TERASAKI
Innovators in Protection Technology

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NHP

TemBreak PRO

P Model Moulded Case Circuit Breaker

SMART Electronic Trip Unit from 160A up to 630A

USER MANUAL

Version
1.7.0

NHP Electrical Engineering Products

AU 1300 NHP NHP
NZ 0800 NHP NHP

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Using this manual

Safety Precautions

Authorised Personnel Only
The product or system described in this documentation must be installed, operated and maintained by qualified personnel only. NHP or Terasaki accept no responsibility for the consequences of the use of this equipment by unqualified personnel.
A qualified person is one with the necessary skills and knowledge of the construction and operation of the installation of electrical equipment and has been trained to identify and avoid risks.

Appropriate use of NHP / Terasaki products
NHP / Terasaki products are intended to be used only for the applications described in the catalogue and technical documentation, which is dedicated to them. If products and components from other manufacturers are used, they must be recommended or approved by NHP or Terasaki.
Appropriate use of NHP / Terasaki products during transport, storage, installation, assembly, commissioning, operation and maintenance is necessary to ensure safe operation and without any problems.
The permissible ambient conditions must be met. The information contained in the technical documentation must be observed.

Publication of responsibility
The contents of this document have been reviewed to ensure that the reliability of the information is correct at time of publication.
NHP or Terasaki are not responsible for printing or damage resulting from errors. NHP or Terasaki reserve the right to make corrections and changes needed in subsequent edition.

Warnings and notes
This documentation contains safety instructions that you must follow for your personal safety and to prevent damage to property.
Safety instructions, referring to your personal safety are reported in the literature by a safety alert symbol.

Safety warning symbols and the words below are classified according to the degree of risk.

WARNING: Indicates an imminently hazardous situation which, if it cannot be avoided, will result in death or serious injury.

WARNING: Indicates a potentially hazardous situation which, if it cannot be avoided, can result serious injury or death.

WARNING: Indicates a potentially hazardous situation which, if it cannot be avoided, may cause minor or moderate injury.

Notice: Indicates a warning of property damage and can also indicate important operating and especially useful information on the product, that it should pay particular attention to efficient and safe operation.

Summary of Changes

This section highlights the details of changes made since the previous issue of this document.

The versioning convention used to track changes in this document follows the structure V**x.y.z** where:

x: Major revision, where extensive changes are made which is generally incompatible with the previous version. Such changes may include new products and/or features, or removal of information which is no longer relevant or applicable to the previous version

y: Minor revision, where changes made do not change the overall scope of the previous version, but may include additional information which complements or corrects the previous version, or provides additional clarity on an existing topic.

z: Patch version, where small changes are made to correct minor errors or adjust existing text, charts, figures and/or images, and which do not add or remove information from the previous version. Example changes may include spelling corrections, image re-sizing and adjustments, updated images, etc.

Version	Publication date	Changes	By
V 1.0.0	19-Apr-2021	Initial release	D.NAT
V 1.1.0	26-Apr-2021	Product information corrections	D.NAT
V 1.2.0	13-May-2021	Clearance distance corrections	N.ALEX
V 1.2.1	24-May-2021	Typo corrections to Part Number Break Down	N.ALEX
V 1.3.0	28-May-2021	Label Identification section added, Temperature Rating tables aligned headings with TD-001-EN, I^2t Curves updated in image quality, added references and links to, TD-001-EN, TD-002-EN, TD-003-EN, & Type2_TBpro_MotorStartTables-TD-001-EN Added links to TemView_PRO-UM-001-EN & TemCom_PRO-UM-001-EN	N.ALEX
V 1.3.1	10-June-2021	Fixed typo on TPED part number and Fixed typo on P250 Let-through scale	N.ALEX
V 1.4.0	20-August-2021	Added ampere data for SMART AUX, fixed typo on Part Number Break Down, correction to P160 Information table data, added resistance watts loss, corrected typo rewording in Navigation section, Clearance section links to Installation Manuals added	N.ALEX
V 1.5.0	20-Jan-2022	Changed watts loss and temperature tables to match TD-001-EN	N.ALEX
V 1.6.0	09-Feb-2022	Added LTD equation, fixed table of contents error and headers error	N.ALEX
V 1.7.0	19-Sept-2022	Added Data around I^2t functions for STD, GF & Thermal Self-Protection, fixed heading issues, fixed thermal imaging key, OCR references changed to “Trip Unit”, Added Annex G, Added information on TP2 to TBP ZSI, added Internal Accessories terminal designations to Annex G	N.ALEX

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Table of Contents

Table of Contents

Introduction

This user manual describes the TemBreak *PRO* Smart Energy (**P_SE**) MCCB features and instructions for use, and provides information for commissioning and configuring.

Some additional features may require the use of additional products and accessories to achieve full utilization of that feature. Refer the respective User Manual in the TemBreak *PRO* series for additional information on the respective product.

> **Notice**: Not all Smart Trip Units in the TemBreak *PRO* series are identical. This document specifically covers the P_SE Trip Units only. Refer to the respective Smart Trip Unit User Manual (e.g. B_SE User Manual) for information and instructions on other Smart Trip Units in the TemBreak *PRO* series.

Who Should Use This Manual?

This manual aims to provide users, electricians, panel builders and maintenance personnel, with the technical information required for commissioning and operation of the NHP / Terasaki TemBreak *PRO* P_SE MCCB.

Users of this document must have at minimum a basic understanding of electrical circuit protection topics including (but not limited to):

- Power distribution and reticulation
- Circuit protection devices
- Fault currents
- Arc faults
- Temperature rise and thermal derating of switchgear

Additional resources

The following resources contain additional information which should be read in conjunction with this document.

Resource	Description
NHP/Terasaki TemBreak *PRO* P_SE Installation Instructions P160_3_SE-IN-001-EN P160_4_SE-IN-001-EN P250_3_SE-IN-001-EN P250_4_SE-IN-001-EN P400_3_SE-IN-001-EN P400_4_SE-IN-001-EN P630_3_SE-IN-001-EN P630_4_SE-IN-001-EN	Information on installing, mounting, and wiring the TemBreak *PRO* Smart Energy MCCB.
NHP/Terasaki TemView *PRO* Installation Instructions TemView_PRO-IN-001-EN	Information on installing, mounting, and wiring the TemView *PRO* external display.
NHP/Terasaki TemView *PRO* User Manual TemView_PRO-UM-001-EN	Reference guide for the TemView *PRO* external display including information for installation, wiring, commissioning, configuration, and troubleshooting.
NHP/Terasaki TemCom *PRO* Installation Instructions TemCom_PRO-IN-001-EN	Information on installing, mounting, and wiring the TemCom *PRO* communications module.
NHP/Terasaki TemCom *PRO* User Manual TemCom_PRO-UM-001-EN	Reference guide for the TemCom *PRO* communication module including information for installation, wiring, commissioning, configuration, and troubleshooting.
Technical Data – Temperature and Watts Loss TBP-TD-001-EN	Temperature and Watts Loss tables for TemBreak *PRO* Moulded Case Circuit Breakers.
Technical Data – Cascading and Selectivity TBP-TD-002-EN	Cascading and Selectivity tables for TemBreak *PRO* Moulded Case Circuit Breakers with Din-T, Din-Safe, & MOD6 MCBs/RCBOs
Technical Data – Coordination TBP-TD-003-EN	Socomec Backup Tables with TemBreak *PRO* Moulded Case Circuit Breakers
Technical Data – Type 2 Coordination Type2_TBpro_MotorStartTables-TD-001-EN	Type 2 Coordination for Premium Efficiency Motor Starters with TemBreak *PRO* Moulded Case Circuit Breakers

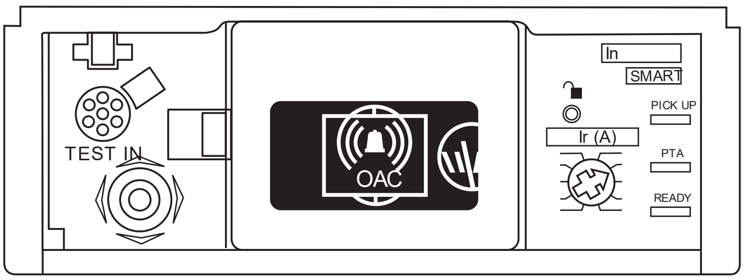
Introduction

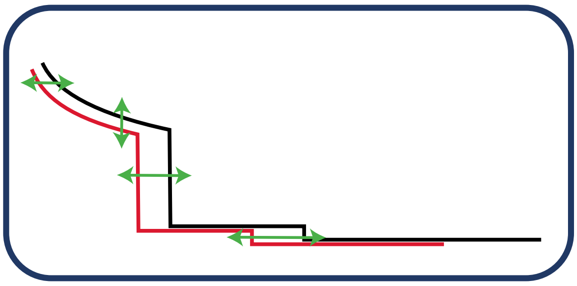
Terminology and Abbreviations

Abbreviation	Description	Abbreviation	Description
ACP	Auxiliary Communications port: Plug for Smart auxiliary / alarm contact block	**MIP**	Maintenance Interface Port: Plug for temporary connection to Trip Unit testing, servicing, and maintenance tools
AL	Alarm: An auxiliary contact indicating trip status	**N**	Neutral
ASCII	American Standard Code for Information Interchange	**NP**	Neutral Protection
AX or AUX	Auxiliary: Auxiliary contact indicating open / closed	**OAC**	Optional Alarm Contact: Connection connector optional alarm output contact
BE	Basic Electronic Trip Unit (dial type, **LSI** and **LSIG**)	**Trip Unit**	Over Current Relay
CCW	Connected Components Workbench software	**P or PTA**	Pre-trip Alarm
CIP [1 2]	[1] Communication Interface Port: Plug for control power and data for use with the TPED remote display and TPCM communication module [2] Common Industrial Protocol	**PDU**	Protocol Data Unit
CRC	Cyclic Redundancy Check – error-detecting code used at the end of each Modbus message	**PELV**	Protected Extra Low Voltage (earthed system)
dec	Decimal (base-10) numbering system	**PTA**	Pre-Trip Alarm: is a programmable output contact to advise when a trip may be imminent.
DINT	Signed Double Integer datatype (4 bytes or 32 bits in length)	**RTU**	Remote Terminal Unit
EIPM	TemBreak *PRO* Ethernet/IP Module	**S or STD**	Short Time Delay Protection
FF	Fixed Thermal and Fixed Magnetic	**SE**	Smart Energy Trip Unit
FM	Fixed Thermal and Adjustable Magnetic	**SELV**	Separated Extra Low Voltage
G or GF	Ground Fault Protection	**SN**	Solid Neutral
hex	Hexadecimal (base-16) numbering system	**SSID**	Service Set Identifier (name of the Wi-Fi wireless network)
I or INST	Instantaneous Protection	**STR**	String datatype
IEC	International Electrotechnical Commission	**TCP**	Transmission Control Protocol
IEEE	Institute of Electrical and Electronics Engineers	**TF**	Adjustable Thermal and Fixed Magnetic
I_g	Ground Fault Protection Current	**THD**	Total Harmonic Distortion
I_i	Instantaneous Protection Current	**TM**	Adjustable Thermal Magnetic
I_n	Rated Current	**TPCM**	TemCom *PRO* Communication Module
I_N	Neutral Protection Current	**TPED**	TemView *PRO* External Display
INT	Signed Integer datatype (2 bytes or 16 bits in length)	t_r	LTD Time delay
IP	International Protection (Ingress Protection)	t_{sd}	STD Time delay
I_r	LTD Protection Current	t_{tsp}	Thermal Self-Protection Time delay
I_{sd}	STD Protection Current	**UDINT**	Unsigned Integer (2 bytes or 16-bits in length)
I_{tsp}	Thermal Self-Protection Current	**UINT**	Unsigned Integer (2 bytes or 16 bits in length)
L or LTD	Long Time Delay Protection	**ULINT**	Unsigned Long Integer datatype (8 bytes or 64 bits in length)
LCD	Liquid Crystal Display (LCD)	**URLs**	Uniform Resource Locator (address of an Internet website)
LED	Light Emitting Diode	**WORD**	2 bytes or 16-bits of data
LINT	Signed Long Integer datatype (8 bytes or 64 bits in length)	**ZSI**	Zone Selective Interlocking (zone selectivity)
LSI	Long Time, Short Time and Instantaneous Protection	θ	Thermal imaging value
LSIG	Long Time, Short Time, Instantaneous and Ground Fault Protection	θ_C	Cold start mode thermal imaging value
MCCB	Moulded Case Circuit Breaker	θ_H	Hot start mode thermal imaging value
microSD	Micro Secure Digital	θ_{trip}	Thermal imaging value tripping threshold

Product Information

The TemBreak *PRO* P model SMART Electronic MCCB with Trip Unit type P_SE, in addition to protecting against overloads and short circuits, offers flexibility via provide fully adjustable LSIG (long time, short time, instantaneous, ground fault) protection settings via the embedded OLED display as well as a host of other standard or optional features. This allows for improved selectivity combinations between MCCBs or other circuit breaker types, plus a wide range of energy measurement and communication functions.





Features

- Setting by rotary switch, joystick and embedded display.
- Signalling the Trip Unit LED status (Ready).
- Signalling PTA overload pre-warning LED (adjustable threshold)
- LED signalling overload alarm (> Ir).
- Possible adjustment of thresholds and time delays for LSIG protection.
- Possible adjustment of the protection of the neutral pole on 4-pole versions (neutral pole positioned to the right).

Frame Sizes

- P160
- P250
- P400
- P630

Protection Functions

- Long Time Delay
- Short Time Delay
- Instantaneous
- Ground Fault
- Neutral Protection (4 Pole only)
- Zone Interlocking

Measurement Functions

The P_SE Trip Unit complies with the requirements of IEC 61557-12 and can be used for metering.
Measurements such as voltage, current, power, THD, frequency and power factor can be sourced from the MCCBs Trip Unit.

Alarm Management

Standard alarms and custom alarms can be setup using the TCPM or TPED.

Historical Events

The P_SE Trip Unit will store measurement history and events; to access this data a TPCM or TPED is required to display these events.

Additional Certificates

Product Information

Part Number Break Down

P	160	F	2	4	160	BE	G
a)	b)	c)	d)	e)	f)	g)	h)

a) Model Type

A	Basic applications (160…250 A)
P	Mid to advanced applications (160…630 A)
B	High current, high kA applications (160…1600 A)
ZS	Earth Leakage applications (125…250 A)
XS	Highest current applications (2000…3200 A)

b) Ampere Frame

125	A
160	A
250	A
400	A
630	A
800	A
1000	A
1250	A
1600	A
2000	A
2500	A
3200	A

c) Short Circuit Break Capacity I_{cu} (kA)

R	200 kA
L	150 kA
P	125 kA
S	110 kA
G	100 kA
HL	85 kA
H	70 kA
M	65 kA
N	50 kA
F	36 kA
E	25 kA
D	Switch

d) Pole Pitch Size (mm) 1)

1	25
2	30
3	35

e) No. of Poles

1	7)
2	8)
3	
4	

f) Trip Unit Rating (I_n)

I_n x A

g) Trip Unit Type

TF	Adj Thermal Fix Magnetic 4)
FF	Fix Thermal Fix Magnetic
TM	Adj Thermal Adj Magnetic
SX	Smart Ammeter 5) 6)
BE	Basic Electronic 6)
SE	Smart Energy 6)
NN	Non-Auto Switch

h) Trip Unit Option

G	Ground Fault 2)
N	Neutral 2)
P	Pre-Trip Alarm 3)
SN	Solid Neutral 9)

Notice: Not all combinations are possible. Confirm part number combination with NHP for availability.

1. 160AF only
2. For P_SE versions these features are standard and therefore are not added to the end of the part number.
3. PTA is standard with P electronic models and therefore P is not added to the end of the part number.
4. Only available in A & ZS models
5. Only available in B models
6. Not available in A and ZS models
7. Only available in A and B models (FF Only Trip Unit)
8. Not available in A and B models (FF Only Trip Unit)
9. ZS Models

Product Information

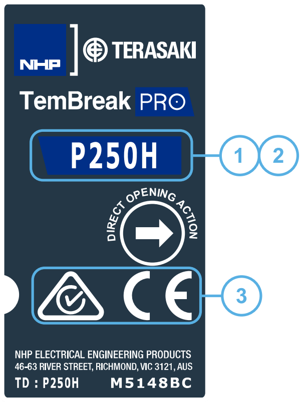
Available MCCBs in the TemBreak *PRO* range:

Rating Short Circuit Break Capacity (kA)		Frame Size										
		160	250	400	630	800	1000	1250	1600	2000	2500	3200
E	*25*	A160E – TF A160E – FF B160E – FF	A250E – TM	P400E-TM	P630E – TM							
F	*36*	A160F – TF P160F – FF P160F – TM P160F – BE P160F – BEG P160F – SE	A250F – TM P250F – TM P250F – BE P250F – BEG P250F – SE	P400F – TM P400F – BE P400F – BEG P400F – SE	P630F – TM P630F – BE P630F – BEG P630F – SE	B800F – TM						
N	*50*	P160N – TM P160N – BE P160N – BEG P160N – SE	P250N – TM P250N – BE P250N – BEG P250N – SE	P400N – TM P400N – BE P400N – BEG P400N – SE	P630N – TM P630N – BE P630N – BEG P630N – SE	B800N – TM B800N – BE B800N – SX B800N – SE	B1000N – BE B1000N – BEG B1000N – SX B1000N – SE	B1250N – BE B1250N – BEG	B1600N – BE B1600N – BEG			
H	*70*	P160H – TM P160H – BE P160H – BEG P160H – SE	P250H – TM P250H – BE P250H – BEG P250H – SE	P400H – TM P400H – BE P400H – BEG P400H – SE	P630H – TM P630H – BE P630H – BEG P630H – SE	B800H – TM B800H – BE B800H – BEG B800H – SX B800H – SE	B1000H – BE B1000H – BEG B1000H – SX B1000H – SE	B1250H – BE B1250H – BEG				
HL	*85*							B1250HL – BE B1250HL – BEG	B1600HL – BE B1600HL – BEG	XS2000HL – BE XS2000HL – BEG	XS2500HL – BE XS2500HL – BEG	XS3200HL – BE
G	*100*					B800G – TM B800G – BE B800G – BEG B800G – SX B800G – SE						
S	*110*			P400S – TM P400S – BE P400S – BEG P400S – SE	P630S – TM P630S – BE P630S – BEG P630S – SE							
P	*125*	B160P – TM	B250P – TM B250P – BE B250P – SE	B400P – BE B400P – BEG		B800P – BE B800P – BEG B800P – SX B800P – SE						
R	*200*	B160R – TM	B250R – TM	B400P – BE B400P – BEG		B800R – BE B800R – BEG B800R – SX B800R – SE						
D	*Switch*	A160D – NN P160D – NN	A250D – NN P250D – NN	P400D – NN	P630D – NN	B800D – NN	B1000D – NN	B1250D – NN	B1600D – NN	XS2000D – NN	XS2500D – NN	

Product Information

Label Identification

The label on the MCCB features information to aid in product identification.



<table>
<tr><th></th><th>Description</th><th>Notes</th></tr>
<tr><td>1</td><td>Circuit Break Identifier</td><td>Identifies the model type, ampere frame, and I_{cu} rating.</td></tr>
<tr><td>2</td><td>Trip Unit type</td><td>The Trip Unit type is indicated by the colour of the label.

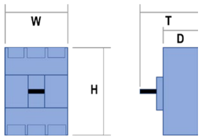
White label – Thermal-magnetic type Trip Unit
<table><tr><td>Trip Units</td><td>FF, TF, FM, TM</td></tr><tr><td>Models</td><td>A, P, B, ZS</td></tr><tr><td>Ampere Frame</td><td>125 – 800</td></tr></table>


Grey label – electronic or non-auto type Trip Unit. To distinguish between the two, electronic Trip Units will have the “I_{cu}” letter and non-auto will use the letter “D”, Switch.
<table><tr><td>Trip Units</td><td>BE, BEG, BEGN , NN</td></tr><tr><td>Models</td><td>A, P, B, XS</td></tr><tr><td>Ampere Frame</td><td>160 – 3200</td></tr></table>


Blue Label – SMART electronic type Trip Unit
<table><tr><td>Trip Units</td><td>SX, SE</td></tr><tr><td>Models</td><td>P, B</td></tr><tr><td>Ampere Frame</td><td>160 – 1000</td></tr></table>
</td></tr>
<tr><td>3</td><td>Certifications</td><td>Identifies the additional localised certifications of the product, in addition to the international product standard, IEC 60947-2 / AS/NZS IEC 60947-2.
For additional certifications please contact NHP.</td></tr>
</table>

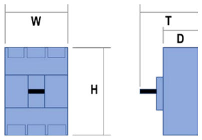
Product Information

P160_SE and P250_SE Information

Frame / Model	Attribute	Unit	Condition	P160F	P160N	P160H	P250F	P250N	P250H
Number of Poles				3, 4	3, 4	3, 4	3, 4	3, 4	3, 4
Nominal current ratings Trip Unit ratings	I_{CT}	(A)	@ 50°C	40 A 100 A 160 A —	40 A 100 A 160 A —	40 A 100 A 160 A —	40 A 100 A 160 A 250 A	40 A 100 A 160 A 250 A	40 A 100 A 160 A 250 A
Electrical characteristics									
Rated maximum operational voltage	U_e	(V)	AC 50/60 Hz	690	690	690	690	690	690
		(V)	DC	—	—	—	—	—	—
Rated insulation voltage	U_i	(V)		800	800	800	800	800	800
Rated impulse withstand voltage	U_{imp}	(kV)		8	8	8	8	8	8
Selectivity category				A	A	A	A	A	A
Rated short time withstand current	I_{cw}	(kA)	0.4 sec	—	—	—	—	—	—
Ultimate breaking capacity	I_{cu}	(kA)	690 Vac	6	6	6	6	6	6
(IEC, JIS, AS/NZS)			400 /415 Vac	36	50	70	36	50	70
			240 Vac	50	85	85	50	85	85
Service breaking capacity	I_{cs}	(kA)	690 Vac	6	6	6	6	6	6
(IEC, JIS, AS/NZS)			400 /415 Vac	36	50	50	36	50	50
			220 /240 Vac	50	85	85	50	85	85
Protection - Over Current Release types									
SE Smart (Meter) Trip Unit fully adjustable LSIG	Std	Standard							
LT Adjustable 40% to 100% in 1% increments	Opt	Optional		—	—	—	—	—	—
LT Adjustable 40% to 100% in 1A increments	—	Not Available		Std	Std	Std	Std	Std	Std
Instantaneous setting independently adjustable	M Req	Module Required		Std	Std	Std	Std	Std	Std
TPED and TPCM compatible				Std	Std	Std	Std	Std	Std
Modbus RTU				M Req	M Req	M Req	M Req	M Req	M Req
Installation (Std / Opt / —)									
Front connection (FC)				Std	Std	Std	Std	Std	Std
Extension bar (FB)	Std	Standard		Opt	Opt	Opt	Opt	Opt	Opt
Cable tunnel clamp (FW)	Opt	Optional		Opt	Opt	Opt	Opt	Opt	Opt
Rear Connection (RC)	—	Not Available		Opt	Opt	Opt	Opt	Opt	Opt
DIN rail adaptor				Opt	Opt	Opt	Opt	Opt	Opt
Withdrawable mechanism				Opt	Opt	Opt	Opt	Opt	Opt
Plug-in				Opt	Opt	Opt	Opt	Opt	Opt
Reverse supply connection possible to 440V				Yes	Yes	Yes	Yes	Yes	Yes
Dimensions 	H	(mm)		130	130	130	165	165	165
	W	(mm)	1 pole	—	—	—	—	—	—
			2 pole	—	—	—	—	—	—
			3 pole	90	90	90	105	105	105
			4 pole	120	120	120	140	140	140
	D	(mm)		68	68	68	68	68	68
	T	(mm)		95.5	95.5	95.5	95.5	95.5	95.5
Weight	W	(kg)	3 pole	1.0	1.0	1.0	1.5	1.5	1.5
			4 pole	1.3	1.3	1.3	2	2	2
Operation options (Std / Opt / —)	Std	Standard							
Toggle operation	Opt	Optional		Std	Std	Std	Std	Std	Std
Extension handle TP-HS/HP or Direct mount T2HB	—	Not Available		Opt	Opt	Opt	Opt	Opt	Opt
Motor operation TP-MC				Opt	Opt	Opt	Opt	Opt	Opt
Endurance	Electrical	Cycles	415 Vac	30000	30000	30000	10000	10000	10000
	Mechanical	Cycles		50000	50000	50000	30000	30000	30000

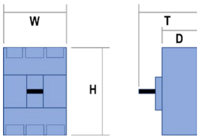
Product Information

P400_SE Information

Frame / Model	Attribute	Unit	Condition	P400F	P400N	P400H	P400S
Number of Poles				3, 4	3, 4	3, 4	3, 4
Nominal current ratings Trip Unit ratings	I_{CT}	(A)	@ 50°C	250 A 400 A	250 A 400 A	250 A 400 A	250 A 400 A
Electrical characteristics							
Rated maximum operational voltage	U_e	(V) (V)	AC 50/60 Hz DC	690 —	690 —	690 —	690 —
Rated insulation voltage	U_i	(V)		800	800	800	800
Rated impulse withstand voltage	U_{imp}	(kV)		8	8	8	8
Selectivity category				B	B	B	B
Rated short time withstand current	I_{cw}	(kA)	0.4 sec	5	5	5	5
Ultimate breaking capacity (IEC, JIS, AS/NZS)	I_{cu}	(kA)	690 Vac	7	12	12	12
			400 /415 Vac	36	50	70	110
			240 Vac	50	85	100	125
Service breaking capacity (IEC, JIS, AS/NZS)	I_{cs}	(kA)	690 Vac	7	12	12	12
			400 /415 Vac	36	50	70	110
			220 /240 Vac	50	85	100	125
Protection - Over Current Release types Smart (Meter) Trip Unit fully adjustable LSIG LT Adjustable 40% to 100% in 1% increments LT Adjustable 40% to 100% in 1A increments Instantaneous setting independently adjustable TPED and TPCM compatible Modbus RTU	Std Opt — M Req	Standard Optional Not Available Module Required		— Std Std Std M Req	— Std Std Std M Req	— Std Std Std M Req	— Std Std Std M Req
Installation (Std / Opt / —) Front connection (FC) Extension bar (FB) Cable tunnel clamp (FW) Rear connection (RC) DIN rail adaptor Withdrawable mechanism Plug-in	Std Opt —	Standard Optional Not Available		Std Std Opt Opt — Opt Opt	Std Std Opt Opt — Opt Opt	Std Std Opt Opt — Opt Opt	Std Std Opt Opt — Opt Opt
Reverse supply connection possible to 440V				Yes	Yes	Yes	Yes
Dimensions 	H	(mm)		260	260	260	260
	W	(mm)	1 pole	—	—	—	—
			2 pole	—	—	—	—
			3 pole	140	140	140	140
			4 pole	185	185	185	185
	D	(mm)		103	103	103	103
	T	(mm)		145	145	145	145
Weight	W	(kg)	3 pole	4.3	4.3	4.3	4.3
			4 pole	5.7	5.7	5.7	5.7
Operation options (Std / Opt / —) Toggle operation Extension handle TP-HS/HP or Direct mount T2HB Motor operation TP-MC	Std Opt —	Standard Optional Not Available		Std Opt Opt	Std Opt Opt	Std Opt Opt	Std Opt Opt
Endurance	Electrical Mechanical	Cycles Cycles	415 Vac	6000 15000	6000 15000	6000 15000	6000 15000

Product Information

P630_SE Information

Frame / Model	Attribute	Unit	Condition	P630F	P630N	P630H	P630S
Number of Poles				3, 4	3, 4	3, 4	3, 4
Nominal current ratings	I_{CT}	(A)	@ 50°C	630A	630A	630A	630A
Trip Unit ratings							
Electrical characteristics							
Rated maximum operational voltage	U_e	(V)	AC 50/60 Hz	690	690	690	690
		(V)	DC	—	—	—	—
Rated insulation voltage	U_i	(V)		800	800	800	800
Rated impulse withstand voltage	U_{imp}	(kV)		8	8	8	8
Selectivity category				A	A	A	A
Rated short time withstand current	I_{cw}	(kA)	0.4 sec	—	—	—	—
Ultimate breaking capacity	I_{cu}	(kA)	690 Vac	7	12	12	12
(IEC, JIS, AS/NZS)			400 /415 Vac	36	50	70	110
			240 Vac	50	85	100	125
Service breaking capacity	I_{cs}	(kA)	690 Vac	7	12	12	12
(IEC, JIS, AS/NZS)			400 /415 Vac	36	50	70	110
			220 /240 Vac	50	85	100	125
Protection - Over Current Release types							
Smart (Meter) Trip Unit fully adjustable LSIG							
LT Adjustable 40% to 100% in 1% increments	Std	Standard		—	—	—	—
LT Adjustable 40% to 100% in 1A increments	Opt	Optional		Std	Std	Std	Std
Instantaneous setting independently adjustable	—	Not Available		Std	Std	Std	Std
TPED and TPCM compatible	M Req	Module Required		Std	Std	Std	Std
Modbus RTU				M Req	M Req	M Req	M Req
Installation (Std / Opt / —)							
Front connection (FC)				Std	Std	Std	Std
Extension bar (FB)				Std	Std	Std	Std
Cable tunnel clamp (FW)	Std	Standard		Opt	Opt	Opt	Opt
Rear connection (RC)	Opt	Optional		Opt	Opt	Opt	Opt
DIN rail adaptor	—	Not Available		—	—	—	—
Withdrawable mechanism				Opt	Opt	Opt	Opt
Plug-in				Opt	Opt	Opt	Opt
Reverse supply connection possible to 440V				Yes	Yes	Yes	Yes
Dimensions 	H	(mm)		260	260	260	260
	W	(mm)	1 pole	—	—	—	—
			2 pole	—	—	—	—
			3 pole	140	140	140	140
			4 pole	185	185	185	185
	D	(mm)		103	103	103	103
	T	(mm)		145	145	145	145
Weight	W	(kg)	3 pole	5.0	5.0	5.0	5.0
			4 pole	6.6	6.6	6.6	6.6
Operation options (Std / Opt / —)	Std	Standard					
Toggle operation	Opt	Optional		Std	Std	Std	Std
Extension handle TP-HS/HP or Direct mount T2HB	—	Not Available		Opt	Opt	Opt	Opt
Motor operation TP-MC				Opt	Opt	Opt	Opt
Endurance	Electrical	Cycles	415 Vac	4000	4000	4000	4000
	Mechanical	Cycles		15000	15000	15000	15000

Internal Accessories

Internal accessories include Auxiliary and Alarm contacts, Shunt Trip and Undervoltage Trip (UVT) modules, which may be installed under the front cover of the MCCB in various combinations to provide additional functionality and connection with external control circuits.

Auxiliary & Alarm Switches

Auxiliary Contact

An auxiliary contact can be installed to indicate whether an MCCB is Open (both OFF and Tripped positions) or Closed (ON). Auxiliary contacts come in either general purpose or micro-switch type, with some combinations pre-wired or with terminals. Each contact type is provided as a single change-over switching arrangement (1x C/O).

Alarm Contact

An alarm contact can be installed to indicate whether an MCCB is in the Tripped or Not Tripped position (ON, OFF). Alarm contacts come in either general purpose or micro-switch type, with some combinations pre-wired or with terminals. Each contact type is provided as a single change-over switching arrangement (1x C/O).

Part Number	Description	Contact Type	Connection Type
T2AX00LML3SWA	Auxiliary	General purpose	Pre-wired
T2AX00LML3STA	Auxiliary	General purpose	Terminal
T2AX00LML3RWA	Auxiliary	Micro-switch	Pre-wired
T2AL00LML3SWA	Alarm; left side only	General purpose	Pre-wired
T2AL00LML3STA	Alarm; left side only	General purpose	Terminal
T2AL00LML3RWA	Alarm; left side only	Micro-switch	Pre-wired

General purpose contact						
AC (V)			DC (V)			Minimum Load
Volts (V)	Amperes (A) Resistive Load	Amperes (A) Inductive Load	Volts (V)	Amperes (A) Resistive Load	Amperes (A) Inductive Load	
480	—	—	250	—	—	100 mA @ 15 Vdc
250	3	2	125	0.4	0.05	
125	3	2	30	3	2	

Micro-switch contact		
DC (V)		Minimum Load
Volts (V)	Amperes (A) Resistive Load	
30	0.1	1 mA @ 5 Vdc

SMART Auxiliary AX / AL Status Indicator

The SMART auxiliary is dedicated to TemBreak *PRO* SMART MCCB range. It allows the SMART Trip Unit to log and count the number of opening / closing cycles, counting the number of electromechanical fault trips and indicate the actual mechanical OPEN CLOSED TRIP status of the breaker's main contacts. The auxiliary mounts inside the MCCB and is connected to the MCCBs Trip Unit via the "ACP" connector socket inside the MCCB, which is under the MCCBs accessory cover. It takes the position of 1 Aux and 1 Alarm on the left-hand side of the MCCB.

The SMART contact blocks are available in three versions:

Part Number	Description
TPSS00MXLSW	Auxiliary contact SMART AX / AL, standard type use for applications 125 – 250 Vac
TPSS00MXLRW	Auxiliary contact SMART AX / AL, micro-current type use for applications 125 Vac 100mA / 24 - 30 Vdc 100mA (e.g. PLC applications)
TPSS00NA	AX / AL SMART MCCB Cycle Counter

Notice: The TPSS00MXLSW and TPSS00MXLRW types include voltage free switching contacts AX and AL. These contacts are provided with pre-wired wired contacts.

Notice: It is recommended to use 24 Vdc backup supply to the MCCB to ensure the SMART AUX continues to operate in the event of upstream power failure.

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Internal Accessories

Shunt Trip

A shunt (normally de-energized) can be installed to trip the MCCB by applying voltage to the shunt coil.

Part Number	Rated voltage AC (V)	Rated voltage DC (V)	Connection Type
T2SH00LA10T	110	—	Terminal
T2SH00LA20T	230…240	—	Terminal
T2SH00LA40T	400…415	—	Terminal
T2SH00LD01T	—	12	Terminal
T2SH00LD02T	—	24	Terminal
T2SH00LD04T	—	48	Terminal
T2SH00LD10T	—	110	Terminal
T2SH00LD20T	—	230	Terminal
T2SH00LA10WA	110	—	Pre-wired cage clamp
T2SH00LA20WA	230…240	—	Pre-wired cage clamp
T2SH00LA40WA	400…415	—	Pre-wired cage clamp
T2SH00LD01WA	—	12	Pre-wired cage clamp
T2SH00LD02WA	—	24	Pre-wired cage clamp
T2SH00LD04WA	—	48	Pre-wired cage clamp
T2SH00LD10WA	—	110	Pre-wired cage clamp
T2SH00LD20WA	—	230	Pre-wired cage clamp

Rated voltage	AC (V)			DC (V)				
	100…120	200…240	380...450	12	24	48	100…120	200…240
Excitation current (mA)	16.0	16.0	6.2	160.0	124.0	32.0	14.0	12.0

Under Voltage Trips

A UVT (normally energized) can be installed to trip the MCCB removing voltage from the UVT coil.

Part Number	Rated voltage AC (V)	Rated voltage DC (V)	Compatible MCCB 3P	Compatible MCCB 4P	Connection Type	Notes
T2UV00LA10NT	110	—	All	P160 / 250	Terminal	Instantaneous
T2UV00LA20NT	230…240	—	All	P160 / 250	Terminal	Instantaneous
T2UV00LA40NT	400…440	—	All	P160 / 250	Terminal	Instantaneous
T2UV00LD02NT	—	24	All	P160 / 250	Terminal	Instantaneous
T2UV00LD10NT	—	110	All	P160 / 250	Terminal	Instantaneous
T2UV00LD20NT	—	230	All	P160 / 250	Terminal	Instantaneous
T2UV00LA10DS	110	—	All	P160 / 250	Terminal	Time Delay 500ms
T2UV00LA24DS	230…240	—	All	P160 / 250	Terminal	Time Delay 500ms
T2UV00LA45DS	440…450	—	All	P160 / 250	Terminal	Time Delay 500ms
T2UV00LD02DS	—	24	All	P160 / 250	Terminal	Time Delay 500ms
T2UV00LD10DS	—	110	All	P160 / 250	Terminal	Time Delay 500ms
T2UV00LD24DS	—	230	All	P160 / 250	Terminal	Time Delay 500ms
T2UV00LA10DL	110	—	—	P400 / 630	Terminal	Time Delay 500ms
T2UV00LA24DL	230…240	—	—	P400 / 630	Terminal	Time Delay 500ms
T2UV00LA40DL	380…415	—	—	P400 / 630	Terminal	Time Delay 500ms
T2UV00LA45DL	440…450	—	—	P400 / 630	Terminal	Time Delay 500ms
T2UV00LD02DL		24	—	P400 / 630	Terminal	Time Delay 500ms
T2UV00LD10DL		110	—	P400 / 630	Terminal	Time Delay 500ms
T2UV00LD24DL		230	—	P400 / 630	Terminal	Time Delay 500ms
T2UV00LA10NWA	110	—	All	P160 / 250	Pre-wired cage clamp	Instantaneous
T2UV00LA20NWA	230…240	—	All	P160 / 250	Pre-wired cage clamp	Instantaneous
T2UV00LA40NWA	440…450	—	All	P160 / 250	Pre-wired cage clamp	Instantaneous
T2UV00LD02NWA	—	24	All	P160 / 250	Pre-wired cage clamp	Instantaneous
T2UV00LD10NWA	—	110	All	P160 / 250	Pre-wired cage clamp	Instantaneous
T2UV00LD20NWA	—	230	All	P160 / 250	Pre-wired cage clamp	Instantaneous

Rated Voltage	AC (V)			DC (V)		
	100…120	200…240	380…450	24	100…120	200…240
Excitation current (mA)	1.3	1.1	2.0	22.0	9.0	3.7

P_SE Only MCCB Accessories

Notice: The following list of accessories are unique to the P_SE model MCCB. For other accessories in the TemBreak *PRO* series, refer to the TemBreak *PRO* technical catalogues, respective user manuals, and installation instructions.

