCITs are used, set ***Remote Values*** in the *MEASURE'T SET UP* column to `Primary`.

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
IEC 61850-9.2LE	18	00		
This column contains all the configure/setting measurement parameters relative to IEC61850-9-2LE.				
Physical Link	18	01	Fibre Optic	Copper, Fibre Optic
This setting specifies the physical connection between the IED and the Process Bus network. The RJ45 copper port is for service use only and should not be used as a permanent connection.				
AntiAias Filter	18	02	Enabled	Disabled, Enabled
This setting activates or deactivates the anti-aliasing filter, which conditions the Sampled Values from the Process Bus network.				
Synchro Alarm	18	03	Local 1PPS	No SYNC CLK, Local 1PPS, Global 1PPS
This setting specifies the type of Sampled Value synchronisation expected by the IED, depending on the application. Global 1PPS: the Sampled Values are synchronised with a global area clock (GPS like clock). The IED issues an alarm ('9-2 Sample Alarm') when it receives Sampled Value frames without Global 1PPS. Local 1PPS: the Sampled Values are synchronised with a local area clock signal at the substation. Sampled Value frames received with Global or Local synchronisation are acceptable with this setting. The IED issues the alarm '9-2 Sample Alarm' if the Sampled Value frames received have no synchronisation. No SYNC CLK: the Sampled Values do not need to be synchronised. With this setting the IED ignores the synchronisation flag in the Sampled Value frames.				
9-2 Test Mode	18	04	Test Blocked	Test Blocked, Test Ignored, Test Only
This setting is used for processing Sampled Value frames with an IEC 61850 Test mode flag. This setting is common to all Logical Nodes configured in the IED. Test Blocked: all channel data frames received with an IEC 61850 Test flag are treated as invalid. The IED blocks relevant protection functions and issues a '9-2 Sample Alarm'. Test Ignored: all channel data frames received with an IEC 61850 Test flag are treated as good so all protection functions remain active. Test Only: all channel data received with an IEC 61850 Test flag are treated as good. Any channel data received without the Test flag are treated as invalid. The IED blocks relevant protection functions and issues a '9-2 Sample Alarm'.				
Merge Unit Delay	18	05	1 ms	
When Sampled Values are received at the IED from different Merging Units, they may not arrive simultaneously due to differences in Merging Unit performance or different network path delays. This setting specifies the maximum time delay expected, starting at the reception of the Sampled Value frame from the first Merging Unit to the reception of the Sampled Value frame from the last Merging Unit for each sample count. Signal processing starts at the end of the Merging Unit delay and if a frame is not received in that specified time, an alarm appears. (9-2 Sample Alarm). The IED has a search command to measure and display the maximum Sampled Value frame delay. The Merging Unit Delay can be set based on the result of the search, which is displayed on the IED.				
LN Count	18	11	8	
This setting specifies the number of Logical Nodes in use for receiving the Sampled Values required by the IED. The default value varies with the product. Modify the LN Count to match the number of Merging Units relevant for the IED in each specific application. The default LN Count is model dependent.				
LN1 Name to LN8 Name	18	12	MiCOM Logical Node 1 to 8	

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
Each Logical Node must be identified by a unique name that allows it to receive Sampled Values from a specific Merging Unit. The default name for LN1 is 'MiCOM Logical Node 1'. You can edit this ASCII text string using between 10 and 34 characters to match the Merging Unit's Logical Node (sample value identifier) name . The same applies for LN2 to 8. The Logical Node name is the system-wide unique identification 'MsvID' defined in the Merging Unit control block MSVCB according to IEC 61850-9-2 Ed 1.0. The number of Logical Nodes available is variable, as set in LN Count. For example, with an LN Count of 3, LN1 Name, LN2 Name and LN3 Name should be set to match those of the corresponding Merging Units. Rename the Logical Nodes used for the application. Use between 10 and 34 characters to match each MU Logical Node name. Each Logical Node name must be exactly the same as the one set in the Merging Unit that broadcasts it.				
IA1 IB1 IC1 - IA5 IB5 IC5	18	31 - 35	LN1 - 5	Unused, LN1, LN2, LN3,...,LN 8
Three-phase current inputs to the IED for HV, LV and TV windings.				
IY1 - IY3	18	36 - 38	LN6 - LN8	Unused, LN1, LN2, LN3,...,LN 8
The single-phase current signals IY1, IY2 and IY3 for REF function. These are recovered from the neutral current in the IEC 61850-9-2LE frame of the assigned LN				
VA VB VC	18	39	LN1	Unused, LN1, LN2, LN3,...,LN 8
The three-phase voltage input [VA VB VC] used for overflux element W1. The IED raises an Illegal Channel Map alarm if the same Logical Node is assigned to both [VA VB VC] and VFLUX.				
VFLUX	18	3A	LN2	Unused,LN1, LN2, LN3,...,LN 8
The single phase input VFLUX is used for overflux element W2. The IED raises an Illegal Channel Map alarm if the same Logical Node is assigned to both [VA VB VC] and VFLUX.				
MUs Delay Search	18	41	No	No, Yes
The IED has a search command to measure and display the maximum Sampled Value frame delay. The Merging Unit Delay can be set based on the result of the search, which is displayed on the IED.				
MUs Delay Max	18	42	0	
When sampled values are received at the IED from different Merging Units, they may not arrive simultaneously due to differences in Merging Unit performance or different network path delays. This setting specifies the maximum time-delay expected, starting at the reception of the sampled value frame from the "first" Merging Unit to the reception of the sampled value frame from the last Merging Unit for each sample count. Signal processing starts at the end of the Merging Unit delay and if a frame is not received in that specified time, a synchronisation alarm appears.				
Trust Ques Data	18	43	000000	0 or 1 for each flag
This setting specifies how the Sampled Values are processed by the IED when the associated Quality tag is 'Questionable'. There are six binary flags (0 = No, 1 = Yes) which can be set by the user, corresponding to the data quality attributes 'Out of Range', 'Bad Reference', 'Oscillatory', 'Old Data', 'Inconsistent' and 'Inaccurate'. Questionable data is treated as invalid if the flag is '0'. To process the data as good samples, the flag is changed to '1'. The setting is common to all Logical Nodes in service.				
Loss Rate Level	18	44	10%	
This setting is related to Process Bus network performance, in particular, the possibility of loss of samples. The set threshold is an upper limit for the loss of Sampled Values from any of the Logical Nodes configured in the IED, calculated every cycle. If the loss rate level exceeds the set value, the IED generates the '9-2 Sample Alarm' and the related protection functions are inhibited. 1.25% corresponds to the loss of 1 out of the 80 samples expected every cycle, averaged over one second. The loss rate calculation and threshold check is performed independently for each Logical Node configured.				
SAV Absence	18	51	00000000	0 or 1 for each flag
This is a data cell with 8 binary flags. It indicates the presence or absence of Sampled Values from each of the Merging Units the IED is communicating with. There is a maximum of 8 Logical Nodes. The cell data for each Logical Node is continuously refreshed. 0: Sampled Values being received from the Merging Unit. 1: No Sampled Values being received from the Merging Unit.				
SAV No SmpSynch	18	52	00000000	0 or 1 for each flag
This is a data cell with 8 binary flags. It indicates the healthiness of the Sampled Values being received from each of the Merging Uniured: 0: Sampled Values received are synchronised and any loss of samples is within acceptable limits. 1: Sampled Values received are not synchronised (Setting : Synchro Alarm) or the Sampled Value delay exceeds the acceptable value (Merging Unit Delay setting). The IED raises a '9-2 Sample Alarm' when any one of the binary flags is '1'.				

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
SAV Test	18	53	00000000 00000000 00000000	0 or 1 for each flag
This is a data cell with 24 binary flags. It indicates the status of the IEC 61850 Test mode flag for each analogue channel processed by the IED (eg: VA, the A-phase voltage). The channel assignment depends on the IED.				
SAV Questionable	18	54	00000000 00000000 00000000	0 or 1 for each flag
This is a data cell with 24 binary flags. It indicates the status of the IEC 61850 Quality attribute 'Questionable' in the Sampled Value frames for each of the analogue channels. The channel assignment depends on the IED.				
SAV Invalid	18	55	00000000 00000000 00000000	0 or 1 for each flag
This is a data cell with 24 binary flags. It indicates the status of the IEC 61850 Quality attribute 'Invalid' in the Sampled Value frames for each of the analogue channels. The channel assignment depends on the IED.				
Frame Loss Data	18	70		
This column contains all the configure/setting measurement parameters relative to frame loss data.				
Frame Loss Rate	18	71	Enabled	Disabled, Enabled
Enables the frame loss rate counter				
LN1 - LN8 LossRate Sec	18	72 - 79	0	
These data cells indicate the percentage of SV frames missing during the past second, for LNx.				
LossRate Reset	18	90	No	No, Yes
Resets the frame loss rate counter				
Reset Time	18	91	0	
This data cell is the time stamp of the most recent instance of Frame Loss Rate counter.				
LN1 – LN8 FrmLoss Cuml	18	92 - 99	0	
These data cells indicate the number of frames lost since last reset for LN 1...8, the most recent reset time available in the IED menu.				
LN1 - LN8 Error Second	18	B1 to 8	0	
Frame Error Seconds is a cumulative value since the last reset per LN. If the Frame Loss Rate exceeds 1.25% (one sample per cycle on average for one second) the IED records this as an Error Second.				

4.2 DDB SIGNALS TABLE

IEDs which have the IEC 61850-9-2LE interface have additional DDBs so they can be configured to the system and application.

Ordinal	English Text	Source	Description
472	9-2 Sample Alarm	Software	Abnormal state of IEC 61850-9-2LE sample.
473	9-2LE Cfg Alarm	Software	This alarm highlights discrepancies in assignments of analogue channels in the IED. For example, if you assign two current inputs to the same Logical Node, the IED raises an Illegal Channel Map alarm.
1088-1119	Quality VIP 33 -64	Software	These are additional virtual inputs that provide Quality attributes.
1152-1183	PubPres VIP 33 -64	Software	These are are additional virtual inputs that indicate if the publisher is present.
1754-1769	Virtual Output33-48	PSL	These are additional GOOSE outputs

5 P743

5.1 SETTINGS TABLE

IEDs which have the IEC 61850-9-2LE interface have additional settings in the ***IEC 61850-9.2LE*** submenu. This allows them to be configured to the system and application.

To display the primary values whether CTs, VTs or NCITs are used, set ***Remote Values*** in the *MEASURE'T SET UP* column to *Primary*.

Menu Text	Col	Row	Default Setting	Available Options
Description				
IEC 61850-9.2LE	18	00		
Physical Link	18	01	Fibre Optic	Copper, Fibre Optic
This setting specifies the physical connection between the IED and the Process Bus network. The RJ45 copper port is for service use only and should not be used as a permanent connection.				
Anti-Alias Filter	10	02	Enabled	Disabled, Enabled
This setting activates or deactivates the anti-aliasing filter, which conditions the Sampled Values from the Process Bus network.				
9-2 Test Mode	10	04	Test Blocked	Test Blocked, Test Ignored, Test Only
This setting is used for processing Sampled Value frames with an IEC 61850 Test mode flag. This setting is common to all Logical Nodes configured in the IED. Test Blocked: all channel data frames received with an IEC 61850 Test flag are treated as invalid. The IED blocks relevant protection functions and issues a '9-2Sample Alarm'. Test Ignored: all channel data frames received with an IEC 61850 Test flag are treated as good so all protection functions remain active. Test Only: all channel data received with an IEC 61850 Test flag are treated as good. Any channel data received without the Test flag are treated as invalid. The IED blocks relevant protection functions and issues a '9-2Sample Alarm'.				
LN1 Name	18	12	MiCOM Logic Node 1	
Logical Node 1 must be identified by a unique name that allows it to receive Sampled Values from a specific Merging Unit. Rename the Logical Node using between 10 and 34 characters to match the MU Logical Node name. The Logical Node name must be exactly the same as the one set in the Merging Unit that broadcasts it.				
Trust Ques Data	18	43	000000	0 or 1 for each flag
This setting specifies how the Sampled Values are processed by the IED when the associated Quality tag is 'Questionable'. There are six binary flags (0 = No, 1 = Yes) which can be set by the user, corresponding to the data quality attributes 'Out of Range', 'Bad Reference', 'Oscillatory', 'Old Data', 'Inconsistent' and 'Inaccurate'. Questionable data is treated as invalid if the flag is '0'. To process the data as good samples, the flag is changed to '1'. The setting is common to all Logical Nodes in service.				
Loss Rate Level	18	44	10%	1.25% to 15%, in steps of 1.25%
This setting is related to Process Bus network performance, in particular, the possibility of loss of samples. The set threshold is an upper limit for the loss of Sampled Values from any of the Logical Nodes configured in the IED, calculated every cycle. If the loss rate level exceeds the set value, the IED generates the '9-2Sample Alarm' and the related protection functions are inhibited. 1.25% corresponds to the loss of 1 out of the 80 samples expected every cycle, averaged over one second. The loss rate calculation and threshold check is performed independently for each Logical Node configured.				
ProcessBus Alarm	18	45	Self Reset	
SAV Absence	18	51	00000000	0 or 1 for each flag
This is a data cell with 8 binary flags. It indicates the presence or absence of Sampled Values from each of the Merging Units the IED is communicating with. There is a maximum of 8 Logical Nodes. The cell data for each Logical Node is continuously refreshed. 0: Sampled Values being received from the Merging Unit. 1: No Sampled Values being received from the Merging Unit.				
SAV No SampSync	18	52	00000000	0 or 1 for each flag

Menu Text	Col	Row	Default Setting	Available Options
Description				
This is a data cell with 8 binary flags. It indicates the healthiness of the Sampled Values being received from each of the Merging Units configured: 0: Sampled Values received are synchronised and any loss of samples is within acceptable limits. 1: Sampled Values received are not synchronised (Setting : SynchroAlarm) or the Sampled Value delay exceeds the acceptable value (Merging Unit Delay setting). The IED raises a '9-2 Sample Alarm' when any one of the binary flags is '1'.				
SAV Test	18	53	00000000 00000000 00000000	0 or 1 for each flag
This is a data cell with 24 binary flags. It indicates the status of the IEC 61850 Test mode flag for each analogue channel processed by the IED (eg: VA, the A-phase voltage). The channel assignment depends on the IED.				
SAV Questionable	18	54	00000000 00000000 00000000	0 or 1 for each flag
This is a data cell with 24 binary flags. It indicates the status of the IEC 61850 Quality attribute 'Questionable' in the Sampled Value frames for each of the analogue channels. The channel assignment depends on the IED.				
SAV Invalid	18	55	00000000 00000000 00000000	0 or 1 for each flag
This is a data cell with 24 binary flags. It indicates the status of the IEC 61850 Quality attribute 'Invalid' in the Sampled Value frames for each of the analogue channels. The channel assignment depends on the IED.				
Jitter Status	18	56		
Only the first bit is used.				
Frame Loss Data	18	70		
Frame Loss Rate	18	71	Enabled	Enabled, Disabled
LN1 LossRate Sec	18	72		
Loss Rate Reset	18	90	No	Yes, No
Last Reset Time	18	91		
LN1 FrmLoss Points	18	92		
Logical node 1 counts how many frames are lost from the time of reset.				
LN1 Error Second	18	B1		
Counter for error seconds.				

5.2 DDB SIGNALS TABLE

IEDs which have the IEC 61850-9-2LE interface have additional DDBs so they can be configured to the system and application.

Ordinal	Signal Name	Source	Type	Response
Description				
112 to 127	VIRTUAL_TC 1-16	PSL	PFSI	Protection Event Log
Virtual output - allows your to control a binary signal which can be mapped using the SCADA protocol output to other devices				
272	SAV_SYNC_ALARM	Software	PFSO	Self reset alarm event
Error in Sampled Value synchronisation.				
273	SAV_MU_ALARM	Software	PFSO	Self reset alarm event
Error in Sampled Value from Merging Unit.				
274	PROCESS_BUS_ALARM	Software	PFSO	Self reset alarm event

Ordinal	Signal Name	Source	Type	Response
Description				
Process Bus error.				
275	QUALITY_BLK_ALARM	Software	PFSO	Self reset alarm event
Due to a quality issue, this alarm indicates that protection functions are blocked on all phases.				
276	QUALITY_BLK_PHASE_A	Software	PFSO	No response
Due to a quality issue on Phase A, this alarm indicates that protection functions are blocked on Phase A.				
277	QUALITY_BLK_PHASE_B	Software	PFSO	No response
Due to a quality issue on Phase B, this alarm indicates that protection functions are blocked on Phase B.				
278	QUALITY_BLK_PHASE_C	Software	PFSO	No response
Due to a quality issue on Phase C, this alarm indicates that protection functions are blocked on Phase C.				
279	QUALITY_BLK_PHASE_N	Software	PFSO	No response
Due to a quality issue on the Neutral phase, this alarm indicates that protection functions are blocked on the Neutral phase.				
365	9_2_SAV_CFG_ALARM	Software	PFSO	Self reset alarm event
Error in 9-2 configuration.				
368 to 383	VIRTUAL TS 1-16	GOOSE Input Command	PFSI	Protection Event Log
Virtual Input received from GOOSE message				
1152 to 1215	VIP_QUALITY_1 to 64	GOOSE Input Command	PFSO	Protection Event Log
GOOSE virtual input - provides the Quality attributes of any data object in an incoming GOOSE message				
1280 to 1343	VIP_PUB_PRES_1 to 64	GOOSE Input Command	PFSO	Protection Event Log
GOOSE virtual input - indicates if the GOOSE publisher responsible for publishing the data that derives a virtual input is present.				

6 P746

6.1 SETTINGS TABLE

IEDs which have the IEC 61850-9-2LE interface have additional settings in the ***IEC 61850-9.2LE*** submenu. This allows them to be configured to the system and application.

To display the primary values whether CTs, VTs or NCITs are used, set ***Remote Values*** in the *MEASURE'T SET UP* column to `Primary`.

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
IEC 61850-9.2LE	18	00		
This column contains all the configure/setting measurement parameters relative to IEC 61850-9-2LE.				
Physical Link	18	01	Fibre Optic	Copper, Fibre Optic
This setting specifies the physical connection between the IED and the Process Bus network. The RJ45 copper port is for service use only and should not be used as a permanent connection.				
AntiAlais Filter	18	02	Enabled	Disabled, Enabled
This setting activates or deactivates the anti-aliasing filter, which filters the Sampled Values from the Process Bus network.				
Synchro Alarm	18	03	Local 1 PPS	No SYNC CLK, Local 1PPS, Global 1PPS
This setting is used for processing Sampled Value frames with an IEC 61850 Test mode flag. This setting is common to all Logical Nodes configured in the IED. Test Blocked: all channel data frames received with an IEC 61850 Test flag are treated as invalid. The IED blocks relevant protection functions and issues a 9-2Sample Alarm. Test Ignored: all channel data frames received with an IEC 61850 Test flag are treated as good so all protection functions remain active. Test Only: all channel data received with an IEC 61850 Test flag are treated as good. Any channel data received without the Test flag are treated as invalid. The IED blocks relevant protection functions and issues a 9-2 Sample Alarm.				
This setting is used for processing Sampled Value frames with an IEC 61850 Test mode flag. This setting is common to all Logical Nodes configured in the IED. Test Blocked: all channel data frames received with an IEC 61850 Test flag are treated as invalid. The IED blocks relevant protection functions and issues a 9-2Sample Alarm. Test Ignored: all channel data frames received with an IEC 61850 Test flag are treated as good so all protection functions remain active. Test Only: all channel data received with an IEC 61850 Test flag are treated as good. Any channel data received without the Test flag are treated as invalid. The IED blocks relevant protection functions and issues a 9-2 Sample Alarm.				
Merge Unit Delay	18	05	1ms	0 to 3 ms, step 0.25 ms
When Sampled Values are received at the IED from different Merging Units, they may not arrive simultaneously due to differences in Merging Unit performance or different network path delays. This setting specifies the maximum time delay expected, starting at the reception of the Sampled Value frame from the first Merging Unit to the reception of the Sampled Value frame from the last Merging Unit for each sample count. Signal processing starts at the end of the Merging Unit delay and if a frame is not received in that specified time, an alarm appears. (9-2 Sample Alarm). The IED has a search command to measure and display the maximum Sampled Value frame delay. The Merging Unit Delay can be set based on the result of the search, which is displayed on the IED.				
LN Count	18	11	6	1 to 8
This setting specifies the number of Logical Nodes in use for receiving the Sampled Values required by the IED. The default value varies with the product. Modify the LN Count to match the number of Merging Units relevant for the IED in each specific application. The default LN Count is model dependent.				
LN1-8 Name	18	12 to 19	MiCOM Logical Node 1-8	

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
Each Logical Node must be identified by a unique name that allows it to receive Sampled Values from a specific Merging Unit. The default name for LN1 is 'MiCOM Logical Node 1'. You can edit this ASCII text string using between 10 and 34 characters to match the Merging Unit's Logical Node (sample value identifier) name . The same applies for LN2 to 8. The Logical Node name is the system-wide unique identification 'MsvID' defined in the Merging Unit control block MSVCB according to IEC 61850-9-2 Ed 1.0. The number of Logical Nodes available is variable, as set in LN Count. For example, with an LN Count of 3, LN1 Name, LN2 Name and LN3 Name should be set to match those of the corresponding Merging Units. Rename the Logical Nodes used for the application. Use between 10 and 34 characters to match each MU Logical Node name. Each Logical Node name must be exactly the same as the one set in the Merging Unit that broadcasts it.				
IA1 IB1 IC1 - IA6 IB6 IC6	18	31 - 36	LN1 - LN6	Unused, LN1, LN2, LN3,...,LN 8
Three-phase current inputs to the IED				
VA VB VC	18	37	LN1	Unused, LN1, LN2, LN3,...,LN 8
Three-phase voltage input to the IED				
MUs Delay Search	18	41	No	No, Yes
The IED has a search command to measure and display the maximum Sampled Value frame delay. The Merging Unit Delay can be set based on the result of the search, which is displayed on the IED.				
MUs Delay Max	18	42		
When sampled values are received at the IED from different Merging Units, they may not arrive simultaneously due to differences in Merging Unit performance or different network path delays. This setting specifies the maximum time-delay expected, starting at the reception of the sampled value frame from the "first" Merging Unit to the reception of the sampled value frame from the last Merging Unit for each sample count. Signal processing starts at the end of the Merging Unit delay and if a frame is not received in that specified time, a synchronisation alarm appears.				
Trust Ques Data	18	43	000000	0 or 1 for each flag
This setting specifies how the Sampled Values are processed by the IED when the associated Quality tag is Questionable. There are six binary flags (0 = No, 1 = Yes) which you can set, corresponding to the data quality attributes Out of Range, Bad Reference, Oscillatory, Old Data, Inconsistent, and Inaccurate. Questionable data is treated as invalid if the flag is 0. To process the data as good samples, the flag is changed to 1. The setting is common to all Logical Nodes in service.				
Loss Rate Level	18	44	0.1	
This setting is related to Process Bus network performance, in particular, the possibility of loss of samples. The set threshold is an upper limit for the loss of Sampled Values from any of the Logical Nodes configured in the IED, calculated every cycle. If the loss rate level exceeds the set value, the IED generates the 9-2 Sample Alarm and the related protection functions are inhibited. 1.25% corresponds to the loss of 1 out of the 80 samples expected every cycle, averaged over one second. The loss rate calculation and threshold check is performed independently for each configured Logical Node.				
SAV Absence	18	51	000000	0 or 1 for each flag
This is a data cell with 8 binary flags. It shows the presence or absence of Sampled Values from each of the Merging Units the IED is communicating with. There is a maximum of 8 Logical Nodes. The cell data for each Logical Node is continuously refreshed. The P743 only uses bit 0 for LN 1 0: No Sampled Values being received from the Merging Unit. 1: Sampled Values being received from the Merging Unit.				
SAV No SmpSynch	18	52	000000	
This is a data cell with 8 binary flags. It indicates the healthiness of the Sampled Values being received from each of the configured Merging Units. The P743 only uses bit 0 for LN 1. 0: Sampled Values received are synchronised and any loss of samples is within acceptable limits. 1: Sampled Values received are not synchronised (Setting :Synchro Alarm) or the Sampled Value delay exceeds the acceptable value (Merging Unit Delay setting). The IED raises a 9-2 Sample Alarm when any one of the binary flags is 1				
SAV Test	18	53	00000000 00000000 00000000	0 or 1 for each flag
This is a data cell with 24 binary flags. It indicates the status of the IEC 61850 Test mode flag for each analogue channel processed by the IED (eg: VA, the A-phase voltage). The channel assignment depends on the IED.				
SAV Questionable	18	54	00000000 00000000 00000000	0 or 1 for each flag

MENU TEXT	Col	Row	Default Setting	Available Setting
Description				
This is a data cell with 24 binary flags. It indicates the status of the IEC 61850 Quality attribute 'Questionable' in the Sampled Value frames for each of the analogue channels. The channel assignment depends on the IED.				
SAV Invalid	18	55	00000000 00000000 00000000	0 or 1 for each flag
This is a data cell with 24 binary flags. It indicates the status of the IEC 61850 Quality attribute 'Invalid' in the Sampled Value frames for each of the analogue channels. The channel assignment depends on the IED.				
Frame Loss Data	18	70		
This column contains all the configure/setting measurement parameters relative to frame loss data.				
Frame Loss Rate	18	71	Enabled	Disabled, Enabled
Enables the frame loss rate counter				
LN1-8 LossRate Sec	18	72-79		
This data cell indicates the percentage of SV frames missing during the past second for each LN				
LossRate Reset	18	90	No	Yes, No
Resets the frame loss rate counter				
Reset Time	18	91	0	
This data cell is the time stamp of the most recent instance of Frame Loss Rate counter				
LN1-8 FrmLoss Cuml	18	92-99	0	
This data cell indicates the number of frames lost since the last reset for the LN, the most recent reset time available in the IED menu.				
LN1-8 Error Second	18	B1-B8	0	
Frame Error Seconds is a cumulative value since the last reset for the LN. If the Frame Loss Rate exceeds 1.25% (one sample per cycle on average for one second) the IED records this as an Error Second.				

6.2 DDB SIGNALS TABLE

IEDs which have the IEC 61850-9-2LE interface have additional DDBs so they can be configured to the system and application.

Ordinal	English Text	Source	Description
508	9-2LE Cfg Alarm	Software	This alarm highlights discrepancies in assignments of analogue channels in the IED. For example, if you assign two current inputs to the same Logical Node, the IED raises an Illegal Channel Map alarm.
511	9-2 Sample Alarm	Software	Abnormal state of IEC 61850-9-2LE sample.
586-599	PubPres VIP 115-128	Software	These are are additional virtual inputs that indicate if the publisher is present.
663-715	Virtual Input 65-117	Software	These are additional virtual Inputs.
951-1007	Quality VIP 65-121	Software	These are additional virtual inputs that provide Quality attributes.
1044-1103	Virtual Output 33-92	PSL	These are additional GOOSE outputs
1186-1267	PubPres VIP 33 -114	Software	These are are additional virtual inputs that indicate if the publisher is present.
1484-1494	Virtual Input 118-128	Software	These are additional virtual Inputs.
1508-1614	Quality VIP 122-128	Software	These are additional virtual inputs that provide Quality attributes.
1560-1591	Quality VIP 33 -64	Software	These are additional virtual inputs that provide Quality attributes.
1678-1695	Virtual Output 93-110	PSL	These are additional GOOSE outputs

Ordinal	English Text	Source	Description
1722-1739	Virtual Output 111-128	PSL	These are additional GOOSE outputs
1888-1919	Virtual Input 33-64	Software	These are additional virtual Inputs.