TemView *PRO* (TPED)

The TemView *PRO* (TPED) is an optional backlit LED external display which permits reading and writing data of the P_SE MCCB Trip Unit Trip Unit, including protection settings, energy measurements, alarms, and event logs. It is used where direct access to the embedded display of the MCCB is not permitted, or otherwise enclosed and inaccessible.

The TPED can be panel mounted to any suitable enclosure which houses the MCCB. For example, a switchboard door or panelboard escutcheon. Data from the MCCB is communicated to the TPED via the RJ9 to CIP cable assembly and plugs directly into the dedicated port on the MCCB.

For more information on the TPED, refer to the TemView *PRO* User Manual and Installation instructions.

TPED Function	Read	Write
Protection Settings	✓	✓
Measurements	✓	—
Alarms	✓	✓
Configuration	✓	—
Historical event log	✓	—
Circuit breaker identification data	✓	—

Part Number	Description
TPED00N	External monitor and configurator for P_SE MCCBs

Technical Data

Attribute	Value
Dimensions	97 x 97 x 46 mm (27mm behind the door)
Door cut-out	92 x 92 mm
Screen size	37 x 78 mm
Viewing backlight	Backlit blue
Temperature operation	-10 ° C ... + 55 ° C
Pollution Category	III
Degree of protection	IP65 (rear is IP20)

Terminals/Plugs	Ratings	Notes
Power Supply	Voltage - 24 V DC (+/- 30%)	Supplied via CIP plug from P_SE MCCB
	Current – 85 mA	
Micro USB	—	For upgrading firmware

Notice: Cables are not provided with the TPED. Refer to CIP-RJ9 Cables section for selection.

P_SE Only MCCB Accessories

TemCom *PRO* (TPCM)

The TemCom *PRO* communications module (TPCM) communicates directly with the TemBreak *PRO* Smart Energy MCCB Trip Unit via CIP connection cable, enabling the MCCB to operate as a slave device on a Modbus RTU network via RS-485. The TPCM polls the MCCB at regular intervals, making data accessible within Modbus holding registers. Data may also be written over Modbus to enact changes to the configuration and protection settings of the Trip Unit. The TPCM module also offers optional embedded Digital I/O which is accessible over Modbus 10).

TPCM Function	Read	Write
Protection Settings	✓	✓
Measurements	✓	–
Alarms	✓	✓
Configuration	✓	–
Historical event log	✓	–
Circuit breaker identification data	✓	–
Digital Input/Output Contacts	✓ 1)	✓ 1)

The TPCM utilizes multiple RJ45 MODBUS ports for RS-485 communication. The use of both ports allows daisy chaining of multiple TPCM and with other third-party Modbus RTU devices for up to 32 devices in series.

For more information on the TPCM, refer to the TemCom *PRO* User Manual and Installation instructions.

Part Number	Description
TPCM00D02N	Modbus RTU communications module without embedded I/O
TPCM00D02W	Modbus RTU communications module with embedded I/O included, 2x Digital input, 2x Digital output

Technical Data

Attribute	Value
Width	2 modules (17.5mm per module)
Communications Protocol	Modbus RTU (RS-485)
Compatible MCCBs	P_SE MCCBs ONLY (1 required per MCCB)
Temperature Ratings	Operational: -25 - +70 °C Storage: -35 - +70 °C
Humidity	Operational: 95% RH @ 40 °C Storage: 95 % RH @ 55 °C

Terminals/Plugs	Ratings		Terminal Number/s	Cable Size
Power Supply	Voltage – 24 V DC ± 30%	Current Consumption - 40 mA	+ /-	Solid and Stranded 0.5 … 1.5 mm²
Inputs ^	Voltage – DC 24 V (15 - 30 V DC)	Current – 2 mA - 15 mA	1, 2, 3, 4	
Output ^	Voltage – ≤ 100V DC (norm. 24, 48 V DC)	Max Current – 50mA	5, 6, 7, 8	
MCCB Coms	Signal / Control Voltage – 24VDC		COM	RJ9
Modbus (RTU)	–		MODBUS 1 & 2	RJ45

Notice: Cables are not provided with the TPCM. Refer to CIP-RJ9 Cables section and TemCom *PRO* User Manual and Installation Instructions for selection.

^ TPCM00D02W model only with embedded digital I/O

P_SE Only MCCB Accessories

Connection Cables

CIP-RJ9 cable

The physical connection between the TPED or TPCM and the P_SE MCCB is via the CIP adapter cable, which provides both the proprietary communications link and auxiliary power supply to the Trip Unit.

The CIP adapter cable is comprised on one end a CIP connector which plugs into the CIP socket on the MCCB, and the other end either RJ9 plug for connection to the TPED or TPCM.

These are pre-wired adapters which are available in various lengths as required.

Connector	Part number reference	Compatible MCCB	Length
CIP	TPPHQTT330H – CIP to RJ9	P160 / P250	0.5 m
	TPPHQTT340H – CIP to RJ9	P160 / P250	1.5 m
	TPPHQTT350H – CIP to RJ9	P160 / P250	3 m
	TPPHQTT360H – CIP to RJ9	P160 / P250	5 m
	TPPHQTT370H – CIP to RJ9	P160 / P250	10 m
	TPPHQTT140H – CIP to free wire (un-terminated end for hardwired 24V dc to MCCB)	P160 / P250	1.2m
	TPPHQTT430H – CIP to RJ9	P400 / P630	0.5 m
	TPPHQTT440H – CIP to RJ9	P400 / P630	1.5 m
	TPPHQTT450H – CIP to RJ9	P400 / P630	3 m
	TPPHQTT460H – CIP to RJ9	P400 / P630	5 m
	TPPHQTT470H – CIP to RJ9	P400 / P630	10 m
	TPPHQTT160H – CIP to free wire (un-terminated end for hardwired 24V dc to MCCB)	P400 / P630	1.2m

ZSI cable

Zone Selective Interlocking is achieved via hardwired connection between SMART MCCBs. Refer to the Zone Selective Interlocking Function (ZSI) section for more information.

Connector	Accessories Reference	Length	Number of Wires	Wire Identification
ZSI1 or ZSI2	TPPHQTT150H – ZSI - Adaptor	1.20m	3	Common: Brown Short time signal: White Earth: Green

OAC and PTA cable

The P_SE MCCB provides on-board digital outputs used for an Optional Alarm Contact (OAC) and Pre-Trip Alarm (PTA) for physical output of alarm events. Refer to the Alarms section for more information.

Connector	Accessories Reference	Length	Number of Wires	Switching rating
OAC or PTA	TPPHQTT130H – OAC and PTA	1.20m	2	Max. 100mA at 24V ac/dc

Plugs & Ports

The P_SE circuit breaker is equipped with specific connectors for connecting interfacing devices and accessories.

Port		Description
PTA		Used to connect the PTA output contact to send the pre-trip alarm over a local signalling circuit. Located on the outside left-hand side of the MCCB.
OAC		The OAC port is an output contact used to send the optional alarm over a local signalling circuit. Located under the front cover.
MIP		Maintenance Interface Port – for temporary connection to Trip Unit testing, servicing, and maintenance tools. Located to the right of the embedded display front cover.
CIP		Communications Input Port – Multiple concurrent CIP connections are possible and are used to connect the TPED, an external 24V dc power supply and/or the TPCM as required. Located under the front cover.
ACP		Used to connect the AX/AL SMART auxiliary. Located under the front cover.
ZSI$_1$		Present only on P250_SE, P400_SE and P630_SE versions and used to connect the downstream circuit breakers to implement zone selective interlocking (ZSI). Located under the front cover.
ZSI$_2$		Used to connect the upstream circuit breaker to implement zone selective interlocking (ZSI). Located under the front cover.

Notice: Port images are representative only. Locations differ slightly for the various ampere frame sizes

Installation

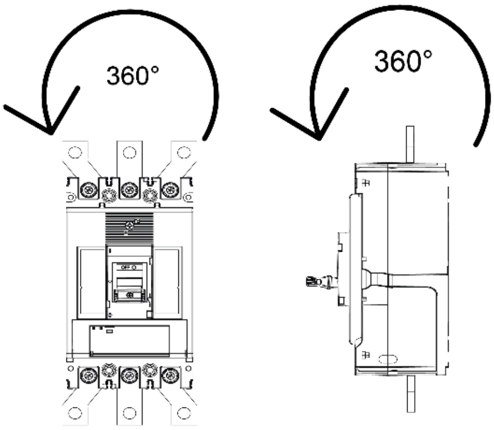
Precautions

WARNING: To prevent electrical shock and damage to equipment, disconnect and isolate power source upstream of the MCCB before installing or servicing the MCCB including its connected accessories.

Notice: To ensure correct performance, and integrity of equipment, the installation instructions and recommendations provided herein shall be respected. Refer to the respective user manual and installation instructions provided with the MCCB and associated accessories.

Mounting Angles

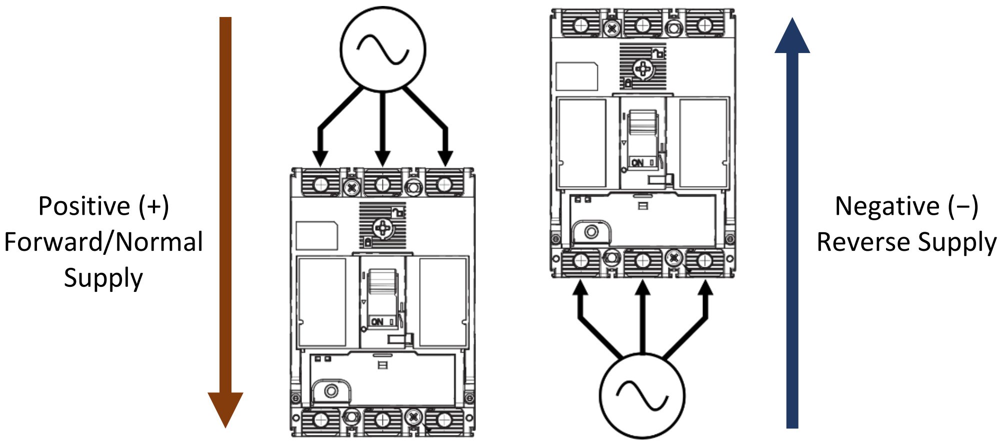
TemBreak *PRO* MCCBs may be mounted at any angle without affecting performance.



Direction of Power Supply

Power supply may be fed in either direction with respect to the MCCB without affecting performance.

Notice: To ensure correct measurements and energy values, the MCCB must be configured with the correct direction of power supply using either TPED or TPCM. Refer to Power flow direction and quadrant section.



Installation

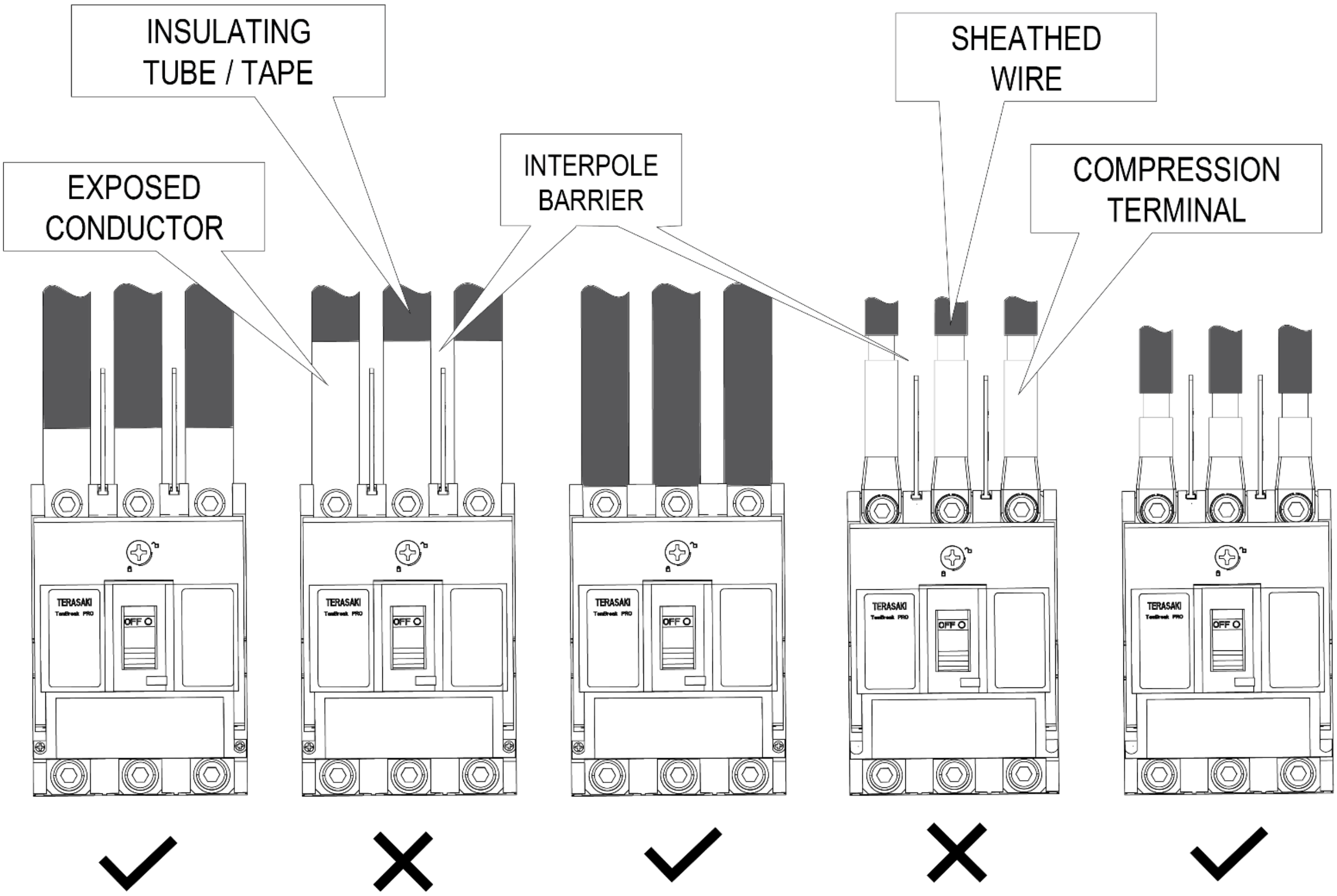
Clearances

WARNING: Exposed conductors including terminals at attached busbars must be insulated to avoid possible short-circuit or earth faults due any foreign matter coming into contact with the conductors.

Phase to Phase and Earth

Interruption of large currents during fault or normal switching operation produces ionised gases and arcing materials which expelled from the vents at the top of the MCCB for P160/P250, and top and bottom for P400/P630. These ionised gases are highly conductive, concentrated, and at an elevated temperature when it exits the MCCB via the arc vents. Care must be taken to avoid an arcing fault from occurring due to the presence of concentrated ionised gases creating a conductive path between exposed conductors. Incoming conductors must therefore be insulated the full length up to the terminal opening of the MCCB, ensuring bare conductors are not exposed directly to concentrated ionised gases. This also applies to the attached busbars supplied as part of the MCCB.

Interpole barriers or terminal covers may be used to achieve creepage and clearance requirements. Conductors must not impede the flow of ionised gas and allow it to clear and disperse safety. Interpole barriers are supplied as standard with Terasaki MCCBs for the line side only. 2 barriers with 3P MCCBs and 3 with 4P MCCBs. In cases where two different MCCB types are installed one above the other, the insulation distance between the two models should be as for the lower model.



Installation

Insulating Distance

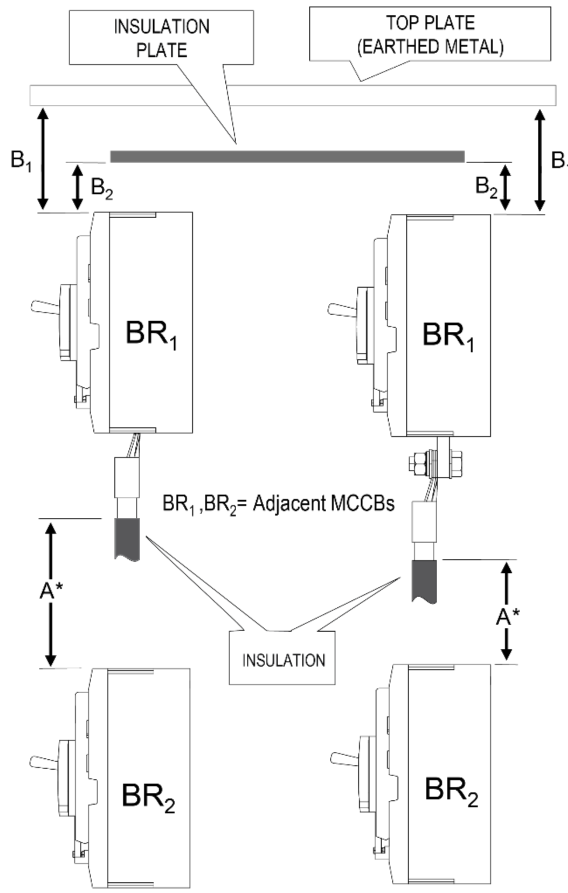
When earth metal is installed within proximity of the breakers, the correct insulating distance must be maintained, (refer to Minimum Clearance). This distance is necessary to allow the exhausted arc gases to disperse. This could include the mounting plate or side panel within a switchboard.

Minimum Clearance

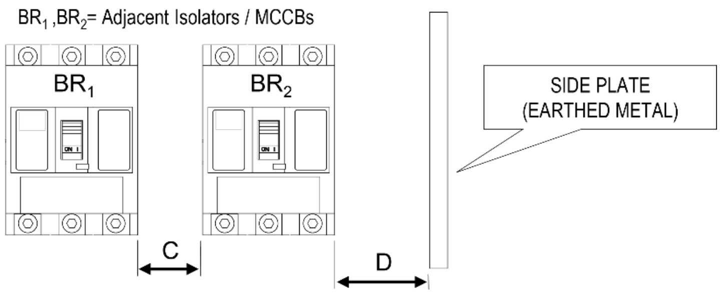
Below illustrates the minimum clearance that must be maintained

Dim.	Description
A	Distance from lower breaker to open charging part of terminal on upper breaker (front connection) or the distance from lower breaker to upper breaker end (rear connection and plug-in type)
B_1	Distance from breaker end to ceiling (earthed metal)
B_2	Distance from breaker end to insulator
C	Clearance between breakers
D	Distance from breaker side to side plate (earthed metal)
E	Length of insulation over exposed conductors.

MCCB Cat. No.	Distances (mm)					
	A	B_1	B_2	C	D	E
P160F	50	10	10	0	25	^
P160N / H / D	75	45	25	0	25	^
P250F	50	40	30	0	25	^
P250N / H / D	80	80	30	0	25	^
P400F / N / H / D	100	80	60	0	80	^
P400S	120	120	80	0	80	^
P630F / N / H / D	100	80	60	0	80	^
P630S	120	120	80	0	80	^



*distance from conductor insulation to downstream MCCB



^ Insulate the exposed conductor until it overlaps the moulded case at the terminal, or the terminal cover.

Installation

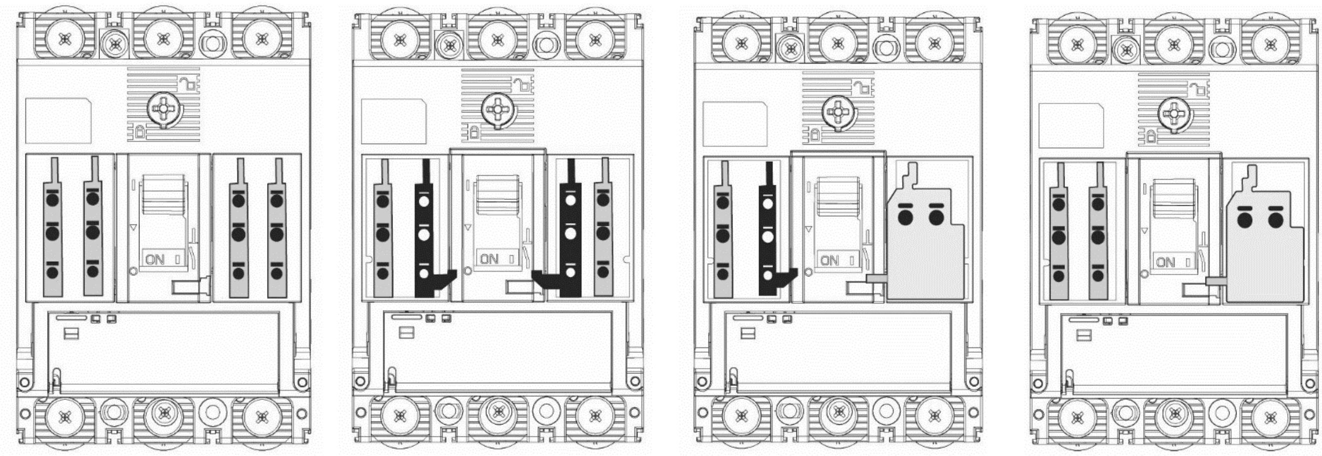
Internal Accessory Mounting Locations

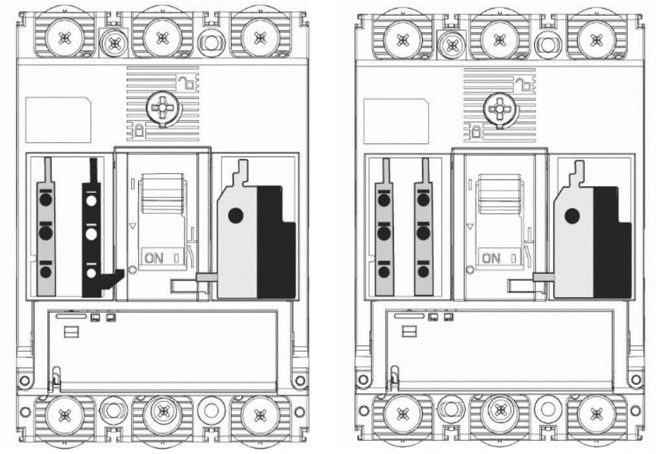
P160, P250 and P400/630 frame sizes have different internal mounting locations for auxiliary contacts, alarm contacts, shunts and, UVTs.

Left-side and right-side mounting locations are independent and accept unique combinations. For example, shunts and UVTs may only be mounted on the right side, whereas auxiliary and alarm contacts may be mounted on either left or right side.

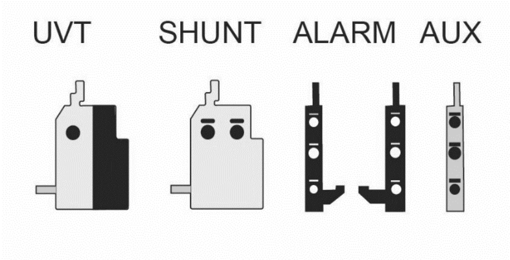
Refer to the following illustrations for each frame size listing the various possible internal accessories combinations.

P160 internal accessories combination



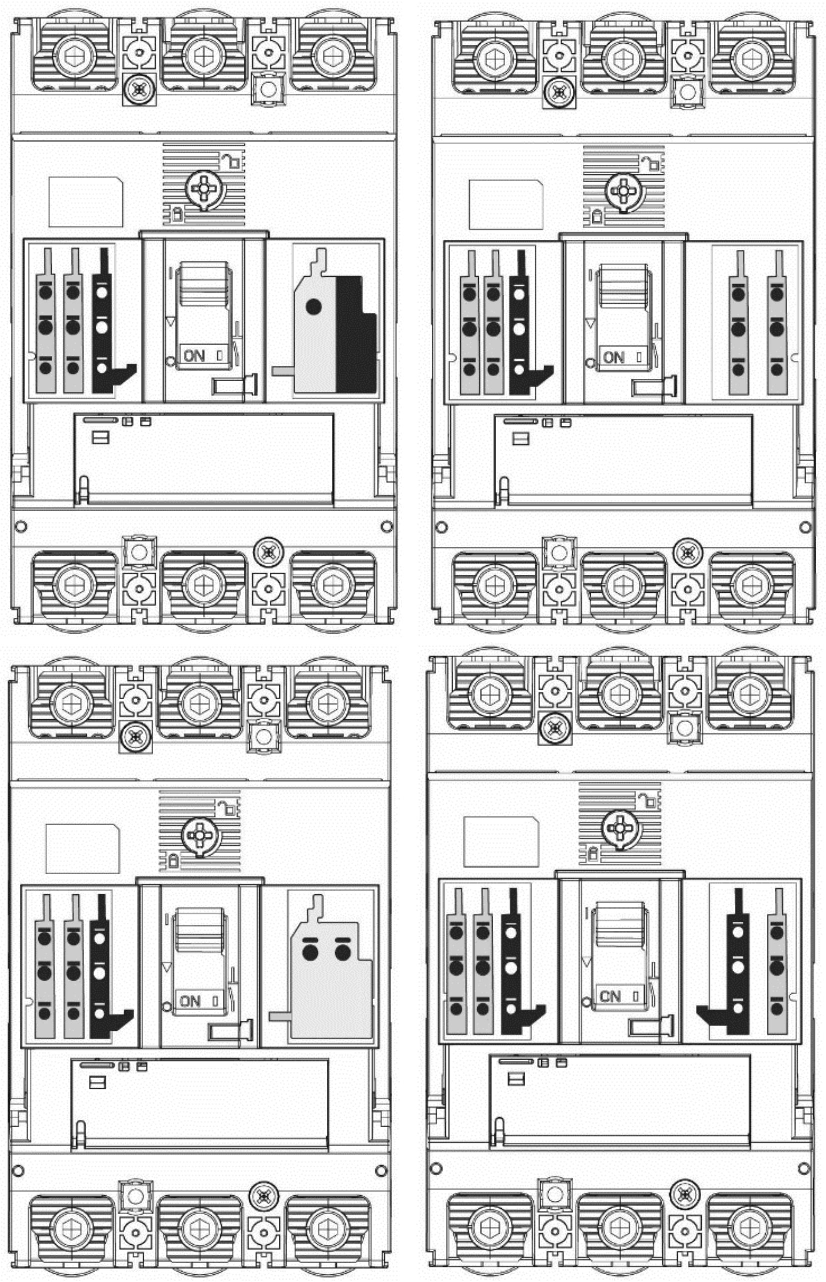


Legend



Installation

P250 internal accessories combination



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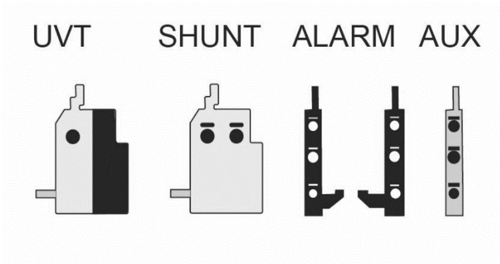
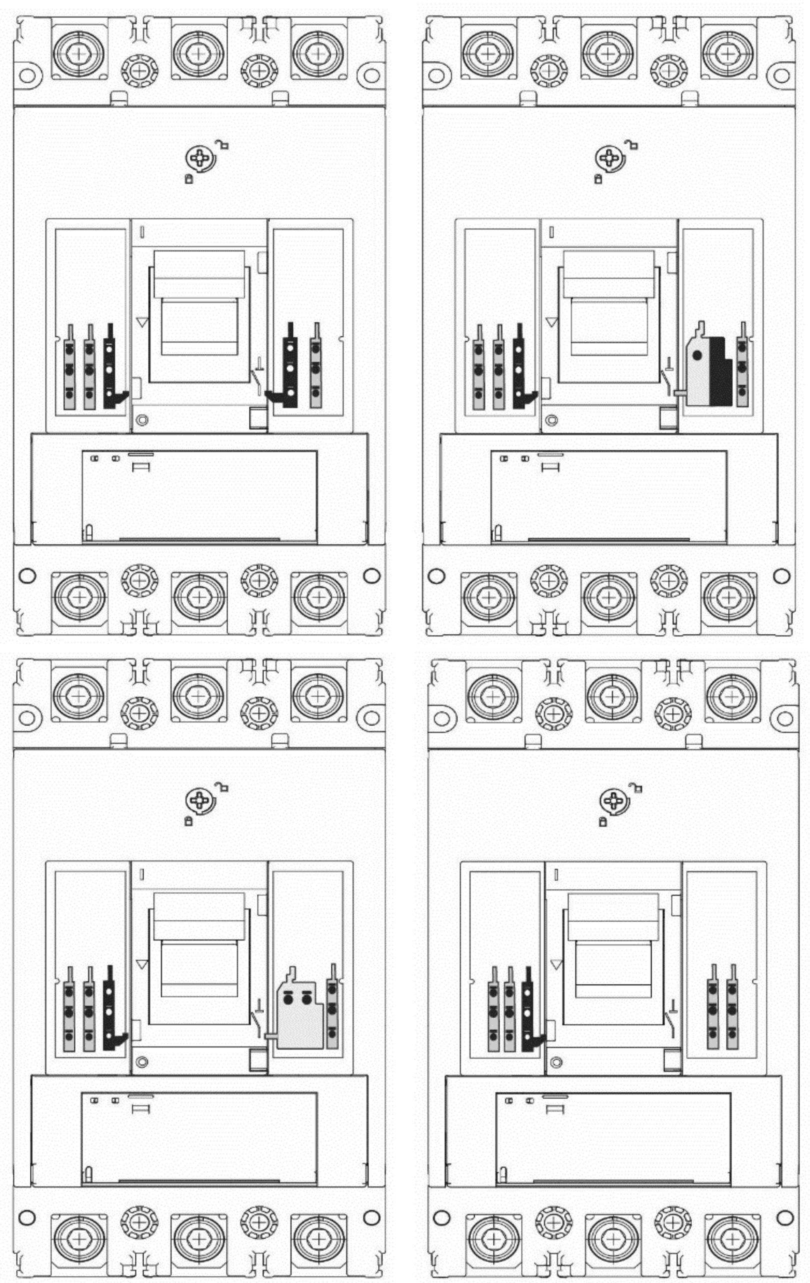
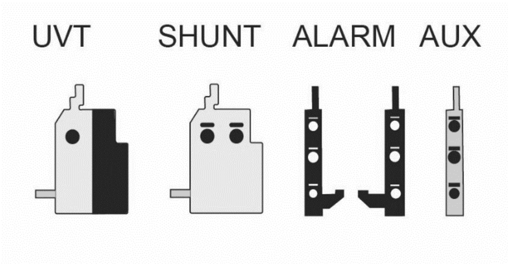


Installation

P400/630 internal accessories combination



Legend



Notice: Only 2 internal accessories can be mounted on the right-hand side of a P400 and P630 MCCB. Under no circumstances can 3 or more be installed.
Examples:

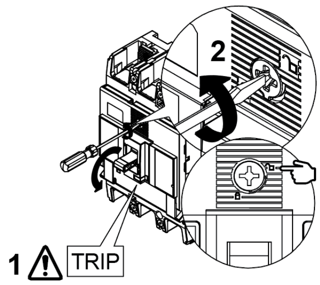
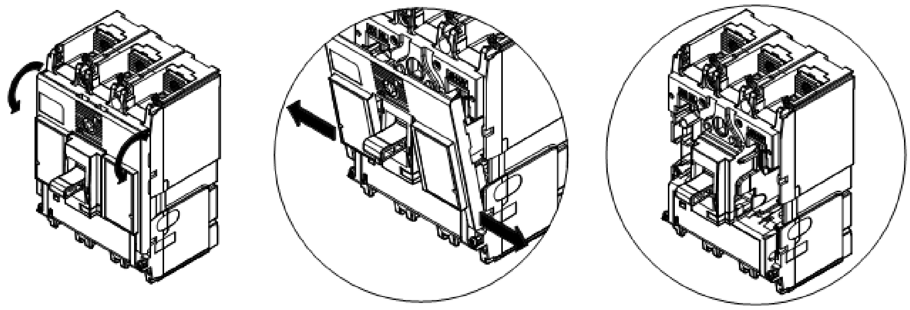
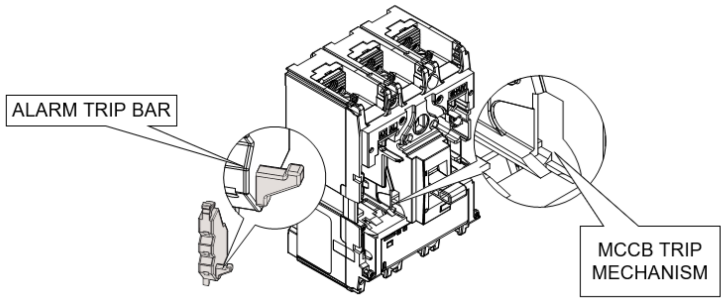
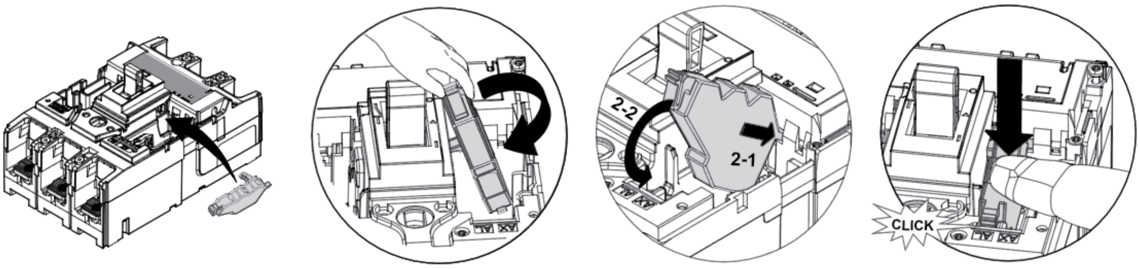
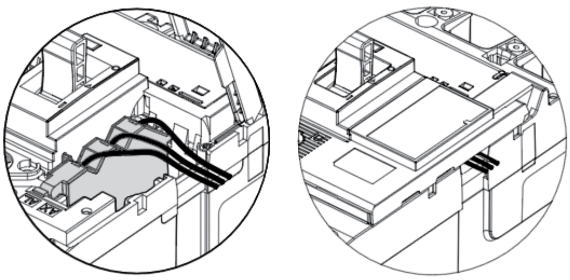
- 2 AUX
- 1 Alarm and 1 AUX
- 1 Shunt and 1 AUX
- 1 UVT and 1 AUX

Installation

Alarm, Shunt & UVT Installation

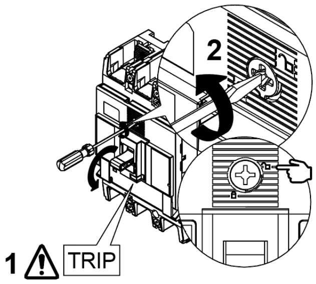
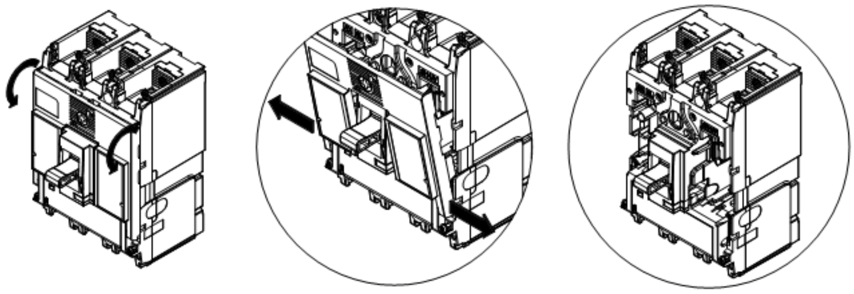
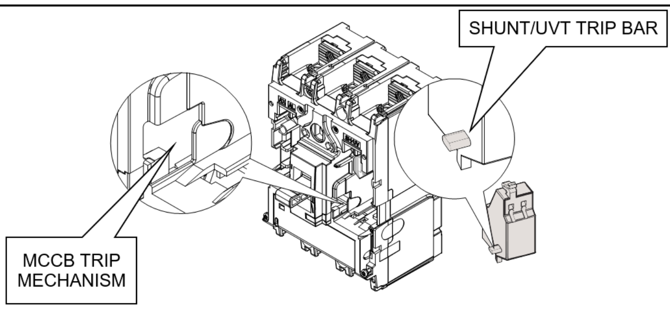
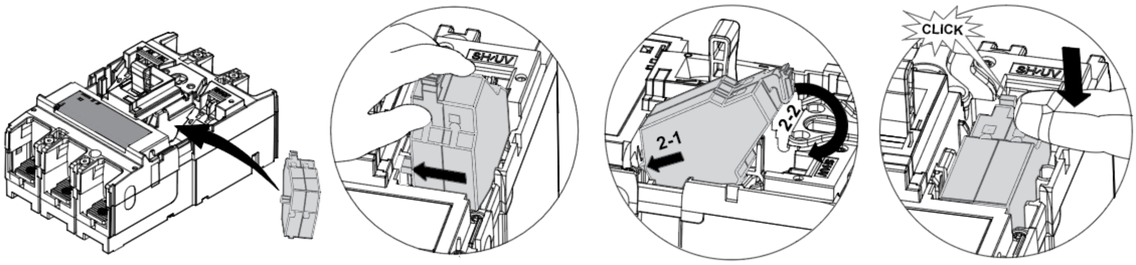
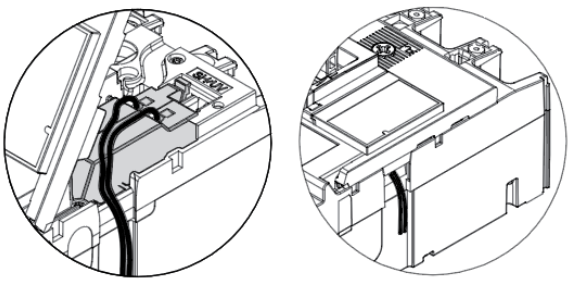
The alarm, shunt and UVT have a trip bar that needs to interact with the MCCBs trip mechanism. As such they must be installed in a specific way. Refer to the supplied Installation Instructions for the respective accessories for further detail.

Standard Alarm & Auxiliary installation

	Action	Note
1	Switch the Smart MCCB to the Tripped Position.	
2	Open the front cover of the MCCB.	
3	Locate the alarm's trip bar into the MCCB trip mechanism slot.	
4	The alarm will need to be rolled into place, follow the images to the right.	
5	Run the wires out the left-hand side of the MCCB, through the allocated groves.	

Installation

Shunt & UVT installation

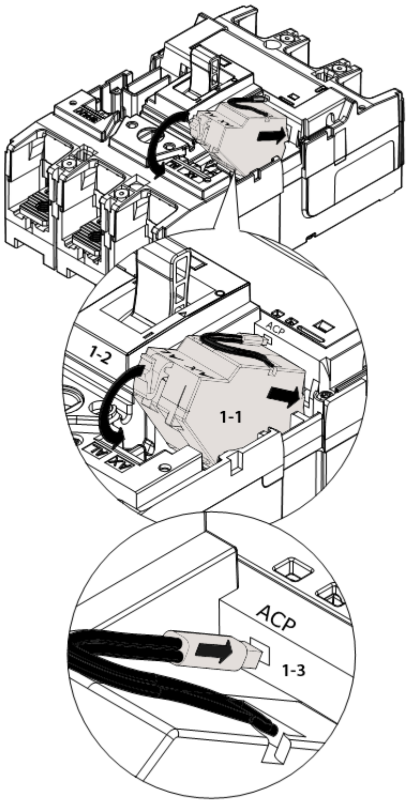
	Action	Note
1	Switch the Smart MCCB to the Tripped Position.	
2	Open the front cover of the MCCB.	
3	Locate the shunt or UVT's trip bar into the MCCB trip mechanism slot.	
4	The shunt or UVT will need to be rolled into place, follow the images to the right.	
5	Run the wires out the right-hand side of the MCCB, through the allocated groves.	

Installation

SMART Auxiliary Installation

Notice: Install auxiliary units last, to ensure the other accessories can be installed correctly.

The method for installing standard and SMART Auxiliary modules are similar to the Alarm contact modules and clip straight in. Refer to the supplied Installation Instructions for the respective accessories for further detail.

	Action	Note
1	Follow steps 1,2 and 5 of the Alarm Installation Instructions to access and close the internal accessories chambers and to run wiring to the Auxiliary. SMART type AX/AL module is dedicated to the TemBreak *PRO* P_SE MCCB range. It can only be installed in the LH side accessories chamber as shown. SMART type AX/AL module must be connected to the ACP socket inside the MCCB accessory chamber.	

Protection Settings

Trip Curve

The TemBreak *PRO* P_SE electronic Trip Unit protects against overcurrent and short circuit faults for many types of electrical distribution systems.
The SE Trip Unit has protective characteristics according to the requirements of the standard AS/NZS IEC 60947.2.

Depending on the protection type, adjusting protection parameters can be made using one or combination of the below methods:

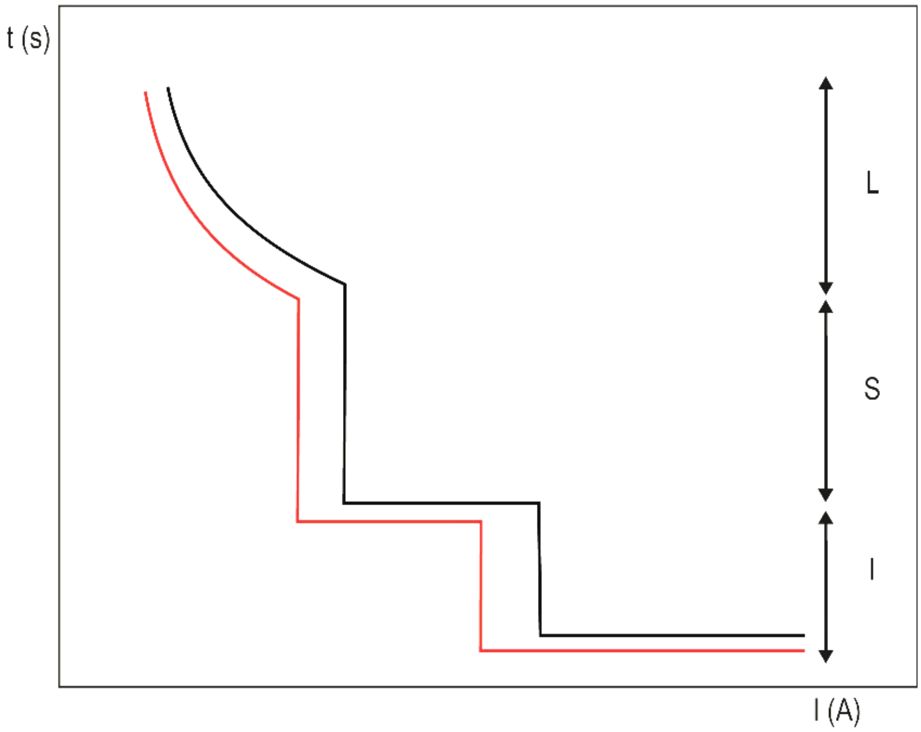
- P_SE Trip Unit rotary switches and embedded display
- TPED
- TPCM

All protection functions are based on the effective value (RMS) of power, to reduce the effects of current harmonics.
The wide range of protection curves adjustments assist in being able to achieve Selectivity combinations of upstream and downstream protection.

List of Protection Functions

Abbreviation	Description	Protection against	Symbol	Definition
L	Long-time delay (LTD) protection	Low level current overload	I_r	Threshold long time protection
			t_r	Long Time Delay
S	Short-time delay (STD protection	Low level short-circuit	I_{sd}	Threshold short time protection
			t_{sd}	Short Time Delay
			I^2t ON / OFF	I^2t curve on Short delay protection activated or not
I	Instantaneous (INST) protection	Larger short-circuit	I_i	Instantaneous protection threshold
G	Ground/Earth protection	Ground / Earth fault	I_g	Earth Protection Threshold
			t_g	Delay protection Earth
			I^2t ON / OFF	I^2t curve on Earth protection or not activated

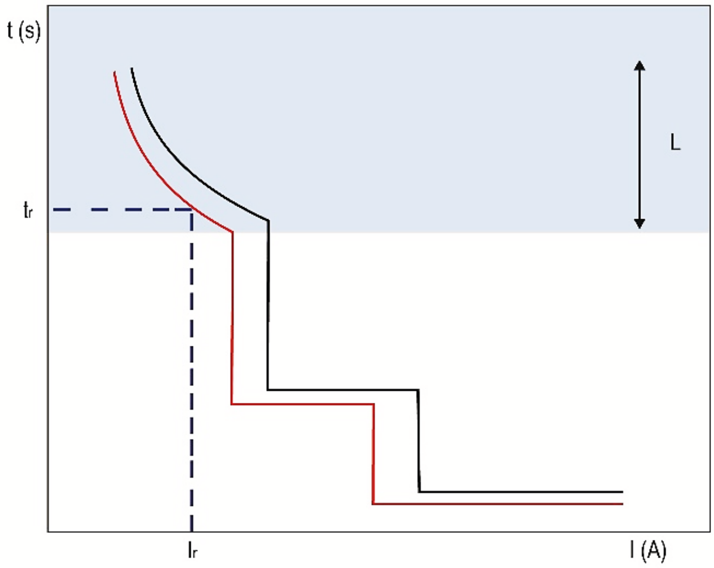
Time-current curve



Protection Settings

Long Time Delay Protection (LTD)

The Long Time Delay protection protects against current overloads or surges in power distribution or motor control applications.
Long Time Delay protection is an inverse-time protection which includes a thermal image function.



	Long Time Delay Settings	Description
L	I_r	Long Time Delay protection threshold (current rating)
	t_r	Long Time Delay (time delay)

Equation

The t_r time delay defines the trip time of the long-time delay protection at a 6 x I_r.
The time to trip at any given current is calculated using the below formula, where *k* is a constant specific to I_r and t_r settings.

The derivation of the constant *k* is given by the below formula, where t_r is equal to the t_r setting, I_r equal to the Ir setting and where *I* equals 6 x I_r.

P Model Long Time Equation	$k = \frac{-t_r}{\log_e\left(1-\left(\frac{1.125 \times I_r}{I}\right)^2\right)}$

Example

P250H3250SE with the below LTD settings
I_r = 250A
tr = 5s

k constant is calculated as below for this example.

$$k = \frac{-t_r}{\log_e\left(1-\left(\frac{1.125 \times I_r}{I}\right)^2\right)} = \frac{-5}{\log_e\left(1-\left(\frac{1.125 \times I_r}{6 \times I_r}\right)^2\right)} = \frac{-5}{\log_e\left(1-\left(\frac{1.125}{6}\right)^2\right)} = 139.71$$

Now the LTD curve for a P250_SE with the above LTD settings can be plotted using the below

$$t_r = -\left(139.71 \times \log_e\left(1-\left(\frac{1.125 \times 250}{I}\right)^2\right)\right), where\ t_r\ is\ the\ time\ delay\ for\ a\ given\ value\ of\ I$$

Protection Settings

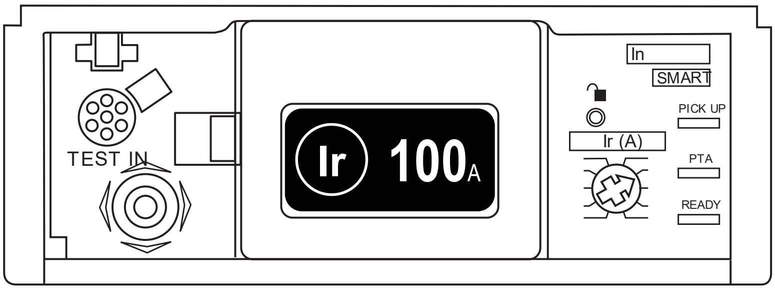
Adjusting I_r (Current)

The LTD protection trip range is: 1.05...1.20 x I_r according to standard AS/NZS IEC 60947.2.
As above the trip threshold tolerance I_r for the long-time delay protection is therefore +5% to +20%.

The I_r trip threshold is firstly set using the I_r max scale dial on the front of the MCCB, then, if necessary, from the embedded screen display to further adjust in fine increments of 1A. Refer to the Commissioning – LTD Protection Adjustments (I_r and t_r) section for further information on using the I_r max adjustment dial and fine adjustments.

Fine adjustments to I_r parameters can be made using one or combination of the below methods:

- P_SE Trip Unit embedded display
- TPED
- TPCM



Rating (I_n)	Dial position									
	1	2	3	4	5	6	7	8	9	10
40A	**I_r max 16**	**I_r max 18**	**I_r max 20**	**I_r max 22**	**I_r max 25**	**I_r max 28**	**I_r max 32**	**I_r max 34**	**I_{r1} max 37**	**I_{r1} max 40**
	16	17…18	19…20	21…22	23…25	26…28	29…32	33…34	35…37	38…40
100A	**I_r max 40**	**I_r max 45**	**I_r max 50**	**I_r max 57**	**I_r max 63**	**I_r max 72**	**I_r max 80**	**I_r max 87**	**I_{r1} max 93**	**I_{r1} max 100**
	40	41…45	46…50	51…57	58…63	64…72	73…80	81…87	88…93	94…100
160A	**I_r max 63**	**I_r max 70**	**I_r max 80**	**I_r max 90**	**I_r max 100**	**I_r max 110**	**I_r max 125**	**I_r max 135**	**I_{r1} max 150**	**I_{r1} max 160**
	63	64…70	71…80	81…90	91…100	101…110	111…125	126…135	136…150	151…160
250A	**I_r max 100**	**I_r max 110**	**I_r max 125**	**I_r max 140**	**I_r max 160**	**I_r max 180**	**I_r max 200**	**I_r max 225**	**I_{r1} max 250**	
	100	101…110	111…125	126…140	141…160	161…180	181…200	201…225	226…250	
400A	**I_r max 160**	**I_r max 180**	**I_r max 200**	**I_r max 225**	**I_r max 250**	**I_r max 300**	**I_r max 350**	**I_r max 370**	**I_{r1} max 400**	
	160	161…180	181…200	201…225	226…250	251…300	301…350	351…370	371…400	
630A	**I_r max 250**	**I_r max 300**	**I_r max 350**	**I_r max 370**	**I_r max 400**	**I_r max 500**	**I_r max 600**	**I_r max 630**		
	250	251…300	301…350	351…370	371…400	401…500	501…600	601…630		

I_r max scale setting (A)
I_r fine adjustment range (A)

Protection Settings

Adjusting t_r (Time Delay)

The t_r time delay defines the trip time of the long-time delay protection for a current of 6 x I_r.

Adjustments to t_r parameter can be made using:

- P_SE Trip Unit embedded display
- TPED
- TPCM

t_r Adjustment Range (seconds)									
0.5	1.5	2.5	5	7.5	9	10	12	14	16

Notice: For the following MCCBs the setting of I_r and t_r can limit the setting of I_{sd} for STD protection.

P160_SE I_n = 160A, P250_SE I_n = 250A

If: I_r > 0.9 x I_n and t_r = 16s I_{sd} is limited to 9 x I_r.

Notice: The trip time tolerance for LTD protection is -20% + 20ms to 0% + 30ms.
Example:
For t_r = 5 s and I = 6 x I_r, the trip time for long time delay protection will be between 4.02 s and 5.03 s.

Protection Settings

Thermal memory / Hot–Cold start mode

TemBreak *PRO* electronic Trip Units have a thermal imaging function, which models the active heating and cooling of electrical conductors as current passes through them. The thermal imaging function calculates a thermal value (θ) for the conductors, which trips the MCCB when its thermal threshold (θ_{trip}) is reached. This allows the MCCB to simulate the true thermal state of the conductors more accurately, and better protect against overload conditions between successive operating cycles.

Thermal imaging cannot be disabled in the Trip Unit, however, the P_SE model can be configured with either a hot or cold start mode, which determines whether the calculated thermal value θ is retained if the current drops below the LTD pick-up current threshold (between 1.05…1.20 x I_r).

Changes to the Hot–Cold start mode can be made using or a combination of the below methods:

- P_SE Trip Unit embedded display
- TPED
- TPCM

P_SE Trip Unit embedded display setting	TPED setting	TPCM setting	Default
 COLD: Cold start mode HOT: Hot start mode	"Thermal memory" OFF: Cold start mode ON: Hot start mode	Command ID: 201 "LTD Start mode" Hex 00 00: Cold start mode Hex 00 01: Hot start mode	Cold start mode

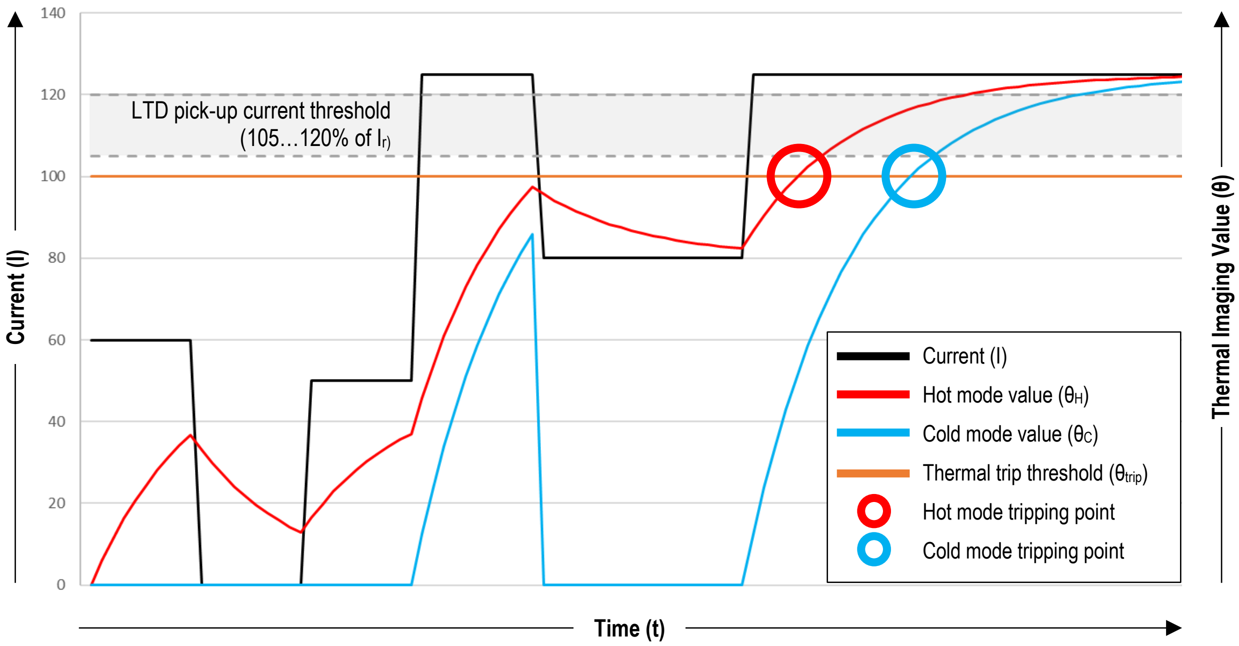
Hot start mode

In Hot start mode, the thermal imaging continues to calculate the thermal value (θ_H), even if the current is below the LTD pick-up threshold.
As long as the Trip Unit is powered (self-supply or external backup power), the thermal imaging will continue to function. If power is removed from the Trip Unit, thermal imaging will continue to operate for at least 20 minutes or until the calculated thermal value θ_H reaches 0.

Cold start mode

In Cold start mode, the thermal value (θ_C) is only calculated from when the current reaches and exceeds the LTD pick-up current threshold.
If the current drops below the LTD pick-up current threshold, then the thermal value θ_C resets to 0.

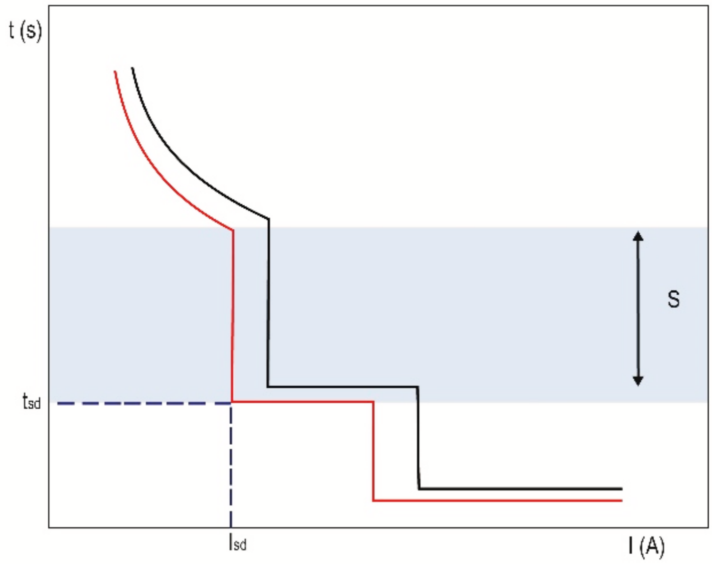
The below figure illustrates the Trip Unit with thermal imaging in both hot and cold start modes. Where the current (I) drops below the LTD pick-up current threshold (region in grey between 105…120% of I_r), the Hot mode thermal value θ_H continues to be calculated, whereas the Cold mode thermal value θ_C resets to 0 each time. In either start mode, the MCCB trips when the respective thermal value threshold θ_{trip} is reached. The differences between start modes is made most apparent by the different tripping times after successive operations, where hot mode θ_H reaches the tripping threshold θ_{trip} earlier, providing added safety and optimum protection of the conductors.



Protection Settings

Short Time Delay Protection (STD)

The short time delay protection is designed to protect against low level short-circuit conditions.



	Short Time Delay Protection Settings	Description
S	I_{sd} (x I_r) / OFF	Short Time Delay protection threshold / Disable
	t_{sd} (ms)	Short Time Delay
	I^2t (ON / OFF)	Inverse I^2t time

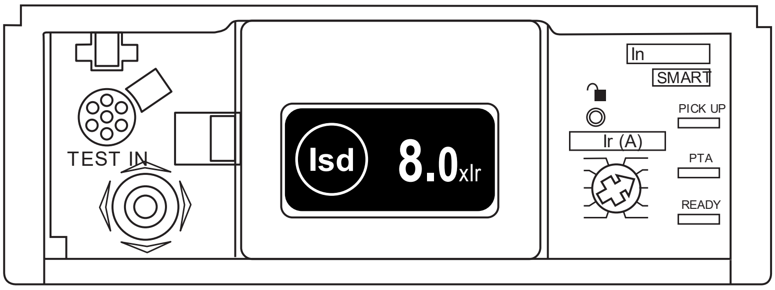
Protection Settings

Adjusting I_{sd} (Current)

The I_{sd} trip threshold tolerance for STD protection is ±10%.

Depending on the MCCB ampere frame size, adjustments to I_{sd} parameter can be made using one or a combination of the below methods:

- P_SE Trip Unit rotary dials and embedded display
- TPED
- TPCM



P160 and P250

On P160 / P250 ampere frame sizes, there are no I_{sd} rotary switches, therefore I_{sd} threshold can only be set from one of or combination of the embedded display, TPED, or TPCM.

Adjustments are made in increments of 0.5 x I_r between 1.5…10 x I_r.

I_{sd} Threshold Adjustment range	Adjustment step
OFF – 1.5 to 10 x I_r	0.5

Notice: For the following MCCBs the setting of I_r and t_r can limit the setting of I_{sd} for STD protection.

P160_SE I_n = 160A, P250_SE I_n = 250A

If: I_r > 0.9 x I_n and t_r = 16s I_{sd} is limited to 9 x I_r.

Notice: In the case where STD protection is disabled (I_{sd} = OFF), thermal self-protection parameters I_{tsp} and t_{tsp} are automatically enabled on the following Trip Units:

P160_SE **I_n** = 160A, P250_SE **I_n** = 250A

In this case, a supplementary I^2t = K curve is added to the end of LTD tripping curve, starting from I_{tsp}, where constant K = $Max(I_i)^2$ x t_{tsp}.

Max(I_i) is the maximum I_i settable on the Trip Unit and is not adjustable.

Refer to Thermal Self-Protection section.

Protection Settings

P400 and P630

Similarly to the LTD parameter settings, on P400 / P630 ampere frame sizes, the I_{sd} settings are split into maximum and fine adjustment settings.

The I_{sd} threshold is firstly set using the I_{sd} max adjustment dial on the front of the MCCB, then, if necessary, further adjust in fine increments of 0.5 x I_r using the embedded screen display or one of the methods below.

Refer to the Commissioning section for further information on using the max adjustment dial and fine adjustments.

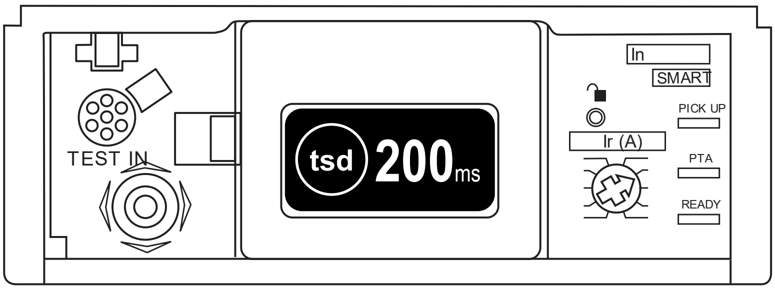
	Dial Position									
	1	2	3	4	5	6	7	8	9	10
I_{sd} max scale (x I_r)	1.5	2	3	4	5	6	7	8	10	OFF
I_{sd} fine adjustment range (0.5 x I_r increments)	1.5	2	2.5…3	3.5…4	4.5…5	5.5…6	6.5…7	7.5…8	8.5…10	–

Protection Settings

Adjusting t_{sd} (Time Delay)

Depending on the MCCB ampere frame size, adjustments to t_{sd} parameter can be made using one or a combination of the below methods:

- P_SE Trip Unit embedded display
- TPED
- TPCM



t_{sd} Time Delay Adjustment Settings (ms)				
50	100	200	300	400

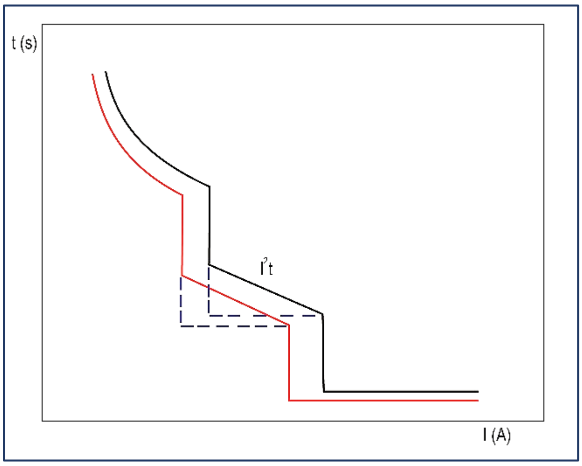
The trip time tolerance for short time delay protection is as follows:

- For t_{sd} = 50 ms: ±30 ms
- For t_{sd} ≥ 100 ms: -20 ms / +50 ms

Protection Settings

I^2t function for STD

When enabled, the I^2t function for STD may be used to improve selectivity with downstream devices by overlaying a supplementary $I^2t = K$ curve within the STD tripping section, starting from the I_{sd} threshold setting up to the I_i threshold setting.



Adjustments to the I^2t for STD setting can be made using one or a combination of the below methods:

- P_SE Trip Unit embedded display
- TPED
- TPCM

P_SE Trip Unit embedded display setting	TPED setting	TPCM setting	Default
 OFF: I^2t for STD disabled ON: I^2t for STD enabled	"I2t short" Off: I^2t for STD disabled On: I^2t for STD enabled	Command ID: 207 "I^2t for STD setting" Hex 00 00: I^2t for STD disabled Hex 00 01: I^2t for STD enabled	I^2t for STD disabled

STD I^2t Equation

Short Time I^2t Equation	$k = I^2t$

Where the k constant is derived from
$k = (10 \times I_r)^2 \times t_{sd}$

The trip time tolerance for short time delay I^2t protection is the same as the standard tolerance for short time delay protection:

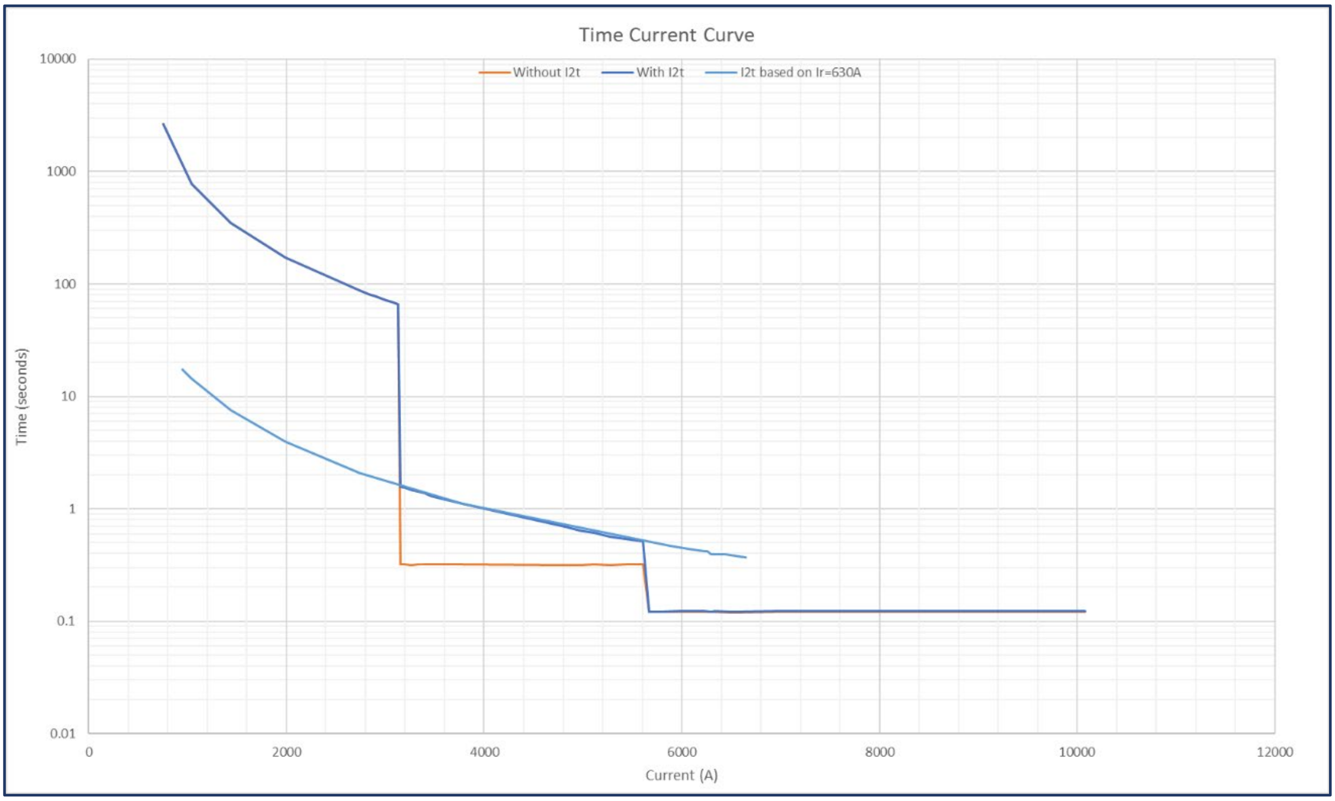
- For I_{sd} = ±10%.
- For t_{sd} = 50 ms: ±30 ms
- For t_{sd} ≥ 100 ms: -20 ms / +50 ms

Exclusive Partner

Protection Settings

The below graphic illustrates the difference between I^2t enabled and disabled with a I^2t curve based on I_r = 630A for reference.

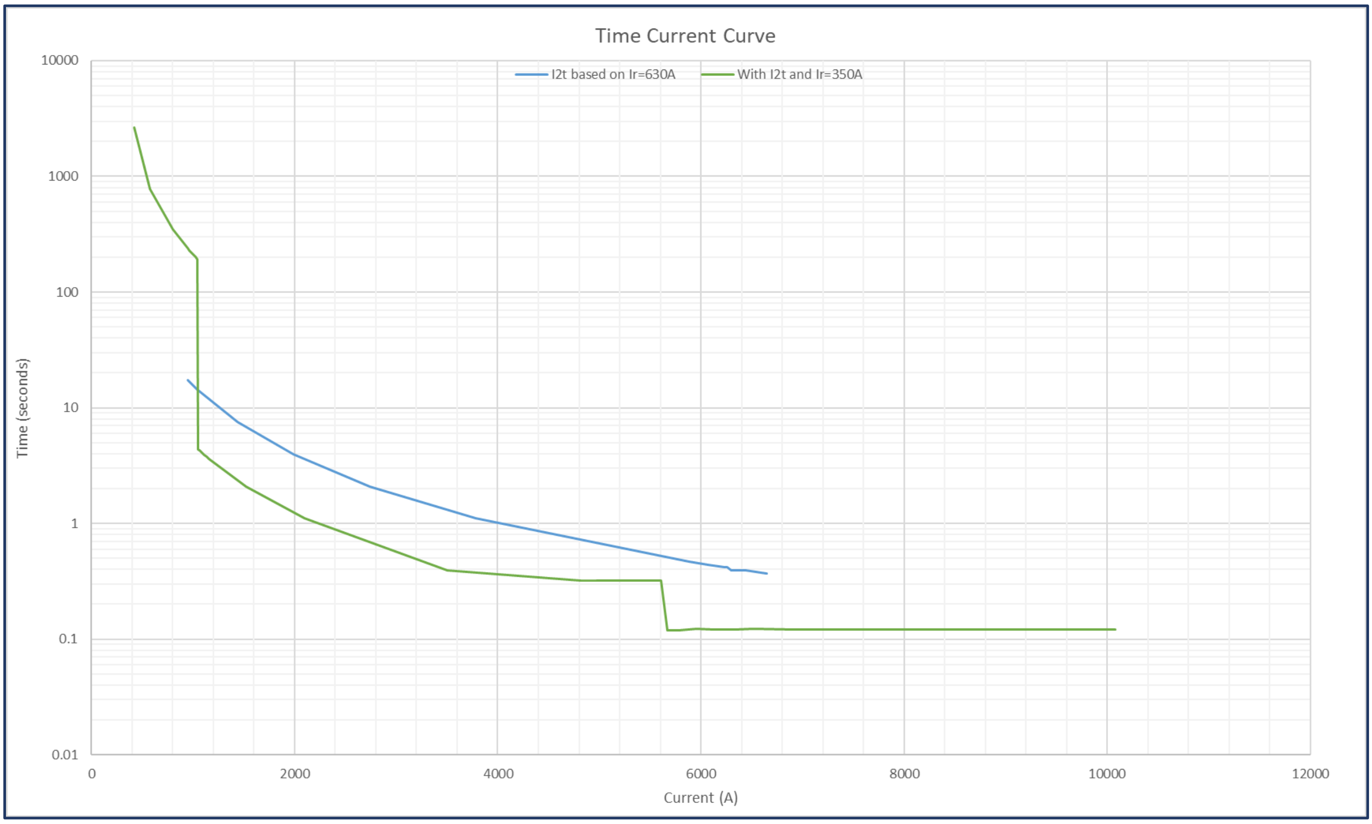
Settings	Full curve with I^2t disabled	Full curve with I^2t enabled	I^2t ONLY base on I_r=630A
I_r	630A	630A	630A
t_r	5s	5s	5s
I_{sd}	5	5	1.5
t_{sd}	50ms	50ms	50ms
I_i	9	9	11
I^2t	Disabled	Enabled	Enabled



Protection Settings

The I^2t curve is based on the setting of I_r. The below time current graph illustrates the effect of the I^2t curves calculated for different I_r settings.

Settings	I^2t ONLY base on I_r=630A	Full curve with I^2t enabled
I_r	630A	350A
t_r	5s	5s
I_{sd}	1.5	3
t_{sd}	50ms	50ms
I_i	11	9
I^2t	Enabled	Enabled



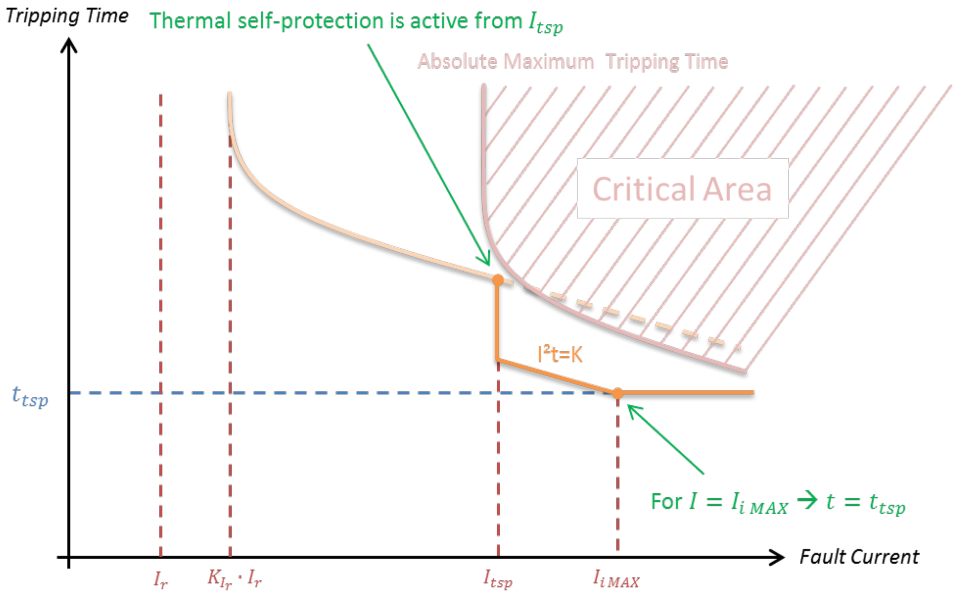
Protection Settings

Thermal Self-Protection

Thermal Self-Protection

Thermal self-protection is enabled automatically where STD is disabled. This is to ensure that the continuation of the LTD curve does not intersect with the Critical Area of the MCCB, which could create overheating stresses in the MCCB and cause irreparable damage and/or undesirable operation or failure of the trip-unit.

To achieve this, a supplementary $I^2t = K$ curve is added to the end of LTD tripping curve, starting from I_{tsp}, where constant $K = Max(I_i)^2 \times t_{tsp}$. $Max(I_i)$ is the maximum I_i settable on the Trip Unit and is not adjustable.



Thermal self-protection is only on the following MCCBs. When activated, I_{tsp} and t_{tsp} values are specified as follows:

MCCB	I_{tsp} x I_r	t_{tsp} (seconds)
P160_SE I_n = 160A	8	2
P250_SE I_n = 250A	8	2

Notice: Thermal self-protection is applied to all phases where LTD protection is enabled.
In the case of 4P MCCBs, Thermal self-protection is also applied to the neutral pole (irrespective of the N Coefficient parameter) provided that Neutral Protection (NP) is enabled. Refer to Neutral Protection section.