APPENDIX A

ORDERING OPTIONS

Variants	Order No.
Compact Distance Protection with reclosing	P441
Nominal Auxiliary Supply (Vx)	
24 - 54Vdc	7
48 - 125Vdc (40 - 100Vac)	8
110 - 250 Vdc (100 - 240 Vac)	9
Current Rating (In) & Voltage Rating (Vn)	
Dual Rated CT (1 & 5A : 100 - 120 V)	1
Non-conventional input transformers NCIT (IEC 61850-9-2 LE) not yet available	A
Module Sum (∑1A / PXDB)	5
IEC 61850-9-2LE Sampled Analogue Values Ethernet board	C
Hardware Options	
Standard Version	1
Single Ethernet 100Mbit/s	6
Single Ethernet (100Mbit/s) plus IRIG-B (Modulated)	A
Single Ethernet (100Mbit/s) plus IRIG-B (Un-modulated)	B
Redundant Ethernet Self-Healing Ring, 2 multi-mode fibre ports + Un-modulated IRIG-B	H
Redundant Ethernet RSTP, 2 multi-mode fibre ports + Modulated IRIG-B	J
Redundant Ethernet RSTP, 2 multi-mode fibre ports + Un-modulated IRIG-B	K
Redundant Ethernet Dual-Homing Star, 2 multi-mode fibre ports + Un-modulated IRIG-B	M
Redundant Ethernet PRP/HSR, 2 fibre ports + Modulated IRIG-B	N
Redundant Ethernet PRP/HSR, 2 fibre ports + Unmodulated IRIG-B	P
Redundant Ethernet PRP/HSR/RSTP/Failover, 2 multi-mode fibre ports + Modulated/Un-Modulated IRIG-B	R
Redundant Ethernet PRP/HSR/RSTP/Failover, 2 copper ports RJ45 + Modulated/Un-Modulated IRIG-B	S
Redundant Ethernet PRP/HSR/RSTP/Failover, 1 copper port RJ45 + 1 multi-mode fibre port + Modulated/Un-Modulated IRIG-B	T
* HSR – contact GE for details	
Software Options	
With 3 phase tripping and 3 phase auto reclose: 8 inputs and 14 outputs	B
With check synchronising	B
With 1 phase tripping and 1 phase auto reclose: 8 inputs and 8 outputs Mounting Op R	C
Protocol Options	
K - Bus	1
Modbus	2
VDEW (IEC 60870-5-103)	3
DNP3.0	4
IEC61850 + Courier via rear RS485 port	6
IEC61850+IEC60870-5-103 via rear RS485 port	7
Mounting / Livery Change	
Flush/Panel Mounting with Harsh Env.Coating, White Front Panel	M
40TE Case (9-2LE models only) Flush/Panel Mounting with Harsh Env. Coating, White Front Panel	R
Flush/Panel Mounting with Harsh Env. Coating, with USB Port, Black and Silver Front Panel	S
40TE Case (9-2LE models only) Flush/Panel Mounting with Harsh Env. Coating, with USB Port, Black and Silver Front Panel	U
Language	
English, French, German, Spanish	0
English, French, German, Italian	4
Chinese, English or French via HMI, with English or French only via Communications port	C
Software Version	
Date and Application Dependant	
Customer Specific Options	
Standard Version	0
Customer Engineered Version	A
Hardware Version	
Model and Hardware Version Dependant	

Variants Order No.																				
Distance Protection P442	**P442**																		**	
Nominal auxiliary voltage																				
24-54 Vdc							7													
48-125 Vdc (40-100 Vac)							8													
110-250 Vdc (100-240 Vac)							9													
In/Vn rating																				
Dual rated CT (1 & 5A : 100 - 120V)								1												
Module Sum ($\sum_{1A / PXDB}$)								5												
Non-conventional input transformers NCIT (IEC 61850-9-2 LE)								C												
Hardware options																				
Standard version									1											
IRIG-B Only (Modulated)									2											
IRIG-B input and Fibre optic converter (Courier, Modbus,IEC60870-5-103 or DNP3)									4											
Ethernet 10Mbit/s									5											
Single Ethernet 100Mbit/s									6											
Second Rear Comms + InterMiCOM									7											
IRIG-B (Modulated) + Second Rear Comms + InterMiCOM									8											
Single Ethernet (100Mbit/s) plus IRIG-B (Modulated) Software version '31' and later (Suffix J)									A											
Single Ethernet (100Mbit/s) plus IRIG-B (Un-modulated) Software version '31' and later (Suffix J)									B											
IRIG-B (Un-modulated) Software version '31' and later (Suffix J)									C											
InterMiCOM + Courier Rear Port *									E											
InterMiCOM + Courier Rear Port + IRIG-B modulated *									F											
Redundant Ethernet Self-Healing Ring, 2 multi-mode fibre ports + Un-modulated IRIG-B									H											
Redundant Ethernet Dual-Homing Star, 2 multi-mode fibre ports + Un-modulated IRIG-B									M											
Redundant Ethernet PRP/HSR/RSTP/Failover, 2 multi-mode fibre ports + Modulated/Un-Modulated IRIG-B									R											
Redundant Ethernet PRP/HSR/RSTP/Failover, 2 copper ports RJ45 + Modulated/Un-Modulated IRIG-B									S											
Redundant Ethernet PRP/HSR/RSTP/Failover, 1 copper port RJ45 + 1 multi-mode fibre port + Modulated/Un-Modulated IRIG-B									T											
* NB: Options available with Software version 45 & later (Design Suffix K)																				
Software options																				
16 Logic Inputs & 21 Relay Outputs										B										
16 Logic Inputs & 21 Relay Outputs (3 Fast trip)										D										
16 Logic Inputs & 21 Relay Outputs (6 Fast trip)										E										
16 Logic Inputs & 18 Relay Outputs (4 High Break) *										C										
* NB: Option C is only available with Design Suffix K & Software version 40 or later																				
Protocol options																				
K-Bus											1									
Modbus											2									
VDEW (IEC 60870-5-103)											3									
DNP3.0											4									
UCA2 + Courier via rear RS485 port (Ethernet hardware options [i.e. 6] only)											5									
IEC61850 + Courier via rear RS485 port *											6									
IEC61850 + IEC60870-5-103 via rear RS485 port *											7									
DNP3 over Ethernet with Courier rear port K-Bus/RS485 protocol											8									
* NB: IEC61850 Edition 2 available with '82' Software																				
Mounting																				
Flush/Panel Mounting with Harsh Env.Coating, White Front Panel												M								
Flush/Panel Mounting with Harsh Env. Coating, with USB Port, Black and Silver Front Panel												S								
Language																				
English, French, German, Spanish													0							
English, French, German, Italian													4							
Chinese, English or French via HMI, with English or French only via Communications port													C							
Software version																				
Date and application dependant																			**	
Customer specific options																				
Standard version																			0	
Customer engineered version: ENEL																			1	
Customer engineered version: TERNA																			2	
Customer engineered version: RTE																			4	
Customer engineered version: general																			A	
Hardware version																				
Model and hardware version dependant																				*

Variants Order No.													
Distance Protection P444	P444								**				
Nominal auxiliary voltage													
24-54 Vdc		7											
48-125 Vdc (40-100 Vac)		8											
110-250 Vdc (100-240 Vac)		9											
In/Vn rating													
Dual rated CT (1 & 5A : 100 - 120V)			1										
Module Sum ($\sum$1A / PXDB)			5										
Non-conventional input transformers NCIT (IEC 61850-9-2 LE) NEW BOARD			C										
Hardware options													
Standard version				1									
IRIG-B input				2									
IRIG-B input and Fibre optic converter (IEC60870-5-103)				4									
Ethernet 10Mbits				5									
Single Ethernet 100Mbit/s				6									
Rear Comms + InterMiCOM				7									
Rear Comms + IRIB-B + InterMiCOM				8									
Single Ethernet (100Mbit/s) plus IRIG-B (Modulated) Software version '31' and later (Suffix J)				A									
Single Ethernet (100Mbit/s) plus IRIG-B (Un-modulated) Software version '31' and later (Suffix J)				B									
IRIG-B (Un-modulated) (Software version '31' and later)				C									
InterMiCOM + Courier Rear Port *				E									
InterMiCOM + Courier Rear Port + IRIG-B modulated *				F									
Redundant Ethernet Self-Healing Ring, 2 multi-mode fibre ports + Un-modulated IRIG-B				H									
Redundant Ethernet RSTP, 2 multi-mode fibre ports + Modulated IRIG-B				J									
Redundant Ethernet RSTP, 2 multi-mode fibre ports + Un-modulated IRIG-B				K									
Redundant Ethernet Dual-Homing Star, 2 multi-mode fibre ports + Un-modulated IRIG-B				M									
Redundant Ethernet PRP/HSR, 2 fibre ports + Modulated IRIG-B				N									
Redundant Ethernet PRP/HSR, 2 fibre ports + Unmodulated IRIG-B				P									
Redundant Ethernet PRP/HSR/RSTP/Failover, 2 multi-mode fibre ports + Modulated/Un-Modulated IRIG-B				R									
Redundant Ethernet PRP/HSR/RSTP/Failover, 2 copper ports RJ45 + Modulated/Un-Modulated IRIG-B				S									
Redundant Ethernet PRP/HSR/RSTP/Failover, 1 copper port RJ45 + 1 multi-mode fibre port + Modulated/Un-Modulated IRIG-B				T									
* NB: Options available with Software version 45 & later (Design Suffix K)													
** For HSR – contact GE for details													
Models					B								
1 & 3 Pole tripping/reclosing with 24 inputs & 32 outputs					B								
1 & 3 Pole tripping/reclosing with 24 inputs & 34 ouputs (12 high break)					C								
1 & 3 Pole tripping/reclosing with 24 inputs & 32 outputs (4 fast output contacts)					D								
1 & 3 Pole tripping/reclosing with 24 inputs & 32 outputs (8 fast output contacts)					E								
1 & 3 Pole tripping/reclosing with 24 inputs & 46 outputs					J								
1 & 3 Pole tripping/reclosing with 24 inputs & 46 outputs (4 fast output contacts)					K								
1 & 3 Pole tripping/reclosing with 24 inputs & 46 outputs (8 fast output contacts)					L								
1 phase tripping and 1 phase auto reclose: 8 inputs and 8 outputs Mounting Option 'R'					R								
Protocol options						1							
K-Bus						1							
Modbus						2							
VDEW (IEC 60870-5-103) (RS485 or Fibre Optic)						3							
DNP3.0						4							
UCA2						5							
IEC61850 + Courier via rear RS485 port *						6							
IEC61850 + IEC60870-5-103 via rear RS485 port *						7							
DNP3 over Ethernet with Courier rear port K-Bus/RS485 protocol						8							
* NB: IEC61850 Edition 2 available with '82' Software													
Mounting							M						
Flush/Panel Mounting with Harsh Env.Coating, White Front Panel							M						
19" Rack Mounting with Harsh Env. Coating, White Front Panel							N						
Flush/panel mounting with harsh environment coating							P						
19" Rack mounting with harsh environmental coating							Q						
40TE Case (9-2LE models only) Flush/Panel Mounting with Harsh Env. Coating, White Front Panel							R						
Flush/Panel Mounting with Harsh Env. Coating, with USB Port, Black and Silver Front Panel							S						
19" Rack Mounting with Harsh Env. Coating, with USB Port, Black and Silver Front Panel							T						
40TE Case (9-2LE models only) Flush/Panel Mounting with Harsh Env. Coating, with USB Port, Black and Silver Front Panel							U						
Language								0					
English, French, German, Spanish								0					
English, French, German, Italian								4					
Chinese, English or French via HMI, with English or French only via Communications port								C					
Software version													
Date and application dependant													
Customer specific options										0			
Standard version										0			
Customer engineered version: ENEL										1			
Customer engineered version: TERNA										2			
Customer engineered version: RTE										4			
Customer engineered version: General										A			
Hardware version													
Model and hardware version dependant													*

Variants Order No.		
Distance Protection P446	**P446**	**
Distance & Autoreclose for 2 Circuit Breakers		
Nominal auxiliary voltage		
24-54 Vdc		7
48-125 Vdc (40-100 Vac)		8
110-250 Vdc (100-240 Vac)		9
In/Vn rating		
In = 1A/5A ; Vn = 100-120Vac		1
IEC 61850-9-2LE Sampled Analogue Values Ethernet board *		C
* Only available with '74'/'80' Software		
Hardware options	**Protocol Compatibilty**	
Nothing	1, 3 & 4	1
IRIG-B Only (Modulated)	1, 3 & 4	2
IRIG-B (Modulated) & Fibre Optic Converter	1, 3 & 4	4
Ethernet (100Mbit/s)	6, 7 & 8	6
Second Rear Comms + InterMiCOM	1, 3 & 4	7
IRIG-B (Modulated) + Second Rear Comms + InterMiCOM	1, 3 & 4	8
Ethernet (100Mbit/s) plus IRIG-B (Modulated)	6, 7 & 8	A
Ethernet (100Mbit/s) plus IRIG-B (Un-modulated)	6, 7 & 8	B
IRIG-B (Un-modulated)	1, 3 & 4	C
InterMiCOM + Courier Rear Port	1, 3 & 4	E
InterMiCOM + Courier Rear Port + IRIG-B modulated	1, 3 & 4	F
Redundant Ethernet Self-Healing Ring, 2 multi-mode fibre ports + Un-modulated IRIG-B	6, 7 & 8	H
Redundant Ethernet RSTP, 2 multi-mode fibre ports + Modulated IRIG-B	6, 7 & 8	J
Redundant Ethernet RSTP, 2 multi-mode fibre ports + Un-modulated IRIG-B	6, 7 & 8	K
Redundant Ethernet Dual-Homing Star, 2 multi-mode fibre ports + Un-modulated IRIG-B	6, 7 & 8	M
Redundant Ethernet PRP/HSR, 2 fibre ports + Modulated IRIG-B	6, 7 & 8	N
Redundant Ethernet PRP/HSR, 2 fibre ports + Unmodulated IRIG-B	6, 7 & 8	P
Redundant Ethernet PRP/HSR/RSTP/Failover, 2 multi-mode fibre ports + Modulated/Un-Modulated IRIG-B	6, 7 & 8	R
Redundant Ethernet PRP/HSR/RSTP/Failover, 2 copper ports RJ45 + Modulated/Un-Modulated IRIG-B	6, 7 & 8	S
Redundant Ethernet PRP/HSR/RSTP/Failover, 1 copper port RJ45 + 1 multi-mode fibre port + Modulated/Un-Modulated IRIG-B	6, 7 & 8	T
* HSR – contact GE for details		
Product Options		
24 inputs and 32 outputs (8 input and 8 outputs Mounting Opt R)		B
24 inputs and 8 standard plus 12 high break outputs		C
24 inputs and 16 standard plus 8 high break outputs		D
As B + 850nm dual channel (8 input and 8 outputs Mounting Opt R)		F
As C + 850nm dual channel		G
As D + 850nm dual channel		H
As B + 1300nm SM single channel (8 input and 8 outputs Mounting Opt R)		J
As C + 1300nm SM single channel		K
As D + 1300nm SM single channel		L
As B + 1300nm SM dual channel (8 input and 8 outputs Mounting Opt R)		N
As C + 1300nm SM dual channel		O
As D + 1300nm SM dual channel		P
As B + 1300nm MM single channel (8 input and 8 outputs Mounting Opt R)		R
As C + 1300nm MM single channel		S
As D + 1300nm MM single channel		T
As B + 1300nm MM dual channel (8 input and 8 outputs Mounting Opt R)		V
As C + 1300nm MM dual channel		W
As D + 1300nm MM dual channel		X
As B + 850nm MM + 1300mn SM (8 input and 8 outputs Mounting Opt R)		Z
As D + 850nm MM + 1300mn SM		1
As B + 1300nm SM + 850nm MM (8 input and 8 outputs Mounting Opt R)		2
As D + 1300nm SM + 850nm MM		3
As B + 850nm MM + 1300mn MM (8 input and 8 outputs Mounting Opt R)		4
As D + 850nm MM + 1300mn MM		5
As B + 1300mn MM + 850nm MM (8 input and 8 outputs Mounting Opt R)		6
As D + 1300mn MM + 850nm MM		7
Protocol options	**Hardware Compatibilty**	
K-Bus	1, 2, 3, 4, C, E & F	1
IEC60870-5-103	1, 2, 3, 4, C, E & F	3
DNP3.0	1, 2, 3, 4, C, E & F	4
IEC61850 + Courier via rear RS485 port	6, A, B, G, H, J, K, L, M, N, P	6
IEC61850+IEC60870-5-103 via rear RS485 port	6, A, B, G, H, J, K, L, M, N, P	7
DNP3.0 Over Ethernet with Courier rear port K-Bus/RS485 protocol	6, A, B, G, H, J, K, L, M, N, P	8
Mounting		
Flush/Panel Mounting with Harsh Env.Coating, White Front Panel		M
19" Rack Mounting with Harsh Env. Coating, White Front Panel		N
Flush/panel mounting with harsh environment coating		P
19" Rack mounting with harsh environmental coating		Q
40TE Case (9-2LE models only) Flush/Panel Mounting with Harsh Env. Coating, White Front Panel		R
Flush/Panel Mounting with Harsh Env. Coating, with USB Port, Black and Silver Front Panel		S
19" Rack Mounting with Harsh Env. Coating, with USB Port, Black and Silver Front Panel		T
40TE Case (9-2LE models only) Flush/Panel Mounting with Harsh Env. Coating, with USB Port, Black and Silver Front Panel		U
Language		
English, French, German, Spanish		0
English, French, German, Russian		5
English, Italian, Polish and Portuguese *		7
Chinese, English or French via HMI, with English or French only via Communications port		C
* Available with '75'/'76'/'82' software		
Software version		
Date and application dependant		**
Customer specific options		
Standard version		0
Customer version		A

Hardware version	
Extended main processor (XCPU2) With Function Keys & Tri-colour LEDs	K
Main processor (CPU3) 40TE	P
As K plus increased main processor memory (XCPU3), Cyber Security	M

Variants Order No.												
Current Differential (Optional Distance)	**P546**								**			
Nominal auxiliary voltage												
24-54 Vdc		7										
48-125 Vdc (40-100 Vac)		8										
110-250 Vdc (100-240 Vac)		9										
In/Vn rating												
In = 1A/5A ; Vn = 100-120Vac			1									
IEC 61850-9-2LE Sampled Analogue Values Ethernet board *			C									
* Only available with '74'/'80' Software												
Hardware options	**Protocol Compatibilty**											
Standard - None	1, 2, 3 & 4			1								
IRIG-B Only (Modulated)	1, 2, 3 & 4			2								
IRIG-B (Modulated) & Fibre Optic Converter	1, 2, 3 & 4			4								
Ethernet (10Mbit/s) *	5			5								
Ethernet (100Mbit/s)	5, 6, 7 & 8			6								
Second Rear Comms	1, 2, 3 & 4			7								
IRIG-B (Modulated) + Second Rear Comms	1, 2, 3 & 4			8								
Ethernet (100Mbit/s) plus IRIG-B (Modulated) **	6, 7 & 8			A								
Ethernet (100Mbit/s) plus IRIG-B (Un-modulated) **	6, 7 & 8			B								
IRIG-B (Un-modulated) **	1, 2, 3 & 4			C								
InterMiCOM + Courier Rear Port ****	1, 2, 3 & 4			E								
InterMiCOM + Courier Rear Port + IRIG-B modulated ****	1, 2, 3 & 4			F								
Redundant Ethernet Self-Healing Ring, 2 multi-mode fibre ports + Un-modulated IRIG-B ***	6, 7 & 8			H								
Redundant Ethernet RSTP, 2 multi-mode fibre ports + Modulated IRIG-B ***	6, 7 & 8			J								
Redundant Ethernet RSTP, 2 multi-mode fibre ports + Un-modulated IRIG-B ***	6, 7 & 8			K								
Redundant Ethernet Dual-Homing Star, 2 multi-mode fibre ports + Un-modulated IRIG-B ***	6, 7 & 8			M								
Redundant Ethernet PRP/HSR, 2 fibre ports + Modulated IRIG-B ***	6, 7 & 8			N								
Redundant Ethernet PRP/HSR, 2 fibre ports + Unmodulated IRIG-B ***	6, 7 & 8			P								
Redundant Ethernet PRP/HSR/RSTP/Failover, 2 multi-mode fibre ports + Modulated/Un-Modulated IRIG-B	6, 7 & 8			R								
Redundant Ethernet PRP/HSR/RSTP/Failover, 2 copper ports RJ45 + Modulated/Un-Modulated IRIG-B	6, 7 & 8			S								
Redundant Ethernet PRP/HSR/RSTP/Failover, 1 copper port RJ45 + 1 multi-mode fibre port + Modulated/Un-Modulated IRIG-B	6, 7 & 8			T								
* Only on Suffix G or J Relays												
** Only on Suffix K & M relays												
*** Only on Suffix K & M relays with software versions 45/55 & later												
**** Only on Suffix K or M relays with 47/57 Software, replaces hardware options '7' & '8'												
***** For HSR – contact GE for details												
Product Options												
Ch1=850nm multi-mode, Ch2=850nm multi-mode, 24 Inputs 32 Standard Outputs (8 inputs, 8 outputs mounting option R)					A							
Ch1=1300nm single-mode, Ch2=not fitted (2 Terminal only), 24 Inputs & 32 Standard outputs (8 inputs, 8 outputs mounting option R)					B							
Ch1=1300nm single-mode, Ch2=1300nm single-mode, 24 inputs & 32 Standard Outputs (8 inputs, 8 outputs mounting option R)					C							
Ch1=1300nm multi-mode, Ch2=not fitted (2 Terminal only), 24 Inputs & 32 Standard Outputs (8 inputs, 8 outputs mounting option R)					D							
Ch1=1300nm multi-mode, Ch2=1300nm multi-mode 24 Inputs & 32 Standard Outputs (8 inputs, 8 outputs mounting option R)					E							
Ch1=1550nm single-mode, Ch2=not fitted (2 Terminal only) 24 Inputs & 32 Standard Outputs (8 inputs, 8 outputs mounting option R)					F							
Ch1=1550nm single-mode, Ch2=1550nm single-mode, 24 Inputs & 32 Standard Outputs (8 inputs, 8 outputs mounting option R)					G							
Ch1=850nm multi-mode, Ch2=1300nm single-mode, 24 Inputs & 32 Standard Outputs (8 inputs, 8 outputs mounting option R)					H							
Ch1=850nm multi-mode, Ch2=850nm multi-mode, 24 Inputs & 8 Standard + 12 High Break Outputs ***					I							
Ch1=850nm multi-mode, Ch2=1300nm multi-mode, 24 Inputs and 32 Standard Outputs * (8 inputs, 8 outputs mounting option R)					J							
Ch1=850nm multi-mode, Ch2=1550nm single-mode 24 Inputs & 32 Standard Outputs * (8 inputs, 8 outputs mounting option R)					K							
Ch1=1300nm single-mode, Ch2=850nm multi-mode 24 Inputs & 32 Standard Outputs * (8 inputs, 8 outputs mounting option R)					L							
Ch1=1300nm multi-mode, Ch2=850nm multi-mode, 24 Inputs & 32 Standard Outputs * (8 inputs, 8 outputs mounting option R)					M							
Ch1=1300nm single-mode, Ch2=not fitted (2 Terminal only) 24 Inputs & 8 Standard + 12 High Break Outputs ***					N							
Ch1=1300nm single-mode, Ch2=1300nm single-mode + 24 Inputs & 8 Standard + 12 High Break Outputs ***					O							
Ch1=1300nm multi-mode, Ch2=not fitted (2 Terminal only) + 24 Inputs & 8 Standard + 12 High Break Outputs ***					P							
Ch1=1300nm multi-mode, Ch2=1300nm multi-mode + 24 Inputs & 8 Standard + 12 High Break Outputs ***					Q							
Ch1=1550nm single-mode, Ch2=850nm multi-mode, 24 Inputs & 32 Standard Outputs * (8 inputs, 8 outputs mounting option R)					R							
Ch1=850nm multi-mode, Ch2=850nm multi-mode, 24 Inputs & 16 Standard + 8 High Break Outputs **					S							
Ch1=1300nm single-mode, Ch2=not fitted (2 Terminal only), 24 Inputs & 16 Standard + 8 High Break Outputs **					T							
Ch1=1300nm single-mode, Ch2=1300nm single-mode, 24 Inputs & 16 Standard + 8 High Break Outputs **					U							
Ch1=1300nm multi-mode, Ch2=not fitted (2 Terminal only) 24 Inputs & 16 Standard + 8 High Break Outputs **					V							
Ch1=1300nm multi-mode, Ch2=1300nm multi-mode, 24 Inputs & 16 Standard + 8 High Break Outputs **					W							
Ch1=1550nm single-mode, Ch2=not fitted (2 Terminal only) 24 Inputs & 16 Standard + 8 High Break Outputs **					X							
Reserved - was used for RWE special					Y							
Ch1=1550nm single-mode, Ch2=1550nm single-mode, 24 Inputs & 16 Standard + 8 High Break Outputs **					Z							
Ch1=850nm multi-mode, Ch2=1300nm single-mode, 24 Inputs & 16 Standard + 8 High Break Outputs **					0							
Ch1=850nm multi-mode, Ch2=1300nm multi-mode, 24 Inputs & 16 Standard + 8 High Break Outputs **					1							
Ch1=850nm multi-mode, Ch2=1550nm single-mode, 24 Inputs & 16 Standard + 8 High Break Outputs **					2							
Ch1=1300nm single-mode, Ch2=850nm multi-mode, 24 Inputs & 16 Standard + 8 High Break Outputs **					3							
Ch1=1300nm multi-mode, Ch2=850nm multi-mode, 24 Inputs & 16 Standard + 8 High Break Outputs **					4							
Ch1 1550nm single-mode, Ch2 850nm multi-mode, 24 Inputs & 16 Standard + 8 High Break Outputs **					5							
Reserved for future single channel					6							
Reserved for future single channel					7							
Ch1=1550nm single-mode, Ch2=not fitted (2 Terminal only), 24 Inputs & 8 Standard + 12 High Break Outputs ***					8							
Ch1=1550nm single-mode, Ch2=1550nm single-mode, 24 Inputs & 8 Standard + 12 High Break Outputs ***					9							
* Only Available with Suffix G, J, K & M Relays												
** Only Available with Suffix K or M Relays												
*** Only on Suffix K or M relays with software versions 45/55 & later												
Protocol options	**Hardware Compatibilty**											
K-Bus	1, 2, 3, 4, C, E & F					1						
Modbus *	1, 2, 3, 4,					2						
IEC60870-5-103 (VDEW)	1, 2, 3, 4, C, E & F					3						
DNP3.0	1, 2, 3, 4, C, E & F					4						
UCA2 **	5 & 6					5						
IEC61850 + Courier via rear RS485 port ***	6, A, B,G, H, J, K, L, M, N, P					6						
IEC61850 + IEC60870-5-103 via rear RS485 port ***	6, A, B,G, H, J, K, L, M, N, P					7						
DNP3.0 Over Ethernet with Courier rear port K-Bus/RS485 protocol ****	6, A, B,G, H, J, K, L, M, N, P					8						
* Only on Suffix B, G or J Relays												
** Only on Suffix G or J Relays												
*** Only On Suffix K or M Relays												

**** Only available On Suffix K or M relays with software versions 44/54 & later					
Mounting					
Flush/Panel Mounting with Harsh Env.Coating, White Front Panel	M				
19" Rack Mounting with Harsh Env. Coating, White Front Panel	N				
40TE Case (9-2LE models only) Flush/Panel Mounting with Harsh Env. Coating, White Front Panel	R				
Flush/Panel Mounting with Harsh Env. Coating, with USB Port, Black and Silver Front Panel	S				
19" Rack Mounting with Harsh Env. Coating, with USB Port, Black and Silver Front Panel	T				
Flush/panel mounting with harsh environment coating	P				
Rack mounting with harsh environmental coating	Q				
40TE Case (9-2LE models only) Flush/Panel Mounting with Harsh Env. Coating, with USB Port, Black and Silver Front Panel	U				
Language					
English, French, German, Spanish		0			
English, French, German, Russian *		5			
English, Italian, Polish and Portuguese ***		7			
Chinese, English or French via HMI, with English or French only via Communications port **		C			
* Design Suffix G, J, K or M only					
** Design Suffix K or M & 42/52 software and later only					
*** Design Suffx M with 65/66/75/76/81/82 software					
Software version					
Without Distance			4/6/8*		
With Distance			5/7/8*		
Customer specific options					
Standard version				0	
Customer version				A	
Hardware version					
Phase 2 Enhanced Coprocessor, wide range opto					B
Enhanced Main Processor (CPU2) with hotkeys					G
As G plus dual characteristic optos					J
Extended main processor (XCPU2) With Function Keys & Tri-colour LEDs					K
Main processor (CPU3) 40TE					P
As K plus increased main processor memory (XCPU3), Cyber Security					M