Notice: LTD thermal image value θ is only affected during a trip event where it is temporarily forced to a value over 100%.

Protection Settings

Thermal Self-Protection

Thermal Self-Protection I²t Equation

Thermal Self-Protection I²t Equation	$k = I^2t$

Where the k constant is derived from
$k = (I_{i\,\max setting})^2 \times t_{tsp}$, Where I_i is the maximum setting I_i can be set to, not adjustable. Refer to Instantaneous Protection (INST)

The trip time tolerance for Thermal Self-Protection protection as follows:

- I_{tsp} = ±10%
- t_{tsp} = ±10%

Example k Constant Calculational
P160 I_i can be set to maximum setting 11 x I_n

$k = (I_{i\,\max setting})^2 \times t_{tsp} = (11 \times I_n)^2 \times 2 = (11 \times 160)^2 \times 2$ = 6,195,200

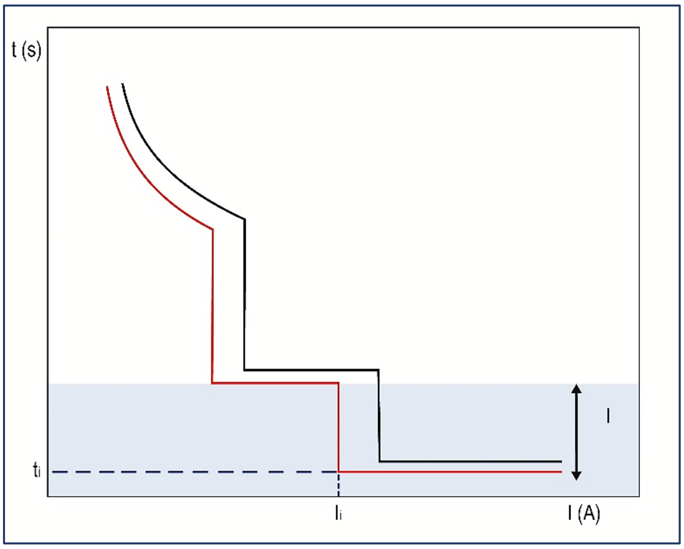
P250 I_i can be set to maximum setting 11 x I_n

$k = (I_{i\,\max setting})^2 \times t_{tsp} = (11 \times I_n)^2 \times 2 = (11 \times 250)^2 \times 2$ = 15,125,000

Protection Settings

Instantaneous Protection (INST)

Instantaneous protection is designed to protect against high current short circuits. This protection is independent of time and is set as a multiple of the rated current I_n.

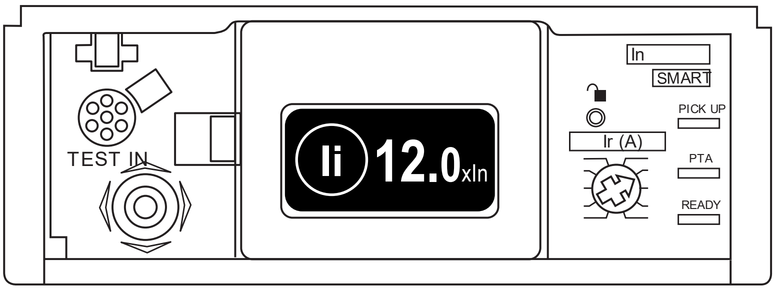


	Instantaneous Protection Settings	Description
I	I_i (x I_n)	Instantaneous protection threshold

Adjusting I_i (Current)

Adjustments to I_i trip threshold can be made using one or a combination of the below methods:

- P_SE Trip Unit embedded display
- TPED
- TPCM



Rating I_n (A)	I_i Adjustment Settings (x I_n) 0.5 x I_n increments
40	3...15
100	
160	3...11
250	
250 (P400 Ampere Frame)	3...12
400	
630	3...11

The instantaneous protection has no adjustable time delay.

Protection Settings

Tolerances

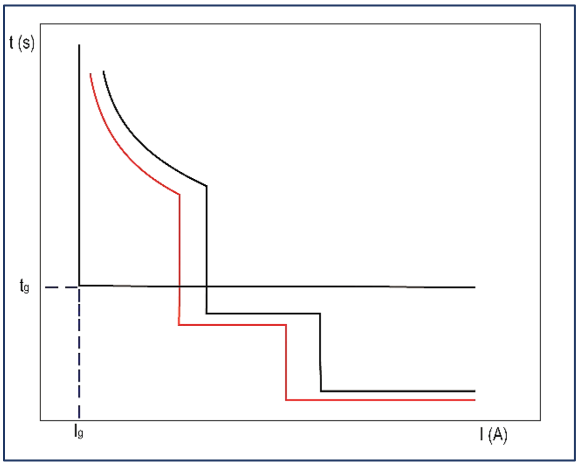
Notice: The following tolerances for instantaneous protection reflect the Trip Unit calculations within the Ii setting range.

- The I_i trip threshold tolerance for instantaneous protection is ±15%.
- The non-trip time is 10 ms with a maximum cut-out time is 50 ms

Protection Settings

Ground/Earth Fault Protection (GF)

Ground Fault protection is protection against high strength insulation / earth faults. Ground fault is available with 3P and 4P P_SE MCCBs as standard.



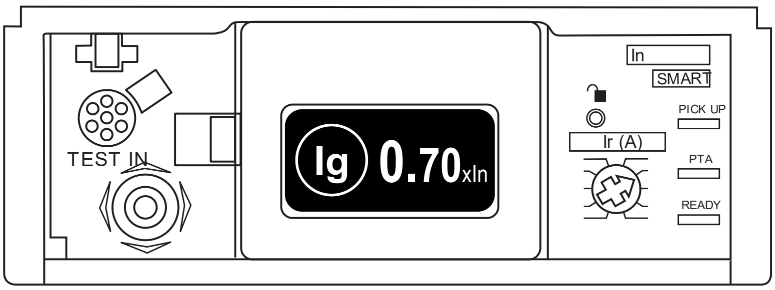
	Ground Fault Protection Settings	Description
G	I_g (x I_n)	Ground fault current trip threshold
	t_g (ms)	Ground fault time delay
	I^2t_g (ON / OFF)	Inverse time I^2t function

Adjusting I_g (Current)

The I_g trip threshold tolerance for ground fault protection is ±10%.
When the I_g threshold is OFF, ground fault protection is deactivated.

Adjustments to I_g trip threshold can be made using one or a combination of the below methods:

- P_SE Trip Unit embedded display
- TPED
- TPCM



Rating I_n (A)	I_g Trip Threshold Adjustment Settings (x I_n) 0.05 x I_n increments
40	0.4…1.0 – OFF
100	0.2…1.0 – OFF
160	
250	
400	
630	

Notice: Enabling GF for 3 pole MCCBs on a 4-wire system may result in nuisance tripping in the case of imbalanced loads. It is recommended in this case that GF should be disabled.

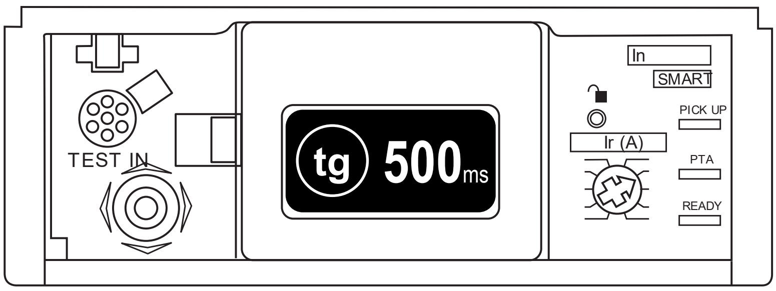
Protection Settings

Adjusting t_g (Time Delay)

The trip time tolerance for ground protection is:
For t_g = 50 ms: ±30 ms
For $t_g \geq$ 100 ms: -20 ms / +50 ms

Adjustments to t_g time delay can be made using one or a combination of the below methods:

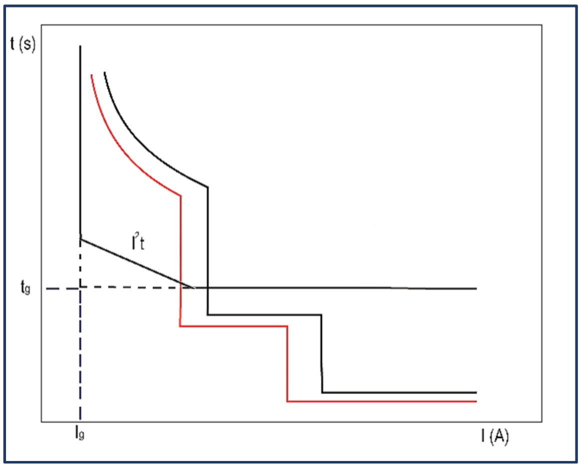
- P_SE Trip Unit embedded display
- TPED
- TPCM



t_g Time Delay Adjustment Range (ms)					
50	100	200	300	400	500

I^2t function for GF

When enabled, the I^2t function for GF may be used to improve selectivity of ground faults with downstream devices by overlaying a supplementary $I^2t = K$ curve within the GF time current curve, starting from the I_g threshold setting up to the I_n threshold setting.



Adjustments to the I^2t for GF setting can be made using one or a combination of the below methods:

- P_SE Trip Unit embedded display
- TPED
- TPCM

P_SE Trip Unit embedded display setting	TPED setting	TPCM setting	Default
 OFF: I^2t for GF disabled ON: I^2t for GF enabled	"I2t ground" Off: I^2t for GF disabled On: I^2t for GF enabled	Command ID: 213 "I^2t for GF setting" Hex 00 00: I^2t for GF disabled Hex 00 01: I^2t for GF enabled	I^2t for GF disabled

Protection Settings

GF I^2t Equation

Ground Fault I^2t Equation	$k = I^2 t$

Where the k constant is derived from
$k = (1 \times I_n)^2 \times t_g$

The trip time tolerance for ground fault I^2t protection is the same as the standard tolerance for ground fault protection:

- For I_g = ±10%.
- For t_g = 50 ms: ±30 ms
- For t_g ≥ 100 ms: -20 ms / +50 ms

Protection Settings

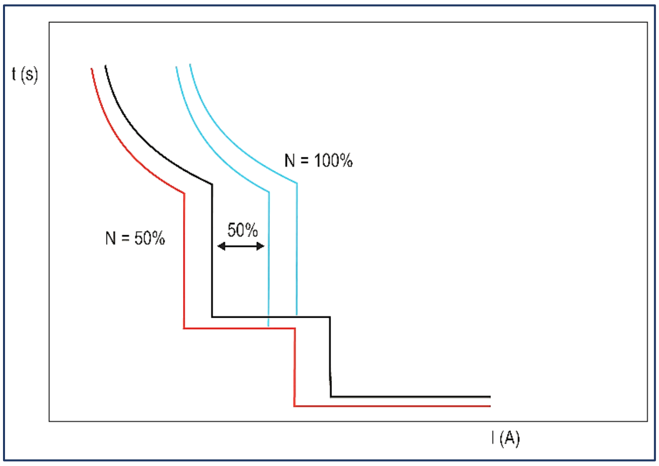
Neutral Protection (NP)

Neutral protection is available with 4P P_SE MCCBs as standard. It is particularly useful when the cross-section of the neutral conductor is reduced in relation to the phase conductors.

Neutral protection is based off the standard LTD and STD protection parameter of the main phases. The I_r and I_{sd} parameters for the Neutral pole are adjusted according to the set Neutral Coefficient percentage. For example, If the Neutral conductor is sized at 50% of the main phases, and the N Coefficient Adjustment parameter is set to 50%, then I_r and I_{sd} of the Neutral pole will be 50% of I_r and I_{sd} of main phase poles.

The time delays for the Neutral pole remain identical to the t_r and t_{sd} time delay adjustment values for the main phases and cannot be independently changed.

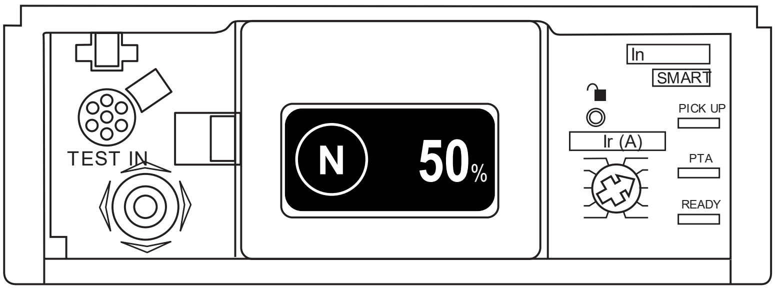
INST protection of the Neutral pole is not affected by the N Coefficient adjustment setting and is identical to the I_i trip threshold of the main phases.



Adjusting I_r and I_{sd} for Neutral Protection (Current)

Adjustments to Ir and Isd for the Neutral pole are made by adjuring the N Coefficient setting, which can be made using one or a combination of the below methods:

- P_SE Trip Unit embedded display
- TPED
- TPCM



N Coefficient Adjustment Settings (%)	Parameters Impacted
50 – 100 – OFF	The coefficient is applied to the adjustment value of the phase I_r and I_{sd} thresholds

Notice: If the I^2t function for STD is enabled, I^2t will also be included in the Neutral Protection curve as calculated from the Neutral pole I_r parameter.

Protection Settings

Zone Selective Interlocking Function (ZSI)

WARNING: The ZSI function is supplementary to time selectivity (t_{sd} and t_g time delay). Under no circumstances shall it be used to replace normal STD and/or GF protection.

Zone interlocking is a high-speed signalling method applied between multiple combinations of MCCBs and ACBs to improve the level of protection in a low voltage power distribution system.

A ZSI signalling cable is connected between the downstream and upstream protective devices, permitting the circuit breakers to signal at high speed to each other to determine whether either circuit breaker has detected a short-time (I_{sd}) or ground-fault (I_g) event and to co-ordinate zone selective tripping with minimal time delay.

The circuit breaker closest to the fault will attempt to clear the fault early without relying on varied time delay (t_{sd} and t_g) settings between upstream and downstream circuit breakers to co-ordinate selectivity. This has potential to reduce the overall tripping time of the power distribution network and reduction in incident energy without disruption to other services.

When the Trip Unit detects a fault current in the STD and/or GF protection curve areas (equal or in excess of I_{sd} and I_g respectively) it closes an internal contact on its ZSI output port (ZSI_2), permitting a signal to propagate along the ZSI signalling cable between upstream and downstream circuit breakers. This is done regardless of whether ZSI is enabled in the Trip Unit.

Only when ZSI is enabled for the required protection type, the Trip Unit will also await a signal from its ZSI input port (ZSI_1) from the downstream breaker. If there is no signal on the ZSI input ZSI_1 then the Trip Unit determines that the fault has occurred closest to itself. The ZSI function overrides any time delay settings for the respective fault type (STD and GF protection, t_{sd} and t_g respectively) and the circuit breaker will initiate an instantaneous trip and clear the fault as soon as possible (total clearing time may be within 20…50ms).

If a signal is detected on ZSI input ZSI_1 port, then the circuit breaker downstream will initiate the trip. Time delay settings t_{sd} and t_g of the circuit breaker and all other upstream circuit breakers are not overridden and will trip with the configured delays in the event that the downstream circuit breaker is unable to clear the fault in time.

Notice: The use of the ZSI signal requires the connection of ZSI Signalling cables to either or both of the required ZSI ports located under the front cover of the P_SE MCCB. Refer to the Connection Cables section for details on the ZSI cable.

Protection Settings

Zone Selective Interlocking Function (ZSI)

Setting the ZSI function

The P250SE / P400SE / P630SE MCCB must activate the ZSI protection to acknowledge selectivity per zone and respond according to any signals received on ZSI$_1$.

Changes to the settings of each of the ZSI functions can be made using one or a combination of the below methods:

- P_SE Trip Unit embedded display
- TPED
- TPCM

P_SE Trip Unit embedded display setting	TPED setting	TPCM setting	Default
 OFF: ZSI for STD disabled ON: ZSI for STD enabled	"ZSI – Short" Off: ZSI for STD disabled On: ZSI for STD enabled	Command ID: 208 "Zone interlocking (ZSI) for STD" Hex 00 00: ZSI for STD disabled Hex 00 01: ZSI for STD enabled	ZSI for STD disabled
 OFF: ZSI for GF disabled ON: ZSI for GF enabled	"ZSI – Ground" Off: ZSI for STD disabled On: ZSI for STD enabled	Command ID: 214 "Zone interlocking (ZSI) for GF" Hex 00 00: ZSI for STD disabled Hex 00 01: ZSI for STD enabled	ZSI for GF disabled

The P160SE MCCB is mainly designed to protect the feed circuit and thus does not require a ZSI signal from a downstream circuit breaker to be acknowledged, therefore it does not have a ZSI input (ZSI$_1$) does not feature any ZSI configurability. It is equipped with a ZSI output (ZSI$_2$) to connect an upstream circuit breaker, still produce the ZSI signal on ZSI2 when a short-time or ground-fault event is detected.

ZSI Port	P160	P250	P400	P630
ZSI$_1$ (Input)	–	✓	✓	✓
ZSI$_2$ (Output)	✓	✓	✓	✓

Notice: If the ZSI function is not in use, it is important to ensure that ZSI function settings on applicable upstream MCCBs remain disabled. If the ZSI function is left enabled without a ZSI$_1$ input signal, the upstream MCCB, upon fault current detection, will override any intended selectivity settings and attempt an instantaneous trip. This may result in nuisance tripping and disruption of other services.

Installation consideration

There is no limit to the number of interconnected upstream and downstream circuit breakers using the ZSI signalling interface; however the reliability of the ZSI signal is dependent on the total impedance of the interconnecting cabling. Therefore, the total impedance of the ZSI signalling cables and intermediate wiring and terminations must be considered.

Total impedance is dependent on wire type, length, material, and gauge of all interconnecting wires and termination devices (e.g. terminal blocks and connectors).

The maximum permissible characteristics for the ZSI signalling cable for the total length is as follows:

Specification	Value
Max length	1000 m
Max impedance	30 kΩ

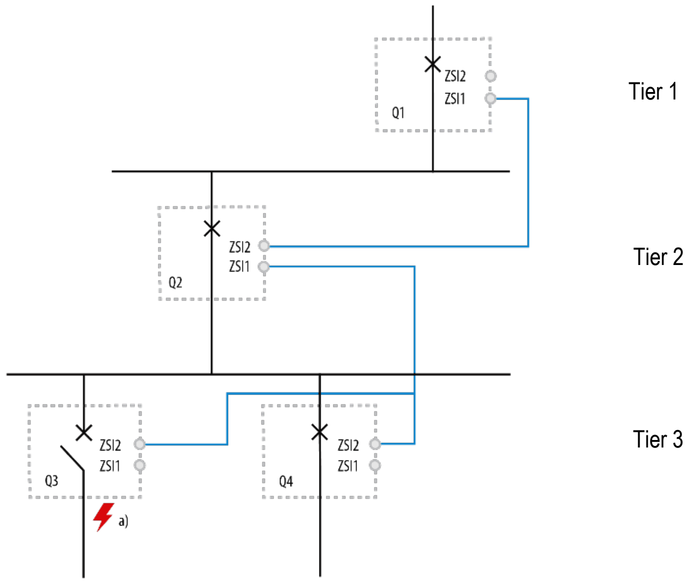
Physical installation of the ZSI signalling cabling shall be considered. Ensure that the cables are mechanically protected from physical damage.

Ensure appropriate clearances and/or shielding of cables when run in proximity to other high-power conductors to avoid induced voltages and electromagnetic interference on the ZSI signal interface.

Protection Settings

Zone Selective Interlocking Function (ZSI)

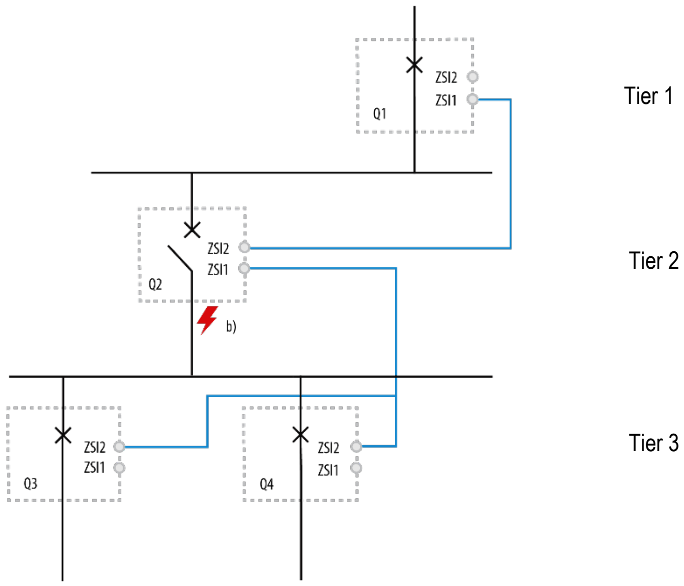
ZSI example A



Fault example a):

A short circuit or ground fault occurs downstream of MCCB Q3. All upstream MCCBs Q1, Q2 and Q3 detect the fault at the same time. The ZSI signalling cable between the circuit breakers produces a signal from Q3, which informs Q2 that the downstream circuit breaker has detected the fault. Q2, also detects the same fault, produces its own ZSI signal, which informs Q1 and so on. As Q1 and Q2 have both received the ZSI signal, they maintain their respective time delays so that Q3 can eliminate the fault instantly.

ZSI example B



Fault example b):

A short circuit or ground fault occurs downstream of MCCB Q2. Only upstream MCCBs Q1 and Q2 detect the fault. As per example a), the ZSI signalling cable between the circuit breakers produces a signal from Q2, which informs Q1 that the downstream circuit breaker it has detected the fault. Q1 then maintains its time delays whilst Q2 overrides its pre-set time delays to eliminate the fault instantly, thus reducing the overall clearance time of the fault whilst maintaining selectivity.

Protection Settings

Zone Selective Interlocking Function (ZSI)

Zone Interlocking with TemPower 2 ACBs

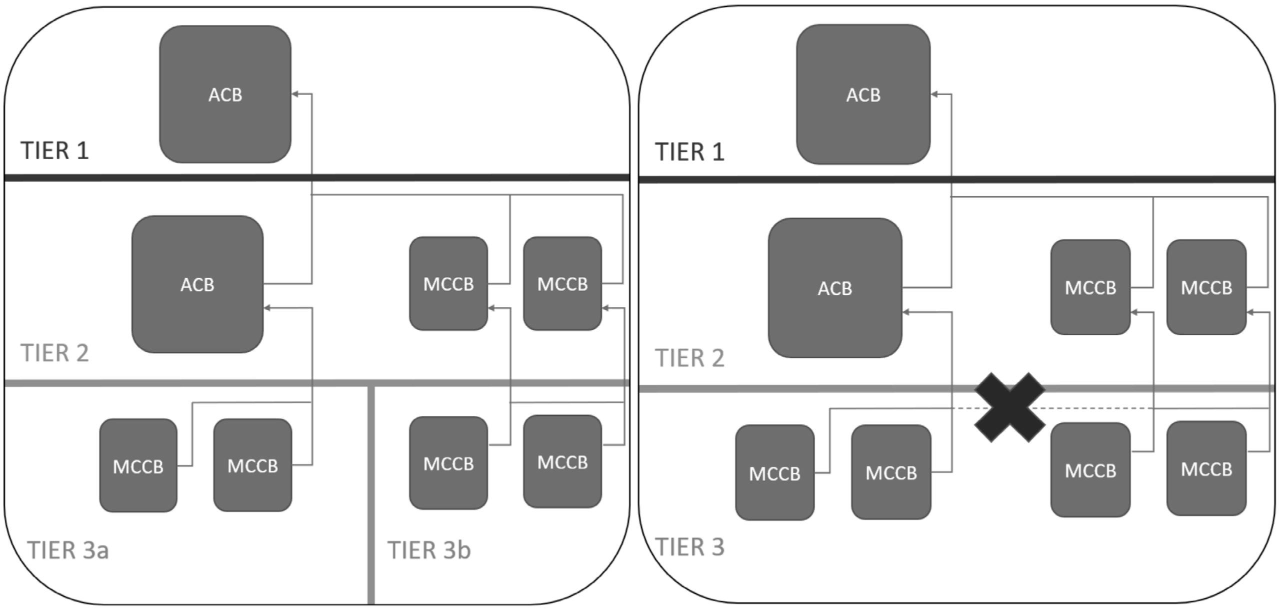
With TemPower 2 ACBs ZSI is available as a custom feature and is designed differently to P_SE ZSI. With these differences it is still possible to zone interlock TemPower 2 with TemBreak PRO P_SE, there are just a few considerations that need to be respected.

Notice: For TemPower 2 ACB's, ZSI function is a custom, factory installed feature.
The instructions for wiring ZSI from ACB to ACB can be found in the ACB Installation Manual & User Manual.

Configuration Restrictions

The ZSI signal is generated by the upstream device, which monitors feedback from the downstream device to determine if the fault is located further downstream. This means that the ZSI scheme cannot be connected in parallel in the downstream tier when fed by different types of upstream device.

Notice: "Different types" refers to ACB ZSI and P_SE ZSI. Once a tier has multiple types of devices the downstream devices can only be connected to either the parallel upstream ACBs or the parallel upstream MCCBs, but not both.



Protection Settings

Zone Selective Interlocking Function (ZSI)

Zone Interlocking with TemPower 2 ACBs

Wiring Requirements
There is no limit to the number of interconnected upstream and downstream circuit breakers using the ZSI signalling interface; however, the reliability of the ZSI signal is dependent on the total impedance of the interconnecting cables. Therefore, the total impedance of the ZSI signalling cables and intermediate wiring and terminations must be considered.
Total impedance is dependent on wire type, length, material, and gauge of all interconnecting wires and termination devices (e.g., terminal blocks and connectors).

The maximum permissible characteristics for the ZSI signalling cable for the total length is as follows:
MCCBs as the Upstream Device

Specification	Value
Max length	1000 m
Max impedance	30 kΩ
Recommended Cable Type	Shielded 3-core

These specifications relate to cable extensions made after the after the 1.2m ZSI cable (TPPHQTT150H).

ACB as the Upstream Device

Specification	Value
Max length	300 m
Max impedance	100 Ω
Recommended Cable Type	Shielded 2-core / Shielded 4-core (with GF ZSI)

See Annex G, or wiring diagrams of ZSI.

Notice: If the total impedance of the interconnecting cables is greater than specified, upon fault current detection, the upstream device may override any intended selectivity settings and attempt an instantaneous ZSI trip. This may result in nuisance tripping and disruption of other services.

WARNING: Physical installation of the ZSI signalling cabling shall be considered.
- Ensure that the cables are mechanically protected from physical damage.
- Ensure appropriate clearances and/or shielding of cables when run in proximity to other high-power conductors to avoid induced voltages and electromagnetic interference on the ZSI signal interface.

Notice: When "type" of upstream device is of ACB type, regardless of a mix of ACB's and MCCBs downstream, the total length of all wires in the ZSI network should not exceed 300m and 100Ω.
The 1000m and 30kΩ limit applies when the upstream device is of MCCB ZSI "type" only.

Protection Settings

Zone Selective Interlocking Function (ZSI)

Zone Interlocking with TemPower 2 ACBs

Power Requirements

For continuous ZSI operation, 24VDC should be supplied to the P_SE Trip Unit externally. While ZSI signalling can work without external 24VDC supply via the CIP port on P_SE MCCB's, it relies on the MCCB contacts being closed and conducting sufficient current to provide the minimum requirements for self-power. See Self-power requirements.

Notice: If external 24VDC supply is not supplied to the P_SE this could lead to nuisance tripping of upstream device when the downstream device does not satisfy the self-powered requirements.

TemPower 2 must have external 24VDC supplied for ZSI to function correctly and it must be the same 24VDC supply for all ACBs in the scheme. Where TemPower 2 ZSI differs from TemBreak PRO is that the 24VDC supply is used as the signal for the upstream device. This is still sent via the downstream device much like TemBreak PRO however, the signal is applied differently. Due to this difference the upstream device must be of the same "type".

Notice: 24VDC Power Supply Required for all devices (ACBs and MCCBs)

- Required to be a single supply for all ACBs in the ZSI scheme
- Not Required to be a single supply for MCCBs in the ZSI scheme

Measurement and Settings

Overview of Measurements

The P_SE Trip Unit measures and makes visible detailed real-time and historic measurements. Visibility of each measurement type is dependent on the interface used to interrogate the Trip Unit and can be made using one or a combination of the below methods:

- P_SE Trip Unit embedded display
- TPED
- TPCM

Measurements		P_SE Trip Unit Embedded Display	TPED	TPCM
Current	**Designator / Description**			
Phase and neutral	I_1, I_2, I_3; I_N	✓	✓	✓
Arithmetic mean	$I_{avg} = \frac{I_1 + I_2 + I_3}{3}$	–	✓	✓
Instantaneous maximum	I_{max} of I_1, I_2, I_3, I_N	–	✓	✓
Instantaneous minimum	I_{min} of I_1, I_2, I_3	–	✓	✓
Ground / Earth	I_g	✓	✓	✓
Imbalance per phase	$I_{1\ Unb}$, $I_{2\ Unb}$, $I_{3\ Unb}$; $I_{N\ Unb}$ with respect to I_{avg}	–	✓	✓
Maximum instantaneous Imbalance	$I_{max\ Unb}$ of $I_{1\ Unb}$, $I_{2\ Unb}$, $I_{3\ Unb}$, $I_{N\ Unb}$	–	✓	✓
Maximum since last reset	Max. of each I_1, I_2, I_3; I_N, I_{max}, I_{min}	✓	✓	✓
Minimum since last reset	Min. of each I_1, I_2, I_3; I_N, I_{max}, I_{min}	–	–	✓
Maximum I_g since last reset	Max. of I_g	–	✓	✓
Minimum I_g since last reset	Min. of I_g	–	–	✓
Maximum average since last reset	Max. of I_{avg}	–	–	✓
Minimum average since last reset	Min. of I_{avg}	–	–	✓
Maximum Imbalance since last reset	Max. of each $I_{1\ Unb}$, $I_{2\ Unb}$, $I_{3\ Unb}$; $I_{N\ Unb}$, $I_{max\ Unb}$	–	–	✓
Minimum Imbalance since last reset	Min. of each $I_{1\ Unb}$, $I_{2\ Unb}$, $I_{3\ Unb}$; $I_{N\ Unb}$, $I_{max\ Unb}$	–	–	✓
Voltage	**Designator / Description**			
Phase-phase	U_{12}, U_{23}, U_{31}	✓	✓	✓
Phase to neutral	V_{1N}, V_{2N}, V_{3N}	✓	✓	✓
Ph-Ph arithmetic mean	$U_{avg} = \frac{U_{12} + U_{23} + U_{31}}{3}$	–	✓	✓
Ph-N arithmetic mean	$V_{avg} = \frac{V_{1N} + V_{2N} + V_{3N}}{3}$	–	✓	✓
Instantaneous maximum	U_{max} of U_{12}, U_{23}, U_{31} V_{max} of V_{1N}, V_{2N}, V_{3N}	–	✓	✓
Instantaneous minimum	U_{min} of U_{12}, U_{23}, U_{31} V_{min} of V_{1N}, V_{2N}, V_{3N}	–	–	✓
Imbalance per phase	% U_{avg} and % V_{avg}	–	✓	✓
Maximum imbalance	$U_{max\ Unb}$, $V_{max\ Unb}$	–	✓	✓
Maximum since last reset	Max. of each U_{12}, U_{23}, U_{31}, U_{max}, U_{min} Max. of each V_{1N}, V_{2N}, V_{3N}, V_{max}, V_{min}	✓	✓	✓
Minimum since last reset	Min. of each U_{12}, U_{23}, U_{31}, U_{max}, U_{min} Min. of each V_{1N}, V_{2N}, V_{3N}, V_{max}, V_{min}	–	–	✓
Maximum average since last reset	Max. of each U_{avg}, V_{avg}	–	✓	✓
Minimum average since last reset	Min. of each U_{avg}, V_{avg}	–	–	✓
Maximum imbalance since last reset	Max. of each $U_{12\ Unb}$, $U_{23\ Unb}$, $U_{31\ Unb}$, $U_{max\ Unb}$ Max. of each $V_{1N\ Unb}$, $V_{2N\ Unb}$, $V_{3N\ Unb}$, $V_{max\ Unb}$	–	–	✓
Minimum imbalance since last reset	Min. of $U_{12\ Unba}$, $U_{23\ Unb}$, $U_{31\ Unb}$, $U_{max\ Unb}$ Min. of $V_{1N\ Unba}$, $V_{2N\ Unb}$, $V_{3N\ Unb}$, $V_{max\ Unb}$	–	–	✓
Network	**Designator / Description**			
Phase rotation (sequence)	1-2-3, 1-3-2	✓	✓	✓
Frequency	**Designator / Description**			
Frequency	f	✓	✓	✓
Maximum frequency since last reset	Max. of f	–	–	✓
Minimum frequency since last reset	Min. of f	–	–	✓

Measurement and Settings

Measurements		P_SE Trip Unit Embedded Display	TPED	TPCM
Power	**Designator / Description**			
Active	P_1, P_2, P_3, P_{tot}	✓	✓	✓
Reactive	Q_1, Q_2, Q_3, Q_{tot}	✓	✓	✓
Apparent	S_1, S_2, S_3, S_{tot}	–	✓	✓
Maximum since last reset	Max. of each P_1, P_2, P_3, P_{tot} Max. of each Q_1, Q_2, Q_3, Q_{tot}	✓	✓	✓
	Max. of each S_1, S_2, S_3, S_{tot}	–	✓	✓
Minimum since last reset	Min. of each P_1, P_2, P_3, P_{tot} Min. of each Q_1, Q_2, Q_3, Q_{tot} Min. of each S_1, S_2, S_3, S_{tot}	–	–	✓
Quadrant	1^{st}, 2^{nd}, 3^{rd}, 4^{th}	–	✓	✓
Power Factor	**Designator / Description**			
Power Factor	PF_1, PF_2, PF_3, PF_{tot}	–	✓	✓
Displacement Power Factor	$Cos\varphi_1$, $Cos\varphi_2$, $Cos\varphi_3$, $Cos\varphi_{tot}$	✓ (only $Cos\varphi_{tot}$)	✓	✓
Maximum since last reset	Max. of each PF_1, PF_2, PF_3, PF_{tot} Max. of each $Cos\varphi_1$, $Cos\varphi_2$, $Cos\varphi_3$, $Cos\varphi_{tot}$	–	–	✓
Minimum since last reset	Min. of each PF_1, PF_2, PF_3, PF_{tot} Min. of each $Cos\varphi_1$, $Cos\varphi_2$, $Cos\varphi_3$, $Cos\varphi_{tot}$	–	–	✓
Total Harmonic Distortion	**Designator / Description**			
THD voltage	THD_{U12}, THD_{U23}, THD_{U31} THD_{V1N}, THD_{V2N}, THD_{V3N}	–	✓	✓
THD current	THD_{I1}, THD_{I2}, THD_{I3}, THD_{Imax}	–	✓	✓
Maximum since last reset	Max. of each THD_{U12}, THD_{U23}, THD_{U31} Max. of each THD_{V1N}, THD_{V2N}, THD_{V3N} Max. of each THD_{I1}, THD_{I2}, THD_{I3}, THD_{Imax}	–	–	✓
Minimum since last reset	Min. of each THD_{U12}, THD_{U23}, THD_{U31} Min. of each THD_{V1N}, THD_{V2N}, THD_{V3N} Min. of each THD_{I1}, THD_{I2}, THD_{I3}, THD_{Imax}	–	–	✓
Energy	**Designator / Description**			
Consumed	$E_{a\ In}$, $E_{r\ In}$	✓	✓	✓
Produced	$E_{a\ Out}$, $E_{r\ Out}$	–	✓	✓
Absolute total (In + Out)	$E_{a\ Abs}$, $E_{r\ Abs}$	–	–	✓
Signed total (In – Out)	E_a, E_r	–	–	✓
Total apparent	E_s	–	✓	✓
Averages Over Interval (Demand Values)	**Designator / Description**			
Active, reactive, apparent power	$P_{1\ Dmd}$, $P_{2\ Dmd}$, $P_{3\ Dmd}$, $P_{tot\ Dmd}$ $Q_{1\ Dmd}$, $Q_{2\ Dmd}$, $Q_{3\ Dmd}$, $Q_{tot\ Dmd}$ $S_{1\ Dmd}$, $S_{2\ Dmd}$, $S_{3\ Dmd}$, $S_{tot\ Dmd}$	–	✓	✓
Maximum power since the last reset	Max. of each $P_{1\ Dmd}$, $P_{2\ Dmd}$, $P_{3\ Dmd}$, $P_{tot\ Dmd}$ Max. of each $Q_{1\ Dmd}$, $Q_{2\ Dmd}$, $Q_{3\ Dmd}$, $Q_{tot\ Dmd}$ Max. of each $S_{1\ Dmd}$, $S_{2\ Dmd}$, $S_{3\ Dmd}$, $S_{tot\ Dmd}$	–	✓	✓
Current	$I_{1\ Dmd}$, $I_{2\ Dmd}$, $I_{3\ Dmd}$; $I_{N\ Dmd}$, $I_{avg\ Dmd}$	–	–	✓
Maximum current since last reset.	Max. of each $I_{1\ Dmd\ max}$, $I_{2\ Dmd\ max}$, $I_{3\ Dmd\ max}$, $I_{N\ Dmd\ max}$	–	–	✓
Integration interval sliding, fixed, or synchronised by Modbus	Adjustable from 5 to 60 minutes in increments of one minute	–	✓	✓

Measurement and Settings

Accuracy of Measurements

The measurement accuracies of the P_SE Trip Unit complies with the requirements of standard IEC 61557-12 Edition 1:

- Class 0.2 for measuring frequency,
- Class 0.5 for measuring voltages,
- Class 1 for measuring current,
- Class 2 for measuring active energy / power.