Variants	Order Number
P645 Transformer Protection	P645 **
Vx Aux Rating :	
24 - 54Vdc	7
48 - 125Vdc (40 - 100Vac)	8
110 - 250 Vdc (100 - 240 Vac)	9
In/Vn Rating :	
HV-LV In = 1A/5A, Vn = (100/120V) (18CT/1VT) Standard CT	1
HV-LV In = 1A/5A, Vn = (100/120V) (18CT/4VT) Standard CT	2
HV-LV In = 1A/5A, Vn = (100/120V) (18CT/1VT) Sensitive CT	3
HV-LV In = 1A/5A, Vn = (100/120V) (18CT/4VT) Sensitive CT	4
IEC 61850-9-2LE Sampled Analogue Values Ethernet board *	C
* Only available with '12'/'20'/'22' Software on 80TE/40TE models	
Hardware Options :	
Standard : no options	1
IRIG-B (Modulated) only	2
IRIG-B (Modulated) & Fibre Optic Converter	4
Ethernet (100Mbit/s)	6
Second Rear Comms Port (Courier EIA232/EIA485/k-bus)	7
Second Rear Comms Port + IRIG-B (modulated) (Courier EIA232/EIA485/k-bus)	8
Ethernet (100Mbit/s) plus IRIG-B (Modulated)	A
Ethernet (100Mbit/s) plus IRIG-B (Un-modulated)	B
IRIG-B (Un-modulated)	C
Redundant Ethernet Self-Healing Ring, 2 multi-mode fibre ports + Un-modulated IRIG-B	H
Redundant Ethernet RSTP, 2 multi-mode fibre ports + Modulated IRIG-B	J
Redundant Ethernet RSTP, 2 multi-mode fibre ports + Un-modulated IRIG-B	K
Redundant Ethernet Dual-Homing Star, 2 multi-mode fibre ports + Un-modulated IRIG-B	M
Redundant Ethernet PRP/HSR, 2 fibre ports + Modulated IRIG-B	N
Redundant Ethernet PRP/HSR, 2 fibre ports + Unmodulated IRIG-B	P
Redundant Ethernet PRP/HSR/RSTP/Failover, 2 multi-mode fibre ports + Modulated/Un-Modulated IRIG-B	R
Redundant Ethernet PRP/HSR/RSTP/Failover, 2 copper ports RJ45 + Modulated/Un-Modulated IRIG-B	S
Redundant Ethernet PRP/HSR/RSTP/Failover, 1 copper port RJ45 + 1 multi-mode fibre port + Modulated/Un-Modulated IRIG-B	T
Product Specific Options :	
Size 12 (60TE) case, 16 optos + 16 relays	A
Size 12 (60TE) case, 16 optos + 16 relays + RTD	B
Size 12 (60TE) case, 16 optos + 16 relays + CLIO (mA I/O)	C
Size 12 (60TE) case, 24 optos + 16 relays	D
Size 12 (60TE) case, 16 optos + 24 relays	E
Size 16 (80TE) case, 24 optos + 24 relays or Size 8 (40TE) 8 optos 8 relays Mounting Opt **R**	F
Size 16 (80TE) case, 24 optos + 24 relays + RTD	G
Size 16 (80TE) case, 24 optos + 24 relays + CLIO (mA I/O)	H
Size 16 (80TE) case, 24 optos + 24 relays + RTD + CLIO (mA I/O)	J
Size 12 (60TE) case, 16 optos + 20 relays (including 4 high break)	K
Size 16 (80TE) case, 24 optos + 20 relays (including 4 high break)	L
Size 16 (80TE) case, 24 optos + 20 relays (including 4 high break) + RTD	M
Size 16 (80TE) case, 24 optos + 20 relays (including 4 high break) + CLIO (mA I/O)	N
Size 16 (80TE) case, 24 optos + 20 relays (including 4 high break) + RTD + CLIO (mA I/O)	P
Size 16 (80TE) case, 16 optos + 24 relays (including 8 high break)	Q
Size 16 (80TE) case, 16 optos + 24 relays (including 8 high break) + RTD	R
Size 16 (80TE) case, 16 optos + 24 relays (including 8 high break) + CLIO (mA I/O)	S
Size 16 (80TE) case, 16 optos + 24 relays (including 8 high break) + RTD + CLIO (mA I/O)	T
Size 16 (80TE) case, 40 optos + 24 relays	U
Size 16 (80TE) case, 40 optos + 16 relays + RTD	V
Size 16 (80TE) case, 40 optos + 16 relays + CLIO (mA I/O)	W
Size 16 (80TE) case, 40 optos + 8 relays + RTD + CLIO (mA I/O)	X
Size 16 (80TE) case, 40 optos + 20 relays (including 4 High Break)	Y
Size 16 (80TE) case, 40 optos + 12 relays (including 4 High Break) + RTD	Z
Size 16 (80TE) case, 40 optos + 12 relays (including 4 High Break) + CLIO (mA I/O)	1
Protocol Options :	
K-Bus/Courier	1
Modbus	2
IEC60870-5-103	3
DNP3.0	4
IEC 61850 over Ethernet and Courier via rear K-Bus/RS485	6
IEC61850 over ethernet with CS103 rear port RS485 protocol **	7
DNP3.0 over Ethernet and Courier via rear K-Bus/RS485	8
** 91 Software only	
Mounting Options :	
Flush/Panel Mounting with Harsh Env.Coating, White Front Panel	M
19" Rack Mounting with Harsh Env. Coating, White Front Panel	N
40TE Case (9-2LE models only) Flush/Panel Mounting with Harsh Env. Coating, White Front Panel	R
Flush/Panel Mounting with Harsh Env. Coating, with USB Port, Black and Silver Front Panel	S
19" Rack Mounting with Harsh Env. Coating, with USB Port, Black and Silver Front Panel	T
40TE Case (9-2LE models only) Flush/Panel Mounting with Harsh Env. Coating, with USB Port, Black and Silver Front Panel	U
Language Options :	
English, French, German, Spanish	0
English, French, German, Russian	5
Chinese, English or French via HMI, with English or French only via Communications port	C
Software Version Options :	
Unless specified the latest version will be delivered	**
Settings Files Options :	
Default	0
Customer Specific	A
Design Suffix :	
Factory determined	

Variants	Order Number
Busbar Protection Peripheral Unit (60TE)	**P743**
Vx Aux Rating	
48 - 125Vdc (40 - 100Vac)	8
110 - 250Vdc (100 - 240Vac)	9
Hardware Options	
Without CT Input	0
With In = 1/5A CT Input	1
IEC 61850-9-2LE Sampled Analogue Values Ethernet board *	C
Hardware Options	
Standard - None	1
Ethernet (100 Mbits/s) without IRIG-B	6
2nd Rear Port & InterMiCOM & IRIG-B (Modulated)	E
Redundant Ethernet Self-Healing Ring, 2 multi-mode fibre ports + Un-modulated IRIG-B	H
Redundant Ethernet RSTP, 2 multi-mode fibre ports + Modulated IRIG-B	J
Redundant Ethernet RSTP, 2 multi-mode fibre ports + Un-modulated IRIG-B	K
Redundant Ethernet Dual-Homing Star, 2 multi-mode fibre ports + Un-modulated IRIG-B	M
Redundant Ethernet PRP/HSR, 2 fibre ports + Modulated IRIG-B	N
Redundant Ethernet PRP/HSR, 2 fibre ports + Unmodulated IRIG-B	P
Redundant Ethernet PRP/HSR/RSTP/Failover, 2 multi-mode fibre ports + Modulated/Un-Modulated IRIG-B	R
Redundant Ethernet PRP/HSR/RSTP/Failover, 2 copper ports RJ45 + Modulated/Un-Modulated IRIG-B	S
Redundant Ethernet PRP/HSR/RSTP/Failover, 1 copper port RJ45 + 1 multi-mode fibre port + Modulated/Un-Modulated IRIG-B	T
Product Specific	
16 Relays Outputs and 24 Status Inputs **	A
16 Relays Outputs, 4 High Break and 16 Status Inputs	B
8 Relays Outputs, 4 High Break and 24 Status Inputs	C
8 Relays Outputs, 8 High Break and 16 Status Inputs	D
Protocol Options	
K-Bus/Courier	1
IEC60870-5-103 (Via KITZ274)	
Courier (K-Bus), IEC60870-5-103 via KITZ274 (Supplied as Courier. KITZ274 to be ordered)	6
Additional IEC61850	
Mounting	
Flush/Panel Mounting with Harsh Env.Coating, White Front Panel	M
Flush/Panel Mounting with Harsh Env. Coating, with USB Port, Black and Silver Front Panel	S
Language	
Multilingual - English, French, German, Spanish	0
Multilingual - English, French, German, Russian	5
Software Issue	
Unless specified the latest version will be delivered	**
Customisation	
Default	0
Customer specific	A
Central Networks Version	5
Design Suffix	

Variants	Order Number
P746 Busbar Protection Relay	**P746**
Vx Aux Rating :	
24 - 54Vdc	7
48 - 125Vdc (40 - 100Vac)	8
110 - 250 Vdc (100 - 240 Vac)	9
In/Vn Rating :	
CT1 - CT18 In = 1A/5A, Vn = (100/120V) (18CT/3VT)	1
CT1 - CT18 In = 1A/5A, Vn = (380/480V) (18CT/3VT)	2
IEC 61850-9-2LE Sampled Analogue Values Ethernet board *	C
* Only available with '12' Software	
Hardware Options :	
Standard : no options	1
IRIG-B (Modulated) only	2
IRIG-B (Modulated) & Fibre Optic Converter	4
Ethernet (100Mbit/s)	6
2nd Rear Comms port	7
2nd Rear comms port + IRIG-B (Modulated)	8
Ethernet (100Mbit/s) plus IRIG-B (Modulated)	A
Ethernet (100Mbit/s) plus IRIG-B (Un-modulated)	B
IRIG-B (Un-modulated)	C
Redundant Ethernet Self-Healing Ring, 2 multi-mode fibre ports + Un-modulated IRIG-B	H
Redundant Ethernet RSTP, 2 multi-mode fibre ports + Modulated IRIG-B	J
Redundant Ethernet RSTP, 2 multi-mode fibre ports + Un-modulated IRIG-B	K
Redundant Ethernet Dual-Homing Star, 2 multi-mode fibre ports + Un-modulated IRIG-B	M
Redundant Ethernet PRP/HSR, 2 fibre ports + Modulated IRIG-B	N
Redundant Ethernet PRP/HSR, 2 fibre ports + Unmodulated IRIG-B	P
Redundant Ethernet PRP/HSR/RSTP/Failover, 2 multi-mode fibre ports + Modulated/Un-Modulated IRIG-B	R
Redundant Ethernet PRP/HSR/RSTP/Failover, 2 coper ports RJ45 + Modulated/Un-Modulated IRIG-B	S
Single Ethernet PRP/HSR/RSTP/Failover, 1 multi-mode fibre port & 1 coper port RJ45 + Modulated/Un-Modulated IRIG-B	T
Product Specific Options :	
Size 16 Case, 16 optos + 16 Relays	A
Size 16 Case, 16 optos + 8 Relays + 8 High Break Relays	B
Size 16 Case, 16 optos + 32 Relays	C
Size 16 Case, 16 optos + 24 Relays + 4 High Break Relays	D
Size 16 Case, 24 optos + 24 Relays	E
Size 16 Case, 24 optos + 16 Relays + 8 High Break Relays	F
Size 16 Case, 24 optos + 8 Relays + 12 High Break Relays	G
Size 16 Case, 32 optos + 24 Relays	H
Size 16 Case, 32 optos + 16 Relays + 8 High Break Relays	J
Size 16 Case, 40 optos + 24 Relays	K
Size 16 Case, 32 optos + 32 Relays	L
Protocol Options :	
K-Bus/Courier	1
Modbus	2
IEC60870-5-103	3
DNP3.0	4
IEC 61850 over Ethernet and Courier via rear K-Bus/RS485	6
IEC61850 over ethernet with CS103 rear port RS485 protocol **	7
DNP3.0 over Ethernet with Courier rear port K-Bus/RS485	8
** Available with Hardware options R, S, T	
Mounting Options :	
Flush/Panel Mounting with Harsh Env.Coating, White Front Panel	M
19" Rack Mounting with Harsh Env. Coating, White Front Panel	N
Flush/Panel Mounting with Harsh Env. Coating, with USB Port, Black and Silver Front Panel	S
19" Rack Mounting with Harsh Env. Coating, with USB Port, Black and Silver Front Panel	T
Panel Mounting, with harsh environment coating	P
Rack Mounting, with harsh environment coating	Q
Language Options :	
English, French, German, Spanish	0
English, French, German, Russian	5
Chinese, English or French via HMI, with English or French only via Communications port	C
Software Version Options :	
Unless specified the latest version will be delivered	**
Settings Files Options :	
Default	0
Customer Specific	A
Design Suffix :	
Factory Determined	

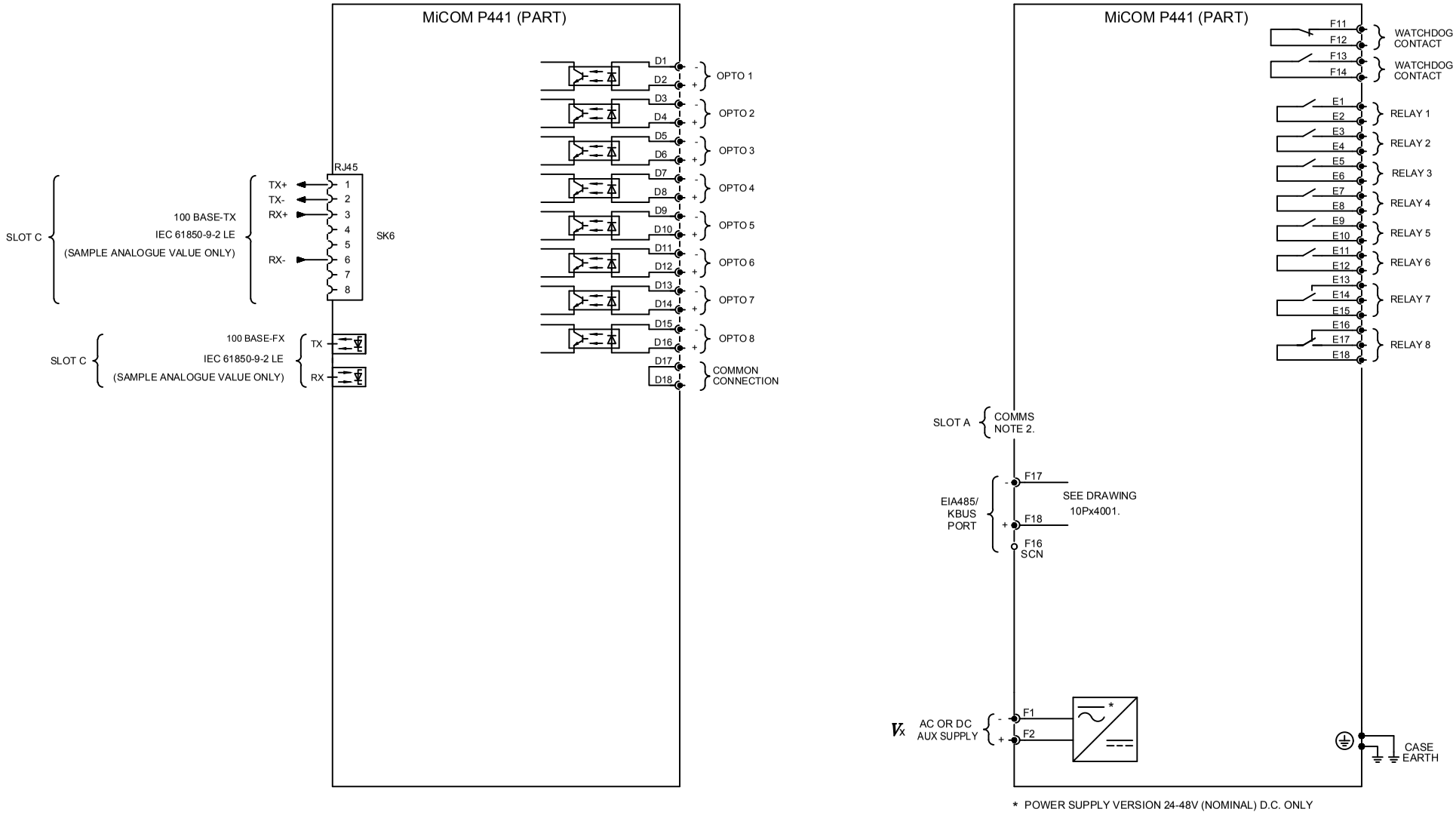
Variants Order No.												
Multi-functional line terminal IED	**P841**								**			
Nominal auxiliary voltage												
24-54 Vdc		7										
48-125 Vdc (40-100 Vac)		8										
110-250 Vdc (100-240 Vac)		9										
In/Vn rating + Main Functionality												
Model A: Autoreclose for one CB (60TE) Dual rated CT(1/5A :100-120V)			1									
Model B: Autoreclose for one/two CB (80TE) Dual rated CT(1/5A :100-120V)			3									
Model B: Autoreclose for one/two CB (80TE) With Ed.1 & IEC 61850-9-2LE Sampled Analog. Values Ethernet board *			C									
Model B: Autoreclose for one/two CB (40TE) With Ed.2 & IEC 61850-9-2LE Sampled Analog. Values Ethernet board **												
* Only available with '74' Software ** Only available with '80' Software												
Hardware options	**Protocol**											
Nothing	1, 3 & 4		1									
IRIG-B Only (Modulated)	1, 3 & 4		2									
IRIG-B (Modulated) & Fibre Optic Converter	1, 3 & 4		4									
Ethernet (100Mbit/s)	6, 7 & 8		6									
Second Rear Comms	1, 3 & 4		7									
IRIG-B (Modulated) + Second Rear Comms	1, 3 & 4		8									
Ethernet (100Mbit/s) plus IRIG-B (Modulated)	6, 7 & 8		A									
Ethernet (100Mbit/s) plus IRIG-B (Un-modulated)	6, 7 & 8		B									
IRIG-B (Un-modulated)	1, 3 & 4		C									
InterMiCOM + Courier Rear Port *	1, 3 & 4		E									
InterMiCOM + Courier Rear Port + IRIG-B modulated *	1, 3 & 4		F									
Redundant Ethernet Self-Healing Ring, 2 multi-mode fibre ports + Un-modulated IRIG-B	6, 7 & 8		H									
Redundant Ethernet RSTP, 2 multi-mode fibre ports + Modulated IRIG-B	6, 7 & 8		J									
Redundant Ethernet RSTP, 2 multi-mode fibre ports + Un-modulated IRIG-B	6, 7 & 8		K									
Redundant Ethernet Dual-Homing Star, 2 multi-mode fibre ports + Un-modulated IRIG-B	6, 7 & 8		M									
Redundant Ethernet PRP/HSR, 2 fibre ports + Modulated IRIG-B	6, 7 & 8		N									
Redundant Ethernet PRP/HSR, 2 fibre ports + Unmodulated IRIG-B	6, 7 & 8		P									
Redundant Ethernet PRP/HSR/RSTP/Failover, 2 multi-mode fibre ports + Modulated/Un-Modulated IRIG-B	6, 7 & 8		R									
Redundant Ethernet PRP/HSR/RSTP/Failover, 2 copper ports RJ45 + Modulated/Un-Modulated IRIG-B	6, 7 & 8		S									
Redundant Ethernet PRP/HSR/RSTP/Failover, 1 copper port RJ45 + 1 multi-mode fibre port + Modulated/Un-Modulated IRIG-B	6, 7 & 8		T									
* Only with 47/ 57 Software & later, replaces hardware options '7' & '8'												
** For HSR – contact GE for details												
Product Options												
16 Inputs & 14 Standard Outputs (60TE only)				A								
16 Inputs & 7 Standard + 4 High Break Outputs (60TE only)				B								
24 Inputs & 32 Standard Outputs (80TE) 8 inputs, 8 outputs mounting option 'R' (40TE)				C								
24 Inputs & 16 Standard + 8 High Break Outputs (80TE only)				D								
24 Inputs & 8 Standard + 12 High Break Outputs (80TE only)				E								
Protocol options	**Hardware Compatibilty**											
K-Bus	1, 2, 3, 4, C, E & F				1							
IEC60870-5-103	1, 2, 3, 4, C, E & F				3							
DNP3.0	1, 2, 3, 4, C, E & F				4							
IEC61850 + Courier via rear RS485 port	6, A, B, G, H, J, K, L, M, N, P				6							
IEC61850+IEC60870-5-103 via rear RS485 port	6, A, B, G, H, J, K, L, M, N, P				7							
DNP3.0 Over Ethernet with Courier rear port K-Bus/RS485 protocol	6, A, B, G, H, J, K, L, M, N, P				8							
Mounting												
Flush/Panel Mounting with Harsh Env.Coating, White Front Panel						M						
19" Rack Mounting with Harsh Env. Coating, White Front Panel						N						
40TE Case (9-2LE models only) Flush/Panel Mounting with Harsh Env. Coating, White Front Panel						R						
Flush/Panel Mounting with Harsh Env. Coating, with USB Port, Black and Silver Front Panel						S						
19" Rack Mounting with Harsh Env. Coating, with USB Port, Black and Silver Front Panel						T						
40TE Case (9-2LE models only) Flush/Panel Mounting with Harsh Env. Coating, with USB Port, Black and Silver Front Panel						U						
						Q						
						U						
Language												
English, French, German, Spanish							0					
English, French, German, Italian (Not yet available!)							4					
English, French, German, Russian							5					
English, Italian, Polish and Portuguese							7					
Chinese, English or French via HMI, with English or French only via Communications port							C					
Software version												
Autoreclose for single Circuit Breaker (60TE)								4/6/8*				
Autoreclose for two Circuit breakers (80TE)								5/7/8*				
Customer specific options												
Standard version									0			
Customer version									A			
Hardware version												
Extended main processor (XCPU2) With Function Keys & Tri-colour LEDs												K
Main processor (CPU3) 40TE												P
As K plus increased main processor memory (XCPU3), Cyber Security												M

APPENDIX B

WIRING DIAGRAMS

MODEL	CORTEC OPTION*	EXTERNAL CONNECTION DIAGRAM TITLE	DRAWING-SHEET	ISSUE
All		COMMS OPTIONS MICOM Px40 PLATFORM	10Px4001-1	K
P441	I/O Option C	DISTANCE PROTECTION 40TE WITH NCIT 8 OPTO INPUTS & 8 RELAY OUTPUTS	10P44102-1	D
P442	I/O Option E	DISTANCE PROTECTION 60TE WITH NCIT 16 INPUTS, 21 STANDARD RELAYS (6 OPTIONAL FAST TRIP)	10P44204-1	D
P444	I/O Option J	COMMS OPTION P444 MICOM PX40 PLATFORM NCIT	10P44404-1	E
	I/O Option C	DISTANCE WITH NCIT 80TE 24 OPTOS 34 RELAYS (12 HIGH BREAK)	10P44406-1	E
	I/O Option R	DISTANCE PROTECTION 40TE WITH 8 OPTO INPUTS & 8 RELAY OUTPUTS	10P44407-1	C
P446	I/O Option 4	DISTANCE 40TE WITH NCIT 8 OPTO INPUTS, 8 RELAY OUTPUTS	10P44607-1	E
	I/O Option 4	DISTANCE 40TE WITH NCIT 8 OPTO INPUTS & 8 RELAY OUTPUTS	10P44607-2	D
P546	I/O Option 4	CURRENT DIFFERENTIAL 40TE WITH NCIT 8 OPTO INPUTS, 8 RELAY OUTPUTS	10P54610-1	E
	I/O Option 4	CURRENT DIFFERENTIAL RELAY 40TE WITH NCIT 8 OPTO INPUTS & 8 RELAY OUTPUTS	10P54610-2	D
P645	I/O Option F	5 BIAS INPUT TRANSFORMER DIFFERENTIAL SAMPLE ANALOGUE VALUE 8 INPUTS & 8 OUTPUTS WITH NCIT	10P64521-1	F
P743	I/O Option A	BUSBAR PROTECTION PERIPHERAL UNIT P743 (60TE) WITH NCIT	10P74307-1	D
	I/O Option B	BUSBAR PROTECTION PERIPHERAL UNIT P743 (60TE) WITH NCIT	10P74308-1	D
	I/O Option C	BUSBAR PROTECTION PERIPHERAL UNIT P743 (60TE) WITH NCIT	10P74309-1	D
	I/O Option D	BUSBAR PROTECTION PERIPHERAL UNIT P743 (60TE) WITH NCIT	10P74310-1	D
P746	I/O Option A	BUSBAR PROTECTION (80TE) WITH 16 I/P & 16 O/P NCIT	10P74612-1	E
	I/O Option D	BUSBAR PROTECTION (80TE) WITH 16 I/P & 28 O/P (4 O/P ARE HIGH BREAK) NCIT	10P74615-1	E
	I/O Option E	BUSBAR PROTECTION (80TE) WITH 24 I/P & 24 O/P NCIT	10P74616-1	E
	I/O Option F	BUSBAR PROTECTION (80TE) WITH 24 I/P & 24 O/P (8 O/P ARE HIGH BREAK) NCIT	10P74617-1	E
	I/O Option G	BUSBAR PROTECTION WITH 24 I/P & 20 O/P (12 O/P ARE HIGH BREAK) NCIT	10P74618-1	E
	I/O Option H	BUSBAR PROTECTION (80TE) WITH 32 I/P & 24 O/P NCIT	10P74619-1	E
	I/O Option J	BUSBAR PROTECTION (80TE) WITH 32 I/P & 24 O/P (8 O/P ARE HIGH BREAK) NCIT	10P74620-1	E
	I/O Option K	BUSBAR PROTECTION (80TE) WITH 40 I/P & 24 O/P NCIT	10P74621-1	E
	I/O Option L	BUSBAR PROTECTION (80TE) WITH 32 I/P & 32 O/P NCIT	10P74622-1	E
	I/O Option C	BUSBAR PROTECTION (80TE) WITH 16 I/P & 32 O/P WITH NCIT	10P74614-1	E
P841	I/O Option C	AUTORECLOSE 80TE WITH NCIT 24 INPUTS AND 32 OUTPUTS	10P84106-1	E
	I/O Option C	AUTORECLOSE 80TE WITH NCIT 24 INPUTS AND 32 OUTPUTS	10P84106-2	C
	I/O Option D	AUTORECLOSE 80TE WITH NCIT 24 INPUTS, 16 STANDARD RELAYS & 8 HIGH BREAK RELAYS	10P84107-1	E
	I/O Option D	AUTORECLOSE 80TE WITH NCIT 24 INPUTS, 16 STANDARD RELAYS & 8 HIGH BREAK RELAYS	10P84107-2	C
	I/O Option E	AUTORECLOSE 80TE WITH NCIT 24 INPUTS, 8 STANDARD RELAYS & 12 HIGH BREAK RELAYS	10P84108-1	E
	I/O Option E	AUTORECLOSE 80TE WITH NCIT 24 INPUTS, 8 STANDARD RELAYS & 12 HIGH BREAK RELAYS	10P84108-2	C
	I/O Option C	AUTORECLOSE 40TE WITH NCIT 8 OPTO INPUTS, 8 RELAY OUTPUTS	10P84111-1	E
	I/O Option C	AUTORECLOSE 40TE WITH NCIT 8 OPTO INPUTS, 8 RELAY OUTPUTS	10P84111-2	D

* When selecting applicable connection diagram(s), it may be helpful to reference the appropriate model's CORTEC.



NOTES .

1. PIN TERMINAL (P.C.B. TYPE)
2. FOR COMMS OPTIONS SEE DRAWING 10Px4001

Issue: E	Revision: CID006234 Outlines updated to GE Format		Title: EXT CONNECTION DIAG DISTANCE PROTECTION 40TE WITH NCIT 8 OPTO INPUTS & 8 RELAY OUTPUTS		
Date: 4/30/2020	Name: S.J.BURTON		Drg No: 10P44102	Sht: 1	©UK Grid Solutions Ltd St Leonards Building Harry Kerr Drive, Stafford. ST16 1WT, UK
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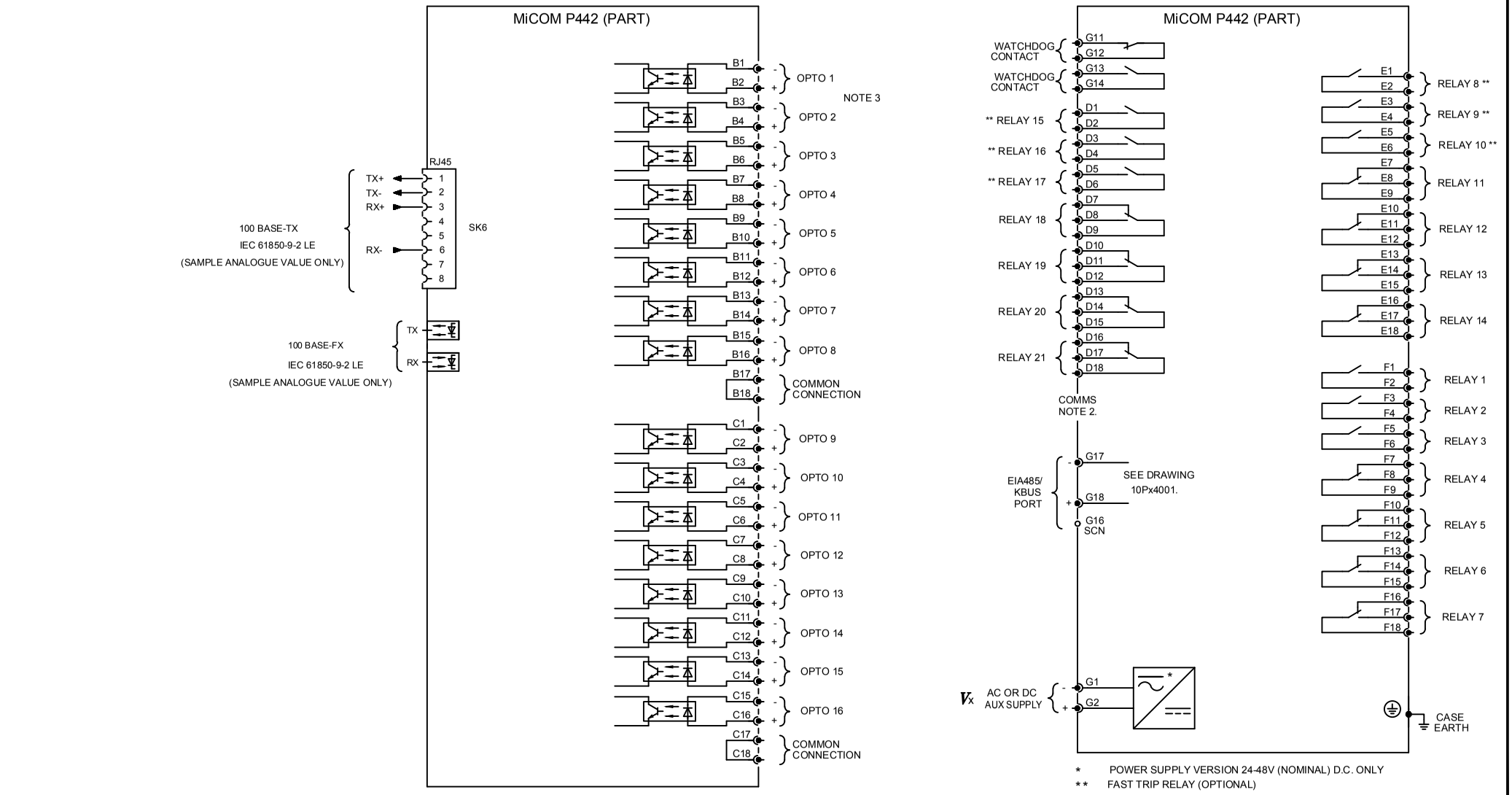

NOTES .

1. PIN TERMINAL (P.C.B. TYPE)
2. FOR COMMS OPTIONS SEE DRAWING 10Px4001
3. OPTO INPUTS 1 & 2 MUST BE USED FOR SETTING GROUP CHANGES IF THIS OPTION IS SELECTED IN THE RELAY MENU.

Issue: D	Revision: CID006234 Outlines updated to GE Format		Title: EXTERNAL CONNECTION DIAG DIST. PROT'N 60TE WITH NCIT 16 INPUTS, 21 STANDARD RELAYS (6 OPTIONAL FAST TRIP)	
Date: 4/30/2020	Name: S.J.BURTON		Drg No: 10P44204	Sht: 1
Date:	Chkd:			Next Sht: 2

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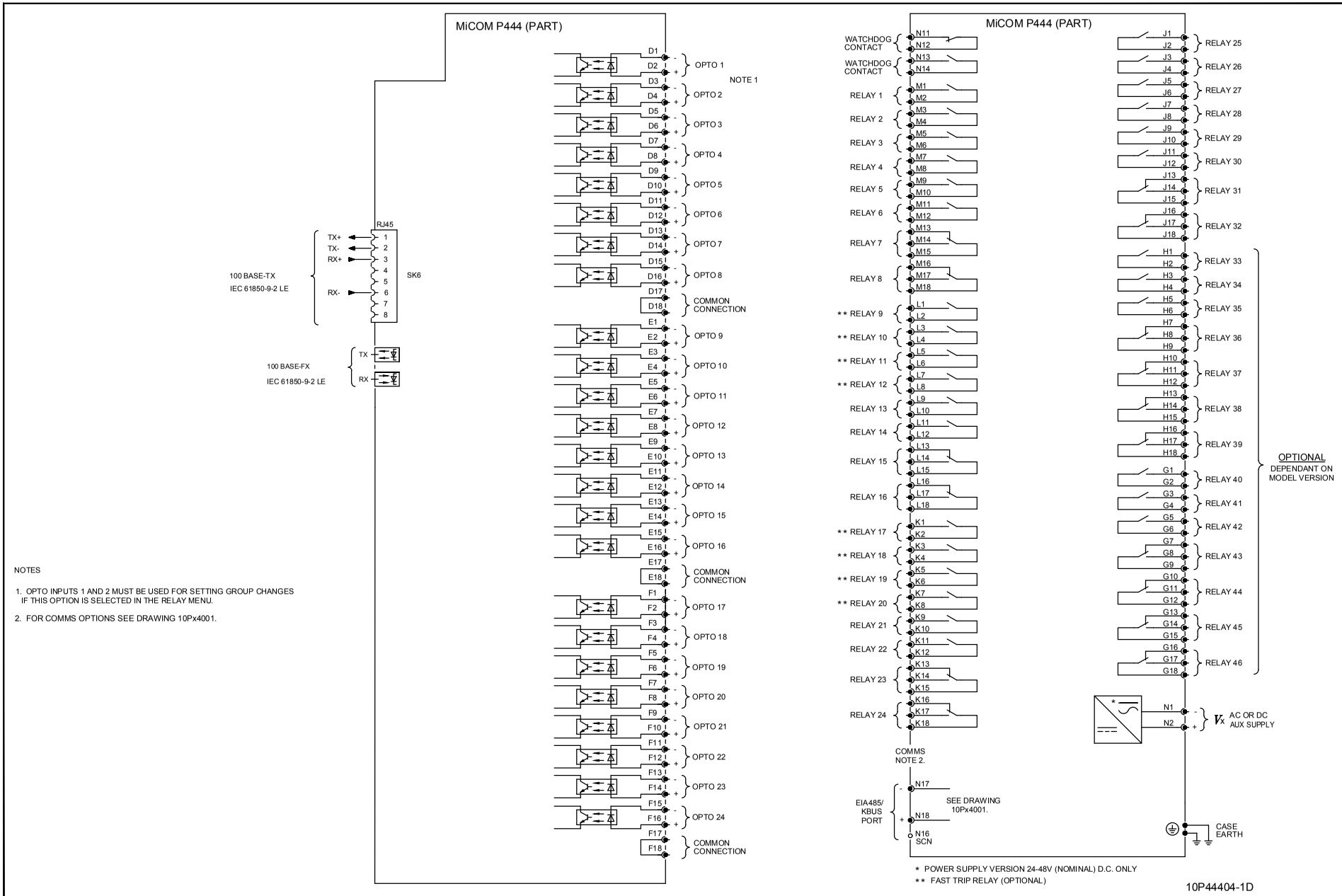
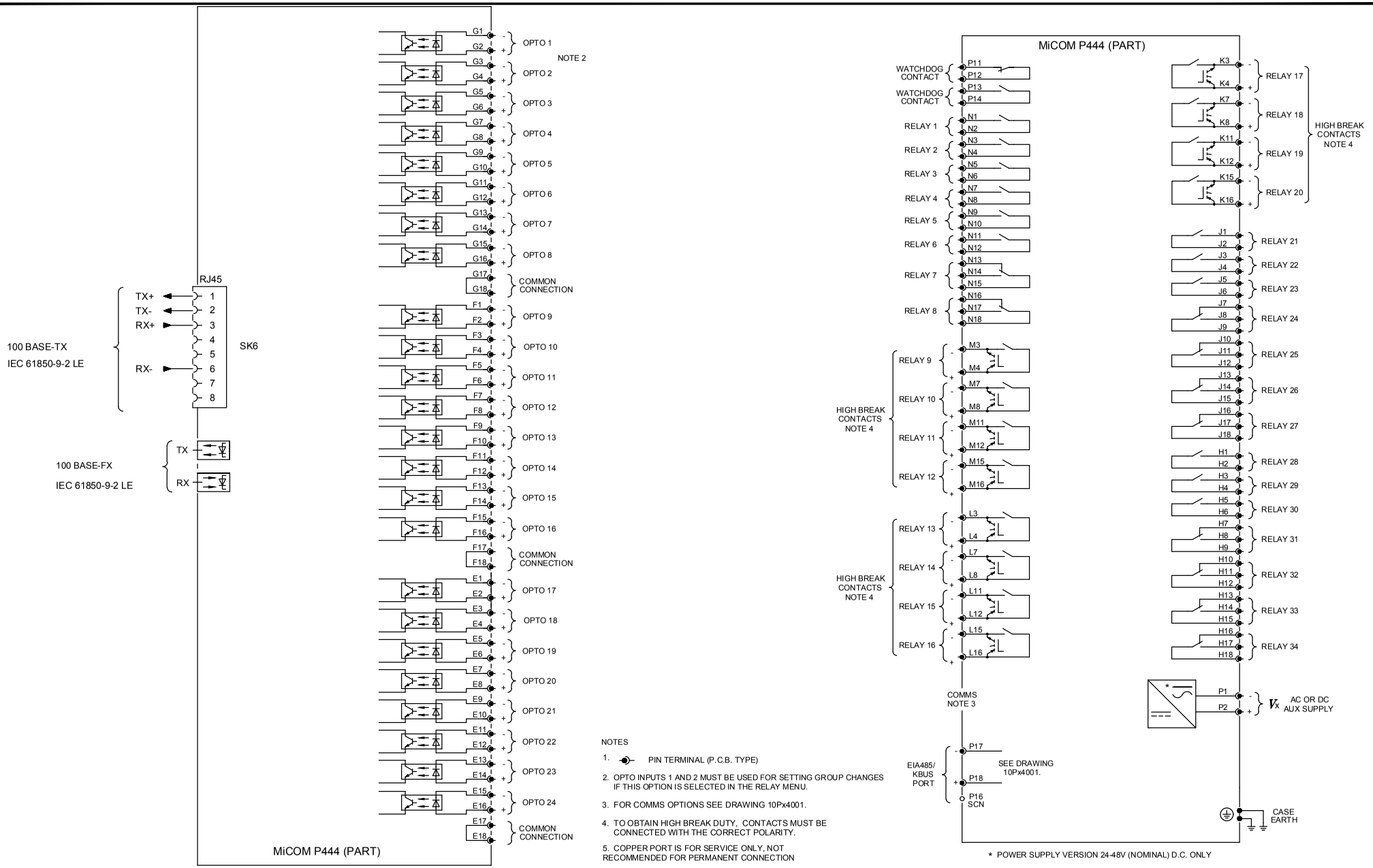


NOTES

1. OPTO INPUTS 1 AND 2 MUST BE USED FOR SETTING GROUP CHANGES IF THIS OPTION IS SELECTED IN THE RELAY MENU.
2. FOR COMMS OPTIONS SEE DRAWING 10Px4001.

Issue: E	Revision: CID006234 Outlines updated to GE Format		Title: EXTERNAL CONNECTION DIAGRAM: COMMS OPTION P444 MICOM PX40 PLATFORM NCIT		
Date: 4/30/2020	Name: S.J.BURTON		Drg No: 10P44404	Sht: 1	© UK Grid Solutions Ltd St Leonards Building Harry Kerr Drive, Stafford. ST16 1WT, UK
Date:	Chkd:			Next Sht: -	



NOTES

1. PIN TERMINAL (P.C.B. TYPE)
2. OPTO INPUTS 1 AND 2 MUST BE USED FOR SETTING GROUP CHANGES IF THIS OPTION IS SELECTED IN THE RELAY MENU.
3. FOR COMMS OPTIONS SEE DRAWING 10Px4001.
4. TO OBTAIN HIGH BREAK DUTY, CONTACTS MUST BE CONNECTED WITH THE CORRECT POLARITY.
5. COPPER PORT IS FOR SERVICE ONLY, NOT RECOMMENDED FOR PERMANENT CONNECTION

Issue: E	Revision: CID006234 Outlines updated to GE Format		Title: EXT. CONNECTION DIAGRAM P444 DISTANCE WITH NCIT 80TE 24 OPTOS 34 RELAYS (12 HIGH BREAK)	
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Date: 07/05/2012	Chkd: N.ROBINSON			Next Sht: -

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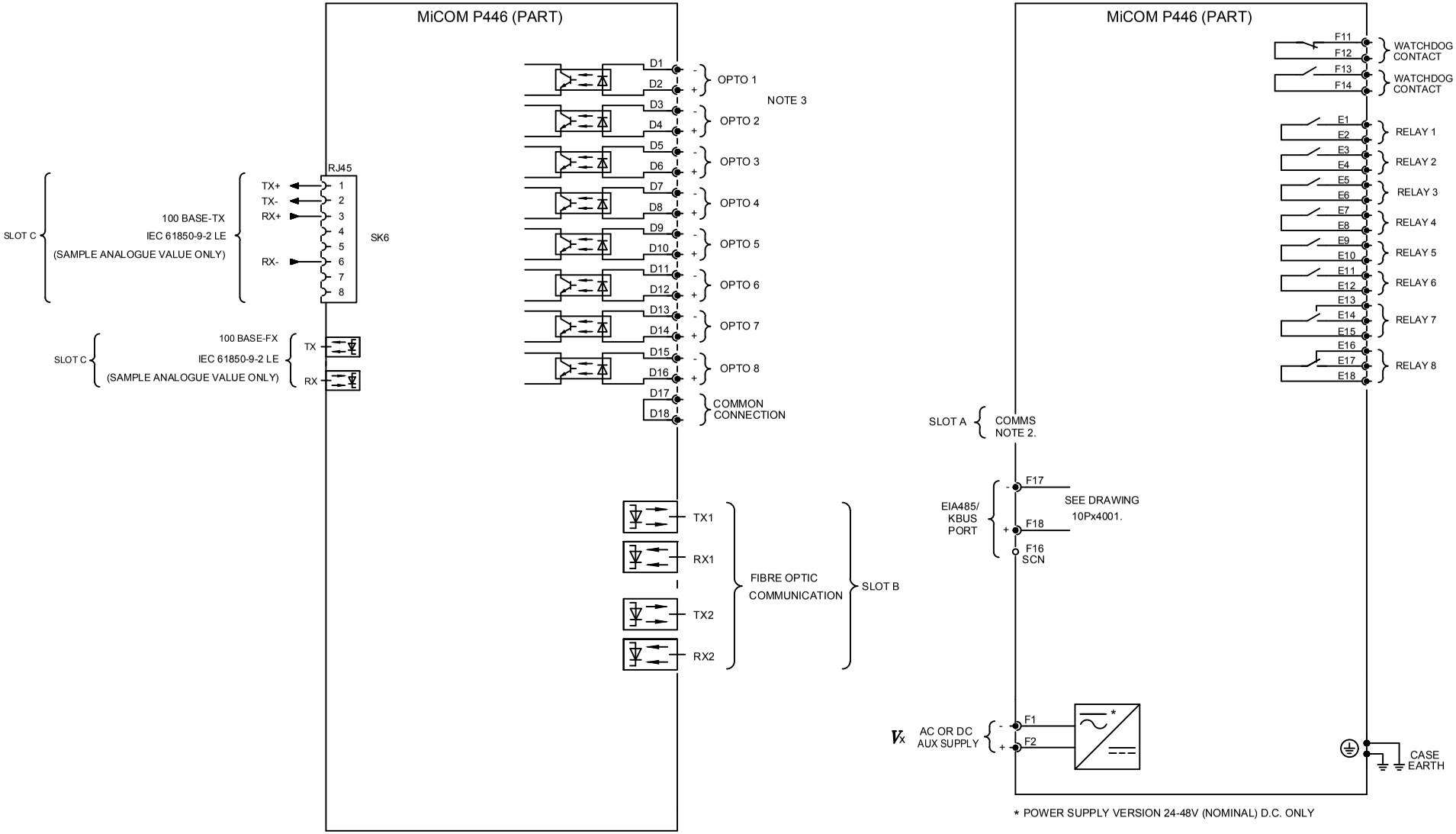

NOTES .

1. PIN TERMINAL (P.C.B. TYPE)
2. FOR COMMS OPTIONS SEE DRAWING 10Px4001

Issue: E	Revision: CID006234 Outlines updated to GE Format		Title: EXT CONN DIAG - DISTANCE 40TE WITH NCIT 8 OPTO INPUTS, 8 RELAY OUTPUTS		
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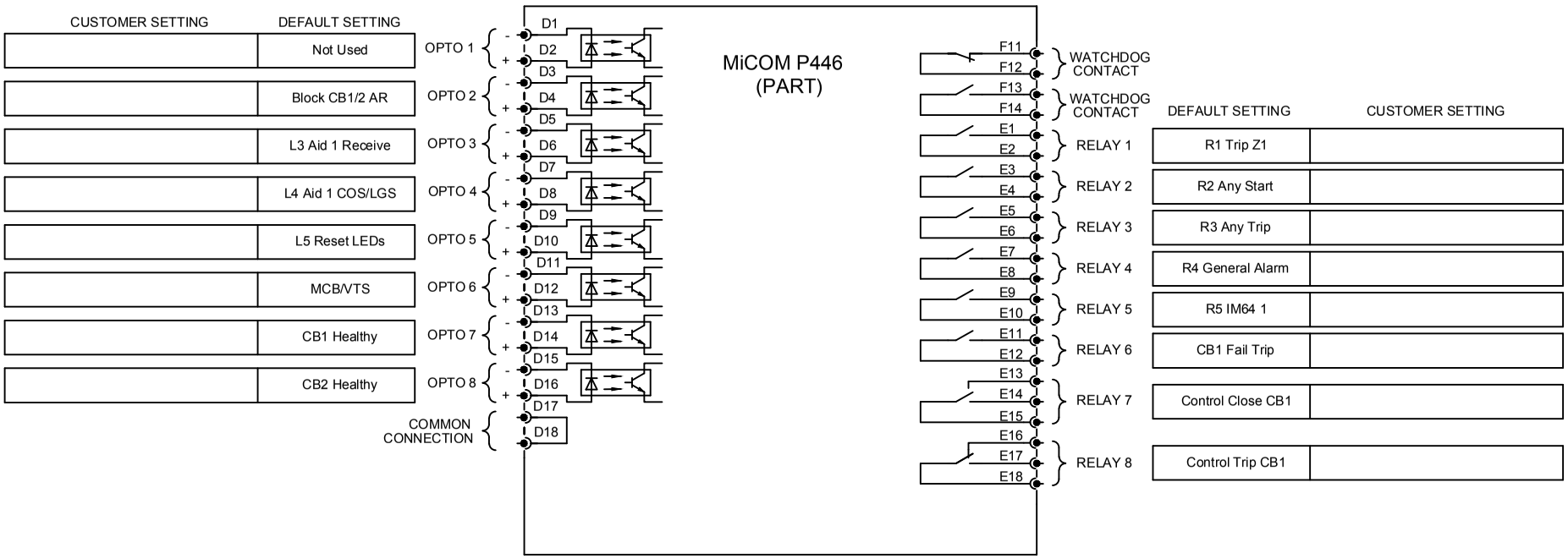
Date:	Chkd:				



Issue: D	Revision: CID006234 Outlines updated to GE Format		Title: EXT CONN DIAG DISTANCE 40TE WITH NCIT 8 OPTO INPUTS & 8 RELAY OUTPUTS		
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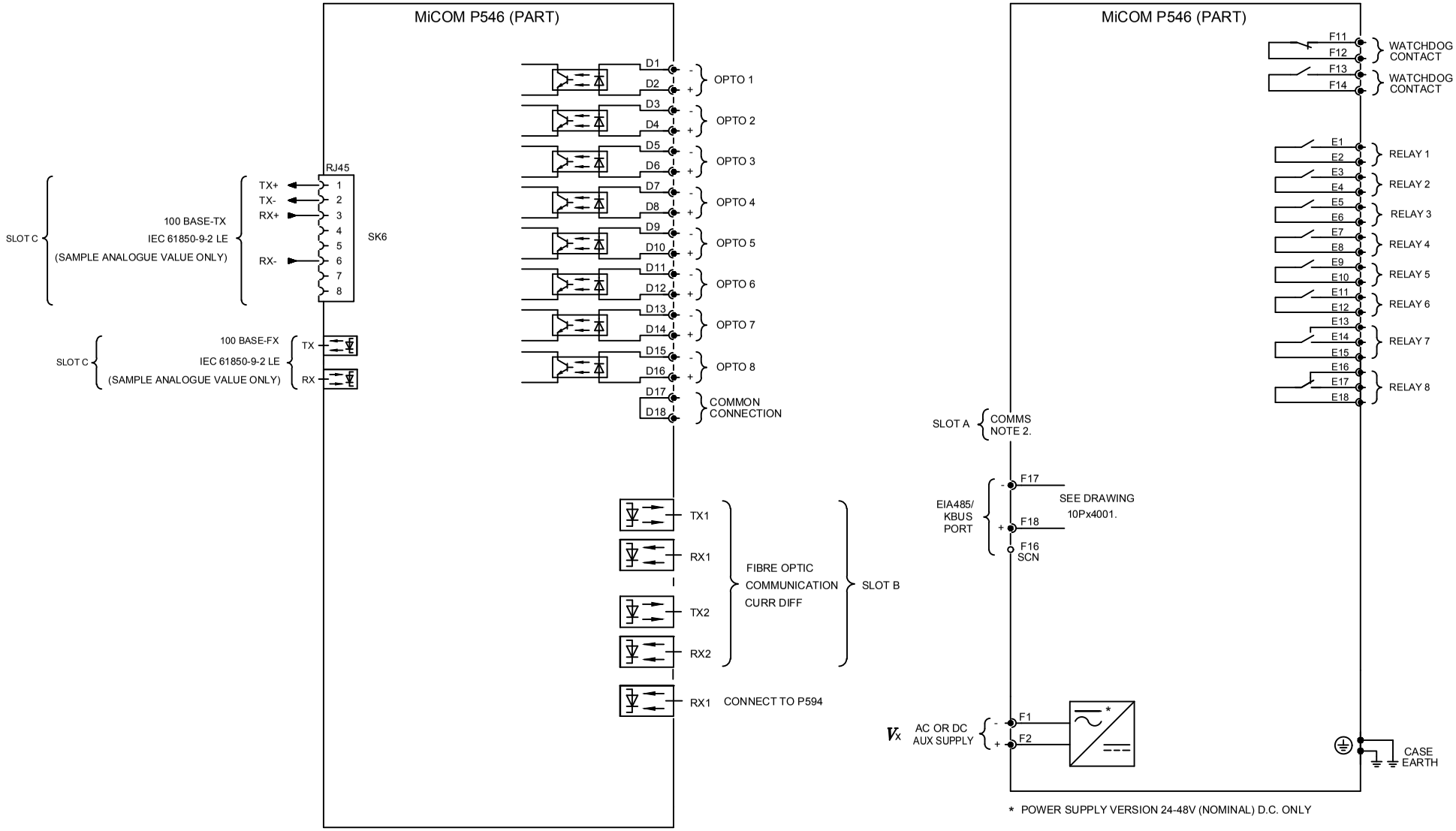
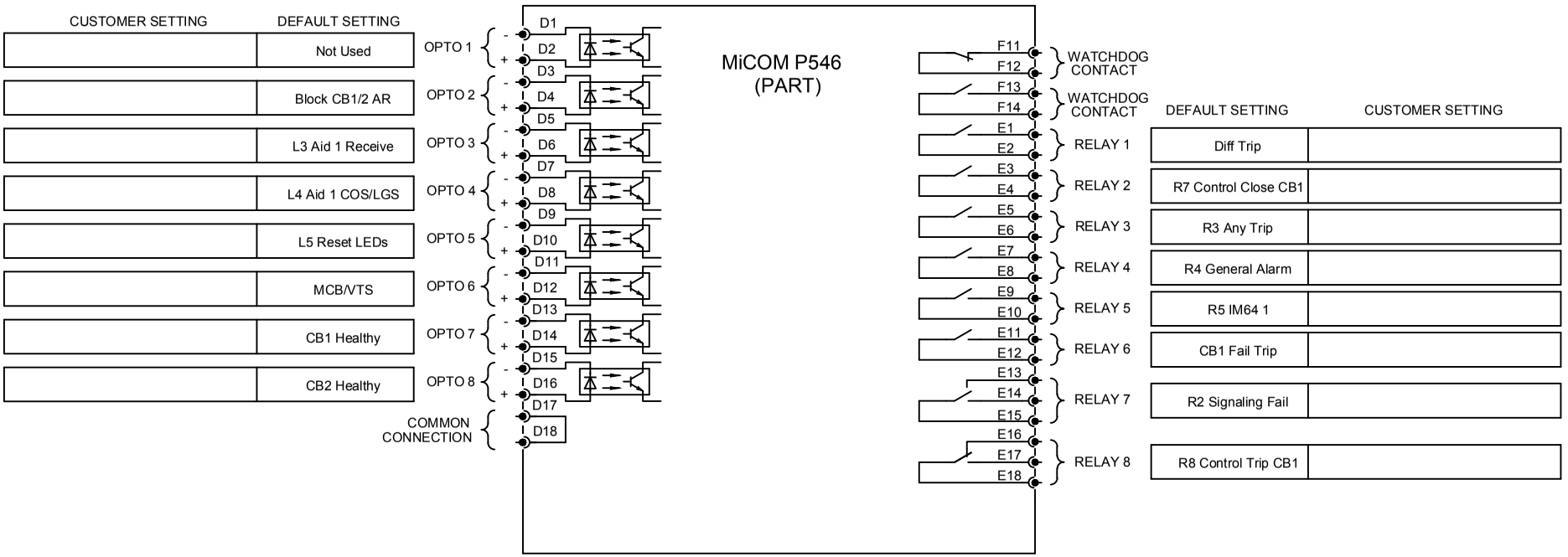
Date:	Chkd:			Next Sht: -	



NOTES .