The accuracy of each measurement is defined, in accordance with IEC 61557-12 Ed 1, for a supply within the rated ambient temperature range of the MCCB (-25°C...+70°C).

Variables	Symbols	Measurement range for accuracy class	IEC 61557-12 Accuracy Class
RMS and min./max. currents	I_1, I_2, I_3, I_N, I_{avg}, I_{max}, I_{min}, ...	0.2...1.2 x I_n	Class 1
Ground / Earth current	I_g	0.2 ... 1.2 x I_n	Class 1
Current imbalance	$I_{1\ Unb}$, $I_{2\ Unb}$, $I_{3\ Unb}$, $I_{N\ Unb}$, $I_{max\ Unb}$	–	–
Ph-Ph RMS and min./max. voltages	U_{12}, U_{23}, U_{31}, U_{avg}, U_{max}, U_{min}	120…690 V	Class 0.5
Ph-N RMS and min./max. voltages	V_{1N}, V_{2N}, V_{3N}, V_{avg}, V_{max}, V_{min}	70…440V	Class 0.5
Voltage imbalance	$U_{12\ Unb}$, $U_{23\ Unb}$, $U_{31\ Unb}$, $U_{max\ Unb}$, $V_{1N\ Unb}$, $V_{2N\ Unb}$, $V_{3N\ Unb}$, $V_{max\ Unb}$	0.8...1.2 x V_n	–
Frequency	f	45…65 Hz	Class 0.2
Power	P_1, P_2, P_3, P_{tot} Q_1, Q_2, Q_3, Q_{tot} S_1, S_2, S_3, S_{tot}	0.05…1.2 x I_n	Class 2
Energy	$E_{a\ In}$, $E_{a\ Out}$, $E_{a\ Abs}$, $E_{a\ net}$ $E_{r\ In}$, $E_{r\ Out}$, $E_{r\ Abs}$, $E_{r\ net}$ $E_{s\ net}$	0.05...1.2 x I_n	Class 2
Average powers over interval (Demand powers)	$P_{1\ Dmd}$, $P_{2\ Dmd}$, $P_{3\ Dmd}$, $P_{tot\ Dmd}$ $Q_{1\ Dmd}$, $Q_{2\ Dmd}$, $Q_{3\ Dmd}$, $Q_{tot\ Dmd}$ $S_{1\ Dmd}$, $S_{2\ Dmd}$, $S_{3\ Dmd}$, $S_{tot\ Dmd}$	0.05...1.2 x I_n	–
Average currents over interval (Demand currents)	$I_{1\ Dmd}$, $I_{2\ Dmd}$, $I_{3\ Dmd}$, $I_{N\ Dmd}$, $I_{avg\ Dmd}$, $I_{1\ Dmd\ max}$, $I_{2\ Dmd\ max}$, $I_{3\ Dmd\ max}$; $I_{N\ Dmd\ max}$	0.2...1.2 x I_n	–
Power factors	PF_1, PF_2, PF_3, PF_{tot}, $Cos\varphi_1$, $Cos\varphi_2$, $Cos\varphi_3$, $Cos\varphi_{tot}$	Capacitive (current leading) 0.5…1 Inductive (current lagging) 0.8…1	–
THD voltage	THD_{U12}, THD_{U23}, THD_{U31} THD_{V1N}, THD_{V2N}, THD_{V3N}	0...20%	Class 2
THD current	THD_{I1}, THD_{I2}, THD_{I3}, THD_{Imax}	0...200%	Class 2

Measurement and Settings

Real-Time and Min./Max. Measurements

The P_SE Trip Unit records historical maximum and minimum measurement values alongside real-time measurements.

Some historical values may be manually reset, include User and Trip Unit timestamps, and/or are unique to MCCB's with Neutral reference (3Ph+N) or without (3Ph) depending on system topology. The properties of each type of available historic values are indicated in the following table.

For example, the "Maximum since reset of minimum of I_1, I_2, I_3" describes the highest I_{min} value calculated/measured since the last manual reset of historical values. If reset, the existing instantaneous I_{min} value will become the new maximum of I_{min} since reset and will be updated accordingly.

Measurement Value	Designator / Description	Minimum		Real-time	Maximum		3Ph	3Ph+N
Current		Value	Timestamp	Value	Value	Timestamp		
RMS current (*I_N 4P MCCB only)	I_1	✓	—	✓	✓	✓	✓	✓
	I_2	✓	—	✓	✓	✓	✓	✓
	I_3	✓	—	✓	✓	✓	✓	✓
	*I_N	✓	—	✓	✓	✓	—	✓*
Ground / Earth current	I_g	✓	—	✓	✓	—	—	✓
Max. RMS current (*I_N 4P MCCB only)	I_{max} = max. of I_1, I_2, I_3, *I_N	✓	—	✓	✓	—	✓	✓*
Min. RMS current	I_{min} = min. of I_1, I_2, I_3	✓	—	✓	✓	—	✓	✓
Avg. RMS current	$I_{avg} = \frac{I_1 + I_2 + I_3}{3}$	✓	—	✓	✓	—	✓	✓
Current imbalance (*$I_{N\ Unb}$ 4P MCCB only)	$I_{1\ Unb}$	✓	—	✓	✓	—	✓	✓
	$I_{2\ Unb}$	✓	—	✓	✓	—	✓	✓
	$I_{3\ Unb}$	✓	—	✓	✓	—	✓	✓
	*$I_{N\ Unb}$	✓	—	✓	✓	—	—	✓*
Max. current imbalance (*$I_{N\ Unb}$ 4P MCCB only)	$I_{max\ Unb}$ = max. of $I_{1\ Unb}$, $I_{2\ Unb}$, $I_{3\ Unb}$, *$I_{N\ Unb}$	✓	—	✓	✓	—	✓	✓*
Voltage								
Ph-Ph RMS voltage	U_{12}	✓	✓	✓	✓	✓	✓	✓
	U_{23}	✓	✓	✓	✓	✓	✓	✓
	U_{31}	✓	✓	✓	✓	✓	✓	✓
Max. Ph-Ph RMS voltage	U_{max} = max. of U_{12}, U_{23}, U_{31}	✓	—	✓	✓	—	✓	✓
Min. Ph-Ph RMS voltage	U_{min} = min. of U_{12}, U_{23}, U_{31}	✓	—	✓	✓	—	✓	✓
Avg. Ph-Ph RMS voltage	$U_{avg} = \frac{U_{12} + U_{23} + U_{31}}{3}$	✓	—	✓	✓	—	✓	✓
Ph-Ph Voltage imbalance	$U_{12\ Unb}$	✓	—	✓	✓	—	✓	✓
	$U_{23\ Unb}$	✓	—	✓	✓	—	✓	✓
	$U_{31\ Unb}$	✓	—	✓	✓	—	✓	✓
Max. Ph-Ph Voltage imbalance	$U_{max\ Unb}$ = max. of $U_{12\ Unb}$, $U_{23\ Unb}$, $U_{31\ Unb}$	✓	—	✓	✓	—	✓	✓
Ph-N RMS voltage	V_{1N}	✓	✓	✓	✓	✓	—	✓
	V_{2N}	✓	✓	✓	✓	✓	—	✓
	V_{3N}	✓	✓	✓	✓	✓	—	✓
Max. Ph-N RMS voltage	V_{max} = max. of V_{1N}, V_{2N}, V_{3N}	✓	—	✓	✓	—	—	✓
Min. Ph-N RMS voltage	V_{min} = min. of V_{1N}, V_{2N}, V_{3N}	✓	—	✓	✓	—	—	✓
Avg. Ph-N RMS voltage	$V_{avg} = \frac{V_{1N} + V_{2N} + V_{3N}}{3}$	✓	—	✓	✓	—	—	✓
Ph-N Voltage imbalance	$V_{1N\ Unb}$	✓	—	✓	✓	—	✓	✓
	$V_{2N\ Unb}$	✓	—	✓	✓	—	✓	✓
	$V_{3N\ Unb}$	✓	—	✓	✓	—	✓	✓
Max. Ph-N voltage imbalance	$V_{max\ Unb}$ = max. of $V_{1N\ Unb}$, $V_{2N\ Unb}$, $V_{3N\ Unb}$	✓	—	✓	✓	—	✓	✓

Measurement and Settings

Measurement Value	Designator / Description	Minimum		Real-time	Maximum		3Ph	3Ph+N
Power		Value	Timestamp	Value	Value	Timestamp		
Active power	P_1	✓	–	✓	✓	–	–	✓
	P_2	✓	–	✓	✓	–	–	✓
	P_3	✓	–	✓	✓	–	–	✓
Total active power	P_{tot}	✓	–	✓	✓	–	✓	✓
Reactive power	Q_1	✓	–	✓	✓	–	–	✓
	Q_2	✓	–	✓	✓	–	–	✓
	Q_3	✓	–	✓	✓	–	–	✓
Total reactive power	Q_{tot}	✓	–	✓	✓	–	✓	✓
Apparent power	S_1	✓	–	✓	✓	–	–	✓
	S_2	✓	–	✓	✓	–	–	✓
	S_3	✓	–	✓	✓	–	–	✓
Total apparent power	S_{tot}	✓	–	✓	✓	–	✓	✓
Power factor								
Power factor	PF_1	✓	–	✓	✓	–	–	✓
	PF_2	✓	–	✓	✓	–	–	✓
	PF_3	✓	–	✓	✓	–	–	✓
Total power factor	PF_{tot}	✓	–	✓	✓	–	✓	✓
Fundamental power factor	$Cos\varphi_1$	✓	–	✓	✓	–	–	✓
	$Cos\varphi_2$	✓	–	✓	✓	–	–	✓
	$Cos\varphi_3$	✓	–	✓	✓	–	–	✓
Total fundamental power factor	$Cos\varphi_{tot}$	✓	–	✓	✓	–	✓	✓
Total Harmonic Distortion								
THD Ph-Ph voltage	THD_{U12}	✓	–	✓	✓	–	✓	✓
	THD_{U23}	✓	–	✓	✓	–	✓	✓
	THD_{U31}	✓	–	✓	✓	–	✓	✓
THD Ph-N voltage	THD_{V1N}	✓	–	✓	✓	–	–	✓
	THD_{V2N}	✓	–	✓	✓	–	–	✓
	THD_{V3N}	✓	–	✓	✓	–	–	✓
THD current	THD_{I1}	✓	–	✓	✓	–	✓	✓
	THD_{I2}	✓	–	✓	✓	–	✓	✓
	THD_{I3}	✓	–	✓	✓	–	✓	✓
Max. THD current	THD_{Imax}	✓	–	✓	✓	–	✓	✓
Frequency								
Network Frequency	f	✓	✓	✓	✓	✓	✓	✓

Measurement and Settings

Current and Voltage Imbalances

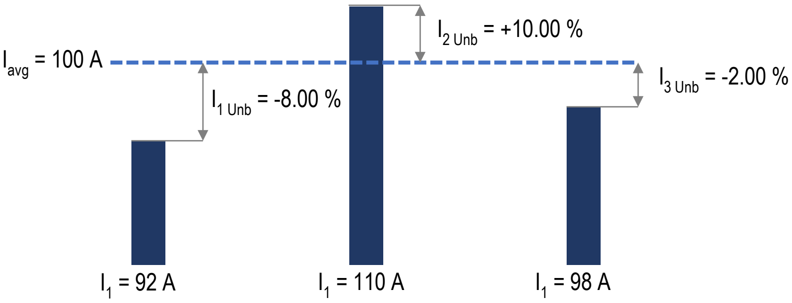
The P_SE Trip Unit calculates in real-time (every second) current and voltage imbalances as expressed as a % in relation to the arithmetic mean (average value)

Current imbalance $I_{p\ Unb}$ is expressed as a % in relation to the arithmetic mean RMS current I_{avg}.

$$I_{avg} = \frac{I_1 + I_2 + I_3}{3}$$

$$I_{p\ Unb} = \frac{I_{ph} - I_{avg}}{I_{avg}} \times 100 \text{ where p = phase: 1, 2, 3}$$

Example, the calculation of $I_{1\ Unb}$ is as follows and per the below illustration:



$$I_{avg} = \frac{I_1 + I_2 + I_3}{3} = \frac{92\ A + 110\ A + 98\ A}{3} = 100\ A$$

$$I_{1\ Unb} = \frac{I_1 - I_{avg}}{I_{avg}} \times 100 = \frac{92 - 100}{100} \times 100$$

$$\therefore I_{1\ Unb} = -8.00\ \%$$

Voltage imbalance $U_{pg\ Unb}$ is expressed as a % in relation to the arithmetic mean RMS Ph-Ph voltage U_{avg} and Ph-N voltage V_{avg} where applicable.

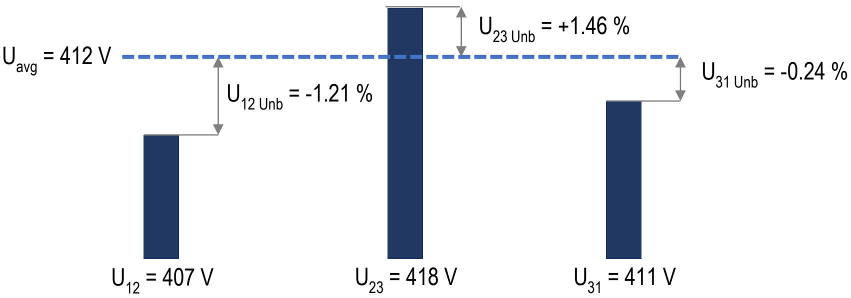
$$U_{avg} = \frac{U_{12} + U_{23} + U_{31}}{3}$$

$$V_{avg} = \frac{V_{1N} + V_{2N} + V_{3N}}{3}$$

$$U_{pb\ Unb} = \frac{U_{ph\text{-}ph} - U_{avg}}{U_{avg}} \times 100 \text{ where pb = ph-ph: 12, 23, 31}$$

$$V_{pN\ Unb} = \frac{V_{ph\text{-}N} - V_{avg}}{V_{avg}} \times 100 \text{ where pN = ph-N: 1N, 2N, 3N}$$

Example, the calculation of $U_{23\ Unb}$ is as follows and per the below illustration:



$$U_{avg} = \frac{U_{12} + U_{23} + U_{31}}{3} = \frac{407\ V + 418\ V + 411\ V}{3} = 412\ V$$

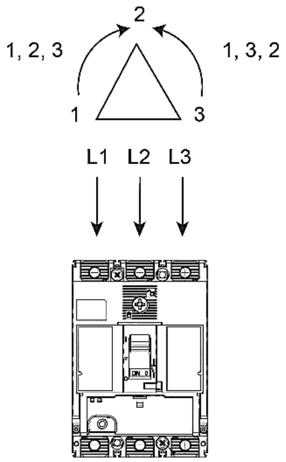
$$U_{23\ Unb} = \frac{U_{23} - U_{avg}}{U_{avg}} \times 100 = \frac{407 - 412}{412} \times 100$$

$$\therefore U_{23\ Unb} = +1.46\ \%$$

Measurement and Settings

System Phase Sequence

This parameter is used to configure the sequence of phases for the network supplying the P_SE MCCB.



Changes to the system phase sequence setting can be made using one or a combination of the below methods:

- P_SE Trip Unit embedded display
- TPED
- TPCM

P_SE Trip Unit embedded display setting	TPED setting	TPCM setting	Default
 1,2.3: 1,2,3 1,3,2: 1,3,2	“Phase sequence 1,2.3: 1,2,3 1,3,2: 1,3,2	Command ID: 101 “System phase sequence” Hex 00 00: 1,2,3 Hex 00 01: 1,3,2	1,2,3

Measurement and Settings

Power Related Measurements

The P_SE Trip Unit calculates the electrical power related parameters in real-time by taking discrete instantaneous measurements of voltage and current at regular sample intervals, with the available data refreshed once every second:

- Active power (P)
- Reactive power (Q)
- Apparent power (S)
- Power Factor (PF)
- Fundamental power factor (Cosφ)
- Power sign
- Power quadrant

Active, Reactive, Apparent power

Active (P), Reactive (Q) and Apparent (S) Power related parameters vary in availability according to system topology (3Ph or 3Ph+N), which are provided in the following table. Individual power values per phase are only available on MCCB variants with a Neutral reference, whereas total 3-phase power values are available for both system topologies.

Electrical Parameter	Symbol	3Ph	3Ph+N
Active power per phase	P_1, P_2, P_3	–	✓
Apparent power per phase	S_1, S_2, S_3	–	✓
Reactive power per phase	Q_1, Q_2, Q_3	–	✓
Total 3-phase active power	P_{tot}	✓	✓
Total 3-phase reactive power	Q_{tot}	✓	✓
Total 3-phase apparent power	S_{tot}	✓	✓

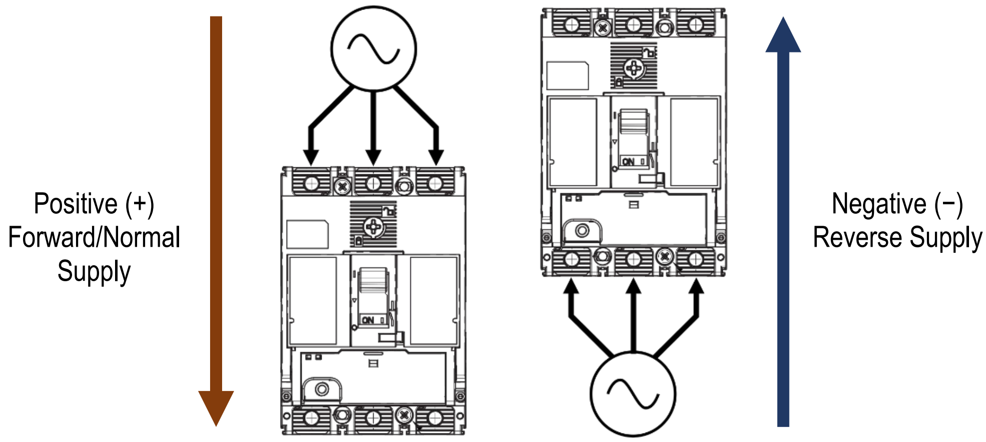
Notice: Accuracy and correct polarity of power related measurements are dependent on several calculation, power flow and sign convention settings. Refer to the respective sections for details on these settings:

- Power flow direction and quadrant
- Reactive and apparent power calculation convention
- Power factor sign convention

Measurement and Settings

Power flow direction and quadrant

The P_SE MCCB power supply can be fed in either forward or reverse direction to allow for varied applications and physical installation requirements. Power measurement values are denoted by positive or negative in accordance with the power sign polarity. To ensure accuracy of measurements and other calculated values (such as energy and quadrant), the P_SE Trip Unit must be configured with the correct power flow direction, which reflects the physical direction of supply.



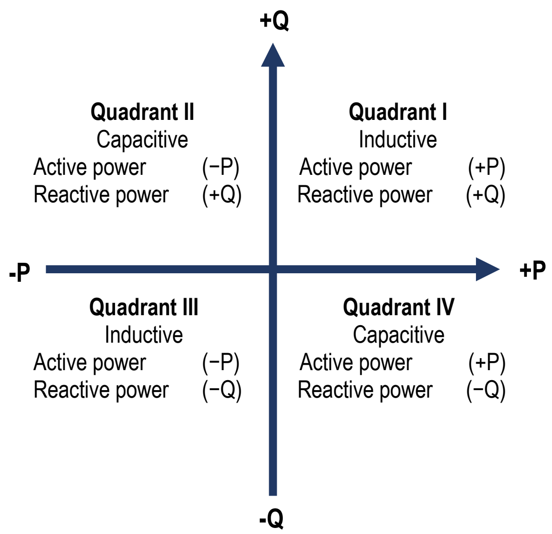
Changes to the power flow direction can be made using one or a combination of the below methods:

- TPED
- TPCM

TPED setting	TPCM setting	Default
"P sign convention" Plus: Forward/normal supply Minus: Reverse supply	Command ID: 103 "Power flow direction" Hex 00 00: Forward/normal supply Hex 00 01: Reverse supply	Forward/normal supply

When represented on the power quadrant display, the power flow direction setting ensures that accurate power signs are shown, i.e. positive (+) and negative (−) signs:

- Positive active power (+P) is shown when power and energy is delivered to the load, i.e. the downstream circuit is consuming power.
- Negative active power (-P) is shown when power and energy is received from the load, i.e. the downstream circuit is generating power.
- Reactive power (Q) follows the active power (P) sign when current lags behind voltage, i.e. when the downstream circuit is inductive.
- Reactive power (Q) is opposite the active power (P) sign when current leads ahead of voltage, i.e. when the downstream circuit is capacitive.



Measurement and Settings

Reactive and apparent power calculation convention

Total reactive (Q_{tot}) and apparent (S_{tot}) power for a 3-phase-3-wire system are calculated in the P_SE Trip Unit using either Arithmetic or Vector convention, which is selectable during configuration.

Changes to the reactive and apparent power calculation convention can be made using one or a combination of the below methods:

- TPED
- TPCM

TPED setting	TPCM setting	Default
"Calc. convention" Arithmetic: Arithmetic convention Vector: Vector convention	Command ID: 104 "Calculation formula for Reactive and Apparent power" Hex 00 00: Arithmetic convention Hex 00 01: Vector convention	Vector convention

The selection of either convention depends on user or application preference, however, does impact the calculation of other power related measurements which utilize total reactive (Q_{tot}) and apparent (S_{tot}) power. Differences between the results of the calculation convention used are more prominent in unbalanced 3-phase systems.

Arithmetic convention: Total apparent power (S_{totA}) is calculated by adding the absolute magnitude of the apparent power ($|S_p|$) of each phase.

$$S_{totA} = |S_1| + |S_2| + |S_3|$$

Therefore, total reactive power (Q_{totA}) is calculated by using the known total real power (P_{tot}) and the arithmetic S_{totA}.

$$Q_{totA} = \pm\sqrt{S_{totA}^2 - P_{tot}^2}$$

Vector convention: Total apparent power (S_{totV}) is calculated by adding the known total real power (P_{tot}) and total reactive power (Q_{totV}).

$$S_{totV}=\sqrt{P_{tot}^2+Q_{totV}^2}$$

The calculation of total reactive power (Q_{totV}) is performed by adding the vector sum of the apparent power for each phase (Q_p).

$$Q_{totA} = Q_1 + Q_2 + Q_3$$

Values which are affected by calculation convention setting are as follows:

Variables	Symbols
Total reactive and apparent power	Q_{tot}, S_{tot}
Average reactive and apparent power over interval (Demand power)	$Q_{tot\ Dmd}$, $S_{tot\ Dmd}$
Maximum Average reactive and apparent power over interval (Demand power) since the last reset	Max. of each $Q_{tot\ Dmd}$, $S_{tot\ Dmd}$
Reactive energy produced, consumed, absolute and signed totals	$E_{r\ In}$, $E_{r\ Out}$, $E_{r\ Abs}$, E_r
Apparent energy	E_s
Power factor	PF_1, PF_2, PF_3, PF_{tot}
Total displacement power factor	$Cos\varphi_{tot}$

Measurement and Settings

Power factor (PF and cosφ)

The P_SE Trip Unit calculates in real-time (every second) the total three-phase power factor (PF_{tot}) from the ratio of total active power (P_{tot}) to total apparent power (S_{tot}) in both MCCB system topology (3Ph or 3Ph+N). It also calculates the power factors per phase from the ratios of total active power per phase to apparent power per phase in MCCB variants with Neutral reference:

$$PF_p = \frac{P_p}{S_p} \text{, where p = phase: 1, 2, 3}$$

In the case of purely sinusoidal current (with no harmonic content), the overall power factor (PF) contains only the power factor of the fundamental frequency also referred to as displacement power factor cosφ, and thus they are equal. However, in the case of non-linear current consumption (as is typical in rectifiers, switch-mode power supplies, variable speed drives, and modern electric lighting), the true overall power factor PF is affected by the harmonic content of the current waveform (THD), and thus PF and cosφ differ. The relationship between PF, cosφ is thus dependent on THD:

$$PF_p = \frac{\cos\varphi_p}{\sqrt{1 + THD_p^2}} \text{, where p = phase: 1, 2, 3}$$

The P_SE Trip Unit provides independent displacement power factor (cosφ) values, in addition to PF, which is also calculated in real-time (every second). Individual power factor values per phase are only available on MCCB variants with a Neutral reference, whereas total 3-phase power factor values are available for both system topologies.

Power Factor	Symbol	3Ph	3Ph+N
Power factor per phase	PF_1, PF_2, PF_3	–	✓
Total power factor	PF_{tot}	✓	✓
Displacement power factor per phase	$\cos\varphi_1$, $\cos\varphi_2$, $\cos\varphi_3$	–	✓
Total displacement power factor	$\cos\varphi_{tot}$	✓	✓

Measurement and Settings

Power factor sign convention

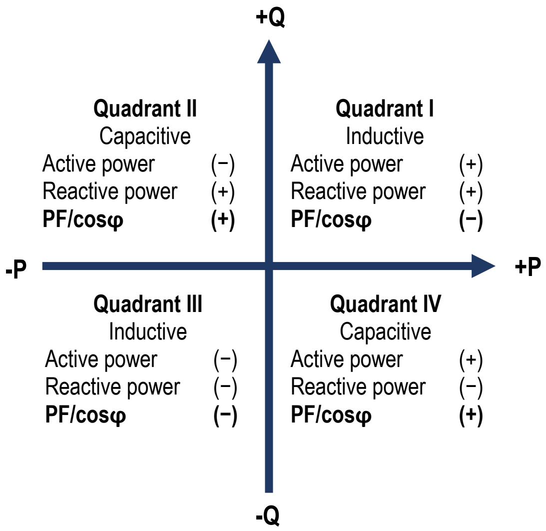
Power factor values (both PF and cosφ) are represented by the P_SE Trip Unit as having either a positive (+) or negative (-) sign depending on the sign convention setting. The two sign conventions are dependent on either IEC or IEEE standards.

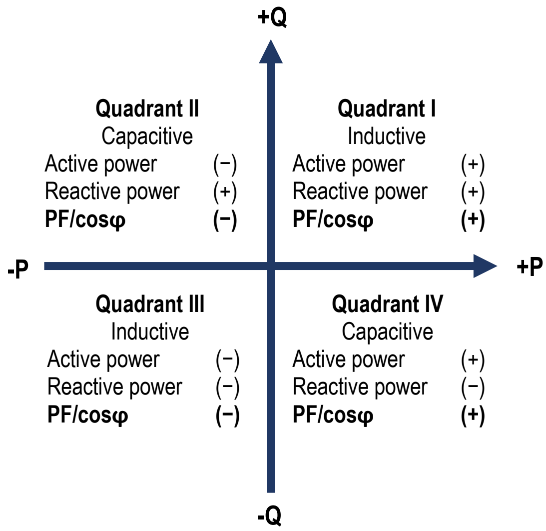
Changes to the power factor sign convention can be made using one or a combination of the below methods:

- TPED
- TPCM

TPED setting	TPCM setting	Default
"PF Sign convention" IEEE: IEEE Standard IEC: IEC Standard	Command ID: 105 "Power factor sign convention" Hex 00 00: IEEE Standard Hex 00 01: IEC Standard	IEEE Standard

IEEE Convention	IEC Convention
The sign for PF and cosφ is dependent on both the flow direction of active power and reactive power components of the load. This can be simplified to whether the load is capacitive or inductive, independent of the active power flow direction: - Inductive load, power factor is negative (-). - Capacitive load, power factor is positive (+).	The sign for PF and cosφ is dependent on the flow direction of active power (P), and is independent of the inductance or capacitance of the load: - Power factor is positive (+) for normal active power flow. I.e. active power flows into a load and energy is consumed. - Power factor is negative (-) for reverse active power flow. I.e. active power flows out of the load and energy is generated.





Measurement and Settings

Total Harmonic Distortion (THD)

The P_SE Trip Unit calculates the total harmonic distortion levels from the real-time current and voltage measurements (every second). These calculations are performed up to the 31st harmonic. The total harmonic distortion levels may be used to indicate load or power supply quality according to the purity of the current and/or voltage waveform, where low level of wave distortion is ideal.

Harmonic content of the respective waveform (THD) is normally attributed to non-linear load and equipment (as is typical in rectifiers, switch-mode power supplies, variable speed drives, and modern electric lighting), which produces non-sinusoidal current waveforms.

A low level THD is generally acceptable, whereas a high level of unwanted THD may have detrimental effects on equipment connected to the same circuit or supply and may result in increases to current and temperature in neutral conductors and distribution transformers, and core losses and overheating of motors. If not mitigated, high THD levels may result in serious degradation, dangerous overheating and/or risk of malfunction of connected equipment.

Acceptable THD levels are dependent on the application and relative standards for the installation.

THD_I is used to determine the current wave harmonic distortion level. THD_U or THD_V is used to determine the voltage wave harmonic distortion level for Ph-Ph and Ph-N voltages respectively.

Total Harmonic Distortion	Symbol	3Ph	3Ph+N
THD phase current	THD_{I1},THD_{I2}, THD_{I3}	✓	✓
THD voltage Ph-N	THD_{V1N}, THD_{V2N}, THD_{V3N}	–	✓
THD Voltage Ph-Ph	THD_{U12}, THD_{U23}, THD_{U31}	✓	✓

For heavily distorted waveforms, it is possible for the THD percentage to exceed 100%, as this indicates that a majority of the total RMS current or voltage is produced by harmonic content. The maximum values indicated by the P_SE Trip Unit are provided in the Range and accuracy section.

Current (THD_I)

The current THD is measured as the percentage of the RMS current of each harmonic above the fundamental frequency (harmonic order > 1) of the current waveform as compared to the RMS current of the fundamental frequency (harmonic order = 1):

$$THD_{I_p} = \frac{\sqrt{{I_{ph_2}}^2 + {I_{ph_3}}^2 + \dots + {I_{ph_{31}}}^2}}{I_{ph_1}} \times 100$$

Where I_{ph_n} = effective harmonic component of order n for phase p.
E.g. I_{1h_1} is the RMS phase 1 current of the fundamental frequency, I_{1h_2} is the RMS phase 1 current of the 2nd harmonic, and so on.

Voltage (THD, THD_U, THD_V)

The voltage THD is measured as the percentage of the RMS voltage of each harmonic above the fundamental frequency (harmonic order > 1) of the voltage waveform as compared to the RMS voltage of the fundamental frequency (harmonic order = 1):

$$THD_{U_{pg}} = \frac{\sqrt{{U_{pgh_2}}^2 + {U_{pgh_3}}^2 + \dots + {U_{pgh_{31}}}^2}}{U_{pgh_1}} \times 100$$

Where U_{pgh_n} = effective harmonic component of order n for the voltage between phases p and g.
E.g. U_{12h_1} is the RMS Ph1-Ph2 voltage of the fundamental frequency, U_{12h_2} is the RMS Ph1-Ph2 voltage of the 2nd harmonic, and so on.

Measurement and Settings

Demand Values (averaged values over an interval)

The P_SE Trip Unit calculates the averaged current and power values by integration over a specified time interval. These are the Demand values or the averaged values over an interval. Demand values are useful in order to create a load profile for the loads supplied by the P_SE MCCB.

Demand values are distinct and not to be confused with other instantaneous average measurements (e.g. I_{avg}, U_{avg} etc.), which are given as arithmetic averages of several phases.

The P_SE Trip Unit calculates an average demand value (G) by adding all the values for G for a time interval (T) and dividing them by the total time in the window interval. The formula is represented by an integral continuous over time, though the Trip Unit does perform this calculation using discrete time and measurement values.

$$G_{average} = \frac{1}{T}\int_0^T G\,dt$$

Where:
T = Time window interval
G = Demand value over time interval

For each averaged value (Demand value) period calculated, the maximum value over the time interval is also stored. The maximum values can be reset via the TPED or TPCM.

The exhaustive list of variables calculated according to system topology (3Ph and 3Ph+N) and the display interface are given in the following table:

Electrical Variable	Symbol	3Ph	3Ph+N	TPED	TPCM
Phase currents	$I_{1\,Dmd}$, $I_{2\,Dmd}$, $I_{3\,Dmd}$	✓	✓	–	✓
Neutral current (*4P MCCB only)	*$I_{N\,Dmd}$	–	✓*	–	✓
Average current	$I_{avg\,Dmd}$	✓	✓	–	✓
Active power per phase	$P_{1\,Dmd}$, $P_{2\,DMD}$, $P_{3\,Dmd}$	–	✓	✓	✓
Total active power	$P_{tot\,Dmd}$	✓	✓	✓	✓
Reactive power per phase	$Q_{1\,Dmd}$, $Q_{2\,Dmd}$, $Q_{3\,Dmd}$	–	✓	✓	✓
Total reactive power	$Q_{tot\,Dmd}$	✓	✓	✓	✓
Apparent power per phase	$S_{1\,Dmd}$, $S_{2\,Dmd}$, $S_{3\,Dmd}$	–	✓	✓	✓
Total apparent power	$S_{tot\,Dmd}$	✓	✓	✓	✓
Maximum current phase	$I_{1\,max\,Dmd}$, $I_{2\,max\,Dmd}$, $I_{3\,max\,Dmd}$	✓	✓	–	✓
Neutral current maximum (*4P MCCB only)	*$I_{N\,max\,Dmd}$	–	✓*	–	✓
Average current maximum	$I_{avg\,max\,Dmd}$	✓	✓	–	✓
Maximum active power per phase	$P_{1\,max\,Dmd}$, $P_{2\,max\,Dmd}$, $P_{3\,max\,Dmd}$	–	✓	✓	✓
Maximum total active power	$P_{tot\,max\,Dmd}$	✓	✓	✓	✓
Maximum reactive power per phase	$Q_{1\,max\,Dmd}$, $Q_{2\,max\,Dmd}$, $Q_{3\,max\,Dmd}$	–	✓	✓	✓
Maximum total reactive power	$Q_{tot\,max\,Dmd}$	✓	✓	✓	✓
Maximum apparent power per phase	$S_{1\,max\,Dmd}$, $S_{2\,max\,Dmd}$, $S_{3\,max\,Dmd}$	–	✓	✓	✓
Maximum total apparent power	$S_{tot\,max\,Dmd}$	✓	✓	✓	✓

Notice: Accuracy and correct polarity of power related measurements are dependent on several calculation, power flow and sign convention settings. Refer to the respective sections for details on these settings:

- Power flow direction and quadrant
- Reactive and apparent power calculation convention
- Power factor sign convention

Measurement and Settings

Demand mode

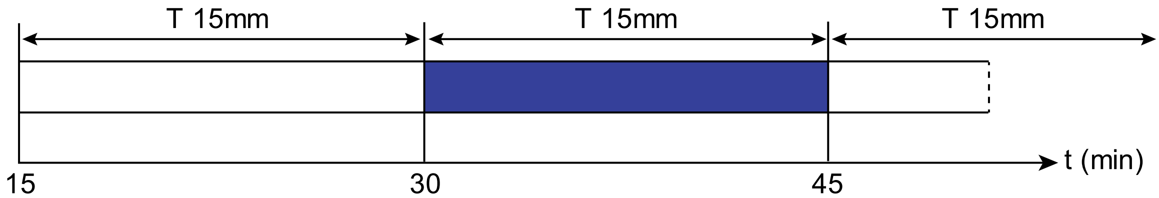
There are 3 types of time window intervals which are configurable in the Trip Unit:
- Fixed window
- Sliding window
- Synchronised window (Sync. Bus)

Changes to the Demand interval type and time can be made using one or a combination of the below methods:
- TPED
- TPCM

TPED setting	TPCM setting	Default
"On Demand Mode" Fixed: Forward/normal supply Sliding: Reverse supply Bus sync: Synchronised window "On Demand Duration" 5…60min: Duration in minutes (5…60 min)	Command ID: 106 "Demand" Address Hex 22 26, Mode: Hex 00 00: Fixed window Hex 00 01: Sliding window Hex 00 02: Synchronised window Address Hex 22 25, Duration: Hex 00 05…00 3C: Duration in minutes (5…60 min)	Mode: Fixed window Duration: 30 min

Fixed window

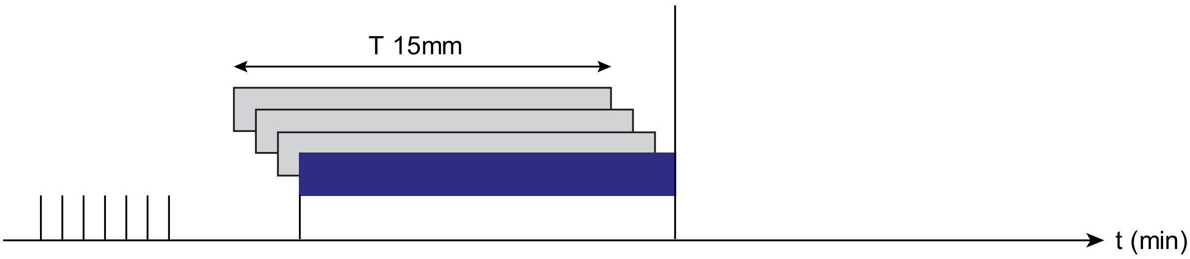
The calculation intervals are performed consecutively in separate and discrete time interval (T) blocks with a new demand value calculated at the end of each interval.



The duration of interval T can be configured between 5 and 60 minutes in increments of 1 minute.

Sliding window

The calculation intervals are performed consecutively within the set time interval (T) with a new demand value produced every minute.
The demand value shows the average of the last time interval (T) from the last minute observed.



The duration of interval T can be configured between 5 and 60 minutes in increments of 1 minute.