1. PIN TERMINAL (P.C.B. TYPE)
2. FOR COMMS OPTIONS SEE DRAWING 10Px4001

Issue: E	Revision: CID006234 Outlines updated to GE Format		Title: EXT CONN DIAG. CURRENT DIFFERENTIAL 40TE WITH NCIT 8 OPTO INPUTS, 8 RELAY OUTPUTS		
Date: 4/30/2020	Name: S.J.BURTON		Drg No: 10P54610	Sht: 1	©UK Grid Solutions Ltd St Leonards Building Harry Kerr Drive, Stafford. ST16 1WT, UK
Date:	Chkd:			Next Sht: 2	



Issue: D	Revision: CID006234 Outlines updated to GE Format		Title: EXT CONN DIAG CURRENT DIFFERENTIAL RELAY 40TE WITH NCIT 8 OPTO INPUTS & 8 RELAY OUTPUTS		
Date: 4/30/2020	Name: S.J.BURTON		Drg No: 10P54610	Sht: 2	©UK Grid Solutions Ltd St Leonards Building Harry Kerr Drive, Stafford. ST16 1WT, UK
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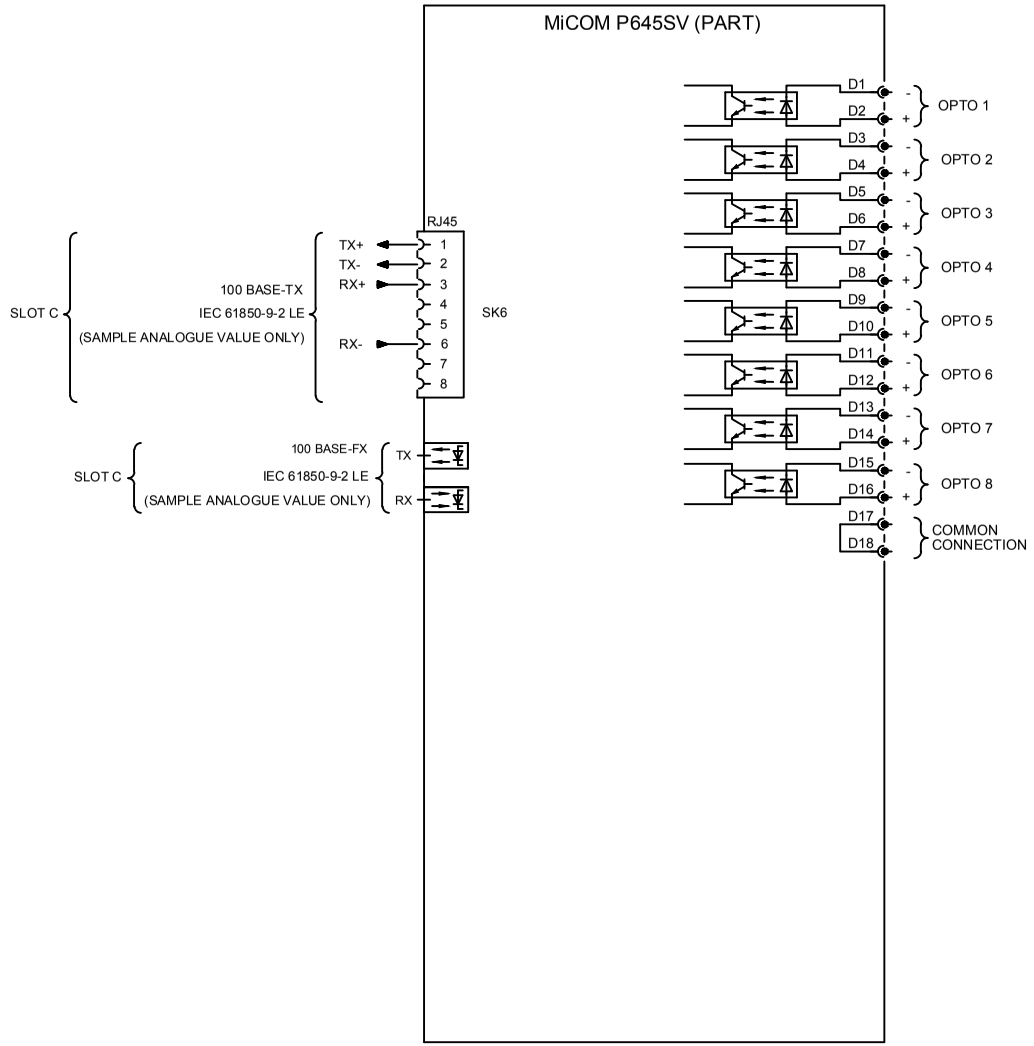
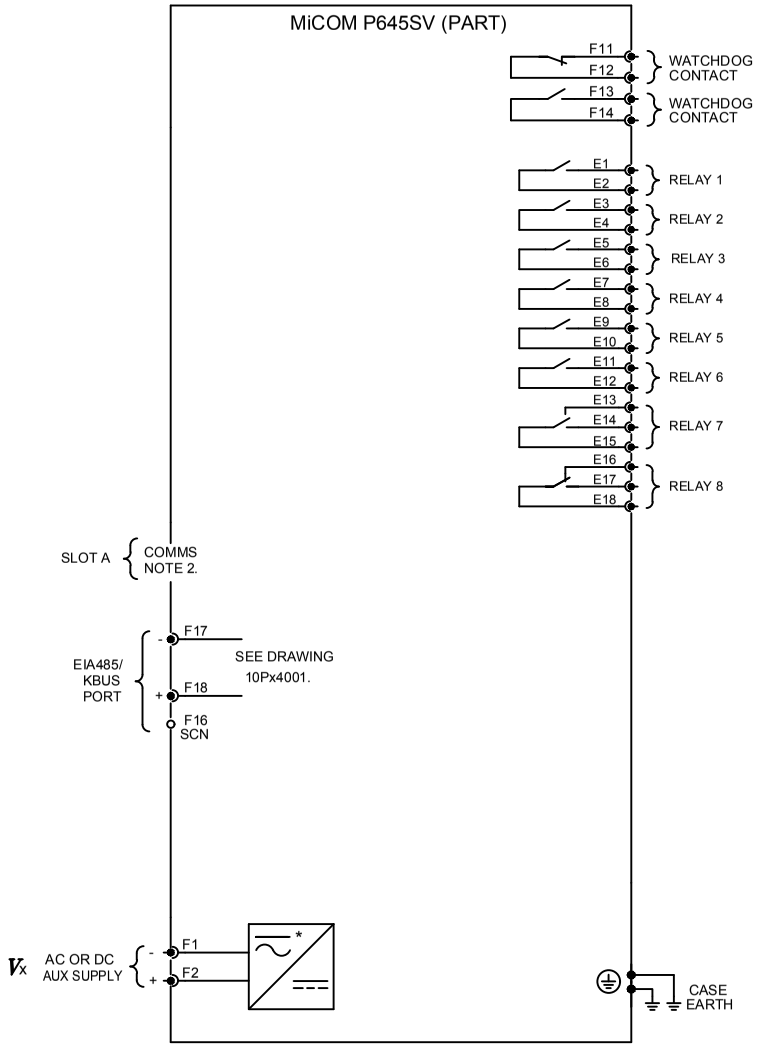


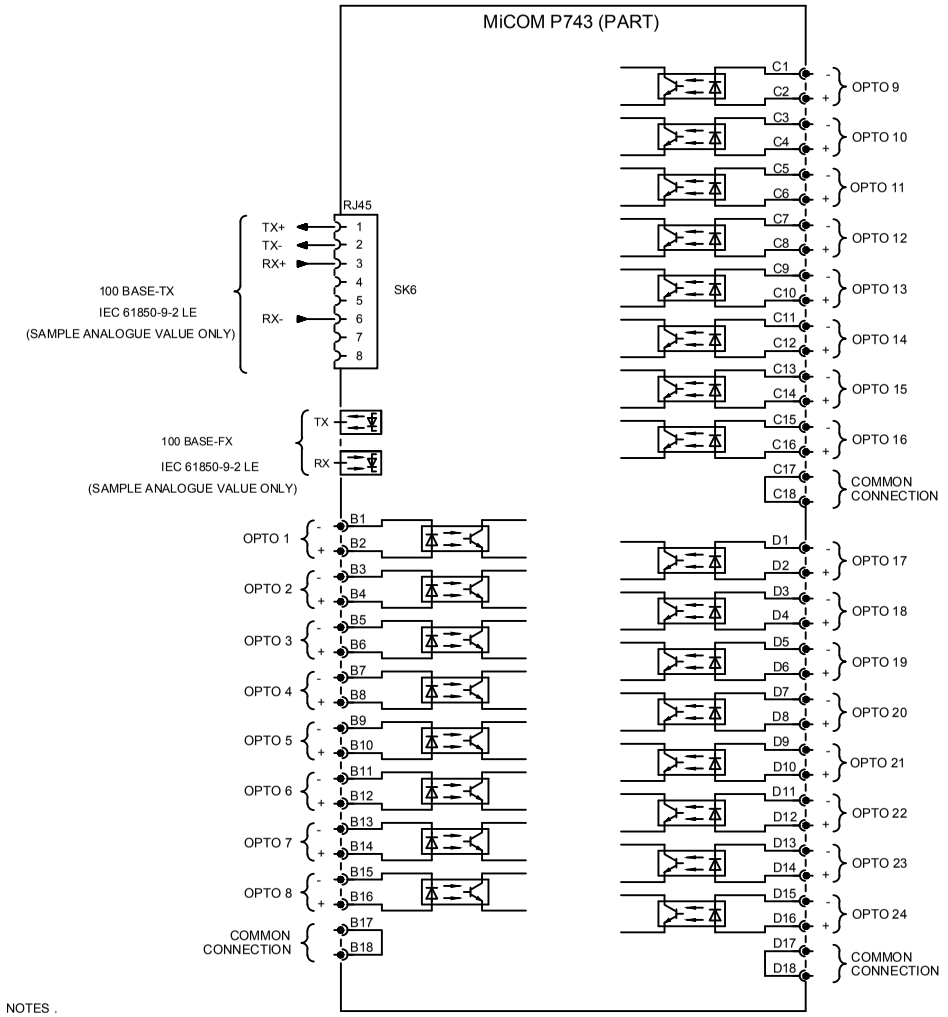


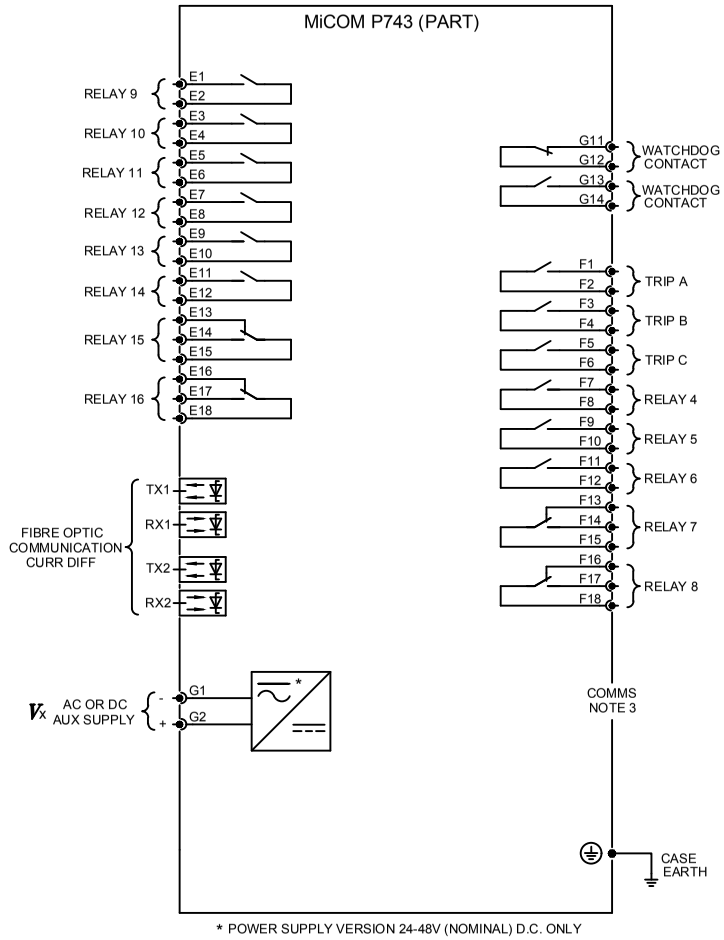
* POWER SUPPLY VERSION 24-48V (NOMINAL) D.C. ONLY

NOTES .

1. PIN TERMINAL (P.C.B. TYPE)
2. FOR COMMS OPTIONS SEE DRAWING 10Px4001

Issue: F	Revision: CID006234 Outlines updated to GE Format		Title: EXT.CONN. DIAG. 5 BIAS INPUT TRANSFORMER DIFFERENTIAL SAMPLE ANALOGUE VALUE 8 INPUTS & 8 OUTPUTS WITH NCIT		
Date: 4/30/2020	Name: S.J.BURTON		Drg No: 10P64521	Sht: 1	©UK Grid Solutions Ltd St Leonards Building Harry Kerr Drive, Stafford. ST16 1WT, UK
Date:	Chkd:			Next Sht: 2	





* POWER SUPPLY VERSION 24-48V (NOMINAL) D.C. ONLY

NOTES .

1. PIN TERMINAL (P.C.B. TYPE)
2. FOR COMMS OPTIONS SEE DRAWING 10Px4001
2. COPPER PORT IS FOR SERVICE ONLY, NOT RECOMMENDED FOR PERMANENT CONNECTION.

Issue: D	Revision: CID006234 Outlines updated to GE Format		Title: EXTERNAL CONNECTION DIAGRAM: BUSBAR PROTECTION PERIPHERAL UNIT P743 (60TE) WITH NCIT		
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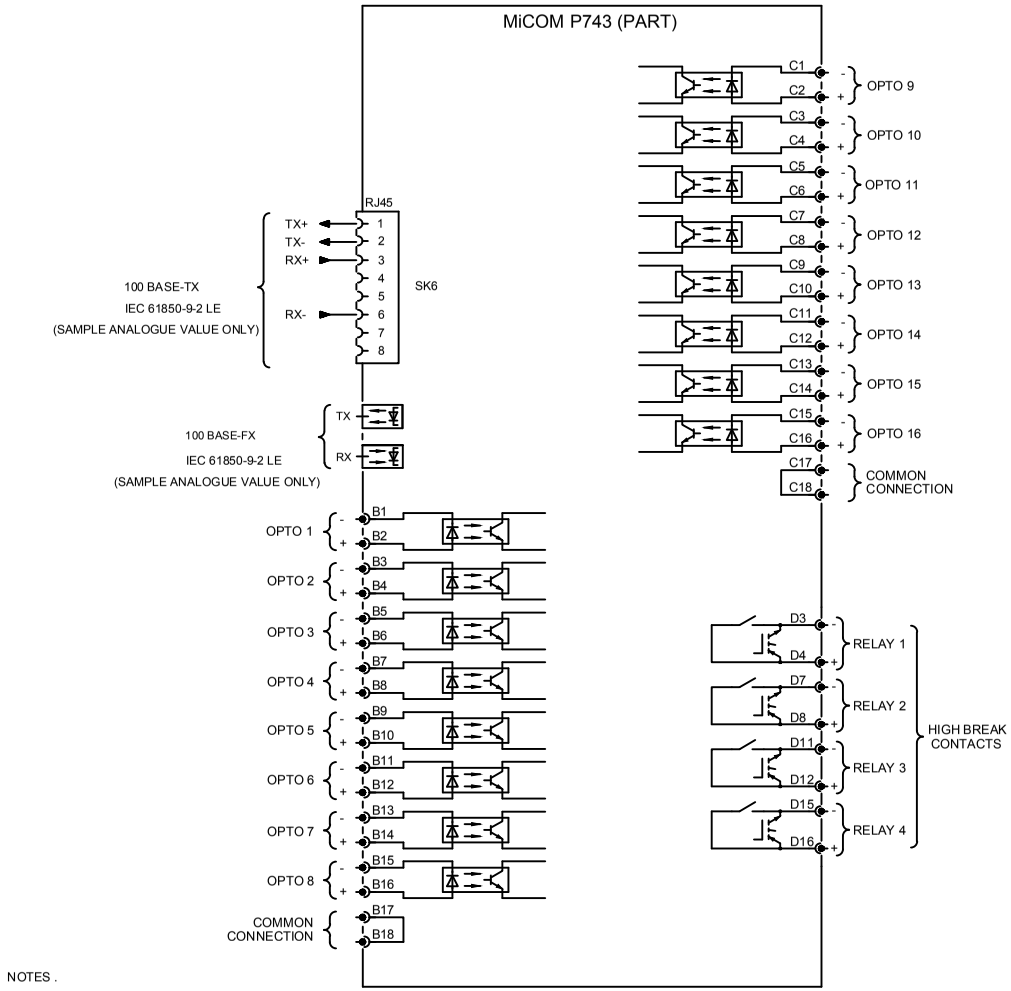

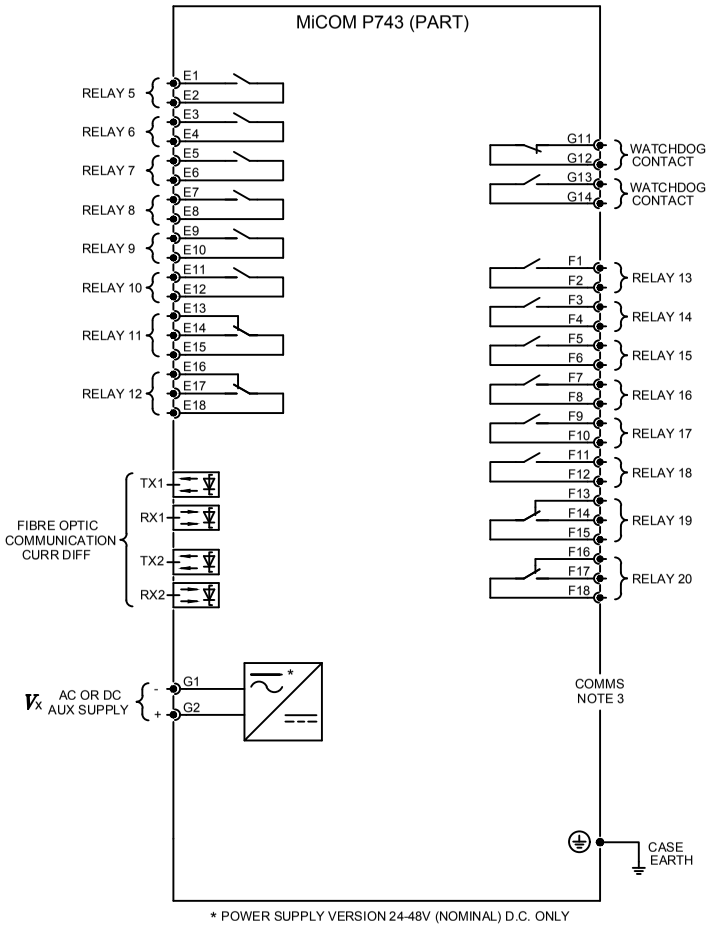

NOTES .

1. PIN TERMINAL (P.C.B. TYPE)
2. FOR COMMS OPTIONS SEE DRAWING 10Px4001
3. COPPER PORT IS FOR SERVICE ONLY, NOT RECOMMENDED FOR PERMANENT CONNECTION.

Issue: D	Revision: CID006234 Outlines updated to GE Format		Title: EXTERNAL CONNECTION DIAGRAM: BUSBAR PROTECTION PERIPHERAL UNIT P743 (60TE) WITH NCIT		
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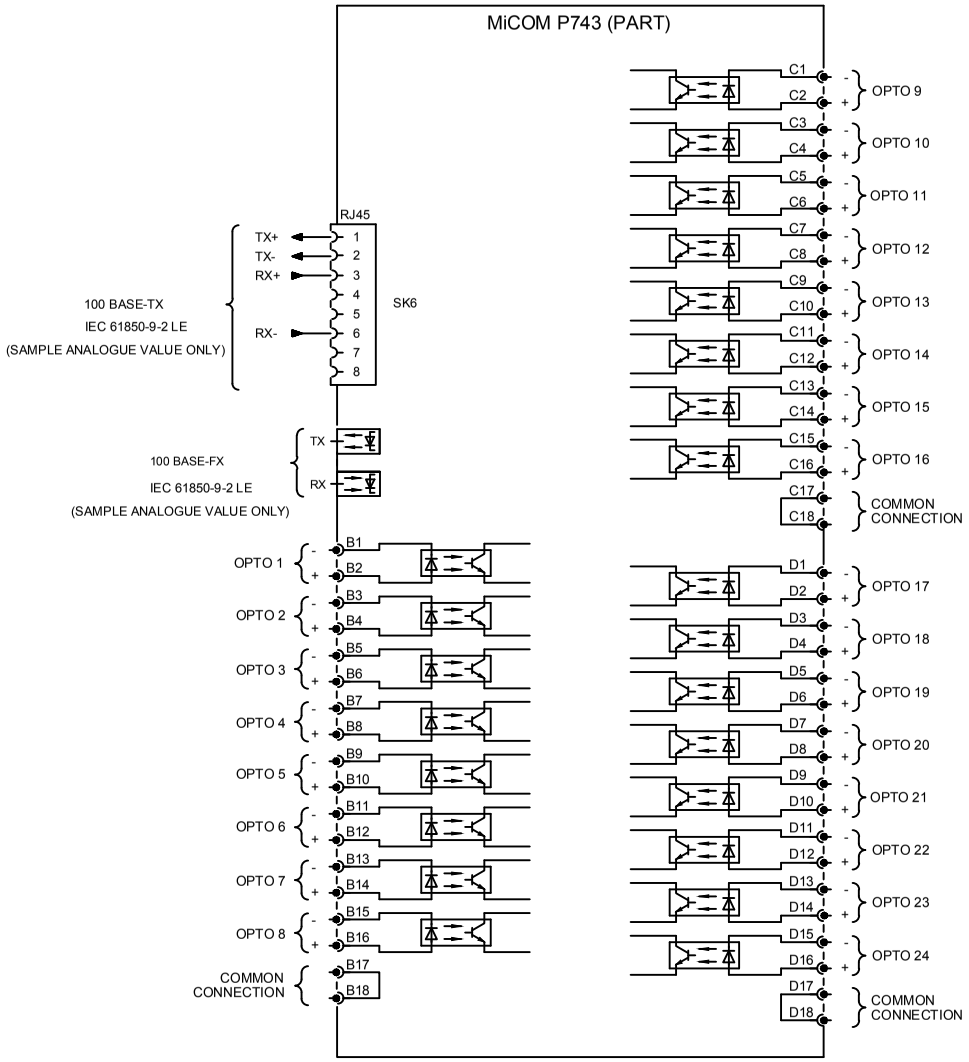
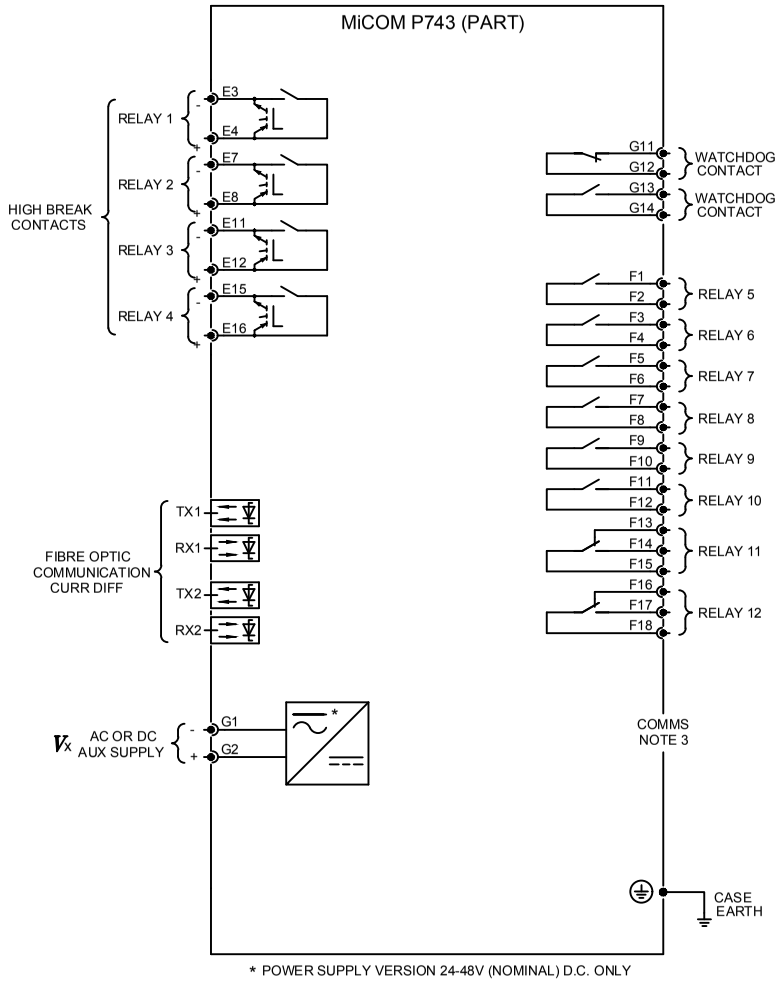
Date:	Chkd:			Next Sht: -	



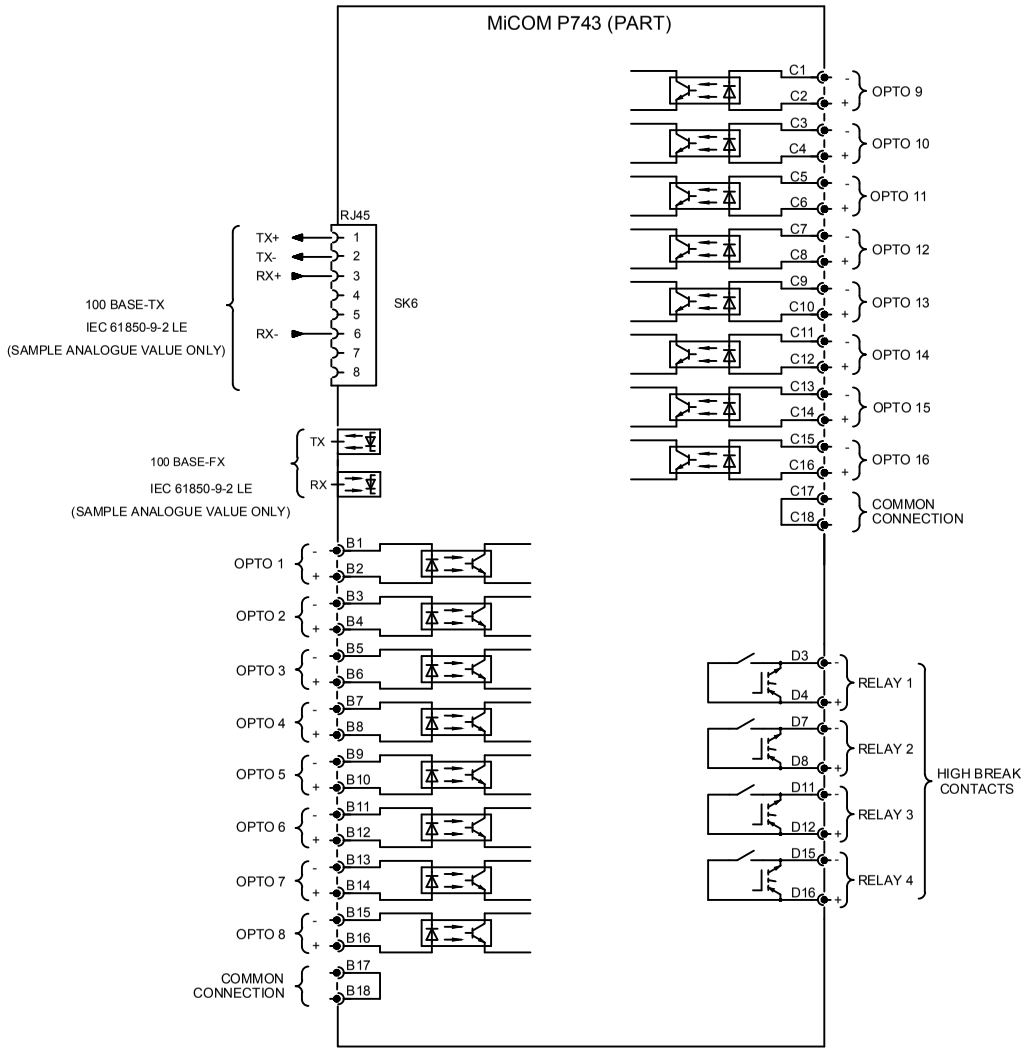


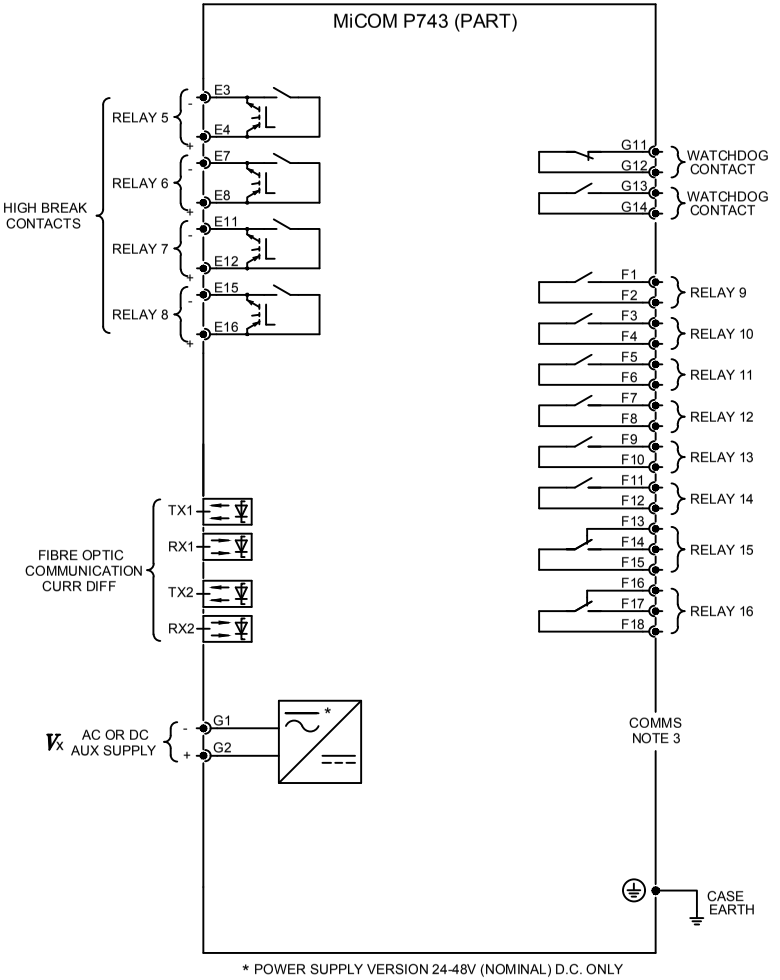
* POWER SUPPLY VERSION 24-48V (NOMINAL) D.C. ONLY

NOTES .