Measurement and Settings

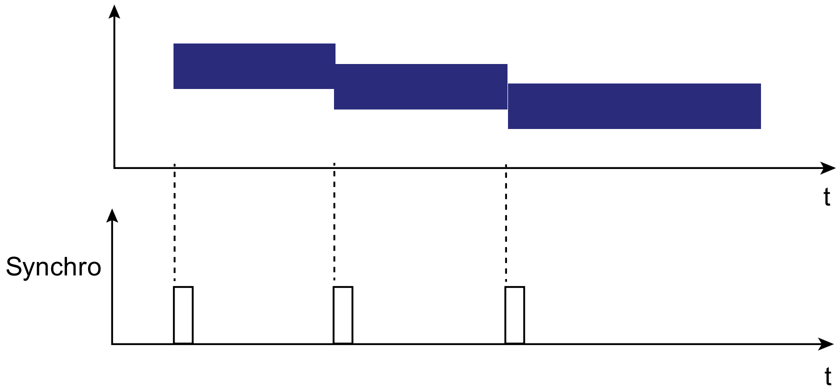
Synchronised window

This mode is only compatible with the use of the TPCM, whereby a synchronisation pulse is generated via write Command ID: 132 “Trigger signal of Bus synchronisation Demand mode”.

The time interval for the calculation of the demand value is determined by the time between synchronisation pulses. When the first synchronisation pulse is received, the start of the time interval is initialised. For the next received pulse, the last time interval is concluded; the demand value is updated and a new time interval is initialised.

The time interval between two synchronisation pulses must be between 1 and 60 minutes. If the interval exceeds 60 minutes, integration of the measurement stops and the measurements up to the next synchronisation pulse are not considered.

Any time interval (T) setting in the Trip Unit is ignored whilst in Synchronised demand mode, as the time interval is determined as the time between pulses.



Measurement and Settings

Energy Measurements

The P_SE Trip Unit provides various energy readings by integrating the instantaneous power over a network period and storing the totalised energy in several counters and incremented once every second.

Active and reactive energy counters provide separate and combined values for produced and consumed energy (i.e. energy flowing through the MCCB in either direction). Absolute counters are unsigned and combine the total energy in either direction regardless of power sign, whereas net counters are signed and will subtract produced energy from consumed.

The partial energy counters can be reset using one or a combination of the below methods:

- P_SE Trip Unit embedded display
- TPED
- TPCM

Separate non-resetable counters are made available for produced and consumed active energy only. These are separate to the partial energy counters as they cannot be reset and are permanently retained in Trip Unit memory.

Partial energy counter	Symbol	User reset
Active energy consumed	$E_{a\ In}$	✓
Active energy produced	$E_{a\ Out}$	✓
Reactive energy consumed	$E_{r\ In}$	✓
Active energy produced	$E_{r\ Out}$	✓
Absolute active energy (In + Out)	$E_{a\ Abs}$	✓
Absolute reactive energy (In + Out)	$E_{r\ Abs}$	✓
Signed total active energy (In – Out)	E_a	✓
Signed reactive energy (In – Out)	E_r	✓
Total apparent energy	E_s	✓

Total energy counter	Symbol	User reset
Active energy consumed – non resetable	Ea In NR	–
Active energy produced – non resetable	Ea Out NR	–

Notice: Accuracy and correct polarity of all energy related measurements are dependent on several calculation, power flow and sign convention settings. Refer to the respective sections for details on these settings:

- Power flow direction and quadrant
- Reactive and apparent power calculation convention
- Power factor sign convention

Alarms

Alarm Types

The P_SE Trip Unit provides alarming for various types of events based on system status and live monitoring of parameters. There are four types of alarms based on functionality and configurability:

- **System alarm**: Correspond to predefined events internal to the Trip Unit.
- **Pre-Trip alarm (PTA):** Provides a warning about the imminent trip risk due to a current overload. It is associated with the PTA output contact.
- **Trip alarm**: Provide warning about trip events and guide diagnostics towards the cause of the trip.
- **Custom alarm:** Used to monitor and be alerted to the measurements taken by the SMART Trip Unit.

> **Notice**: Custom alarms are not available on the P_SE Trip Unit embedded display and are only accessible and configurable by using the TPED, or TPCM.

In addition to these alarms, the Optional Alarm Contact (OAC) may be configured to report certain alarms via a physical output contact (OAC cable required). Such alarms which can be assigned to the OAC include system alarms, custom alarms, and PTA. Refer to OAC (Optional Alarm Contact) section for more information.

Alarm Indication

Alarm and Trip Unit status indicators are made visible on the P_SE Trip Unit via LEDs on the front or notification messages on the embedded display, depending on the alarm/status type as shown in the below table:

Alarm/Status type	P_SE Trip Unit display notification	Front LED	Indication	Notes
LTD Pick-up Alarm	–	✓		OFF: Current < 105% x I_r RED Flashing: Current ≥ 105% x I_r RED Solid: Current ≥ 112.5% x I_r
PTA (Pre-Trip Alarm)	–	✓		OFF: Current < PTA threshold ORANGE Flashing: Current ≥ PTA threshold ORANGE Solid: PTA output activated
Trip Unit Status	–	✓		GREEN Solid: Trip Unit operating normally ORANGE Flashing: Internal Trip Unit fault detected
OAC (Optional Alarm Contact)	✓	–		Alarm programmed to OAC activated
Trip Alarm	✓	–		Indicates the type of trip and its cause: - LTD : Long time delay protection - STD : Short time delay protection - INST : Instantaneous protection - GROUND : Ground/Earth fault protection TEST : Test mode by MIP
Trip Unit Temperature Alarm	✓	–		Internal Trip Unit temperature > 105°C

Alarms

Priority Level

Each trip and custom alarm is associated with it a priority level, which determines how each alarm is displayed and logged.

Notice: Custom alarms are only visible using the TPED or TPCM, however, the P_SE Trip Unit will still monitor and log any prior configured alarms without either TPED or TPCM connected.

Upon reconnection to a TPED or TPCM, the custom alarm trip history log will be populated and can be accessed.

Configuration of alarm priority levels are made using one or a combination of the below methods:
- TPED
- TPCM

Refer to the respective device's User Manual for detailed instructions on how to configure the respective alarms and priority levels.

The characteristics of each priority are provided in the below table:

Priority	Active alarm list	Alarm history log	TPED Alarm LED	TPED Alarm notification icon	TPED Alarm pop-up
None	✓	–	–	–	–
Low	✓	✓	–	–	–
Medium	✓	✓	✓	✓	–
High	✓	✓	✓	✓	✓

Priority None: Active alarms will not produce any notification, and will not be stored in the alarm history log of either TPED or TPCM. The respective alarm status will still display as active or inactive in the custom alarm configuration list of the TPED, and the Custom Alarms Status register of the TPCM.

Priority Low: Active alarms behave in the same way as Priority None alarms, but in addition will be logged in the alarm history log which is accessible on both TPED and TPCM. Both alarm activation and deactivation events will be logged (as applicable), complete with the details of the alarm type and event time.

Priority Medium: Active alarms behave in the same way as Priority Low alarms, but in addition will produce a notification on the TPED in the form of a flashing red alarm LED on the front, and an alarm notification icon on the lower right of the display. Pressing the "Fn" key under the alarm icon will open a pop-up display to view the details of active alarms and acknowledge deactivated alarms.

Priority High: Active alarms behave in the same way as Priority Medium alarms, but in addition will automatically produce a pop-up notification on the TPED without requiring the user the press the "Fn" key under the alarm icon.

Notice: PTA, System Alarms and OAC Alarm are always assigned Priority High and cannot be modified.

Alarms

System Alarms

System alarms are produced as a result of at least one of the following pre-defined events, which are not user configurable:

- Internal Trip Unit error
- Trip Unit temperature alarm
- Disconnection of neutral

Internal Trip Unit error: The P_SE Trip Unit constantly monitors its protection function. In the event of an operating fault concerning the electronics of the Trip Unit, the *Internal Trip Unit error* alarm is activated and the Trip Unit Status LED flashes orange.

Trip Unit Temperature: The P_SE Trip Unit constantly monitors its internal temperature. In the event that the temperature exceeds 105°C, the *Trip Unit temperature alarm* is activated and a pop-up appears on the P_SE embedded display and TPED where used. The alarm features a lower hysteresis threshold, which keeps the alarm active until the internal temperature of the Trip Unit drops below 100°C.

Disconnection of Neutral: Only available on MCCB's with Neutral reference (3Ph+N). This alarm is activated if the neutral pole is disconnected and if this alarm has been assigned to the OAC output contact. A disconnected neutral in the network supply may produce a dangerous increase in Phase-Neutral voltage in unbalanced 3-phase systems. This sustained overvoltage can result in damage to equipment and insulation and poses a safety risk to personnel. Neutral disconnection detection is based on monitoring a threshold Ph-N overvoltage of approximately 275 Vac with a time delay as defined by standard EN 50550 for a rated Ph-N voltage of 230 V.

Notice: Disconnection of Neutral alarm is only indicated by assigning it to the OAC (Optional Alarm Contact), in which case it will display as an OAC alarm. Other system alarms can be assigned to the OAC, however, only one at a time is possible. Refer to OAC (Optional Alarm Contact) section.

These alarms are identified by LEDs or pop-ups depending on the Trip Unit version and display used:

Alarm/Status type	P_SE Trip Unit display notification	Front LED	Indication	Notes
Internal Trip Unit Error	–	✓		GREEN Solid: Trip Unit operating normally ORANGE Flashing: Internal Trip Unit fault detected
Trip Unit Temperature	✓	–		Internal Trip Unit temperature > 105°C
Disconnection of Neutral (OAC)	✓	–		Alarm programmed to OAC activated

Alarms

PTA (Pre-Trip Alarm)

The Pre-Trip Alarm permits monitoring and early warning of overload conditions prior to an actual LTD trip. The PTA setting is defined by two parameters which define the Pre-trip warning and Pre-trip Alarm zones and thus the behaviour of the PTA contact and status LED:

- PTA current threshold I_p: Threshold expressed as a percentage of I_r and is adjustable from 60…95%
- PTA time delay t_p : Expressed as a percentage of t_r and is adjustable from 5…80%

The I_p current threshold defines the lowest current that could be considered to be within the Pre-trip warning and Pre-trip alarm zones. The t_p time delay threshold defines the shortest time in which the Pre-trip alarm will activate. The time delay for PTA follows the LTD protection curve and varies with current as shown in the figure below. Lower currents in the Pre-trip zones will activate the alarm with a longer delay than higher currents.

The behaviour of the various pre-trip zones are illustrated in the figure and table below.

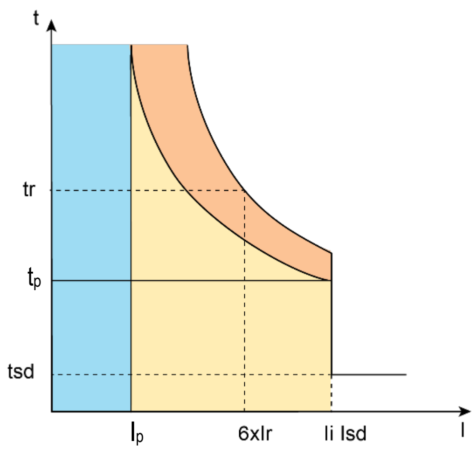
If the load current is less than the I_p current threshold, then this is considered the normal load zone, and the PTA LED and contact are unaffected and remain OFF and OPEN, respectively.

As the load current increases to at or above I_p, the Pre-trip warning zone is entered, and is indicated by the PTA LED illuminating FLASHING orange. Whilst in the pre-trip warning zone, the load current is monitored and characterised with thermal imaging by the Trip Unit.

If the current remains above I_p for an extended period of time, the Pre-trip Alarm zone is entered, and is indicated by the PTA LED illuminating SOLID orange, and the PTA contact activating CLOSED. The time required for the Pre-trip Alarm to activate is dependent on the current value and the t_p parameter set, as this follows the LTD protection curve.

Notice: The use of the PTA contact requires the connection of the OAC/PTA cable to the PTA port located on the external left-hand side of the P_SE MCCB. Refer to the Connection Cables section for details on the OAC/PTA cable.

Pre-trip zone	Current I vs. I_p	PTA LED status	PTA Contact status
Normal load	$I < I_p$	OFF READY	OPEN
Pre-trip Warning	$I \geq I_p$	FLASHING READY	OPEN
Pre-trip Alarm	$I \geq I_p$	SOLID READY	CLOSED



Alarms

Pre-Trip Alarm Configurable Settings

The trip threshold and time delay for the PTA overload pre-alarm can be adjusted. The parameters are defined in relation to the long-time delay I_r and t_r parameters.

Changes to the PTA I_p current threshold and t_p time delay can be made using one or a combination of the below methods:

- P_SE Trip Unit embedded display
- TPED
- TPCM

P_SE Trip Unit embedded display setting	TPED setting	TPCM setting	Default
 Off: PTA Disabled 60…95% Ir: I_p = 60…95% of I_r	"PreTrip Threshold Ir" Off: PTA Disabled 60…95% Ir: I_p = 60…95% of I_r	Command ID: 113 "Pre-trip Alarm Pick-up threshold I_p setting" Hex 00 3C…00 5F: I_p = 60…95% of I_r *Disabling of PTA is performed via Command ID: 115 – Refer to TemCom *PRO* User Manual	I_p = 80% of I_r
 5…80% tr: t_p = 5…80% of I_r	"PreTrip Delay" 5…80% tr: t_p = 5…80% of I_r	Command ID: 114 "Pre-trip Alarm time-delay t_p setting" Hex 00 05…00 50: t_p = 5…80% of I_r	t_p = 50% of t_r

Alarms

Trip Alarms

The trip alarms indicate a trip type and provide information about the trip event values.
The possible trips alarms are:

- Trip related to LTD protection
- Trip related to STD protection
- Trip related to INST protection
- Trip related to GF protection
- Trip related to Trip Unit testing, servicing, and maintenance tools

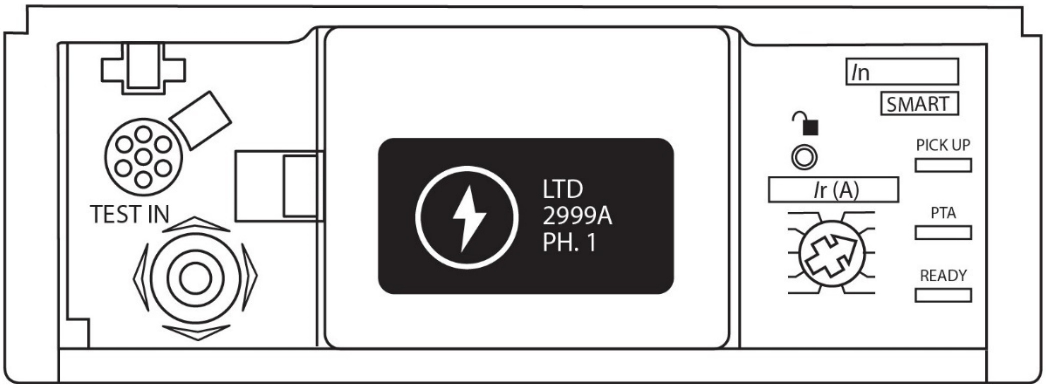
The following information is provided in the case of the message for a trip alarm:

- Trip cause
- Phase concerned by the fault (only for LTD, STD and INST related trips)
- Fault current value (only LTD, STD, INST and GF)

Last trip

Information regarding the last trip is consistently stored, regardless of the priority associated with the alarm and can be viewed using one or a combination of the below methods:

- P_SE Trip Unit embedded display
- TPED
- TPCM



Alarms

Custom Alarms

Custom alarms make it possible to produce alarms based specific events and measurements made by the P_SE Trip Unit. They are only available to be configured and displayed using the TPED and/or TPCM in conjunction with the P_SE MCCB.

Up to 12 custom alarms may be individually configured for a single P_SE Trip Unit, with each used to monitor a single event of measurement.

Custom alarms may also be assigned to the OAC (Optional Alarm Contact) to provide a physical output when the respective custom alarm has been activated. Refer to OAC (Optional Alarm Contact) section for more information.

> **Notice**: The use of the OAC physical contact requires the connection of the OAC/PTA cable to the OAC port located under the front cover of the P_SE MCCB. Refer to the Connection Cables section for details on the OAC/PTA cable.
>
> Only one Alarm can be configured to use the OAC at any one time

A custom alarm is defined through the following parameters:

- Measurement monitored
- Activation threshold
- Deactivation threshold
- Activation time delay
- Deactivation time delay
- Priority level

Custom alarm parameters

Configuration of custom alarm types, pick-up and drop-out thresholds and time delays can be made using one or a combination of the below methods:

- TPED
- TPCM

Refer to the respective device's User Manual for detailed instructions on how to configure the custom alarms.

Custom alarms may be configured to activate under specific conditions, which, depending on the event or measurement type may include one or more of the following parameters:

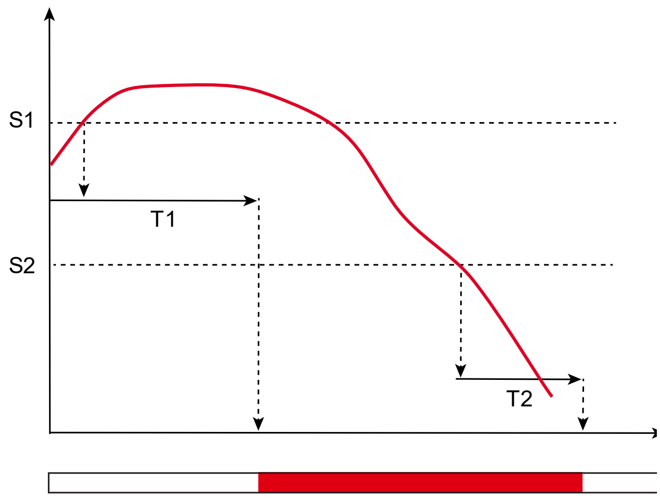
- Pick-up threshold
- Pick-up time delay
- Drop-out threshold
- Drop-out time delay
- Equivalent value

The pick-up threshold in conjunction with its time delay determine the value in which the custom alarm is activated, whereas the drop-out threshold is the value which de-activates the alarm. One may be set to a value higher or lower than the other, which determines whether the alarm activation is positive or negative with respect to the change in the measurement value.

Alarms

Positive activation

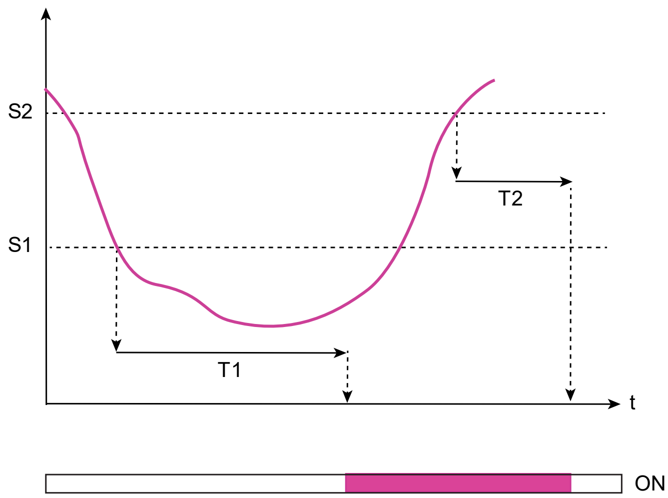
In the case of a positive activation, the alarm is activated when the monitored value increases towards the pick-up threshold. This occurs when the pick-up threshold is set to a higher value than the drop-out threshold.



Symbol	Description
S1	Pick-up threshold
S2	Drop-out threshold
T1	Pick-up time delay
T2	Drop-out time delay

Negative activation

In the case of a negative activation, the alarm is activated when the monitored value decreases towards the pick-up threshold. This occurs when the pick-up threshold is set to a lower value than the drop-out threshold.

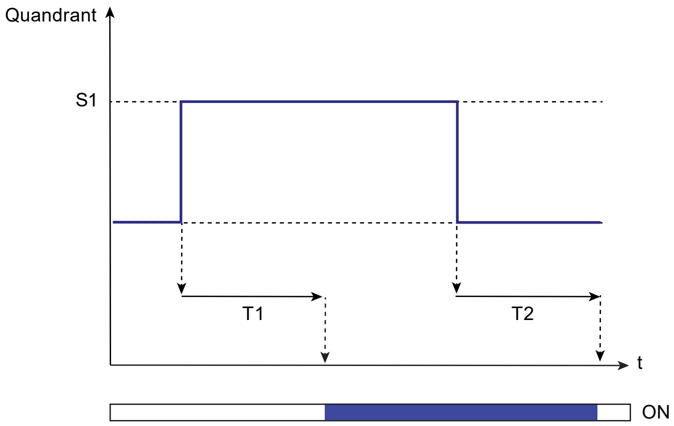


Symbol	Description
S1	Pick-up threshold
S2	Drop-out threshold
T1	Pick-up time delay
T2	Drop-out time delay

Alarms

Equivalent value activation

For the equal value activation, the alarm is activated when the value measured is equal to the configured value. The activation threshold is the same as the activation value.



Symbol	Description
S1	Pick-up value
T1	Pick-up time delay
T2	Drop-out time delay

Alarms

Time delays

Custom alarms are activated once the pick-up threshold has been reached and the configured pick-up time delay has elapsed. Likewise, custom alarms are deactivated after the drop-out threshold is reached and the drop-out time delay has elapsed. Both pick-up and drop-out time delays are independently configurable, from a minimum 1 second to maximum 3000 seconds.

The time delays are provided as cumulative counters based on the time elapsed, which increments as the measured value reaches or exceeds the threshold value, and decrements if the measured value drops below the threshold value. Activation and deactivation of the respective custom alarm requires the time-delay counter to reach the configured time delay.

Pick-up time delay: For the activation of a custom alarm, the pick-up time delay counter:

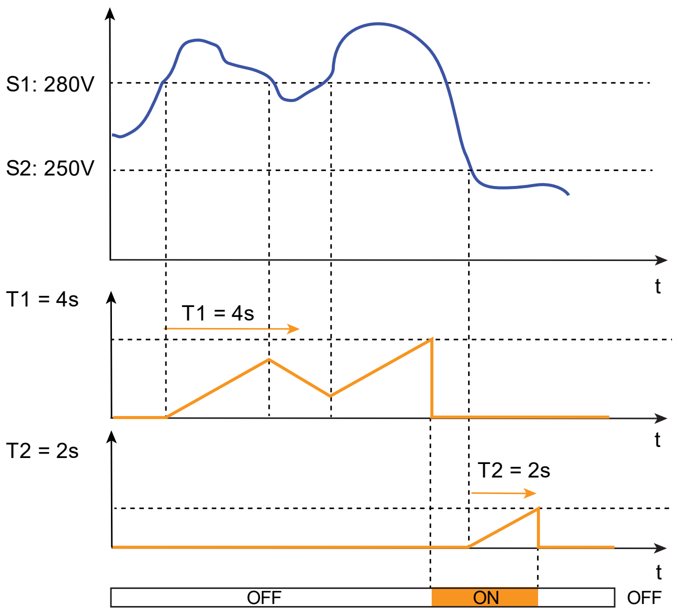
- Increases by 1 per second when the pick-up threshold value is met or exceeded.
- Decreases by 1 per second if the pick-up threshold value is not met and the cumulative elapsed time is not reached.
- Resets to 0 when the cumulative time delay is reached and custom alarm is activated.

Drop-out time delay: For the deactivation of a custom alarm, the drop-out time delay counter:

- Increases by 1 per second when the drop-out threshold value is met or exceeded.
- Decreases by 1 per second if the drop-out threshold value is not met and the cumulative elapsed time is not reached.
- Resets to 0 when the cumulative time delay is reached and custom alarm is activated.

If an alarm is reconfigured using the TPED or TPCM whilst a custom alarm time delay counter has begun, the counters are reset to 0.

Example: A custom alarm is set to a positive activation pick-up threshold of 280 V for an overvoltage measurement of V1N. The pick-up time delay is set to 4 seconds. The drop-out threshold value is set at 250 V and the drop-out time delay at 2 seconds.



Symbol	Meaning
S1	Pick-up threshold
S2	Dop-out threshold
T1	Pick-up time delay
T2	Drop-out time delay

Alarms

Custom alarms list

ID	Name	Pick-up or Drop-out threshold value				Pick-up or Drop-out time delay value				3Ph	3Ph+N
		Unit	Res	Min. value	Max. value	Unit	Res	Min. value	Max. value		
0	No assignment	—	—	—	—	—	—	—	—	✓	✓
1	Over Instantaneous Current [I_1]	A	0.1	8	6300	sec	1	1	3000	✓	✓
2	Over Instantaneous Current [I_2]	A	0.1	8	6300	sec	1	1	3000	✓	✓
3	Over Instantaneous Current [I_3]	A	0.1	8	6300	sec	1	1	3000	✓	✓
4	Over Instantaneous Current [I_N] (*4P MCCB Only)	A	0.1	8	6300	sec	1	1	3000	—	✓*
5	Over Instantaneous Current [I_{max}]	A	0.1	8	6300	sec	1	1	3000	✓	✓
6	Under Instantaneous Current [I_1]	A	0.1	8	6300	sec	1	1	3000	✓	✓
7	Under Instantaneous Current [I_2]	A	0.1	8	6300	sec	1	1	3000	✓	✓
8	Under Instantaneous Current [I_3]	A	0.1	8	6300	sec	1	1	3000	✓	✓
9	Under Instantaneous Current [I_N] (*4P MCCB Only)	A	0.1	8	6300	sec	1	1	3000	—	✓*
10	Ground Current	x I_g	0.01	0.1	1	sec	1	1	3000	✓	✓
11	Over Unbalance Current [I_1]	x I_{avg}	0.1%	5%	60%	sec	1	1	3000	✓	✓
12	Over Unbalance Current [I_2]	x I_{avg}	0.1%	5%	60%	sec	1	1	3000	✓	✓
13	Over Unbalance Current [I_3]	x I_{avg}	0.1%	5%	60%	sec	1	1	3000	✓	✓
14	Over Unbalance Current [$I_{max\ Unb}$]	x I_{avg}	0.1%	5%	60%	sec	1	1	3000	✓	✓
15	Over Average Current [I_{avg}]	A	0.1	8	6300	sec	1	1	3000	✓	✓
16	Under Average Current [I_{avg}]	A	0.1	8	6300	sec	1	1	3000	✓	✓
17	Over Instantaneous Voltage [V_{1N}]	V	0.1	80	800	sec	1	1	3000	—	✓
18	Over Instantaneous Voltage [V_{2N}]	V	0.1	80	800	sec	1	1	3000	—	✓
19	Over Instantaneous Voltage [V_{3N}]	V	0.1	80	800	sec	1	1	3000	—	✓
20	Over Instantaneous Voltage [V_{max}]	V	0.1	80	800	sec	1	1	3000	—	✓
21	Under Instantaneous Voltage [V_{1N}]	V	0.1	80	800	sec	1	1	3000	—	✓
22	Under Instantaneous Voltage [V_{2N}]	V	0.1	80	800	sec	1	1	3000	—	✓
23	Under Instantaneous Voltage [V_{3N}]	V	0.1	80	800	sec	1	1	3000	—	✓
24	Under Instantaneous Voltage [V_{min}]	V	0.1	80	800	sec	1	1	3000	—	✓
25	Over Unbalance Voltage [V_{1N}]	x V_{avg}	0.1%	2%	30%	sec	1	1	3000	—	✓
26	Over Unbalance Voltage [V_{2N}]	x V_{avg}	0.1%	2%	30%	sec	1	1	3000	—	✓
27	Over Unbalance Voltage [V_{3N}]	x V_{avg}	0.1%	2%	30%	sec	1	1	3000	—	✓
28	Over Unbalance Voltage [$V_{max\ Unb}$]	x V_{avg}	0.1%	2%	30%	sec	1	1	3000	—	✓
29	Over Average Voltage [V_{avg}]	V	0.1	80	800	sec	1	1	3000	—	✓
30	Under Average Voltage [V_{avg}]	V	0.1	80	800	sec	1	1	3000	—	✓
31	Over Instantaneous Voltage [U_{12}]	V	0.1	80	800	sec	1	1	3000	✓	✓
32	Over Instantaneous Voltage [U_{23}]	V	0.1	80	800	sec	1	1	3000	✓	✓
33	Over Instantaneous Voltage [U_{31}]	V	0.1	80	800	sec	1	1	3000	✓	✓
34	Over Instantaneous Voltage [U_{max}]	V	0.1	80	800	sec	1	1	3000	✓	✓
35	Under Instantaneous Voltage [U_{12}]	V	0.1	80	800	sec	1	1	3000	✓	✓
36	Under Instantaneous Voltage [U_{23}]	V	0.1	80	800	sec	1	1	3000	✓	✓
37	Under Instantaneous Voltage [U_{31}]	V	0.1	80	800	sec	1	1	3000	✓	✓
38	Under Instantaneous Voltage [U_{min}]	V	0.1	80	800	sec	1	1	3000	✓	✓
39	Over Unbalance Voltage [U_{12}]	x U_{avg}	0.1%	2%	30%	sec	1	1	3000	✓	✓
40	Over Unbalance Voltage [U_{23}]	x U_{avg}	0.1%	2%	30%	sec	1	1	3000	✓	✓
41	Over Unbalance Voltage [U_{31}]	x U_{avg}	0.1%	2%	30%	sec	1	1	3000	✓	✓
42	Over Unbalance Voltage [$U_{max\ Unb}$]	x U_{avg}	0.1%	2%	30%	sec	1	1	3000	✓	✓

Alarms

ID	Name	Pick-up or Drop-out threshold value				Pick-up or Drop-out time delay value				3Ph	3Ph+N
		Unit	Res	Min. value	Max. value	Unit	Res	Min. value	Max. value		
43	Over Direct Active power [P_1]	kW	0.1	1	1000	sec	1	1	3000	—	✓
44	Over Direct Active power [P_2]	kW	0.1	1	1000	sec	1	1	3000	—	✓
45	Over Direct Active power [P_3]	kW	0.1	1	1000	sec	1	1	3000	—	✓
46	Over Direct Active power [P_{tot}]	kW	0.1	1	3000	sec	1	1	3000	✓	✓
47	Under Direct Active power [P_1]	kW	0.1	1	1000	sec	1	1	3000	—	✓
48	Under Direct Active power [P_2]	kW	0.1	1	1000	sec	1	1	3000	—	✓
49	Under Direct Active power [P_3]	kW	0.1	1	1000	sec	1	1	3000	—	✓
50	Under Direct Active power [P_{tot}]	kW	0.1	1	3000	sec	1	1	3000	✓	✓
51	Over Return Active power [P_1]	kW	0.1	1	1000	sec	1	1	3000	—	✓
52	Over Return Active power [P_2]	kW	0.1	1	1000	sec	1	1	3000	—	✓
53	Over Return Active power [P_3]	kW	0.1	1	1000	sec	1	1	3000	—	✓
54	Over Return Active power [P_{tot}]	kW	0.1	1	3000	sec	1	1	3000	✓	✓
55	Under Return Active power [P_1]	kW	0.1	1	1000	sec	1	1	3000	—	✓
56	Under Return Active power [P_2]	kW	0.1	1	1000	sec	1	1	3000	—	✓
57	Under Return Active power [P_3]	kW	0.1	1	1000	sec	1	1	3000	—	✓
58	Under Return Active power [P_{tot}]	kW	0.1	1	3000	sec	1	1	3000	✓	✓
59	Over Direct Reactive power [Q_1]	kVAr	0.1	1	1000	sec	1	1	3000	—	✓
60	Over Direct Reactive power [Q_2]	kVAr	0.1	1	1000	sec	1	1	3000	—	✓
61	Over Direct Reactive power [Q_3]	kVAr	0.1	1	1000	sec	1	1	3000	—	✓
62	Over Direct Reactive power [Q_{tot}]	kVAr	0.1	1	3000	sec	1	1	3000	✓	✓
63	Under Direct Reactive power [Q_1]	kVAr	0.1	1	1000	sec	1	1	3000	—	✓
64	Under Direct Reactive power [Q_2]	kVAr	0.1	1	1000	sec	1	1	3000	—	✓
65	Under Direct Reactive power [Q_3]	kVAr	0.1	1	1000	sec	1	1	3000	—	✓
66	Under Direct Reactive power [Q_{tot}]	kVAr	0.1	1	3000	sec	1	1	3000	✓	✓
67	Over Return Reactive power [Q_1]	kVAr	0.1	1	1000	sec	1	1	3000	—	✓
68	Over Return Reactive power [Q_2]	kVAr	0.1	1	1000	sec	1	1	3000	—	✓
69	Over Return Reactive power [Q_3]	kVAr	0.1	1	1000	sec	1	1	3000	—	✓
70	Over Return Reactive power [Q_{tot}]	kVAr	0.1	1	3000	sec	1	1	3000	✓	✓
71	Under Return Reactive power [Q_1]	kVAr	0.1	1	1000	sec	1	1	3000	—	✓
72	Under Return Reactive power [Q_2]	kVAr	0.1	1	1000	sec	1	1	3000	—	✓
73	Under Return Reactive power [Q_3]	kVAr	0.1	1	1000	sec	1	1	3000	—	✓
74	Under Return Reactive power [Q_{tot}]	kVAr	0.1	1	3000	sec	1	1	3000	✓	✓
75	Over Apparent power [S_1]	kVA	0.1	1	1000	sec	1	1	3000	—	✓
76	Over Apparent power [S_2]	kVA	0.1	1	1000	sec	1	1	3000	—	✓
77	Over Apparent power [S_3]	kVA	0.1	1	1000	sec	1	1	3000	—	✓
78	Over Apparent power [S_{tot}]	kVA	0.1	1	3000	sec	1	1	3000	✓	✓
79	Under Apparent power [S_1]	kVA	0.1	1	1000	sec	1	1	3000	—	✓
80	Under Apparent power [S_2]	kVA	0.1	1	1000	sec	1	1	3000	—	✓
81	Under Apparent power [S_3]	kVA	0.1	1	1000	sec	1	1	3000	—	✓
82	Under Apparent power [S_{tot}]	kVA	0.1	1	3000	sec	1	1	3000	✓	✓
83	Lagging power factor [PF_1]	—	0.01	0	0.99	sec	1	1	3000	—	✓
84	Lagging power factor [PF_2]	—	0.01	0	0.99	sec	1	1	3000	—	✓
85	Lagging power factor [PF_3]	—	0.01	0	0.99	sec	1	1	3000	—	✓
86	Lagging power factor [PF_{tot}]	—	0.01	0	0.99	sec	1	1	3000	✓	✓
87	Leading displacement PF [$Cos\varphi_1$]	—	0.01	0	0.99	sec	1	1	3000	—	✓
88	Leading displacement PF [$Cos\varphi_2$]	—	0.01	0	0.99	sec	1	1	3000	—	✓
89	Leading displacement PF [$Cos\varphi_3$]	—	0.01	0	0.99	sec	1	1	3000	—	✓
90	Leading displacement PF [$Cos\varphi_{tot}$]	—	0.01	0	0.99	sec	1	1	3000	✓	✓
91	Lagging displacement PF [$Cos\varphi_1$]	—	0.01	0	0.99	sec	1	1	3000	—	✓
92	Lagging displacement PF [$Cos\varphi_2$]	—	0.01	0	0.99	sec	1	1	3000	—	✓
93	Lagging displacement PF [$Cos\varphi_3$]	—	0.01	0	0.99	sec	1	1	3000	—	✓
94	Lagging displacement PF [$Cos\varphi_{tot}$]	—	0.01	0	0.99	sec	1	1	3000	✓	✓
95	Over THD Current [$THDI_1$]	—	0.1%	0%	1000%	sec	1	1	3000	✓	✓

Alarms

ID	Name	Pick-up or Drop-out threshold value				Pick-up or Drop-out time delay value				3Ph	3Ph+N
		Unit	Res	Min. value	Max. value	Unit	Res	Min. value	Max. value		
96	Over THD Current [$THDI_2$]	—	0.1%	0%	1000%	sec	1	1	3000	✓	✓
97	Over THD Current [$THDI_3$]	—	0.1%	0%	1000%	sec	1	1	3000	✓	✓
98	Over THD Voltage [$THDV_{1N}$]	—	0.1%	0%	1000%	sec	1	1	3000	—	✓
99	Over THD Voltage [$THDV_{2N}$]	—	0.1%	0%	1000%	sec	1	1	3000	—	✓
100	Over THD Voltage [$THDV_{3N}$]	—	0.1%	0%	1000%	sec	1	1	3000	—	✓
101	Over THD Voltage [$THDU_{12}$]	—	0.1%	0%	1000%	sec	1	1	3000	✓	✓
102	Over THD Voltage [$THDU_{23}$]	—	0.1%	0%	1000%	sec	1	1	3000	✓	✓
103	Over THD Voltage [$THDU_{31}$]	—	0.1%	0%	1000%	sec	1	1	3000	✓	✓
104	Over frequency [F]	Hz	0.01	45	65	sec	1	1	3000	✓	✓
105	Under frequency [F]	Hz	0.01	45	65	sec	1	1	3000	✓	✓
106	Over Current demand [$I_{1\ Dmd}$]	A	0.1	8	6300	sec	1	1	3000	✓	✓
107	Over Current demand [$I_{2\ Dmd}$]	A	0.1	8	6300	sec	1	1	3000	✓	✓
108	Over Current demand [$I_{3\ Dmd}$]	A	0.1	8	6300	sec	1	1	3000	✓	✓
109	Over Current demand [$I_{N\ Dmd}$] (*4P MCCB Only)	A	0.1	8	6300	sec	1	1	3000	—	✓*
110	Over Current demand [$I_{avg\ Dmd}$]	A	0.1	8	6300	sec	1	1	3000	✓	✓
111	Under Current demand [$I_{1\ Dmd}$]	A	0.1	8	6300	sec	1	1	3000	✓	✓
112	Under Current demand [$I_{2\ Dmd}$]	A	0.1	8	6300	sec	1	1	3000	✓	✓
113	Under Current demand [$I_{3\ Dmd}$]	A	0.1	8	6300	sec	1	1	3000	✓	✓
114	Under Current demand [$I_{N\ Dmd}$] (*4P MCCB Only)	A	0.1	8	6300	sec	1	1	3000	—	✓*
115	Under Current demand [$I_{avg\ Dmd}$]	A	0.1	8	6300	sec	1	1	3000	✓	✓
116	Over Active power demand [$P_{tot\ Dmd}$]	kW	0.1	1	3000	sec	1	1	3000	✓	✓
117	Under Active power demand [$P_{tot\ Dmd}$]	kW	0.1	1	3000	sec	1	1	3000	✓	✓
118	Over Reactive power demand [$Q_{tot\ Dmd}$]	kVAr	0.1	1	3000	sec	1	1	3000	✓	✓
119	Under Reactive power demand [$Q_{tot\ Dmd}$]	kVAr	0.1	1	3000	sec	1	1	3000	✓	✓
120	Over apparent power demand [$S_{tot\ Dmd}$]	kVA	0.1	1	3000	sec	1	1	3000	✓	✓
121	Under apparent power demand [$S_{tot\ Dmd}$]	kVA	0.1	1	3000	sec	1	1	3000	✓	✓
122	Operating quadrant 1 (P>0, Q>0)	—	—	1	1	sec	1	1	3000	✓	✓
123	Operating quadrant 2 (P<0, Q>0)	—	—	2	2	sec	1	1	3000	✓	✓
124	Operating quadrant 3 (P<0, Q<0)	—	—	3	3	sec	1	1	3000	✓	✓
125	Operating quadrant 4 (P>0, Q<0)	—	—	4	4	sec	1	1	3000	✓	✓
126	Phase sequence 1->2->3	—	—	0	0	sec	1	1	3000	✓	✓
127	Phase sequence 1->3->2	—	—	1	1	sec	1	1	3000	✓	✓
128	Operating quadrant 2 or 4 (Capacitive)	—	—	0	0	sec	1	1	3000	✓	✓
129	Operating quadrant 1 or 3 (Inductive)	—	—	1	1	sec	1	1	3000	✓	✓
130	Leading Power factor PF1	—	0.01	0	0.99	sec	1	1	3000	—	✓
131	Leading Power factor PF2	—	0.01	0	0.99	sec	1	1	3000	—	✓
132	Leading Power factor PF3	—	0.01	0	0.99	sec	1	1	3000	—	✓
133	Leading Power factor PFtot	—	0.01	0	0.99	sec	1	1	3000	✓	✓

Alarms

OAC (Optional Alarm Contact)

The OAC is an optional alarm which can be assigned with one of several types of alarms. When the assigned alarm is activated, the alarm will display on the P_SE embedded display. The OAC also has a physical contact which closes with the activation of the OAC alarm. Refer to the Optional Alarms List for the list of available OAC alarm assignments.