1. PIN TERMINAL (P.C.B. TYPE)
2. FOR COMMS OPTIONS SEE DRAWING 10Px4001
3. COPPER PORT IS FOR SERVICE ONLY, NOT RECOMMENDED FOR PERMANENT CONNECTION.

Issue: D	Revision: CID006234 Outlines updated to GE Format		Title: EXTERNAL CONNECTION DIAGRAM: BUSBAR PROTECTION PERIPHERAL UNIT P743 (60TE) WITH NCIT		
Date: 4/30/2020	Name: S.J.BURTON		Drg No: 10P74309	Sht: 1	©UK Grid Solutions Ltd St Leonards Building Harry Kerr Drive, Stafford. ST16 1WT, UK
Date:	Chkd:			Next Sht: -	





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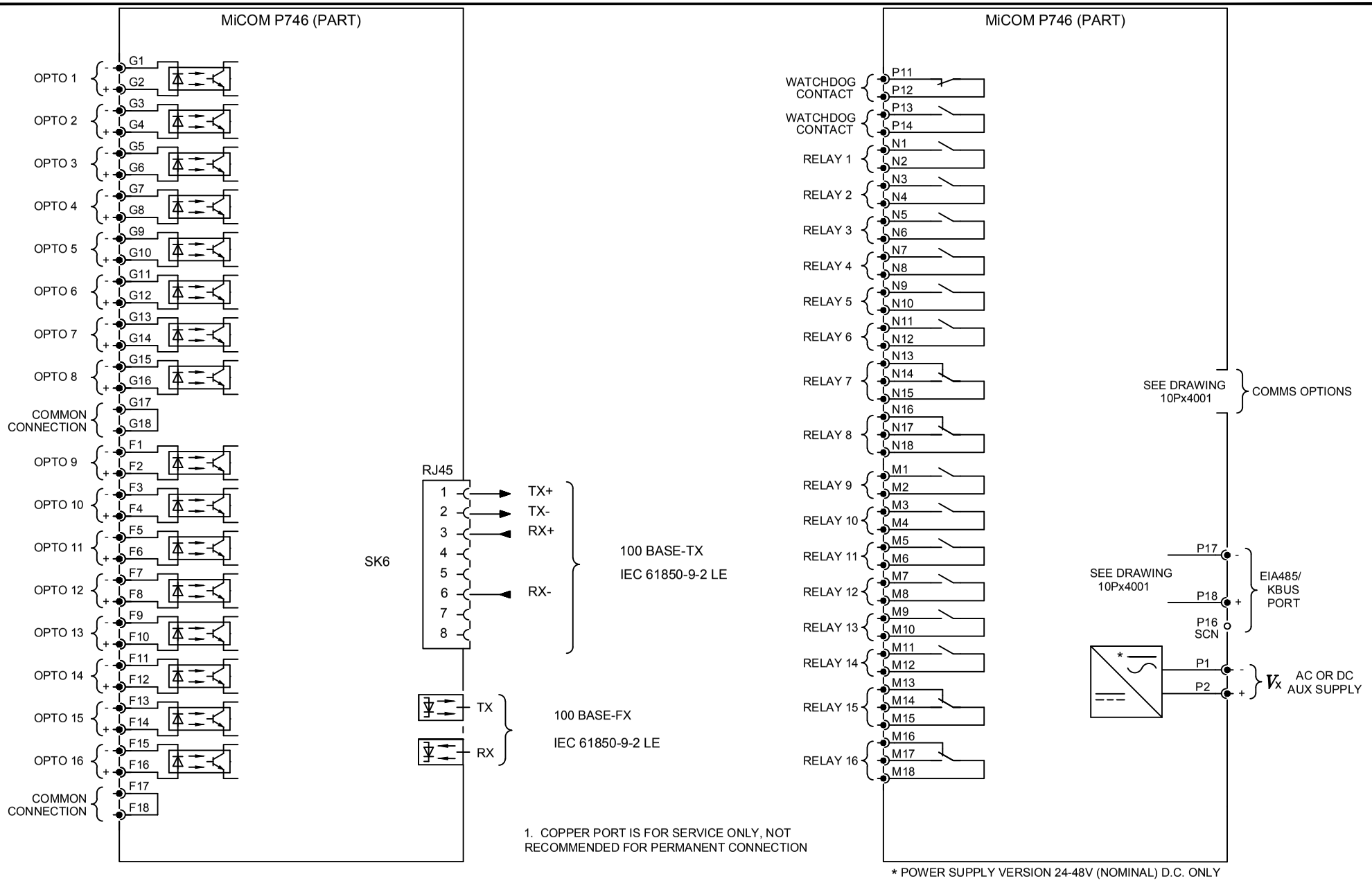
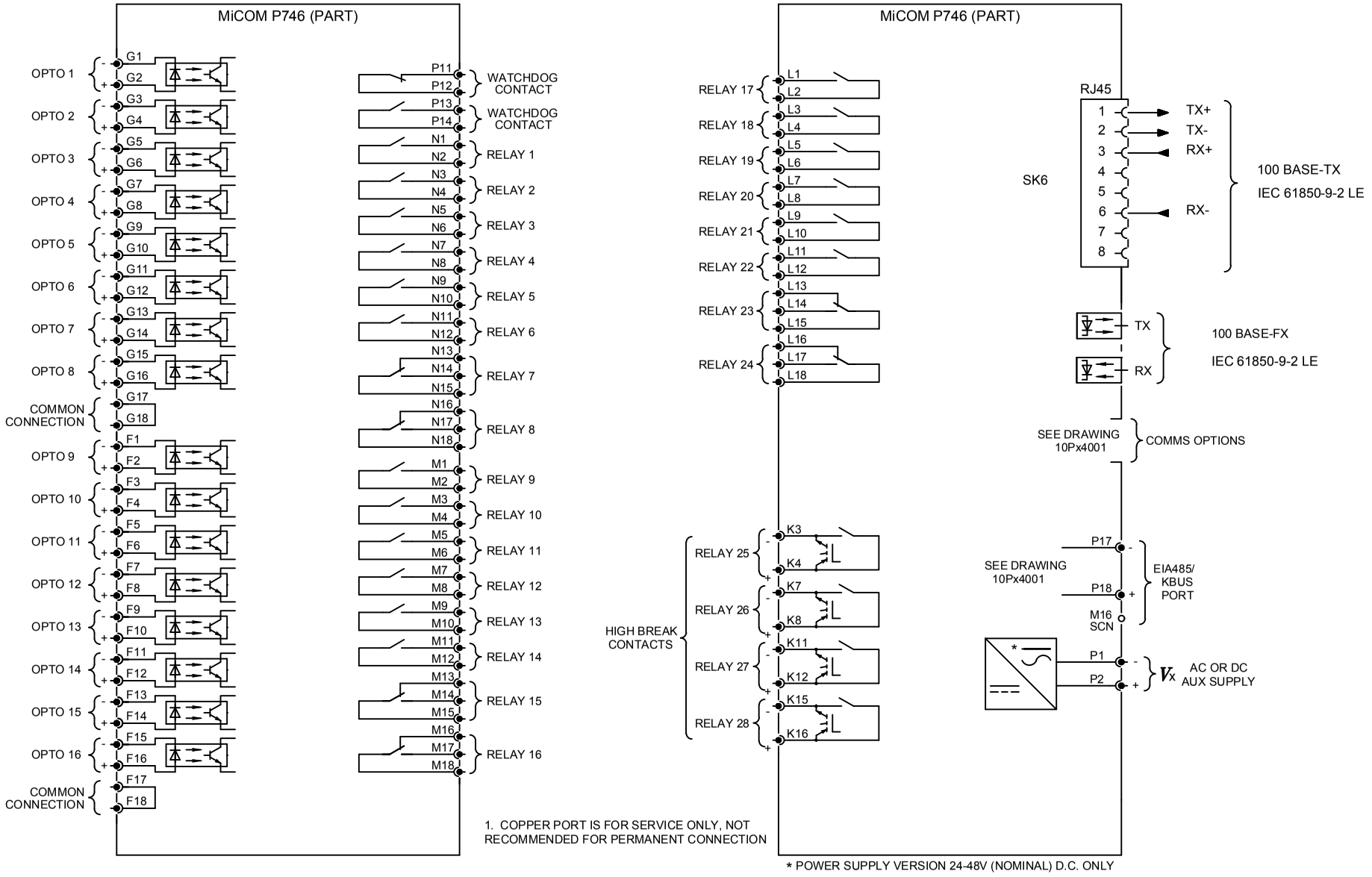
NOTES .

1. PIN TERMINAL (P.C.B. TYPE)
2. FOR COMMS OPTIONS SEE DRAWING 10Px4001
3. COPPER PORT IS FOR SERVICE ONLY, NOT RECOMMENDED FOR PERMANENT CONNECTION.

Issue: D	Revision: CID006234 Outlines updated to GE Format		Title: EXTERNAL CONNECTION DIAGRAM: BUSBAR PROTECTION PERIPHERAL UNIT P743 (60TE) WITH NCIT		
Date: 4/30/2020	Name: S.J.BURTON		Drg No: 10P74310	Sht: 1	©UK Grid Solutions Ltd St Leonards Building Harry Kerr Drive, Stafford. ST16 1WT, UK
Date:	Chkd:			Next Sht: -	



Issue: E	Revision: CID006234 Outlines updated to GE Format		Title: EXT. CONNECTION DIAG: P746 BUSBAR PROTECTION (80TE) WITH 16 I/P & 16 O/P NCIT		
Date: 4/30/2020	Name: S.J.BURTON		Drg No: 10P74612	Sht: 1	©UK Grid Solutions Ltd St Leonards Building Harry Kerr Drive, Stafford. ST16 1WT, UK
Date: 07/05/2012	Chkd: N.ROBINSON			Next Sht: -	



Issue: E	Revision: CID006234 Outlines updated to GE Format		Title: EXT. CONNECTION DIAG: P746 BUSBAR PROTECTION (80TE) WITH 16 I/P & 28 O/P (4 O/P ARE HIGH BREAK) NCIT	
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Date: 07/05/2012	Chkd: N.ROBINSON			Next Sht: -

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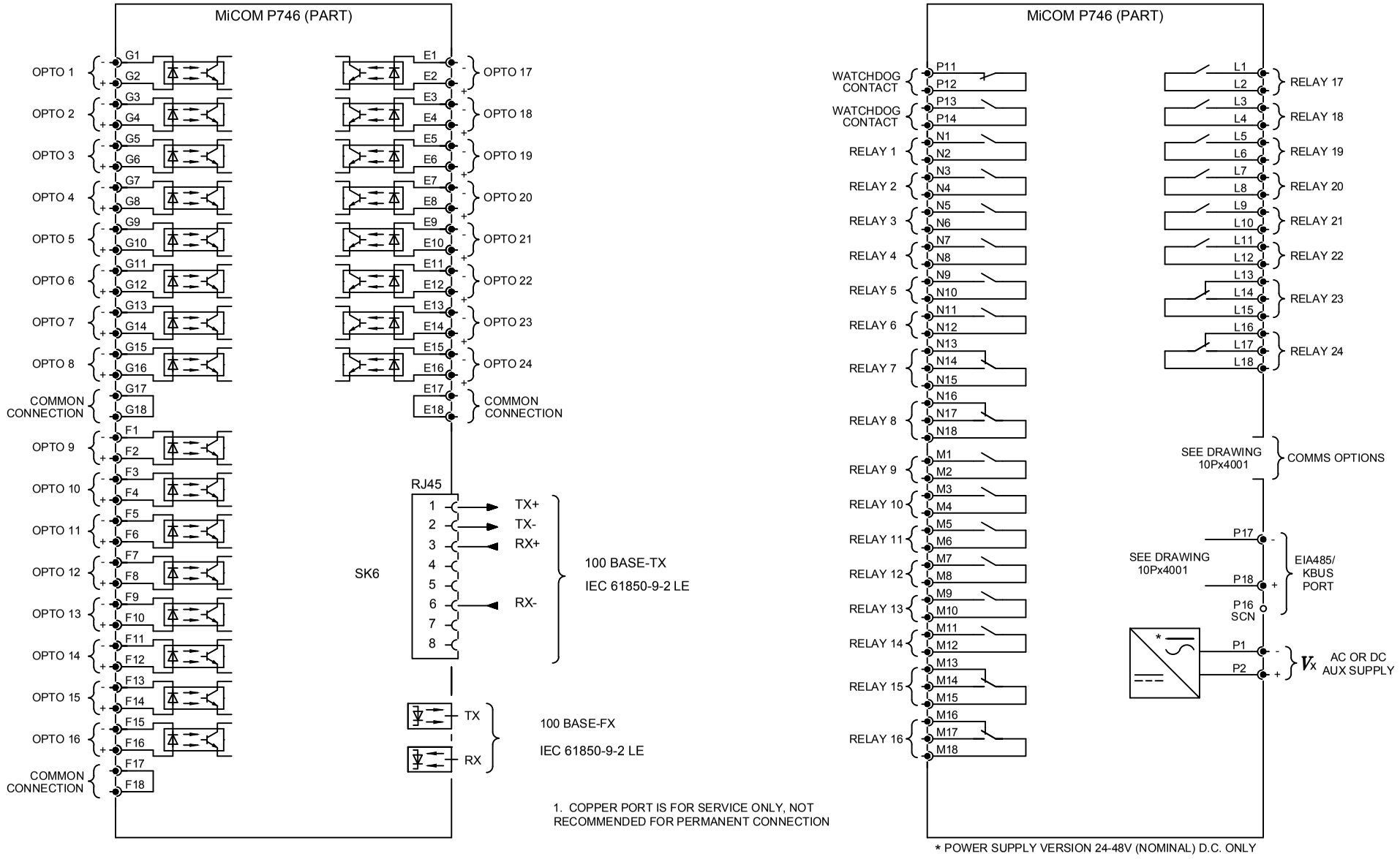

Issue: E	Revision: CID006234 Outlines updated to GE Format		Title: EXT. CONNECTION DIAG: P746 BUSBAR PROTECTION (80TE) WITH 24 I/P & 24 O/P NCIT		
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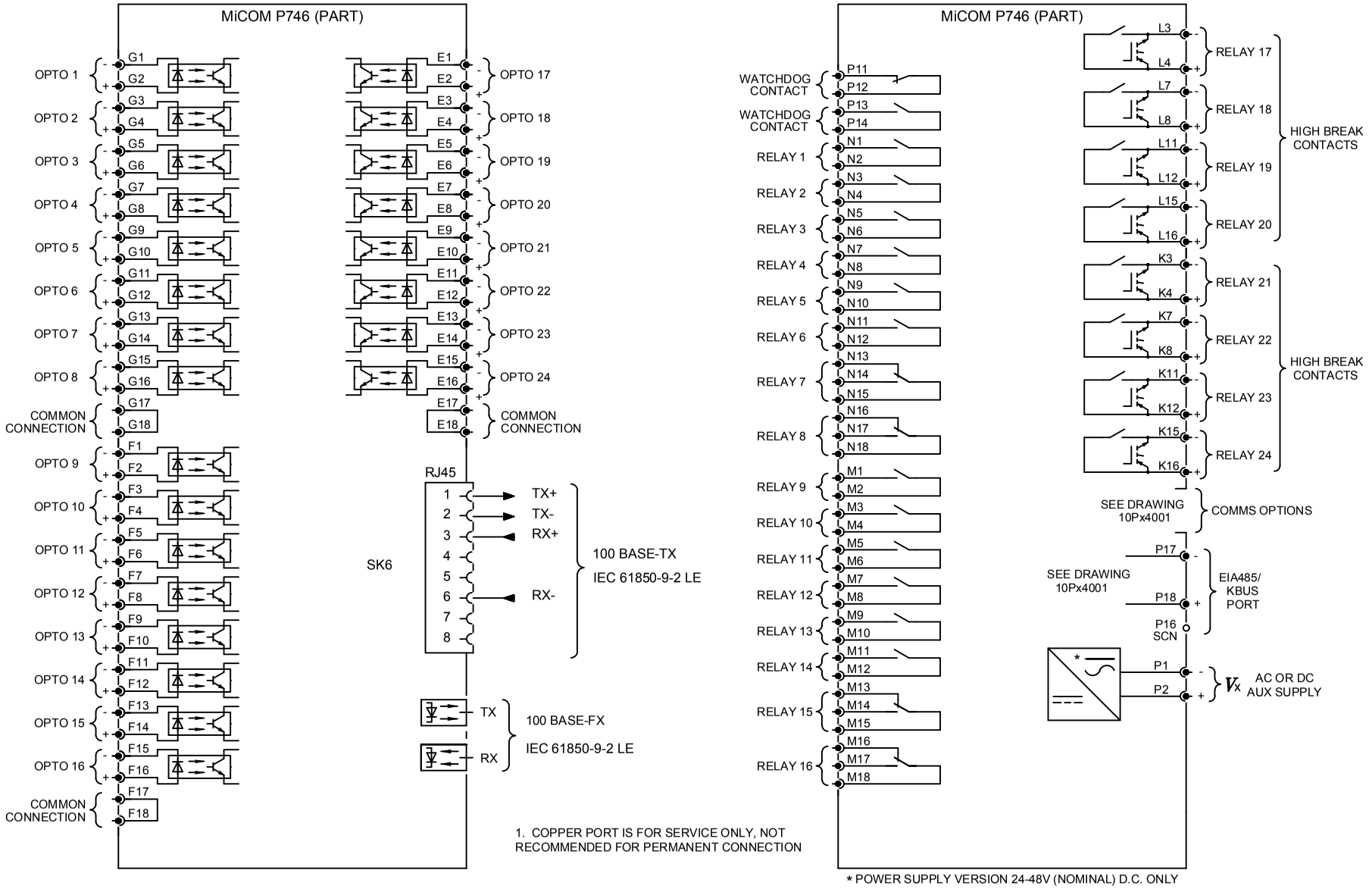

Issue: E	Revision: CID006234 Outlines updated to GE Format		Title: EXT. CONNECTION DIAG: P746 BUSBAR PROTECTION (80TE) WITH 24 I/P & 24 O/P (8 O/P ARE HIGH BREAK) NCIT	
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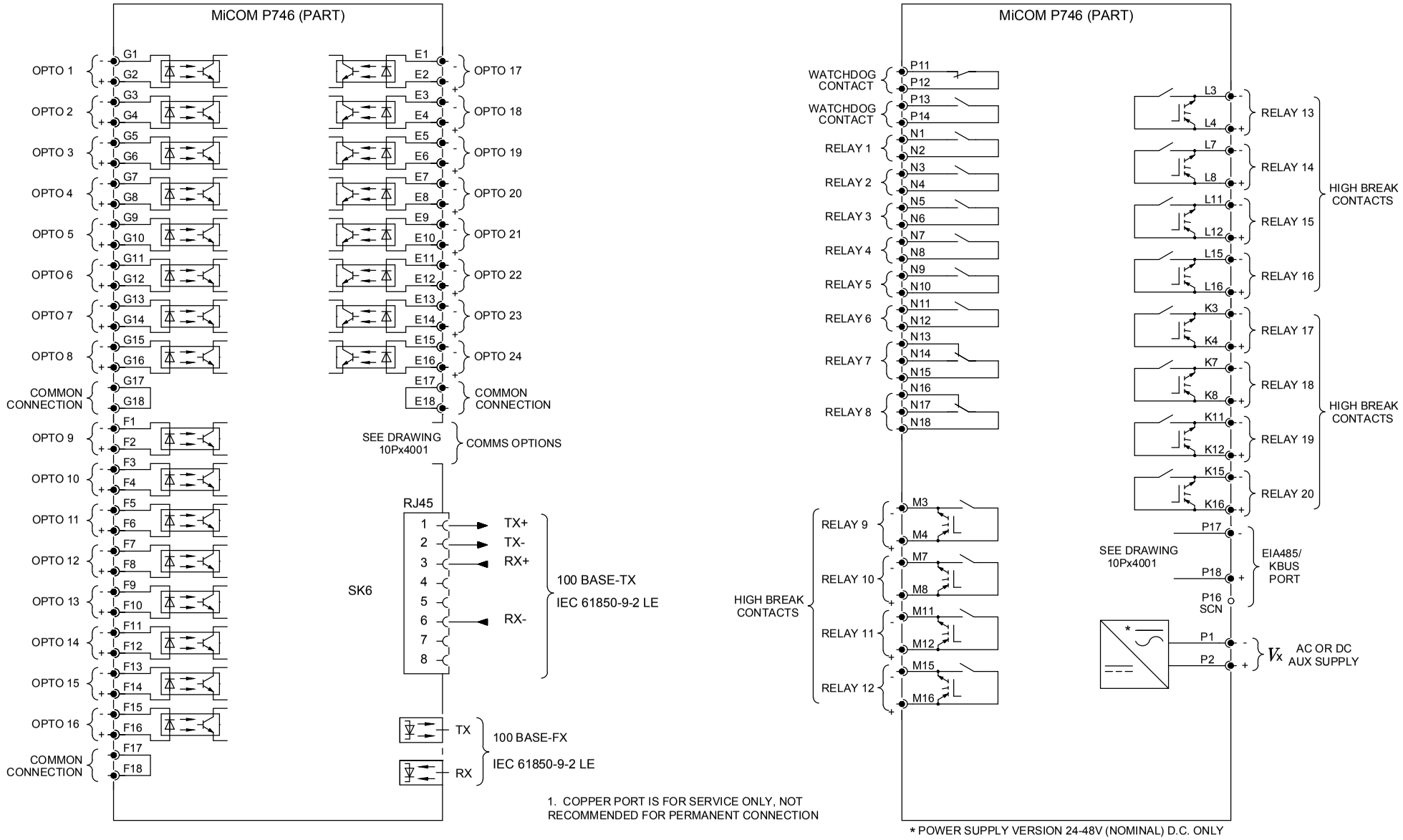

Issue: E	Revision: CID006234 Outlines updated to GE Format		Title: EXTERNAL CONNECTION DIAG: P746 BUSBAR PROTECTION WITH 24 I/P & 20 O/P (12 O/P ARE HIGH BREAK) NCIT		
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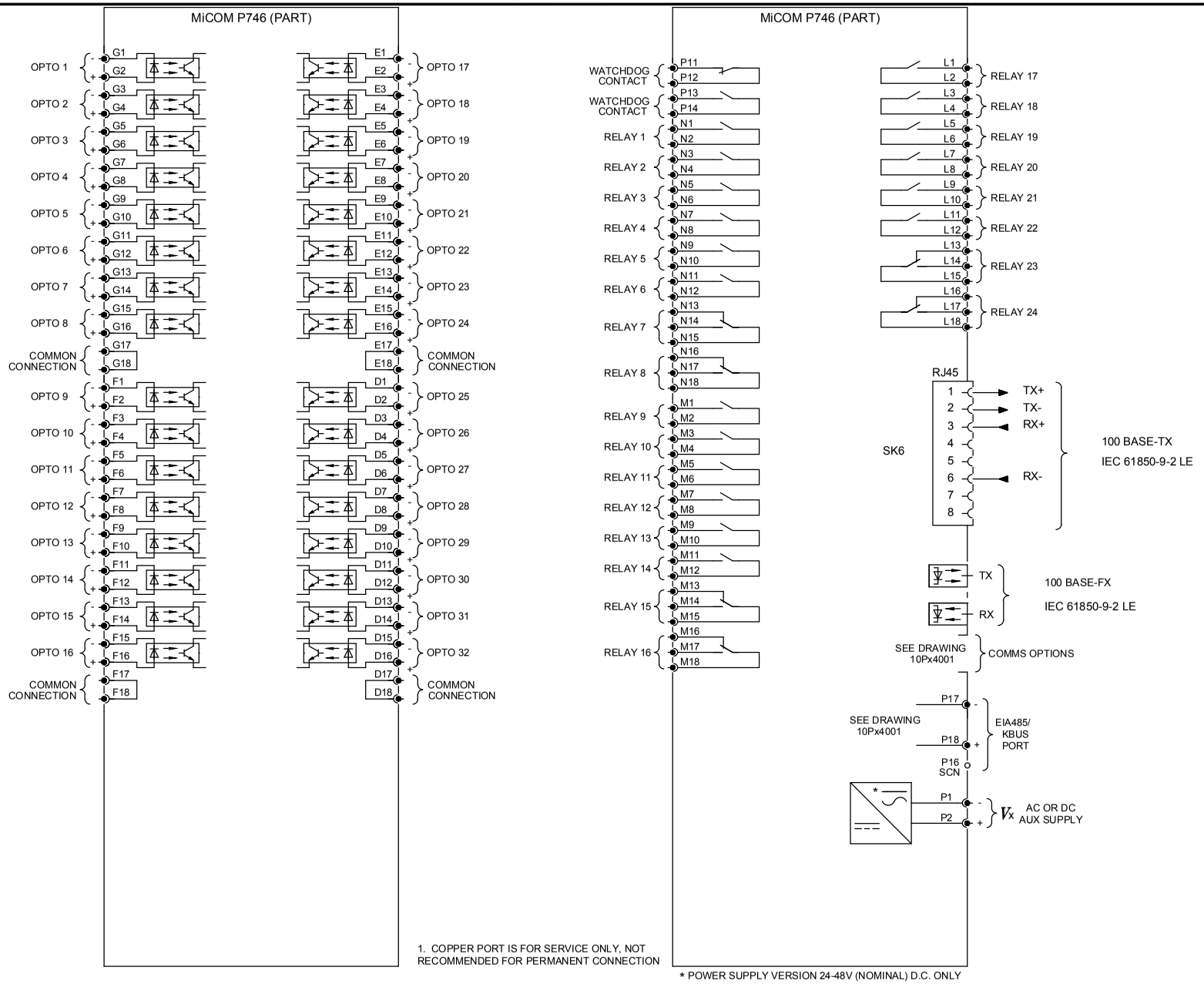