Notice: The use of the OAC physical contact requires the connection of the OAC/PTA cable to the OAC port located under the front cover of the P_SE MCCB. Refer to the Connection Cables section for details on the OAC/PTA cable.

The OAC is configurable by assigning it an alarm type (assignment), and the contact behaviour (reset mode), which can made using one or a combination of the below methods:

- TPED
- TPCM

The physical contact mode is defined as either Auto-reset mode, or latching mode:

Auto-reset mode: Contact will remain CLOSED for up to 500ms after the alarm deactivates, at which point it will OPEN automatically.

Latching mode: Contact will remain CLOSED after the alarm deactivates, until the alarm is cleared via the P_SE embedded display or the TPED where used.

Notice: In the event that PTA (Pre trip alarm) is assigned to OAC, the contact operation mode is forced to auto-reset mode, where the contact will OPEN up to 500ms after the PTA is no longer active.

TPED setting	TPCM setting	Default
"Assignment" (Refer Optional Alarms List)	Command ID: 117 "Optional Alarm assignment setting" (Refer Optional Alarms List)	PTA (Pre trip Alarm)
"Reset mode" Automatic: Auto-reset mode Latching: Latching mode	Command ID: 116 "Optional Alarm contact operation mode setting" Hex 00 00: Auto-reset mode Hex 00 01: Latching mode	Auto-reset mode

Optional alarms List

ID	TPCM holding register value (hex)	Custom Alarm Assignment	Remark
0	00 00	None	
1	00 01	High Trip Unit internal temperature	
2	00 02	Neutral monitoring wire disconnection	3Ph+N Only
3	00 03	Trip Unit self-test failure	
4	00 04	Reserved	
5	00 05	PTA (Pre trip alarm)	
6	00 06	Custom Alarm 1	
7	00 07	Custom Alarm 2	
8	00 08	Custom Alarm 3	
9	00 09	Custom Alarm 4	
10	00 0A	Custom Alarm 5	
11	00 0B	Custom Alarm 6	
12	00 0C	Custom Alarm 7	
13	00 0D	Custom Alarm 8	
14	00 0E	Custom Alarm 9	
15	00 0F	Custom Alarm 10	
16	00 10	Custom Alarm 11	
17	00 11	Custom Alarm 12	

Date & Time

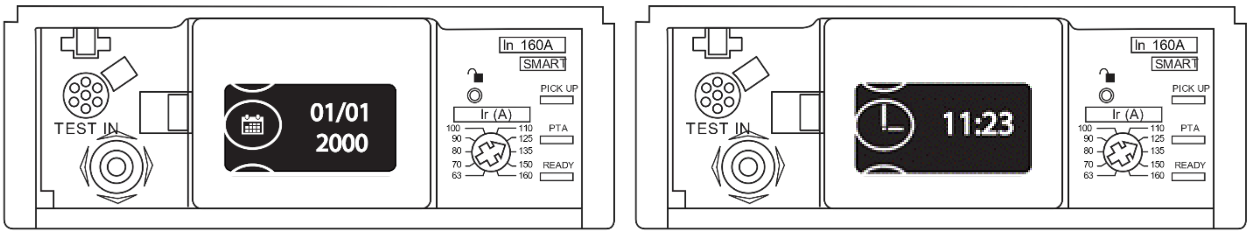
There are two types of Date & Time accessible from the Trip Unit of the MCCB and which are used as timestamp of trips, alarms, and events, and which are affected by the presence of supply or control power to the Trip Unit.

Trip Unit Time: Non-resettable time which is the absolute operating time of the Trip Unit seconds. Trip Unit time increments whilst the Trip Unit is in service and is stored in the Trip Unit non-volatile memory. Trip Unit time does not increment if power is removed from the Trip Unit.

User Time: Resettable time which is configurable by the user locally via the P_SE Trip Unit embedded display, or remotely via TPED or TPCM. This time is displayed on the P_SE Trip Unit embedded display. Unlike the Trip Unit time, however, the User Time is stored in volatile memory, and is cleared back to 1st January 2000, 00:00:00 if power is removed from the Trip Unit.

Notice: where accuracy of timestamps are critical (e.g. for alarm history and logging), it is recommended that the Trip Unit is supplied with an uninterruptable external power supply. This is such that disconnection of incoming supply does not remove power from the Trip Unit and reset the User Time and cease upkeep of Trip Unit time.

On the embedded display of the MCCB, the date and time is represented in the format DD/MM/YYYY (or YYYY/MM/DD depending on settings) and HH:MM (24H or AM/PM depending on settings).



History

The P_SE Trip Unit has an internal memory to enable the following logs to be stored:

- Trip alarm log (up to 10 most recent events)
- Custom alarm log (up to 40 most recent events)
- Log of changes to the protection settings (up to 5 most recent events per protection parameter)

These logs are updated internal to the Trip Unit after each event.

Notice: Historical logs are only visible using the TPED or TPCM, however, the P_SE Trip Unit will still monitor and log any prior configured alarms and setting changes without either TPED or TPCM connected.

Upon reconnection to a TPED or TPCM, the respective alarm history logs will be populated and can be accessed.

Trip Alarm Log

Trip alarms for the 10 most recent trips events are accessible using one or a combination of the below methods:

- TPED
- TPCM

Each trip alarm log is stored with the following information with respect to the alarm type:

Trip alarm type		Timestamp of alarm		Fault details		Notes
Trip ID	Description	Trip Unit time	User Time	Duration	Current	
1	LTD trip on Phase 1	✓	✓	✓	✓	
2	LTD trip on Phase 2	✓	✓	✓	✓	
3	LTD trip on Phase 3	✓	✓	✓	✓	
4	LTD trip on Neutral	✓	✓	✓	✓	4P MCCB Only
5	STD trip on Phase 1	✓	✓	✓	✓	
6	STD trip on Phase 2	✓	✓	✓	✓	
7	STD trip on Phase 3	✓	✓	✓	✓	
8	STD trip on Neutral	✓	✓	✓	✓	4P MCCB Only
9	GF trip	✓	✓	✓	✓	
10	INST trip on Phase 1	✓	✓	✓	✓	
11	INST trip on Phase 2	✓	✓	✓	✓	
12	INST trip on Phase 3	✓	✓	✓	✓	
13	INST trip on Neutral	✓	✓	✓	✓	4P MCCB Only

Custom Alarm Log

Trip alarms for the 10 most recent trips events are accessible using one or a combination of the below methods:

- TPED
- TPCM

Each trip alarm log is stored with the following information with respect to the alarm type:

Custom alarm type		Timestamp of alarm		Alarm activated / deactivated	Notes
Alarm ID	Description	Trip Unit time	User Time		
1…133	See Custom alarms list	✓	✓	✓	

History

Protection Setting Changes Log

Changes to the protection settings are logged for the 5 most recent changes for each setting type are accessible using one or a combination of the below methods:

- TPED
- TPCM

Each protection setting changes log is stored with the following information with respect to the protection setting type:

Previous setting type		Timestamp of change		Notes
Description	Symbol	Trip Unit time	User time	
LTD current	I_r	✓	✓	
LTD time delay	t_r	✓	✓	
STD enable / disable	–	✓	✓	
STD current	I_{sd}	✓	✓	
STD time delay	t_{sd}	✓	✓	
I^2t for STD enable / disable	–	✓	✓	
INST current	I_i	✓	✓	
GF enable / disable	–	✓	✓	
GF current	I_g	✓	✓	
GF time delay	t_g	✓	✓	
I^2t for GF enable / disable	–	✓	✓	
NP enable / disable	–	✓	✓	4P MCCB only
N Coefficient	x I_r	✓	✓	4P MCCB only
ZSI for STD enable / disable	–	✓	✓	Excluding P160
ZSI for GT enable / disable	–	✓	✓	Excluding P160

Write Protection

> **WARNING**: Changes and adjustments to protection settings and levels (either local or remotely) should only be performed by qualified personnel. Failure to comply may result in malfunction or damage of protective equipment, serious injury or death.

Modifications made remotely over communications to the MCCB configuration settings may be dangerous for personnel near the circuit breaker or may cause damage to the equipment if the protection parameters are modified.

Therefore, remote data write commands are secured with two levels of protection:

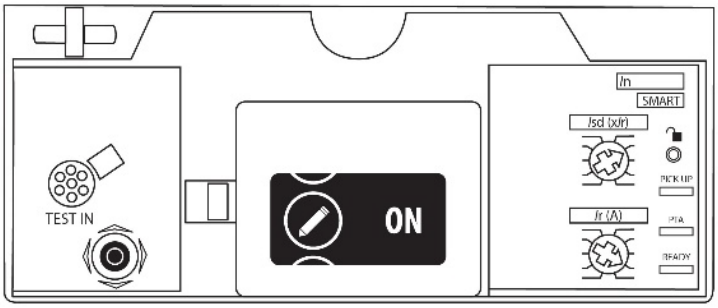
- Remote Write Authorization parameter at the MCCB for localized locking out of individual circuit breakers from remote writing access.
- Password Management with various security access levels for limiting accessibility of performing certain write commands.

Remote Write Authorization

To permit writing of data to the MCCB via remote devices (i.e. external to the MCCB, such as TPCM, TPED, etc.), the remote write authorization parameter must be enabled on the MCCB via the embedded LCD display menu.

This parameter is enabled via the Configuration menu of the embedded display by navigating to the Remote Write Authorization symbol as shown below and changing the value to “ON”.

Refer to the Navigation section for further information on navigating the embedded display.



Remote Write Authorization	Default setting
ON – OFF ON – enabled, data write commands for remote devices permitted. OFF – disabled, data write commands for remote devices prohibited.	ON

Write Protection

Password Management

Changes to certain configuration settings are protected by varying security access levels. A password corresponding to the required security level must be used when writing data to the TPCM.

Refer to the TemCom *PRO* User Manual for more information on remote writing and reading of data over Modbus communications.

Security access levels and their default passwords are as follows:

Security Access Level	Classification	Default Password
0	Settings that do not cause damage even if the settings are incorrect. No password required.	N/A
1	Settings that can cause undesired operation or malfunction if settings are incorrect. Level 1 or Level 2 password required	"Level1"
2	Settings that can cause damage of protective equipment, serious injury or death if settings are incorrect. Level 2 password required.	"Level2"

Changing the Password

WARNING: Level 1 and Level 2 passwords should be changed during commissioning to prevent unauthorized modification to protected settings.

Password changes are performed using the Writing Data process with Command ID: 2001.

The new password must be between 4 and 8 characters inclusive; and may consist of a combination of alphabetic and numerical characters (A-Z, a-z, 0-9, case-sensitive, no special symbols or characters).

- The Level 1 password can be modified with security access level 1 or 2.
- The Level 2 password can only be modified with security access level 2.

WARNING: If the Level 2 password is lost, it can only be reset or restored via authorised service and maintenance tools via the Maintenance Interface Port. Contact NHP for information on restoring lost passwords.

Trip Unit Power Supply

The P_SE Trip Unit requires auxiliary power supply to operate and provide measurement, alarm, and configured protection functions.
Auxiliary power to the Trip Unit is self-powered whilst sufficient current is flowing through the MCCB, but can also be supplied via external 24V dc power supply for uninterrupted functionality.

Self-power requirements

Minimum conditions for energizing the Trip Unit without an external power supply:
- Circuit breaker closed
- Minimum current through the circuit breaker; below is a table per rating

Trip Unit rating	1 Pole fed	2 Poles fed	3 Poles fed
40A	—	> 14A	> 10A
100A	> 25A	> 15A	> 15A
160A	> 32A	> 16A	> 16A
250A	> 50A	> 25A	> 25A
400A	> 80A	> 40A	> 40A
630A	> 126A	> 63A	> 63A

Notice: 40A Trip Unit with 1 Pole feed, will still provide INST protection for I > 2x I_n (>80A).

External 24V dc supply requirements

An external 24 Vdc supply may be used for uninterrupted functionality of the Trip Unit whilst the MCCB contacts are open, or where there is insufficient current to provide the minimum requirements for self-power.

The external 24V dc power supply must be capable of delivering the necessary maximum current of the Trip Unit and any connected accessories.

Trip Unit / accessories	Current consumption @ 24V dc nominal
P_SE Trip Unit	60 mA
TPED	85 mA
TPCM	40 mA

The external 24 Vdc supply is connected to the circuit breaker in two ways:
- Direct connection to MCCB with via CIP adapter cable TPPHQTT140H (P160 / P250), or TPPHQTT160H (P400 / P630)
- Connection via the TPCM provided power supply.

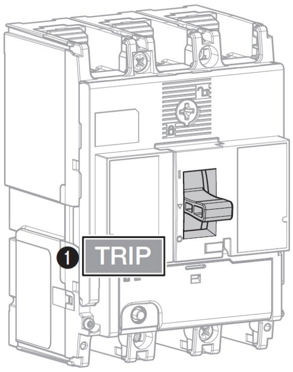
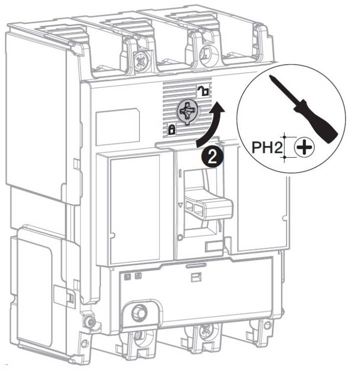
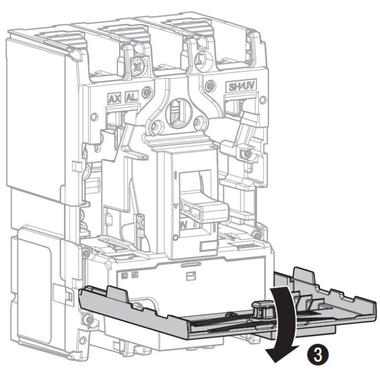
Trip Unit Power Supply

External 24V dc supply instructions – CIP adapter cable

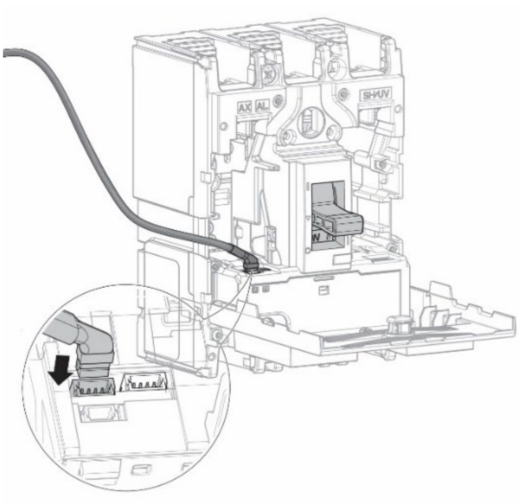
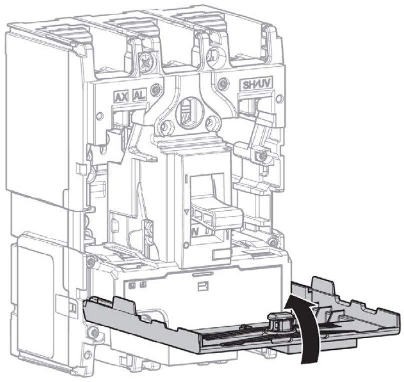
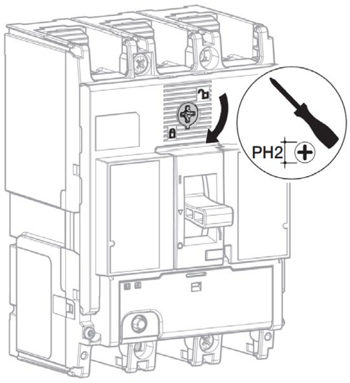
Below are the steps for direct connection of power supply to the Trip Unit with via CIP adapter cable:

- TPPHQTT140H (P160 / P250), or
- TPPHQTT160H (P400 / P630).

WARNING: Local wiring rules shall be respected (e.g. AS/NZS 3000: Wiring Rules) and shall provide:
- Separation of the power cables and ELV / communication cables
- Secure the cable along the routing.

	Action	Note / Illustration
1	Switch the MCCB to the OFF or TRIP position.	
2	Using a No.2 Phillips screwdriver, unlock the front cover by rotating the lock counter-clockwise	
3	Open the front cover of the MCCB	

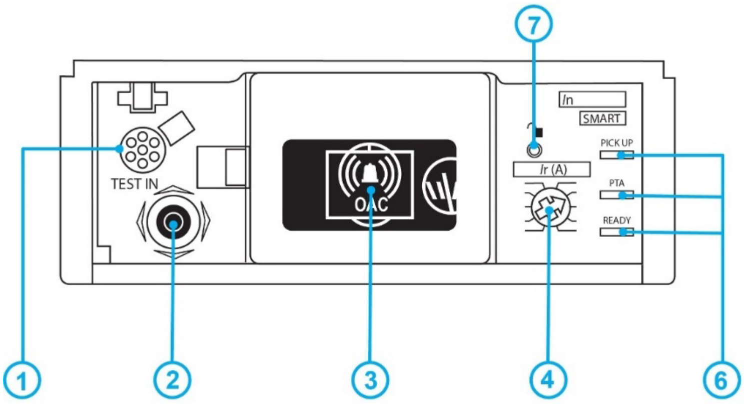
Trip Unit Power Supply

	Action	Note / Illustration
4	Insert the CIP connector for the CIP adapter in one of the connectors marked CIP inside the circuit breaker on the left-hand side. Route the cable for the CIP adapter along the left-hand side cable channel of the circuit breaker provided for this purpose.	 Respect the direction of insertion for the connector: The adapter part marked CIP must be visible from the front. Avoid forcing the connector when inserting.
5	Close the front cover of the MCCB	
6	Using a No.2 Phillips screwdriver, lock the front cover by rotating the lock clockwise	
7	Terminate the other end of the CIP adapter cable to 24V dc power supply terminals.	Brown wire +24V dc White wire 0V dc

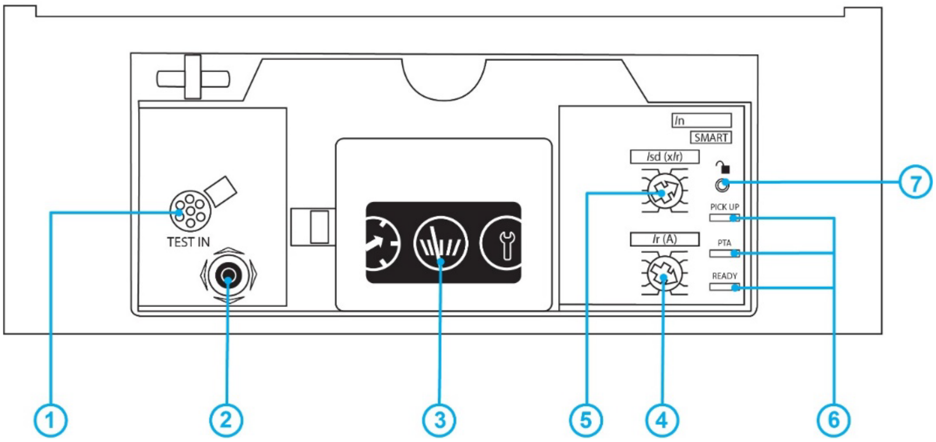
Navigation

P_SE Trip Unit Overview

P160 / P250



P400 / P630

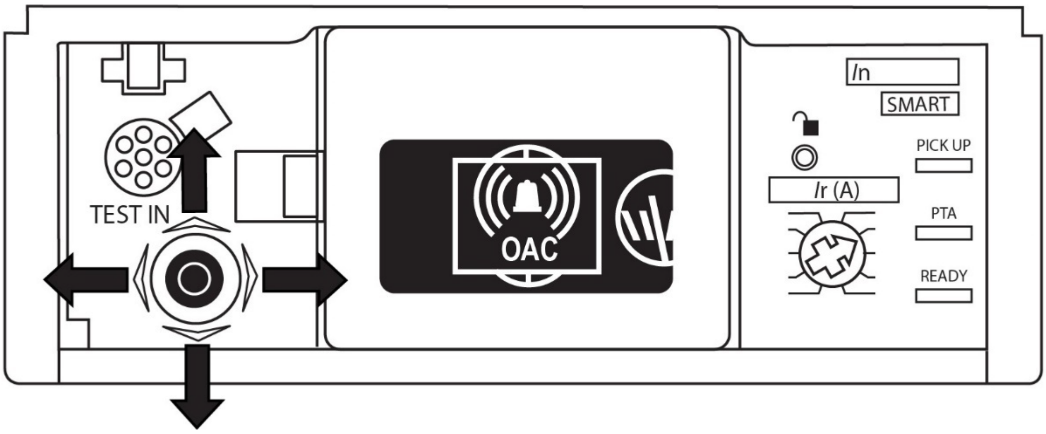


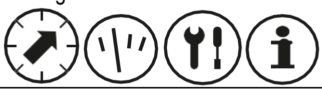
Operation key	
1	MIP Port
2	SMART Trip Unit Joystick
3	Embedded Display
4	I_r Coarse Setting Dial
5	I_{sd} Coarse Setting Dial
6	LED Indication
7	Unlock Button

Navigation

Principles of Navigation

The menu navigation and selection is performed using the joystick on the left side Trip Unit display.



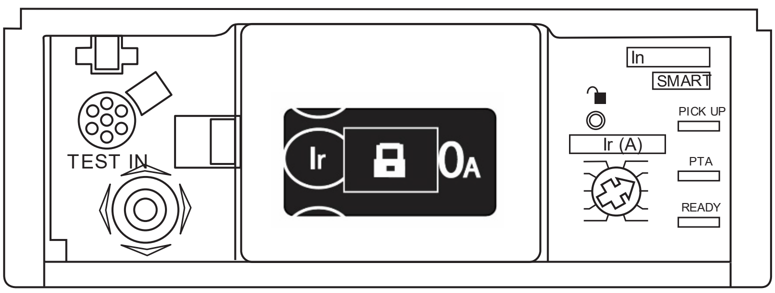
Button Action	Description
⬅ ➡	Navigation between main menus: 
⬆⬇	Navigation within a submenu
	Selection / Entering / validation of a setting, by pressing the joystick

Locking / Release Button

By default, changing P_SE Trip Unit protection settings are protected via a locking function. Navigation of general monitored data is still possible on locked Trip Units. The lock prevents unauthorised access to changes to the following Trip Unit settings and functions:

- Altering Protection Settings
- Reset or change of measurement statistics
- Return to factory settings
- Modification of the remote data write locking parameter

Attempting to use the joystick from a locked Trip Unit causes the screen to display a padlock indicating the active lock.



There are two ways to unlock access:

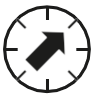
- By using the I_r max adjustment dial
- By pressing the unlock button.

To unlock the P_SE Trip Unit in order to modify the settings, the transparent cover will need to be opened to access the unlock button or max I_r adjustment dial.

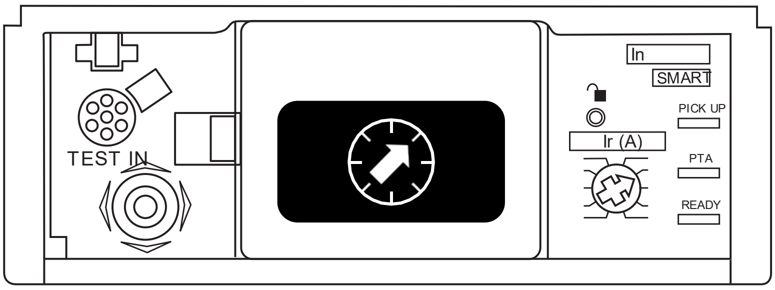
Navigation

Navigation Menus

The embedded display provides access to P_SE Trip Unit settings and measurement viewing and status via 4 main menus:

Protection	Measurement	Configuration	Information
			

Protection Setting Menu



The protection menu consists of sub-menus to view and edit each Trip Unit protection setting.

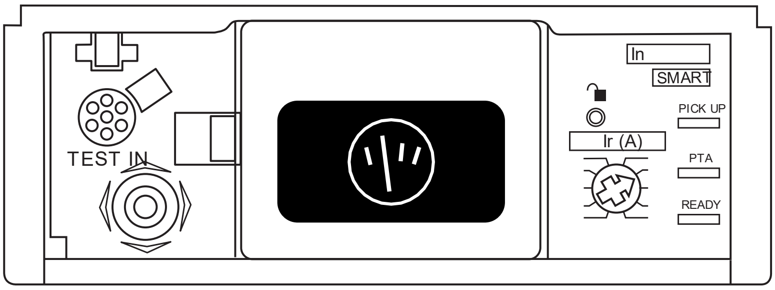
Refer to the Protection Settings section for more details on each of the available protection setting parameters and their adjustments via the P_SE Trip Unit embedded display and dials where required.

Pressing the joystick down on the Protection Setting menu allows scrolling through and viewing of the following parameters and options

	Threshold Adjustment	Time Setting	Other Settings
LTD – Long-time protection	Ir	tr	
STD – Short-time protection	Isd	tsd I^2t	ZSI
INST – Instantaneous protection	Ii		
GF – Ground fault protection	Ig	tg I^2t	ZSI
NP – Neutral protection	N		

Navigation

Measurement Menu



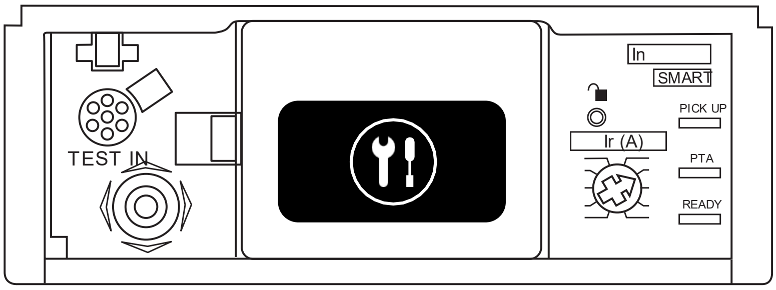
The measurement menu is where you can view measurements and set favourites for screen saver. Refer to the Measurements and Settings section for more details on the measurements available on the P_SE Embedded display

Pressing the joystick down on the Measurements menu allows scrolling through and viewing of the following parameters and options.

Measurement	Designator / Description	Notes
Phase and neutral current	I_1, I_2, I_3; I_N	I_N available on 4P MCCB only
Ground / Earth current	I_g	
Maximum current since last reset	Max. of each I_1, I_2, I_3; I_N, I_{max}, I_{min}	
Phase-phase voltage	U_{12}, U_{23}, U_{31}	
Phase to neutral voltage	V_{1N}, V_{2N}, V_{3N}	3Ph+N only
Maximum Ph-Ph voltage since last reset	Max. of each U_{12}, U_{23}, U_{31}, U_{max}, U_{min}	
Maximum Ph-N voltage since last reset	Max. of each V_{1N}, V_{2N}, V_{3N}, V_{max}, V_{min}	3Ph+N only
Phase rotation (sequence)	1-2-3, 1-3-2	
Frequency	f	
Active power	P_1, P_2, P_3, P_{tot}	
Reactive power	Q_1, Q_2, Q_3, Q_{tot}	
Maximum active power since last reset	Max. of each P_1, P_2, P_3, P_{tot}	
Maximum reactive power since last reset	Max. of each Q_1, Q_2, Q_3, Q_{tot}	
Total Displacement Power Factor	$Cos\varphi_{tot}$	
Energy consumed	$E_{a\ In}$, $E_{r\ In}$	

Navigation

Setup Menu



The Setup menu consists of sub-menus to view and change Trip Unit embedded display settings for:

- Date & Time
- Display Orientation and Brightness
- Standby mode.
- Reset the maximum measurement values.
- Return to factory settings.
- Permission to remotely write data

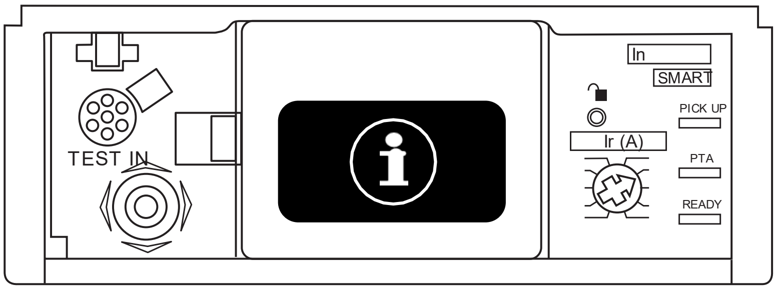
Pressing the joystick down on the Setup menu allows scrolling through and viewing of the following parameters and options

Parameter	Symbol	Description
Time setting using the menu		Trip Unit time settings can be adjusted using this menu – this setting constitutes the time portion of the User time. It is also possible to set the date and time using the TPED or TPCM. Refer to Date & Time section.
Date setting using the menu		Trip Unit date settings can be adjusted using this menu – this setting constitutes the date portion of the User time. It is also possible to set the date and time using the TPED or TPCM. Refer to Date & Time section.
Viewing orientation setting using the menu		A user can rotate the screen display in four directions: up, down, left or right. The display contents are automatically optimised based on the orientation for maximum readability regardless of orientation.
Menu Brightness adjustment		The brightness can be adjusted to 20%, 40%, 60%, 80% or 100% (60% by default).
Sleep / Standby setting using the menu		When Sleep mode is activated, the display switches off after 5 minutes if there is no movement of the Trip Unit joystick. Standby mode is enabled by default and can be disabled. If the joystick is pressed within 15 minutes after activation of the screen going into sleep mode, the last view before sleep mode will be displayed. Otherwise, the display will move to the Main menu view. The output of the standby mode is caused by one of the following events: - Joystick movement - A message alarm notification.
Resetting maximum measurement values using the menu	MAX	This submenu allows a user to reset the stored maximum values of currents, voltages, and power. This reset control is not only for maximum value reset, also for resetting of the energy counters.
Return to factory settings using the menu		This menu allows the user to reset the settings accessible from the P_SE Trip Unit embedded display.
Authorisation for remote writing data using the menu		This submenu allows the user to enable or disable authorisation to write data to the Trip Unit remotely via the TPED or TPCM. By factory default, remote write authorisation is enabled (set to ON).

Notice: Restoring to factory settings only affects parameters which are configurable using the P_SE Trip Unit embedded display. Other parameters which are configurable via remote accessories such as the TPED and TPCM are not restored to their default settings using this method.

Navigation

Information Menu



Pressing the joystick down on the Information menu allows scrolling through and viewing of the following parameters and options:

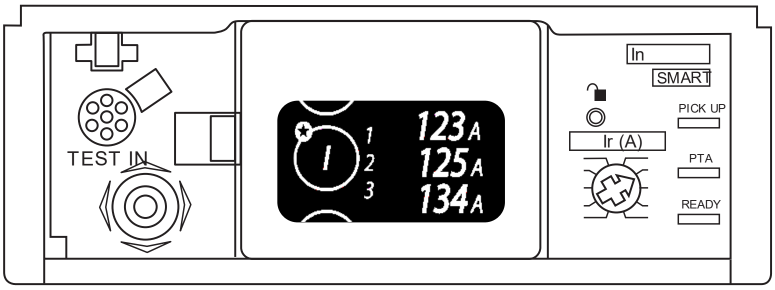
Parameter	Symbol	Description
Trip History		Information on the last trip cause – Refer to Last Trip section for more information
AX	AX	Number of operating cycles opening / closing
AL	AL	Number of electromechanical fault trips

Notice: AX and AL cycle counters are only available when the SMART Auxiliary accessory is installed in the MCCB. Otherwise, these values will display as 0.

Refer to the SMART Auxiliary AX / AL Status Indicator section

Navigation

Sleep / Standby



After 30 seconds of inactivity (no movement of the joystick), the embedded display will enter Standby mode, whereby it will automatically scroll through a loop of favourited measurements every 3 seconds.

Refer Setting Favourites section for information on how to set favourite measurements to be displayed in Standby mode.

If Sleep mode is activated from the information menu, the display switches off after 5 minutes of inactivity.

If the joystick is pressed within 15 minutes after activation of the screen going into sleep mode, the last view before sleep mode will be displayed. Otherwise, the display will move to the Main menu view.

Notice: If less than 2 favourites are selected, the display first actives Sleep / Standby mode after 30 seconds and then turns off after 5 minutes, regardless of Sleep /Standby mode is disabled.

Commissioning

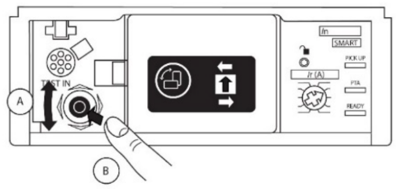
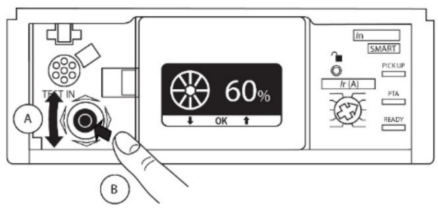
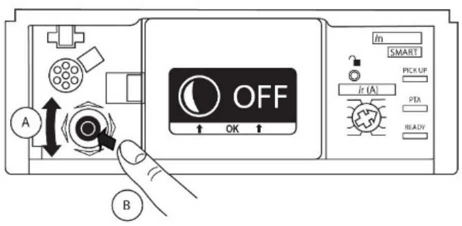
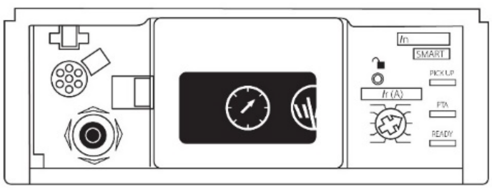
Starting the P_SE MCCB for the First Time

WARNING: Before applying power to the MCCB for the first time, an initial inspection must be performed.

At first start-up, before being able to access the various menus, the embedded display will prompt the user to set the orientation, brightness and Standby mode. These settings can be confirmed using the joystick on the left-hand side of the display.

Once the correct setting has been selected, press the joystick to confirm the setting and move on to the next screen.

After these three settings are confirmed, the Main menu is displayed.

	Action		Note / Illustration
1	Orientation of the display		
	Ⓐ	Push the joystick upwards or downwards to select the orientation of the display.	
	Ⓑ	Press the joystick in to confirm the choice	
2	Setting the screen brightness		
	Ⓐ	Push the joystick upwards or downwards to select the brightness.	
	Ⓑ	Press the joystick in to confirm the choice	
3	Activating/deactivating Standby mode		
	Ⓐ	Push the joystick upwards or downwards to activate/deactivate Standby mode.	
	Ⓑ	Press the joystick in to confirm the choice	
4	Navigation through the main menus		
	After these three settings are confirmed, the Main menu is displayed.		