Issue: E	Revision: CID006234 Outlines updated to GE Format		Title: EXT. CONNECTION DIAG: P746 BUSBAR PROTECTION (80TE) WITH 32 I/P & 24 O/P NCIT		
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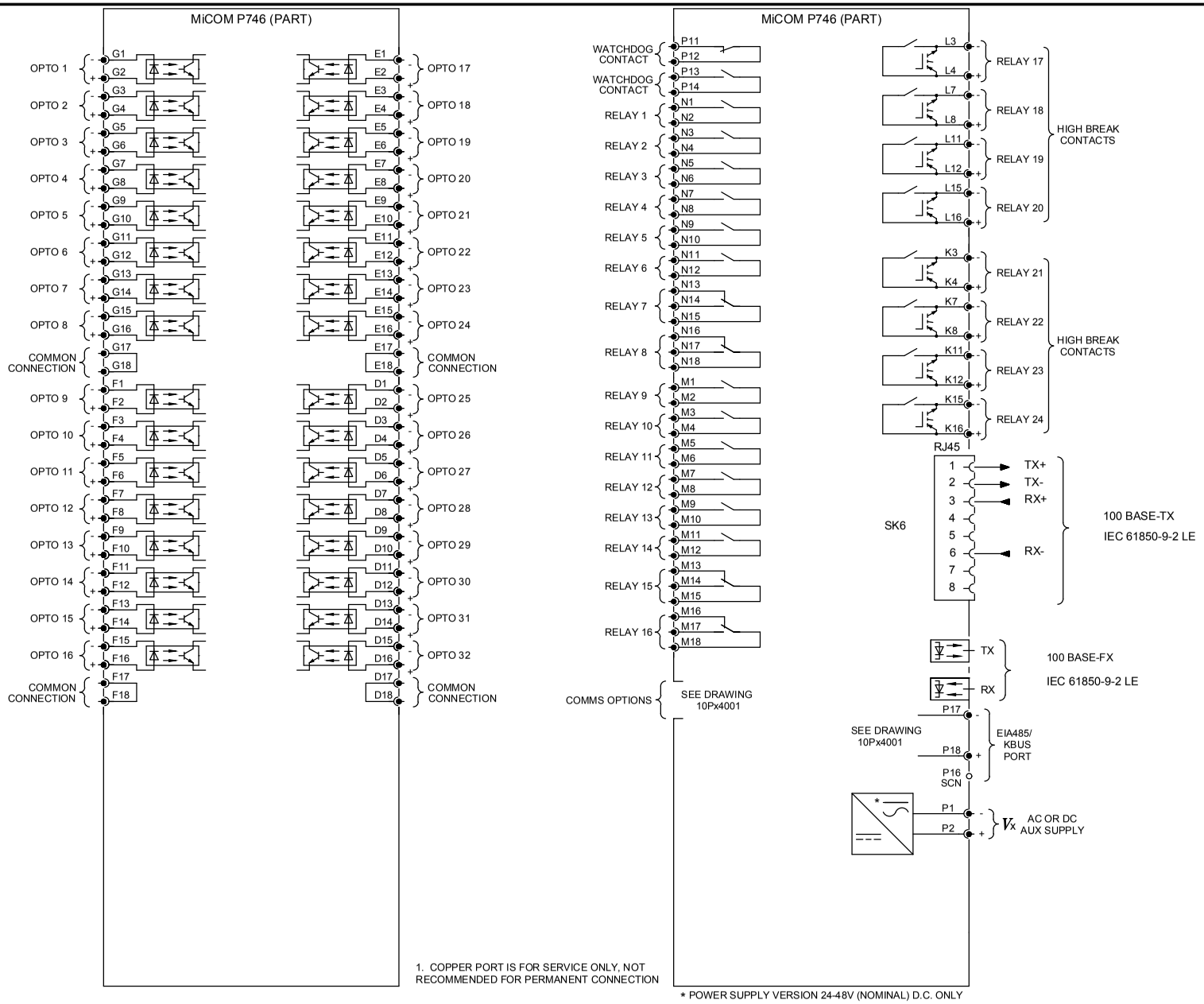

Issue: E	Revision: CID006234 Outlines updated to GE Format		Title: EXTERNAL CONNECTION DIAG: P746 BUSBAR PROTECTION (80TE) WITH 32 I/P & 24 O/P (8 O/P ARE HIGH BREAK) NCIT		
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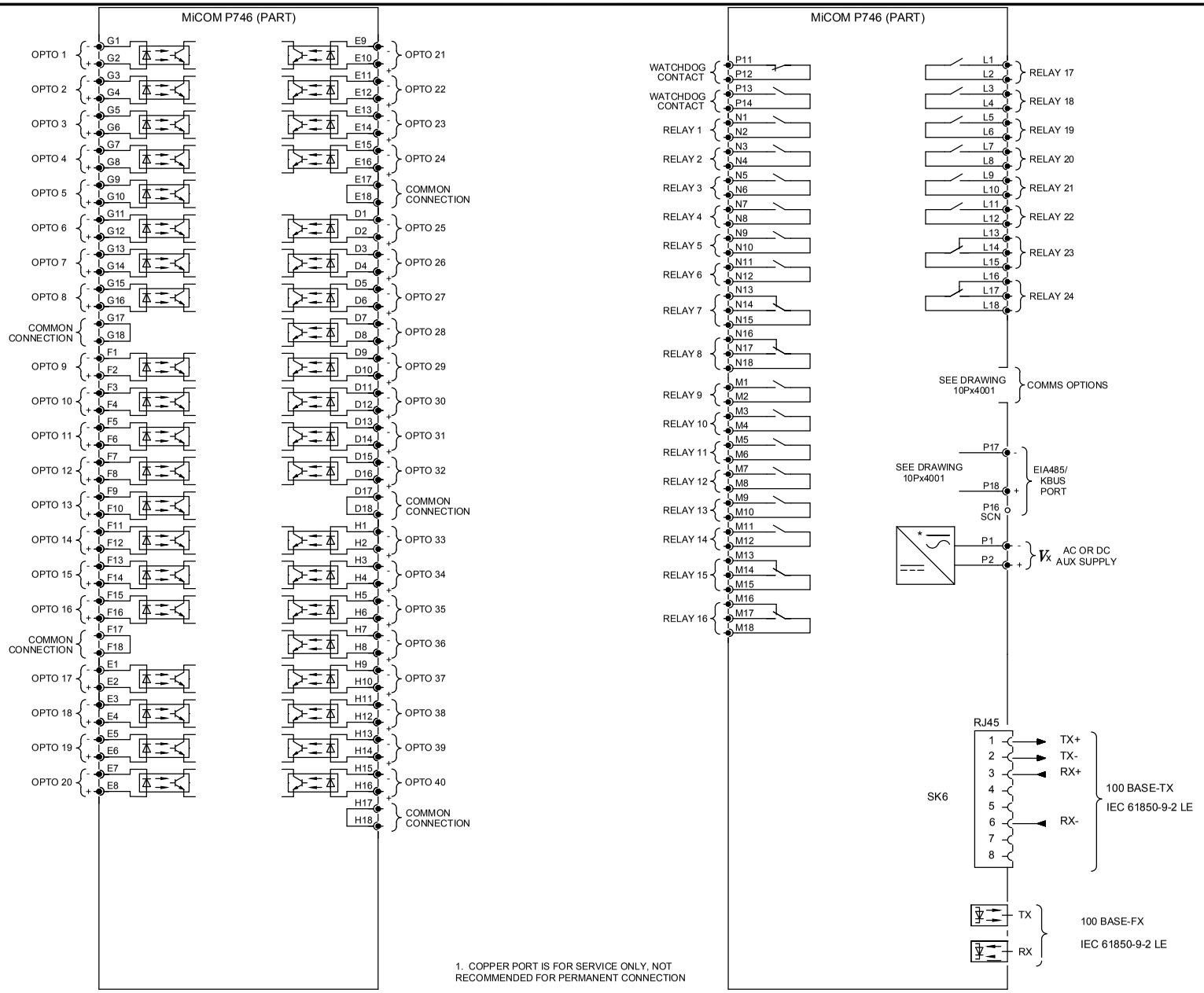

Issue: E	Revision: CID006234 Outlines updated to GE Format	Title: EXT. CONNECTION DIAG: P746 BUSBAR PROTECTION (80TE) WITH 40 I/P & 24 O/P NCIT	
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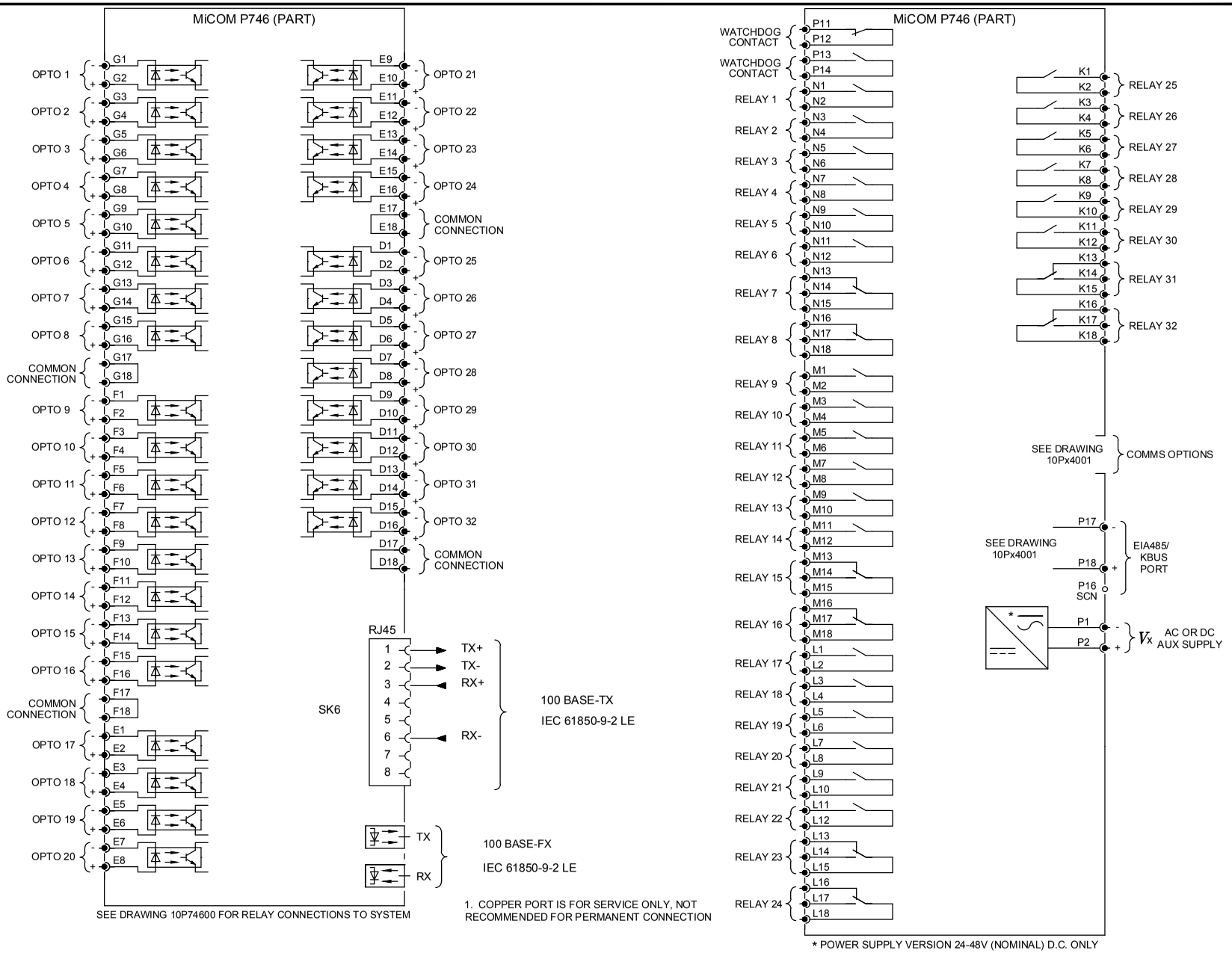

Issue: E	Revision: CID006234 Outlines updated to GE Format		Title: EXT. CONNECTION DIAG: P746 BUSBAR PROTECTION (80TE) WITH 32 I/P & 32 O/P NCIT		
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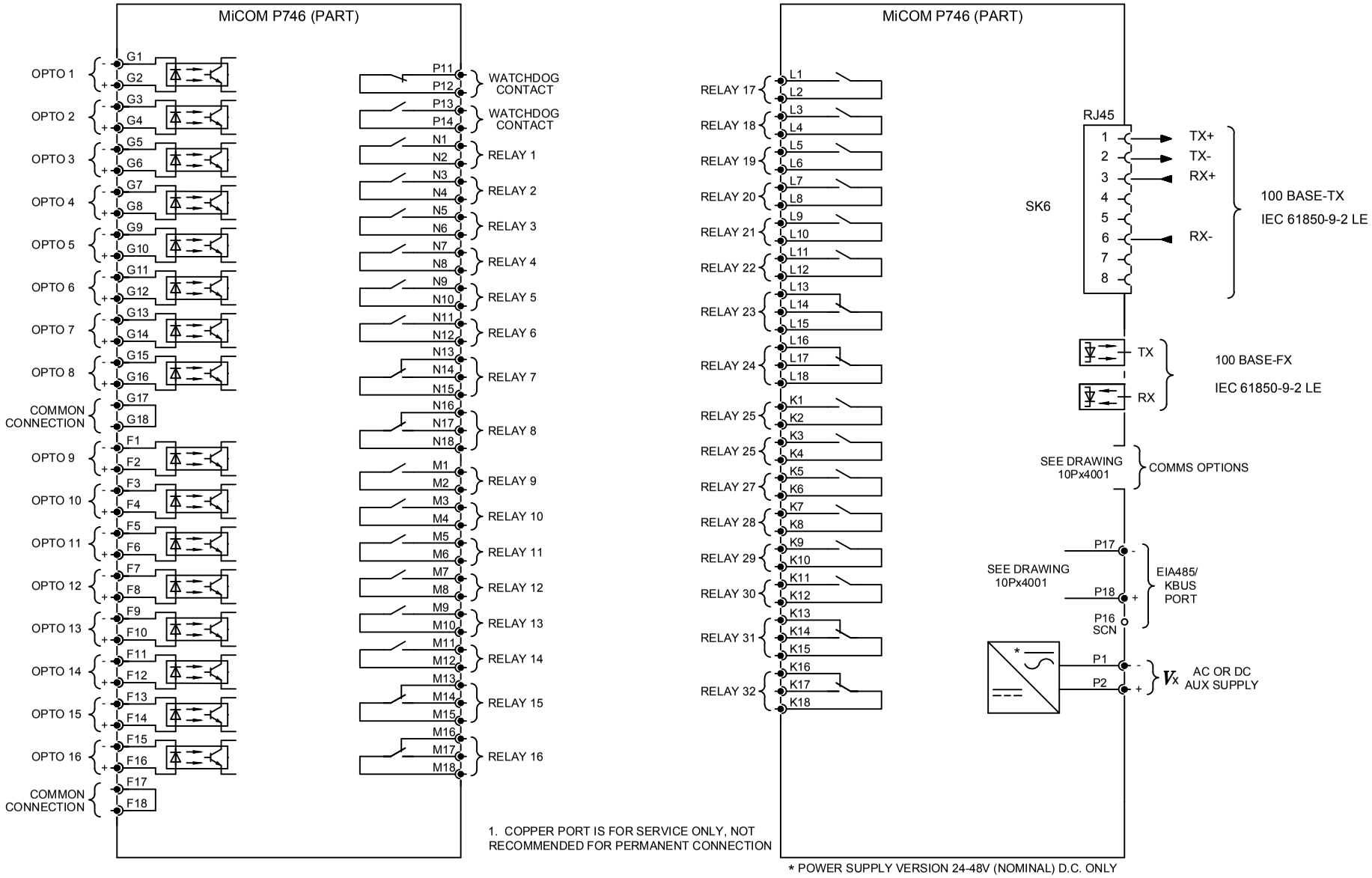

Issue: E	Revision: CID006234 Outlines updated to GE Format		Title: EXT. CONNECTION DIAG: P746 BUSBAR PROTECTION (80TE) WITH 16 I/P & 32 O/P NCIT	
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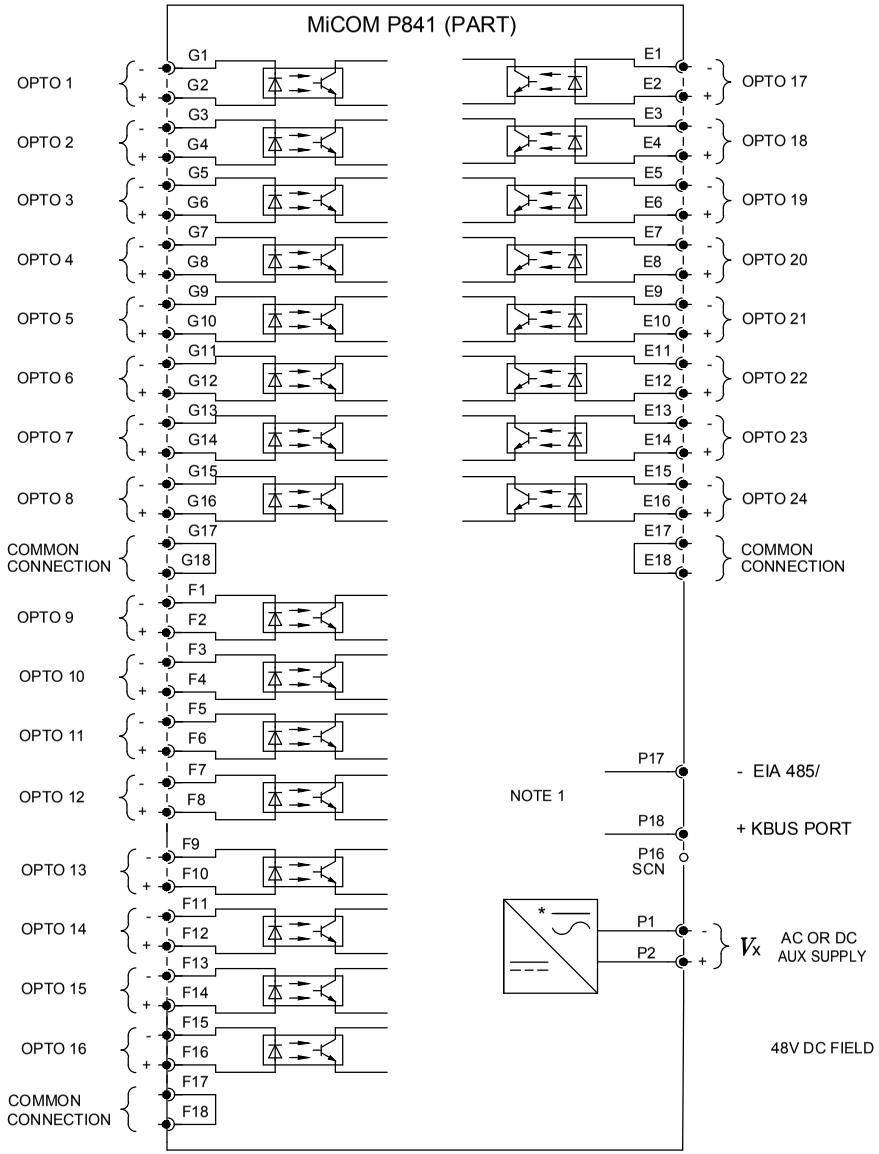

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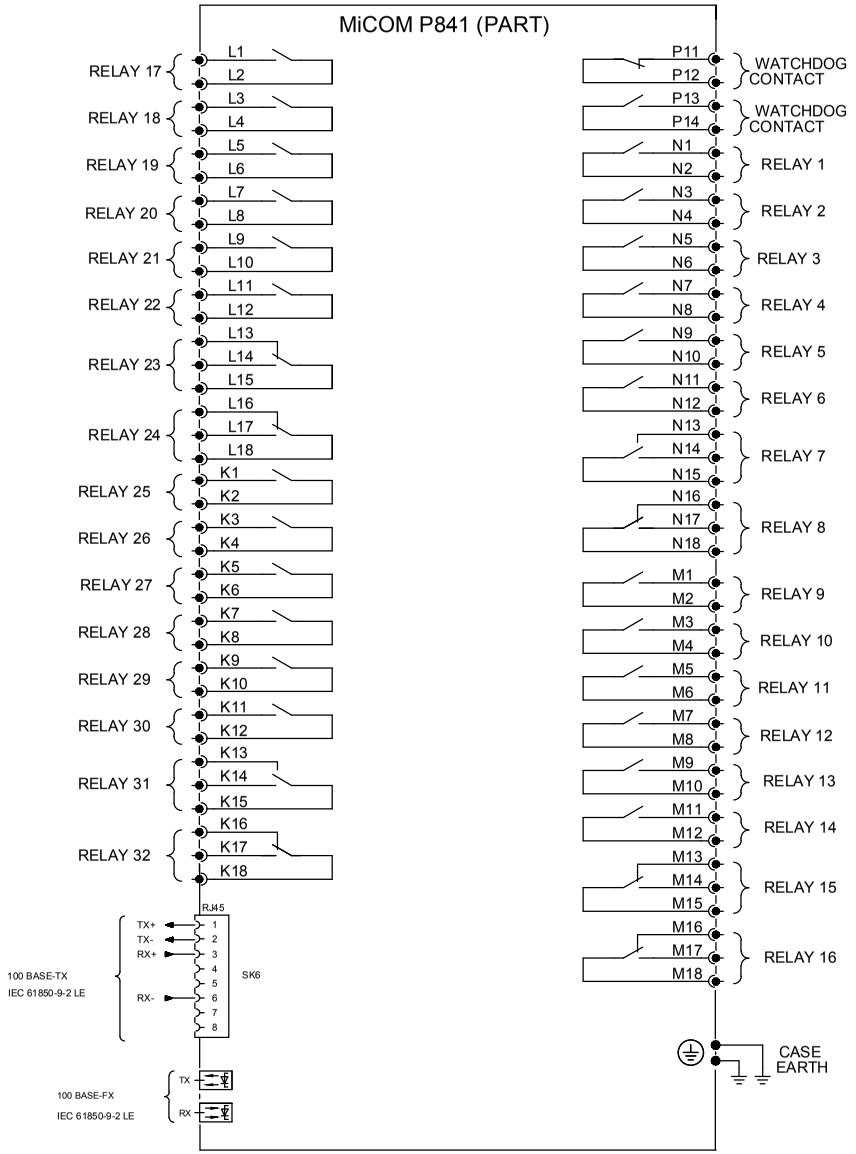

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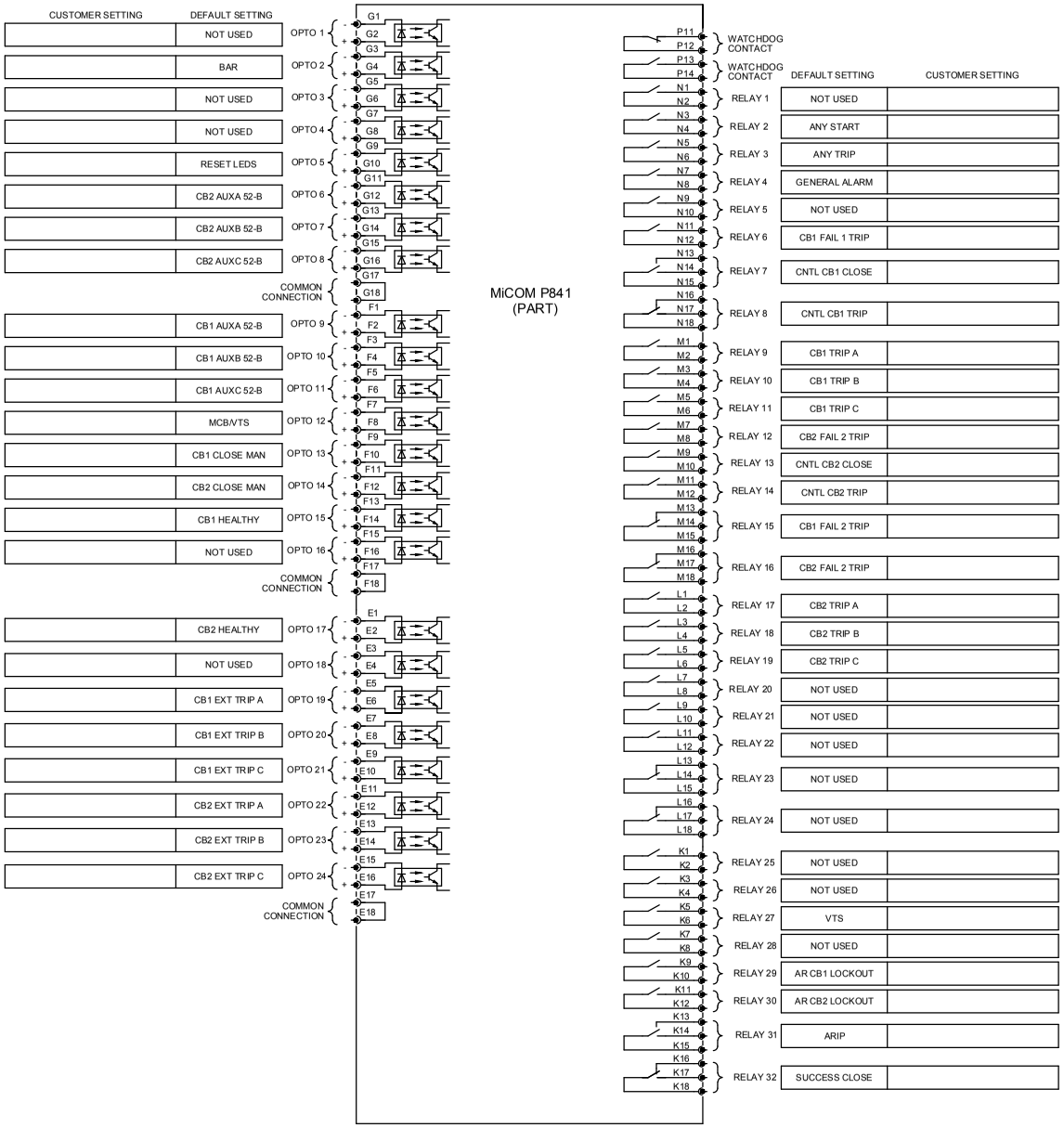
2. PIN TERMINAL (PCB TYPE)
3. COPPER PORT IS FOR SERVICE ONLY, NOT RECOMMENDED FOR PERMANENT CONNECTION

Issue: E	Status: **Approved**	Revision: CID006234 - Outline update only	Title: EXT. CONN DIAG : AUTORECLOSE 80TE WITH NCIT 24 INPUTS AND 32 OUTPUTS		
Date: 23/12/19	Name: S Burton		Drg No: **10P84106**	Sht: 1	©UK Grid Solutions Ltd St Leonards Building Harry Kerr Drive, Stafford. ST16 1WT, UK
Date:	Chkd:			Next Sht: 2	



Issue: C	Status: **Approved**	Revision: CID006234 - Outline update only	Title: EXT. CONN DIAG : AUTORECLOSE 80TE WITH NCIT 24 INPUTS AND 32 OUTPUTS
Date: 23/12/19	Name: S Burton	GE PROPRIETARY AND CONFIDENTIAL INFORMATION This document is the property of General Electric Company ("GE") and contains proprietary information of GE. This document is loaned on the express condition that neither it nor the information contained therein shall be disclosed to others without the express written consent of GE, and that the information shall be used by the recipient only as approved expressly by GE. This document shall be returned to GE upon its request. This document may be subject to certain restrictions under U.S. export control laws and regulations.© General Electric Company, GE CONFIDENTIAL UNPUBLISHED WORK.	Drg No: **10P84106**
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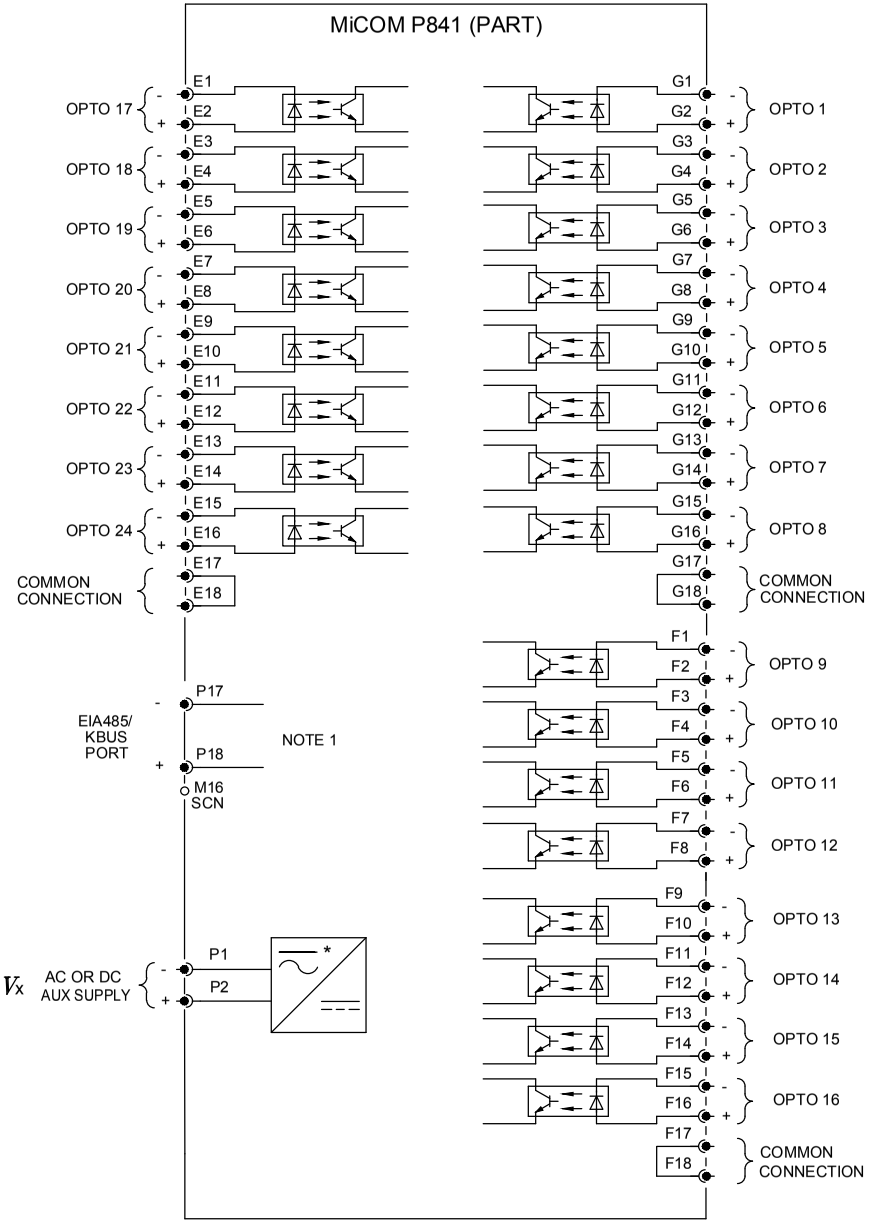

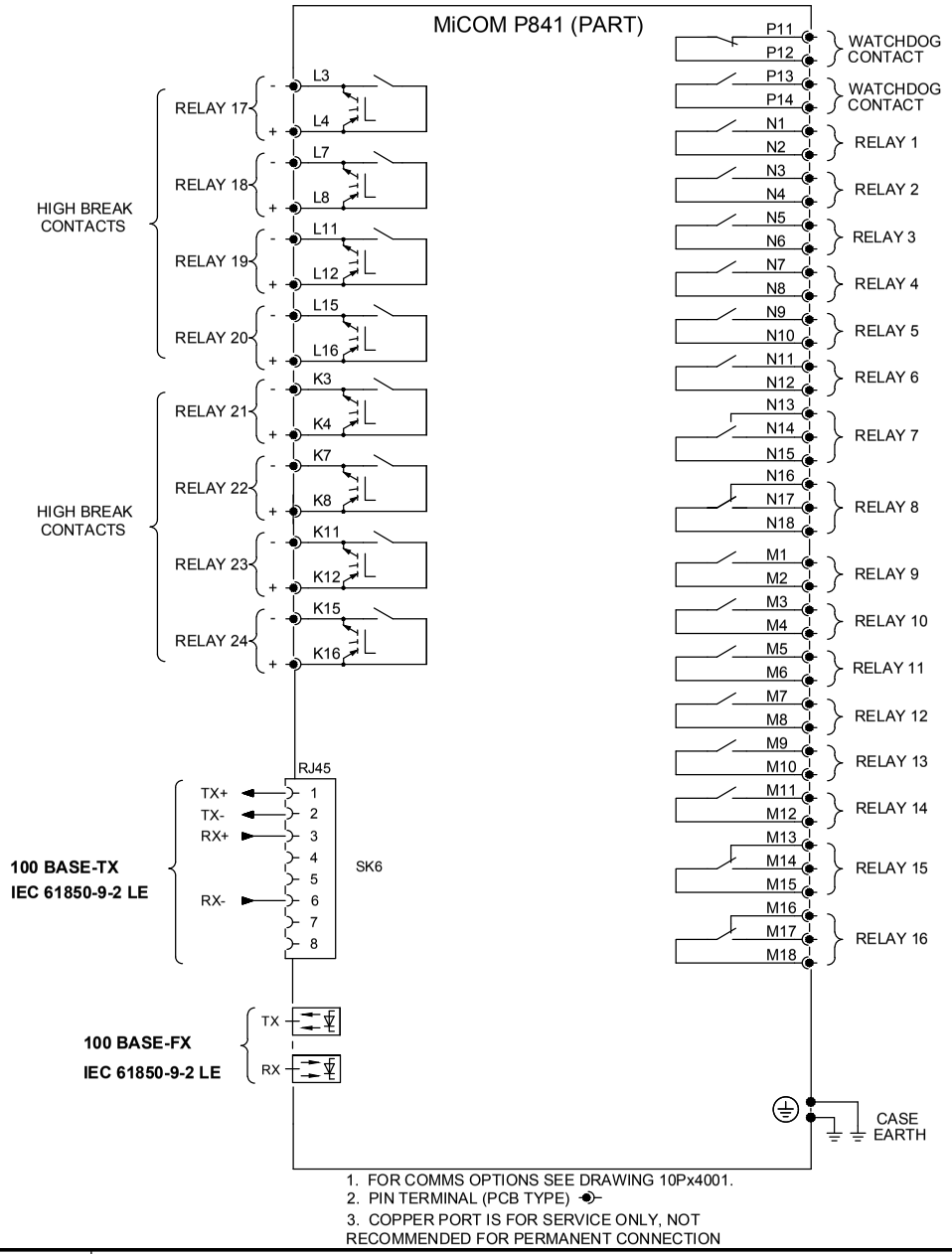

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Issue: E	Status: **Approved**	Revision: CID006234 - Outline update only	Title: EXT. CONN DIAG : AUTORECLOSE 80TE WITH NCIT 24 INPUTS, 16 STANDARD RELAYS & 8 HIGH BREAK RELAYS		
Date: 23/12/19	Name: S Burton		Drg No: **10P84107**	Sht: 1 / Next Sht: 2	©UK Grid Solutions Ltd St Leonards Building Harry Kerr Drive, Stafford. ST16 1WT, UK
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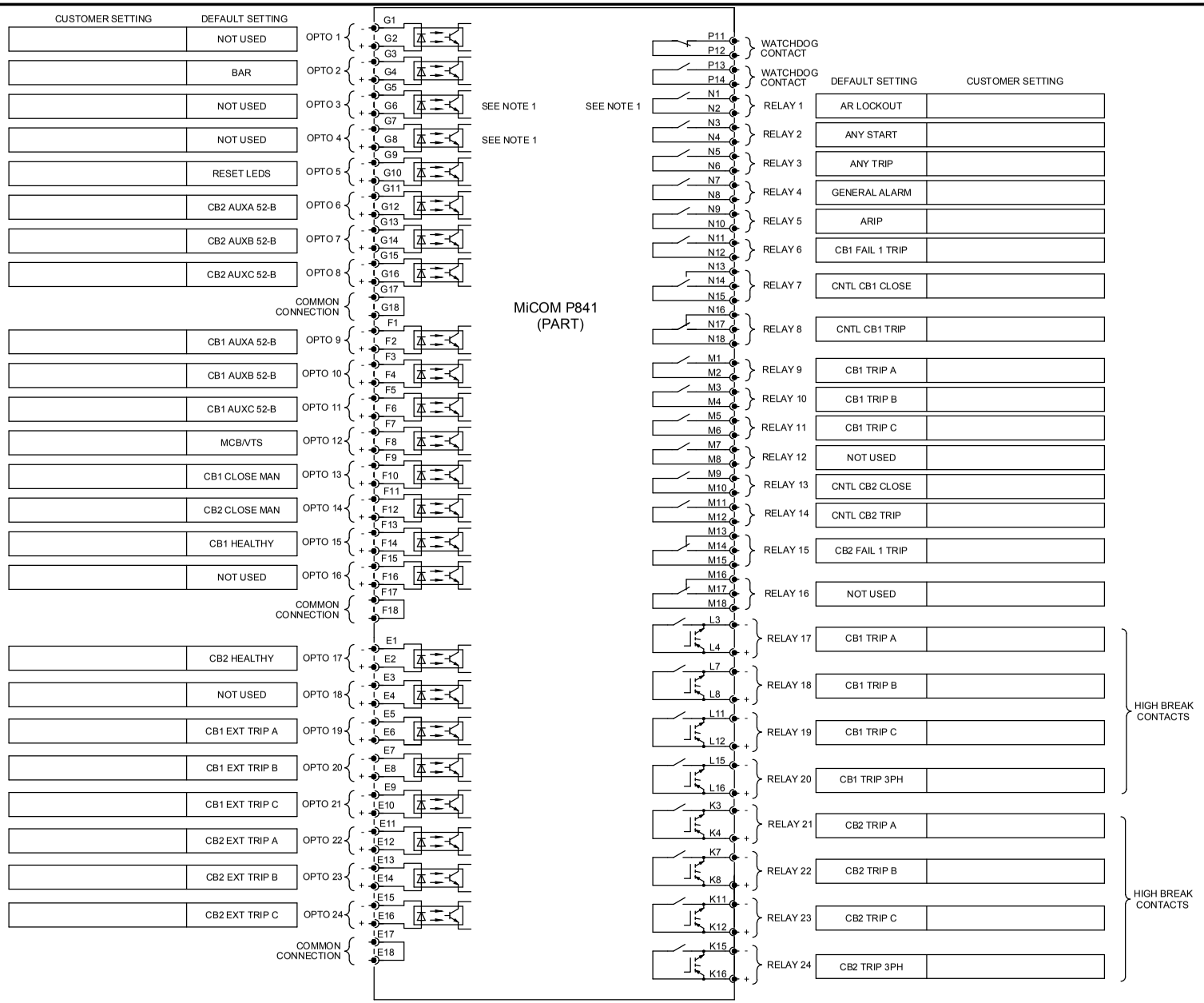

NOTE 1:
ONLY FOR RELAYS WITH DISTANCE PROTECTION OPTION.

Issue: C	Status: **Approved**	Revision: CID006234 - Outline update only	Title: EXT. CONN DIAG : AUTORECLOSE 80TE WITH NCIT 24 INPUTS, 16 STANDARD RELAYS & 8 HIGH BREAK RELAYS	
Date: 23/12/19	Name: S Burton		Drg No: **10P84107**	Sht: 2
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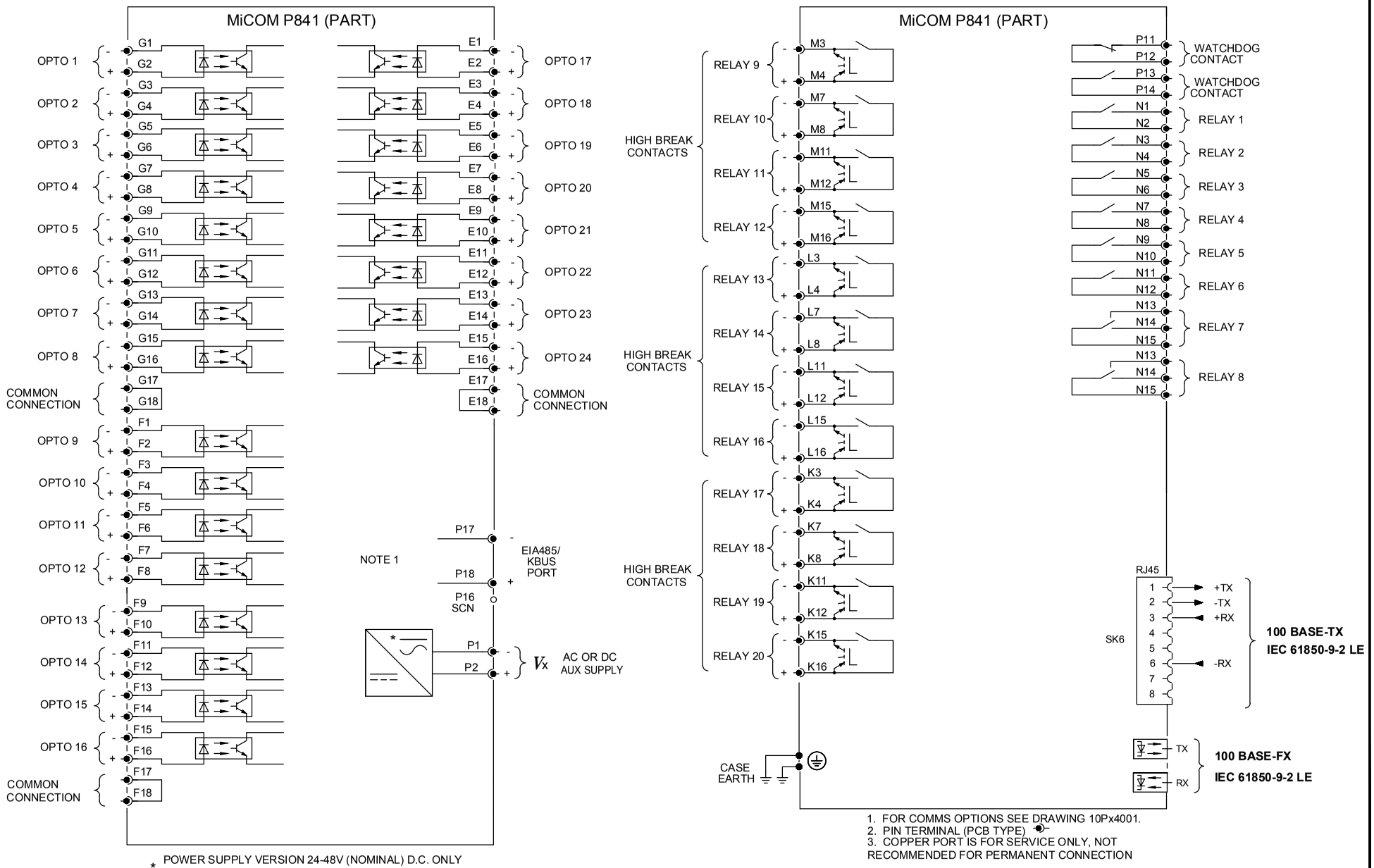

1. FOR COMMS OPTIONS SEE DRAWING 10Px4001.
2. PIN TERMINAL (PCB TYPE)
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Issue: E	Status: **Approved**	Revision: CID006234 - Outline update only	Title: EXT. CONN DIAG : AUTORECLOSE 80TE WITH NCIT 24 INPUTS, 8 STANDARD RELAYS & 12 HIGH BREAK RELAYS		
Date: 23/12/19	Name: S Burton		Drg No: **10P84108**	Sht: 1	©UK Grid Solutions Ltd St Leonards Building Harry Kerr Drive, Stafford. ST16 1WT, UK
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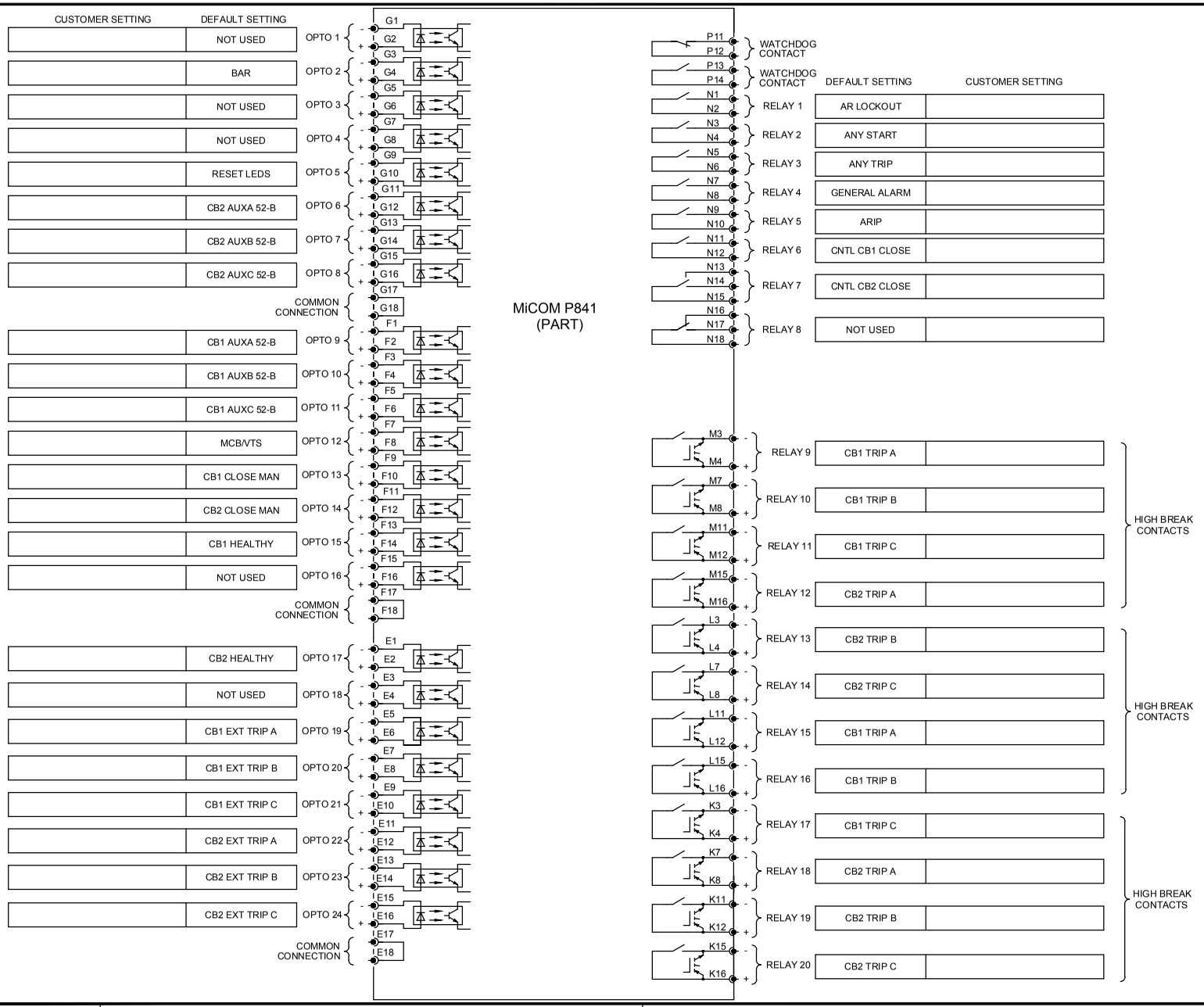

Issue: C	Status: **Approved**	Revision: CID006234 - Outline update only	Title: EXT. CONN DIAG : AUTORECLOSE 80TE WITH NCIT 24 INPUTS, 8 STANDARD RELAYS & 12 HIGH BREAK RELAYS
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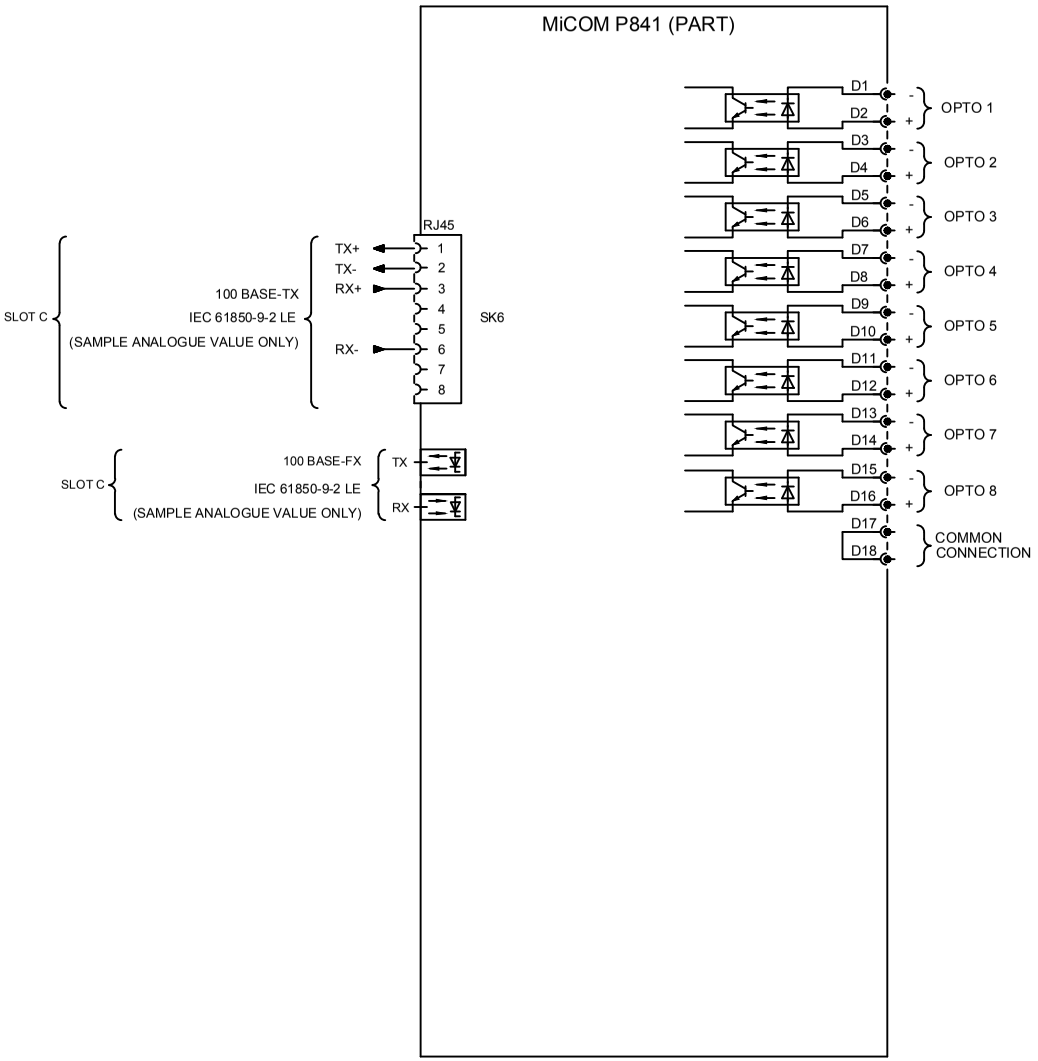

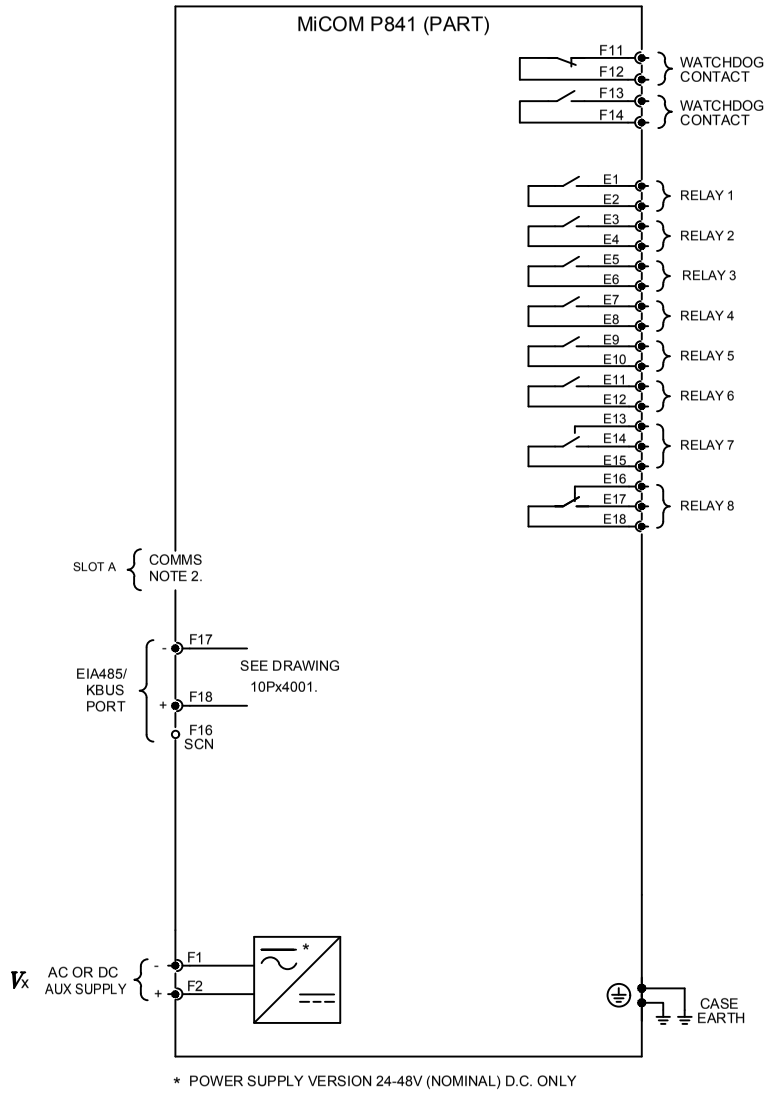

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NOTES .

1. PIN TERMINAL (P.C.B. TYPE)
2. FOR COMMS OPTIONS SEE DRAWING 10Px4001

Issue: E	Revision: CID006234 Outlines updated to GE Format		Title: EXT CONN DIAG AUTORECLOSE 40TE WITH NCIT 8 OPTO INPUTS, 8 RELAY OUTPUTS	
Date: 4/30/2020	Name: S.J.BURTON		Drg No: 10P84111	Sht: 1
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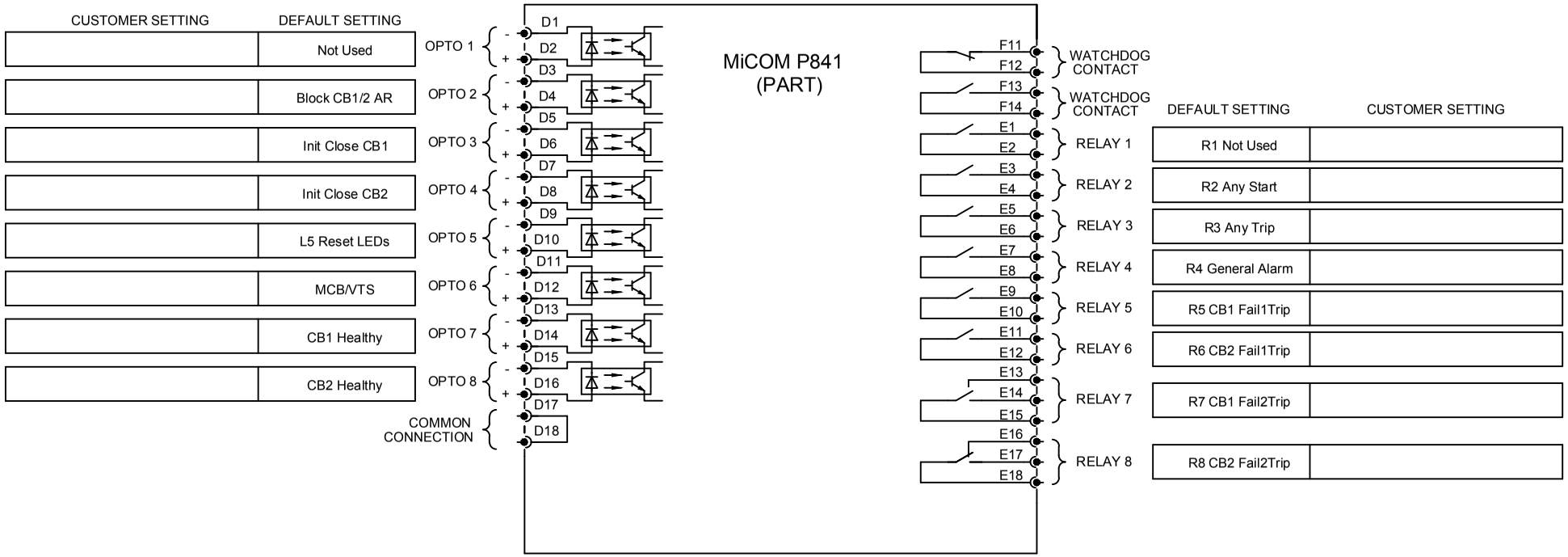

Issue: D	Revision: CID006234 Outlines updated to GE Format		Title: EXT CONN DIAG AUTORECLOSE 40TE WITH NCIT 8 OPTO INPUTS, 8 RELAY OUTPUTS		
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