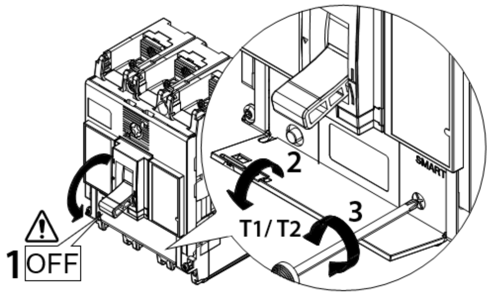
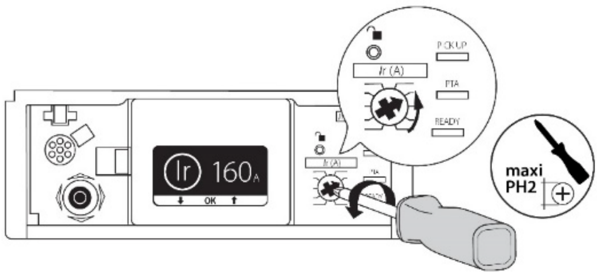
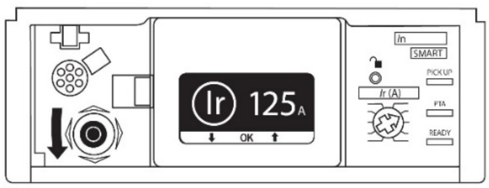
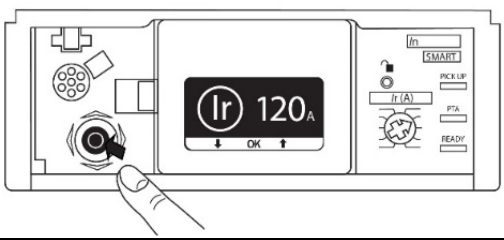
Commissioning

LTD Protection Adjustments (I_r, t_r)

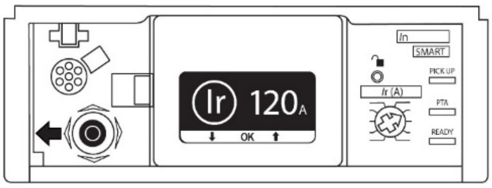
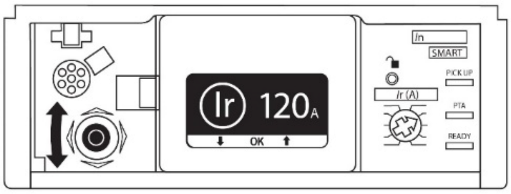
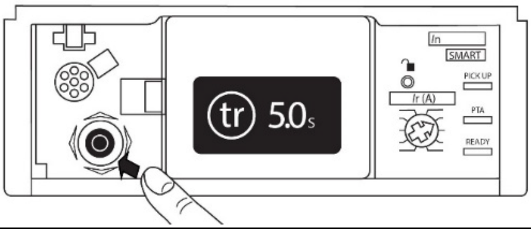
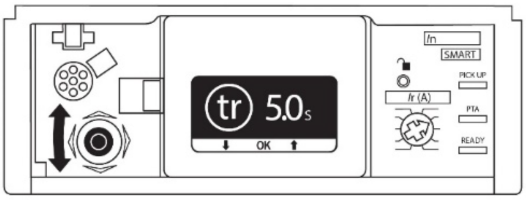
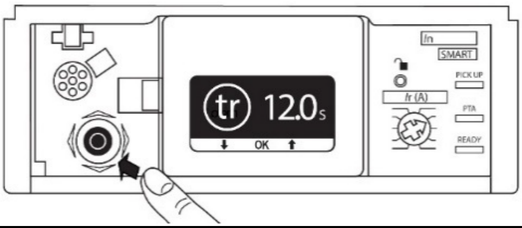
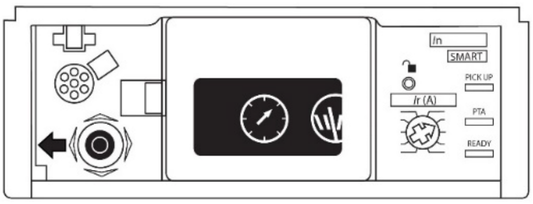
> **WARNING**: Risk of nuisance tripping.
> Only qualified personnel are to set the protection levels. Failure to respect these instructions may cause death, serious injuries or equipment damage.

After having set the display, the I_r max setpoint and I_r current should be set as follows:

<table>
<tr><th></th><th>Action</th><th>Note / Illustration</th></tr>
<tr><td>1</td><td>Turn the MCCB to the OFF Position

Open the transparent flap in order to access the max I_r adjustment dial</td><td>
</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Using a PH1, PH2 or PZ2 size screwdriver, rotate the I_{r1} adjustment dial to the maximum scale value of I_r.</td><td>
</td></tr>
<tr><td>Note:
The display automatically switches to Unlocked mode and asks you to modify the I_r value. The I_r value, and icon is then displayed in inverted colours.</td></tr>
<tr><td>3</td><td>Push the navigation joystick down for fine adjustment of the value I_r.</td><td>
</td></tr>
<tr><td>4</td><td>Press the joystick in to confirm new value.</td><td>
</td></tr>
</table>

Commissioning

	Action	Note / Illustration
5	At this stage it is possible to modify the other protection settings. To do this, it is important to remain in Unlocked mode, unsure only press the left arrow once. Pressing more than once will lock the display, the display would need to be unlocked to proceed.	 Note: Check that the entire setting parameters icon to the left of the setting value remains displayed in the inverted colour
6	Move the navigation joystick upwards or downwards to select another setting parameter.	
7	Press the joystick in to confirm the selection. The display will immediately ask you to change the value selected.	
8	Move the navigation joystick upwards or downwards to perform the setting.	
9	Press the joystick in to confirm the new value	
10	Repeat steps 5 to 9 to perform another protection setting	
11	Move the joystick to the left to first return to locked mode and a second time to exit and return to the Main menu.	

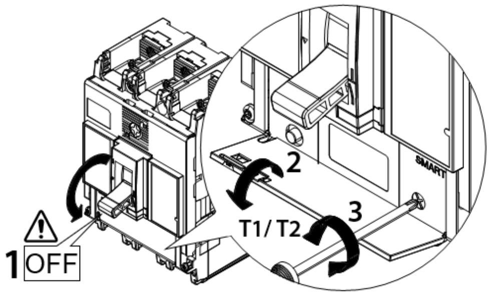
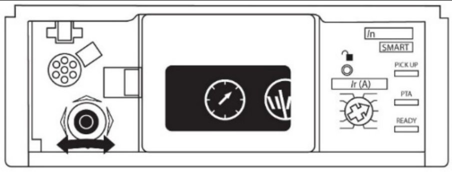
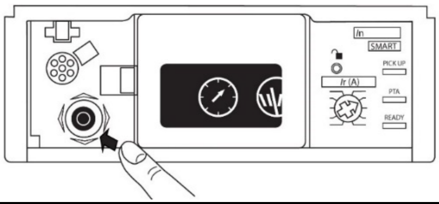
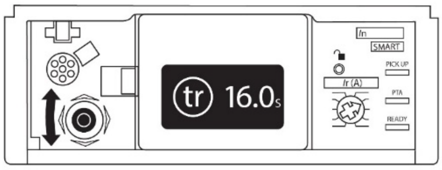
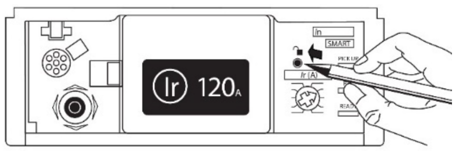
Commissioning

Navigation and Settings After the First Setup

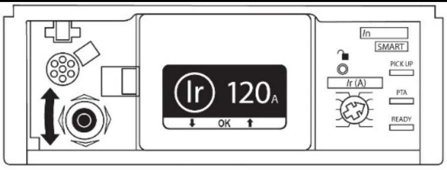
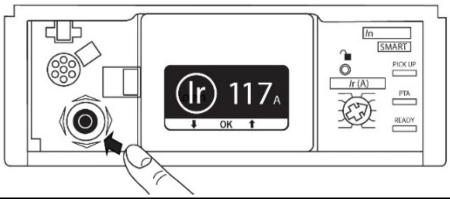
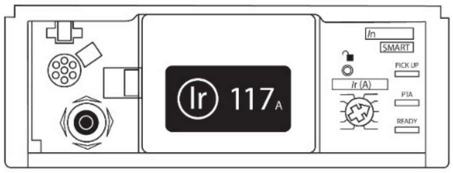
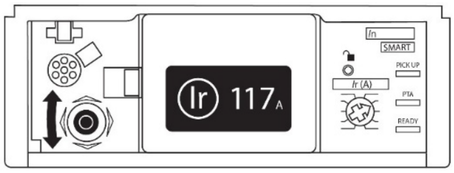
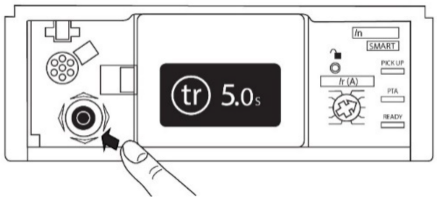
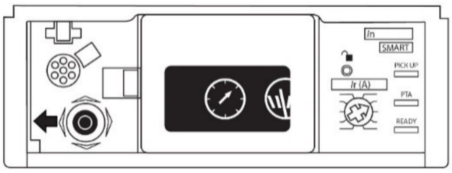
After setting the max I_r setpoint (I_r dial), it is necessary to:

- Set the other protection parameters for the circuit breaker
- Set the Trip Unit clock

Below uses I_r as an example for setting all other protection settings. Refer to Protection Settings section for more information in additional settings.

	Action	Note / Illustration
1	Open the transparent flap in order to access the unlock button.	
2	Move the joystick to the left or right to select the menu (Protection or Configuration) containing the parameter to be set.	
3	Press the centre of the joystick to access the menu.	
4	Move the joystick upwards or downwards to select the parameter to be set.	
5	Briefly press the unlock button using a rounded tip such as a ballpoint pen.	
		Note: The embedded display automatically switches to Unlocked mode. The parameter icon found to the left of the value to be set is then displayed in inverted colours.

Commissioning

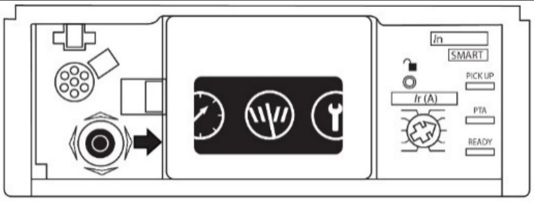
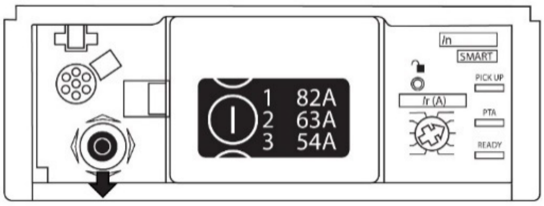
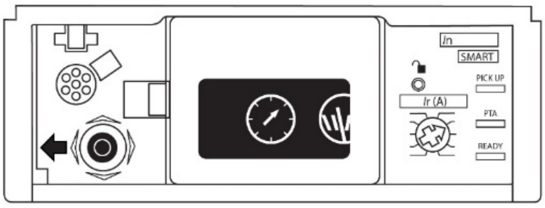
	Action	Note / Illustration
6	Move the navigation joystick upwards or downwards to select the desired value or method.	
7	Press the centre of the joystick to confirm the new setting	
8	At this stage it is possible to modify other settings of the current menu. To do this, it is important to remain in Unlocked mode	 Note: Check that the entire setting parameters icon to the left of the setting value remains displayed in the inverted colour
9	Move the navigation joystick upwards or downwards to select another setting parameter	
10	Press the centre of the joystick or move it to the right to start adjusting the value. The display will then ask you to modify the value.	
11	Repeat steps 6 and 7	
12	Move the joystick to the left to first return to locked mode and a second time to exit and return to the Main menu.	

Notice: If there is no movement on the navigation joystick for more than 30 seconds, Locked mode is automatically activated again.

Commissioning

Accessing Measurements

Refer to the Measurements and Settings section for more details on the measurements available on the P_SE Embedded display

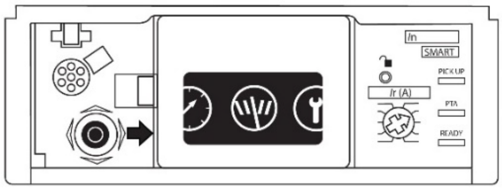
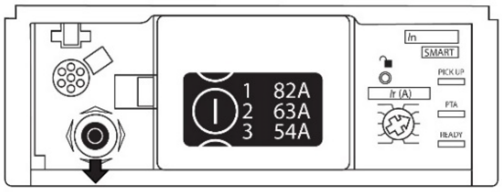
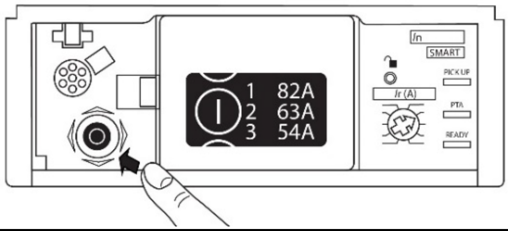
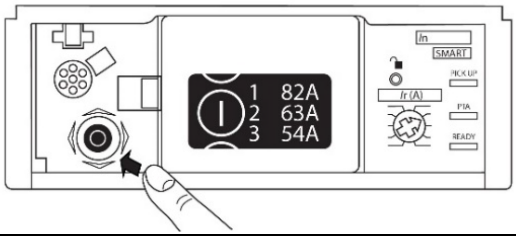
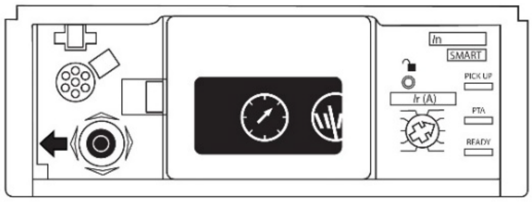
	Action	Note / Illustration
1	Move the joystick to the right to select the Measurements menu. Then press the joystick to access the Measurements menu.	
2	Move the navigation joystick downwards or upwards to view the available measurements.	
3	Move the joystick to the left to return to the Main menu.	

Exclusive
Partner

Commissioning

Setting Favourites

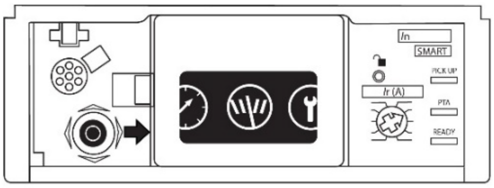
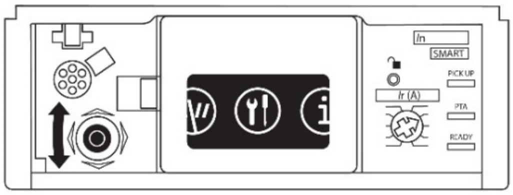
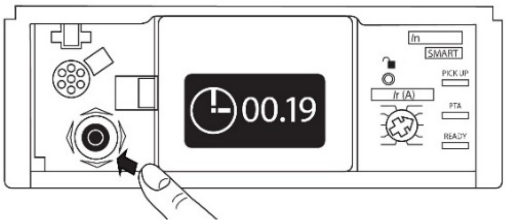
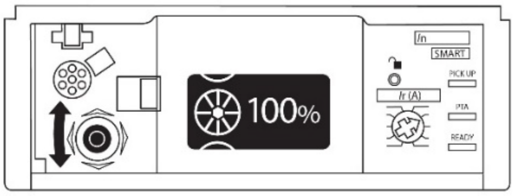
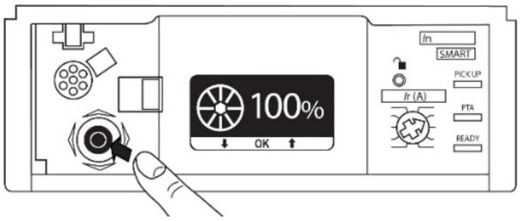
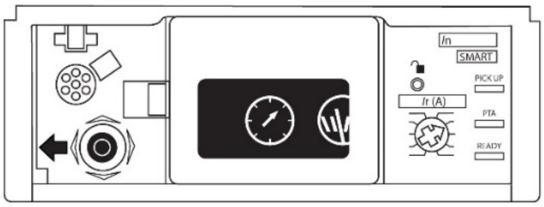
Default Display Favourites are deactivated by default.
To manage favourites, proceed as follows:

	Action	Note / Illustration
1	Move the joystick to the right to select the Measurements menu. Then press the joystick to access the Measurements menu.	
2	Move the navigation joystick downwards to select the view to be set as the favourite.	
3	Briefly press the centre of the joystick to confirm the selection. A star appears on the measurements icon to confirm the validation.	
4	Repeat steps 2 and 3 to add other favourites.	
5	To delete a favourite briefly press the centre of the joystick on a view confirmed as a favourite. The star disappears on the measurements icon to confirm the validation.	
6	Move the joystick to the left to return to the Main menu.	

Commissioning

Accessing Setup Settings

Default Display Favourites are deactivated by default.
To manage favourites, proceed as follows:

	Action	Note / Illustration
1	Move the joystick to the right to select the Setup menu. Then press the joystick in to access the Setup menu.	
2	Move the navigation joystick upwards or downwards to view the available settings.	
3	Briefly press the centre of the joystick to confirm the selection.	
4	Move the navigation joystick upwards or downwards to change the setting.	
5	Briefly press the centre of the joystick to confirm the setting.	
6	Repeat steps 2, 3 and 4 to change other settings.	
7	Move the joystick to the left to return to the Main menu.	

Commissioning

Settings	Icon	Available Settings		Default	Unlock Required
Time		Hours / Minutes	AM / PM	-	NO
Date		Day / Month / Year Or Year / Month / Day	Values	D / M / Y	NO
Display Orientation		← / ↑ / → / ↓		↑	NO
Display Brightness		20 / 40 / 60 / 80 / 100%		60%	NO
Sleep		OFF / ON		OFF	NO
Max Measurements Reset		RESET		-	YES
Factory Default		RESET		-	YES
Data Right Permission		ON / OFF		ON	YES
Phase Sequence		1, 2, 3 / 1, 3, 2		1, 2, 3	YES

Troubleshooting

Troubleshooting

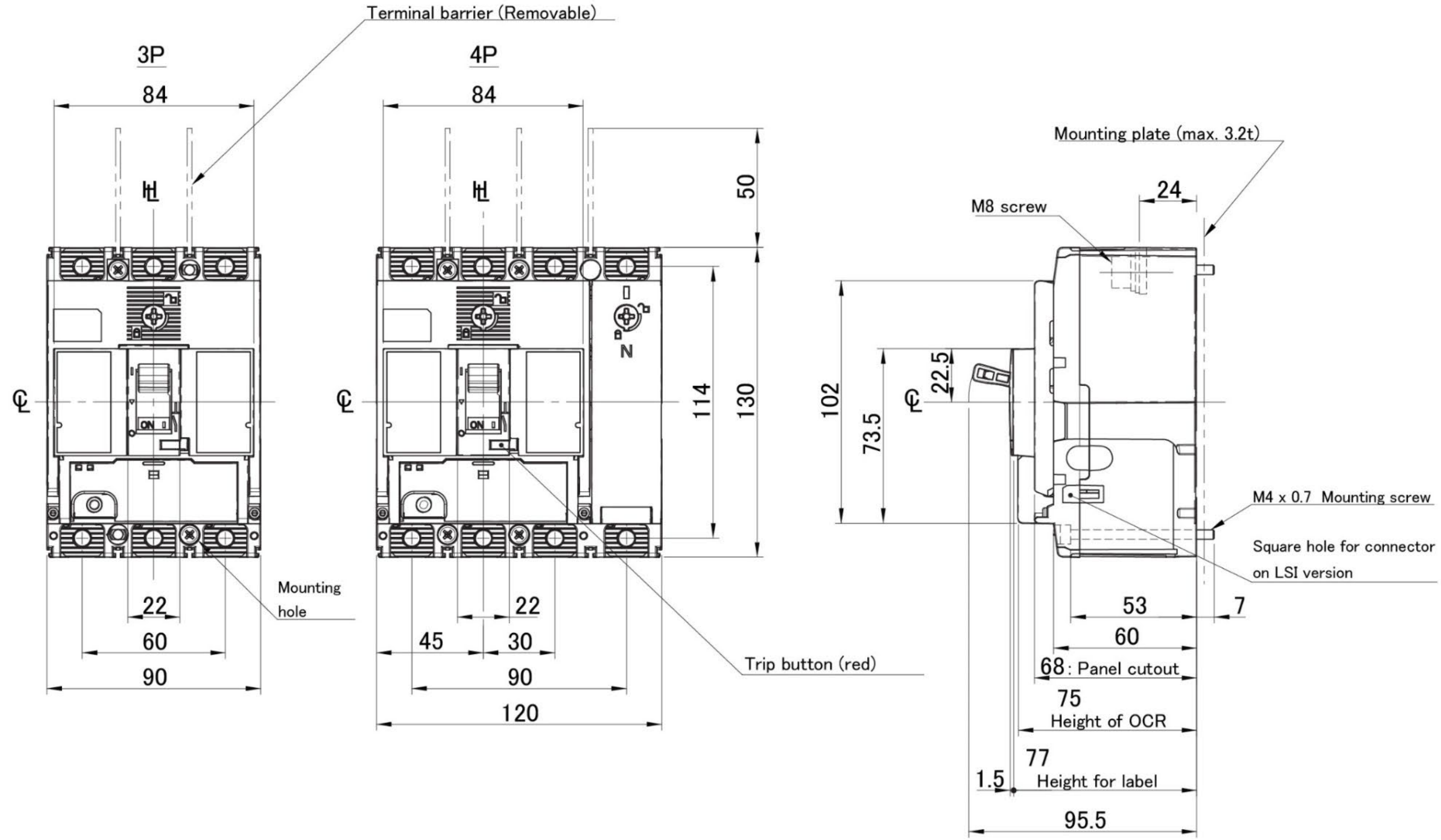
In the event of a problem when using the TemBreak *PRO* system, this section provides advice on how to resolve issues.

	Problem description	Possible cause	Remedial advice
1	Ready LED OFF	Insufficient or no power to the Trip Unit	Verify power supply requirements. Refer to Trip Unit Power Supply section. If Trip Unit is self-powered: - MCCB must be closed and load drawing sufficient current through main poles. - Verify the current through the MCCB poles meets the minimum requirements. If Trip Unit is externally powered: - Verify external 24V dc power supply is operational at correct voltage.
		Incorrect or faulty wiring	Verify integrity of wiring and connections. If Trip Unit is self-powered, verify and correct any: - Loose connections to line and load terminals - Incorrect terminals / conductors / connector pins If Trip Unit is externally powered, check for and correct any: - Loose connection of CIP connector and cable - Loose connection of CIP cable to external supply terminals - Incorrect supply terminals / conductors / connector pins Refer to External 24V dc supply instructions section.
2	Ready LED flashing orange	Incorrect settings	Verify adjustment dials are in correct defined positions For 3P MCCB, ensure that NP (Neutral Protection) is not enabled.
		Trip Unit is faulty	Replace MCCB
3	The embedded display is blank	Insufficient or no power to the Trip Unit.	Verify power supply requirements. Refer to Trip Unit Power Supply section. If Trip Unit is self-powered: - MCCB must be closed and load drawing sufficient current through main poles. - Verify the current through the MCCB poles meets the minimum requirements. If Trip Unit is externally powered: - Verify external 24V dc power supply is operational at correct voltage.
		Incorrect or faulty wiring	Verify integrity of wiring and connections. If Trip Unit is self-powered, verify and correct any: - Loose connections to line and load terminals - Incorrect terminals / conductors / connector pins If Trip Unit is externally powered, check for and correct any: - Loose connection of CIP connector and cable - Loose connection of CIP cable to external supply terminals - Incorrect supply terminals / conductors / connector pins Refer to External 24V dc supply instructions section.
		Display is not seated correctly	Verify display connections are not damaged or dirty: - Un-clip embedded display from the Trip Unit. - Verify connection pins and gold tabs on underside of display are clean and free of debris. - Re-insert display and click into position firmly.
		Display is faulty	Replace display

	Problem description	Possible cause	Remedial advice
4	Trip Unit over temperature alarm (Internal Trip Unit temperature > 105°C)	Excessive ambient temperature.	Verify ambient temperature surrounding the MCCB do not exceed the maximum rated ambient temperature range (-25°C...+70°C)
		Loose terminal screw or conductor connecting screw.	Verify and correct any loose connections to load and line terminals. Refer to torque and connection requirements in TemBreak *PRO* P_SE Installation Instructions supplied with MCCB
		Increased contact resistance, loose internal connection or contact failure.	Replace MCCB
		High proportion of high frequency distortion in load current.	Decrease distortion content of load circuit
5	Abnormal voltage on load side	Excessive wear of contacts	Replace MCCB.
		Foreign matter interfering with contacts or contact surfaces	
6	Failure in ON position	Reset operation not conducted after tripping operation.	Perform reset operation.
7	Failure in RESET position	UVT not energised	Apply voltage to UVT
		Circuit breaker service life ended due to large number of switching cycles using SHT or UVT	Replace MCCB
		Fault of tripping mechanism	
8	Nuisance tripping while rated current not reached	Vibration and/or shock	Dampen vibration of MCCB and review installation requirements
		High proportion of high frequency distortion in load current.	Decrease distortion content of load circuit
		Electromagnetic induced interference (from nearby conductors or external radio sources)	Review nearby sources of conducted and radiated emissions (e.g. radio sources, high-speed switching devices including variable frequency drives)
		Excessive surge	Isolate and mitigate surge source (e.g. surge protection devices)
		Erroneous connection of control circuit for SHT or UVT	Verify control wiring and supply to SHT and UVT
9	Nuisance tripping due to starting current	Excessive inrush starting current due to load type	Review INST and STD protection settings for load type where applicable
		Switching operation of star-delta motor starter, incorrect wiring	Verify and correct any issues with star-delta starter wiring with respect to the motor windings and phase sequence. Refer to motor and/or starter manufacturer
		Short-circuit in motor (e.g. windings, starter circuit)	Verify and correct any issues with motor wiring. Inspect and verify motor winding insulation. Refer to motor manufacturer
		Erroneous connection of control circuit for SHT or UVT	Verify control wiring and supply to SHT and UVT
10	No trip at pickup current	Failure in selectivity/coordination with upstream circuit breaker or fuse	Review selectivity/coordination study and protection parameters of each device
		Incorrect protection settings	Review enabled protection settings ensuring correct pickup current and time-delay for load type. (e.g. LTD, STD, INST pickup currents and time delays)

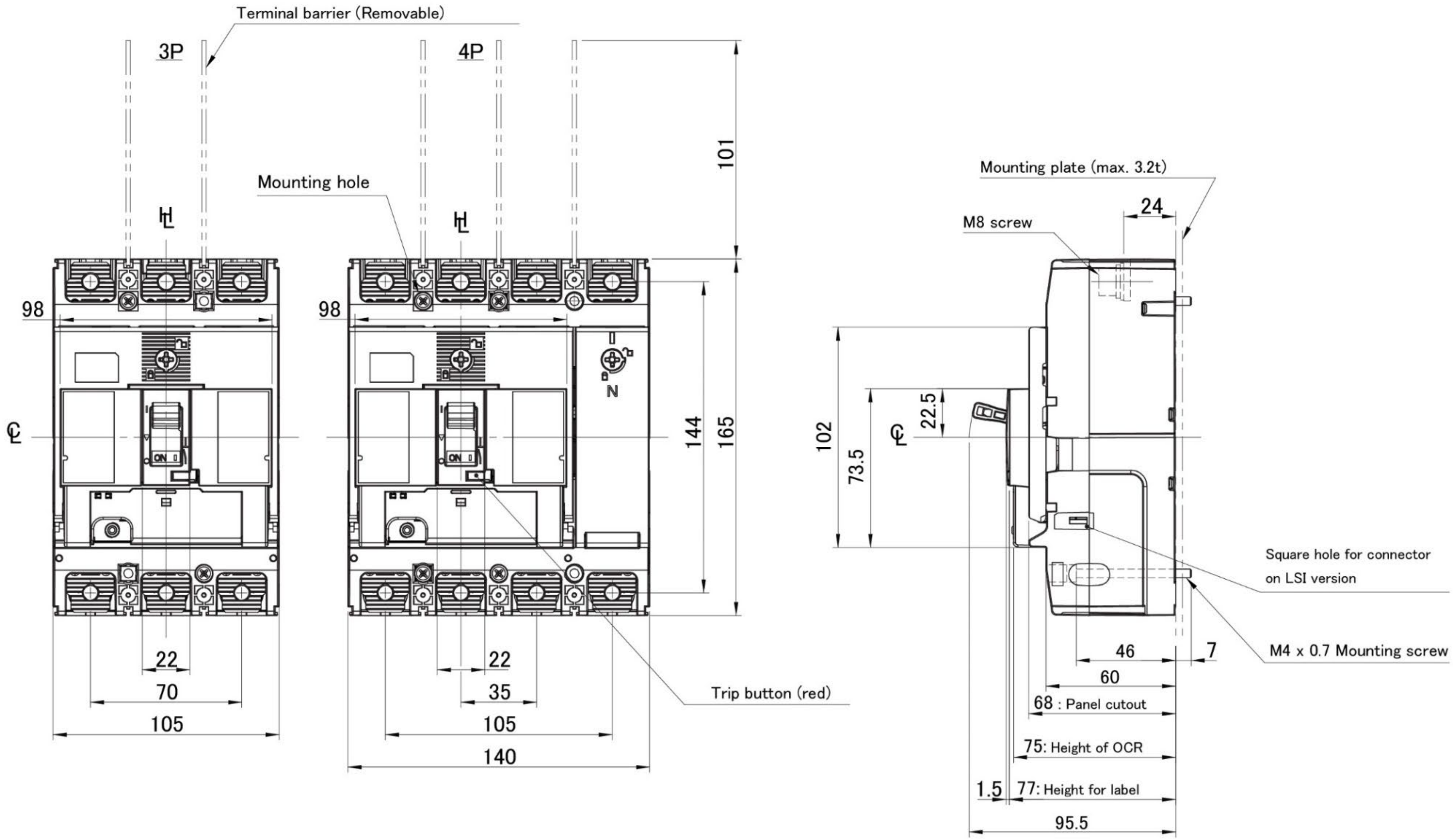
Annex A – Dimensions

P160 Dimensions



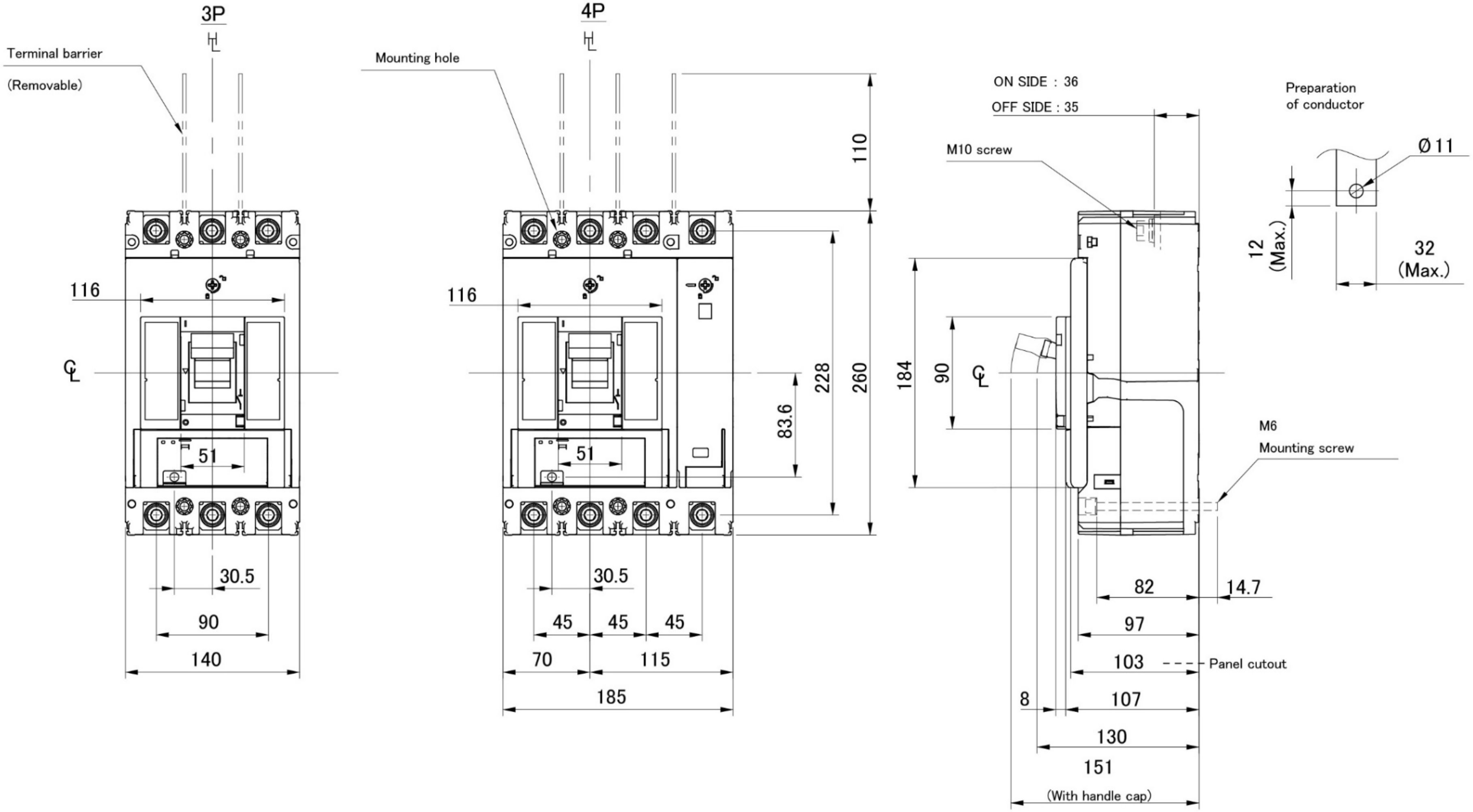
Annex A – Dimensions

P250 Dimensions



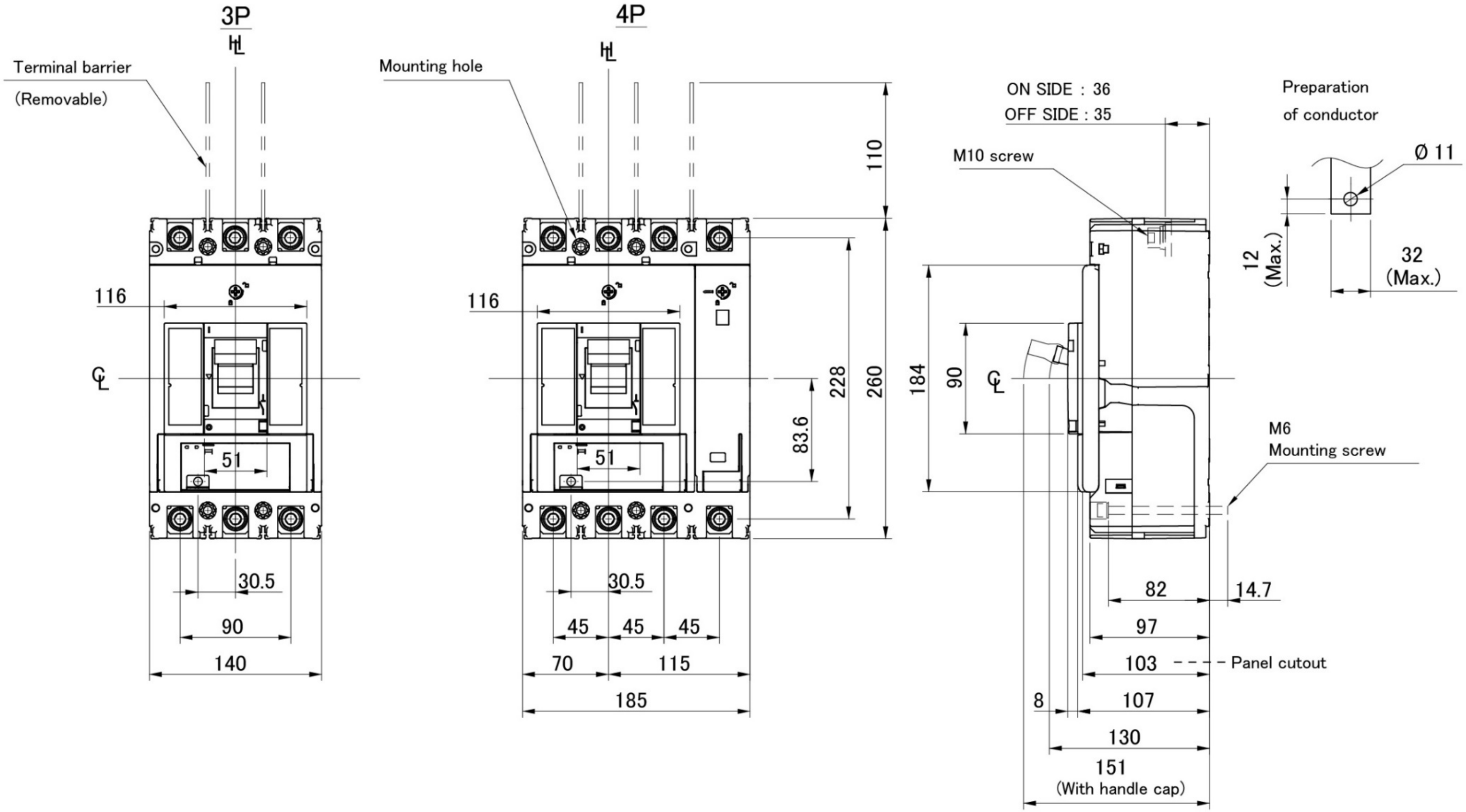
Annex A – Dimensions

P400 Dimensions



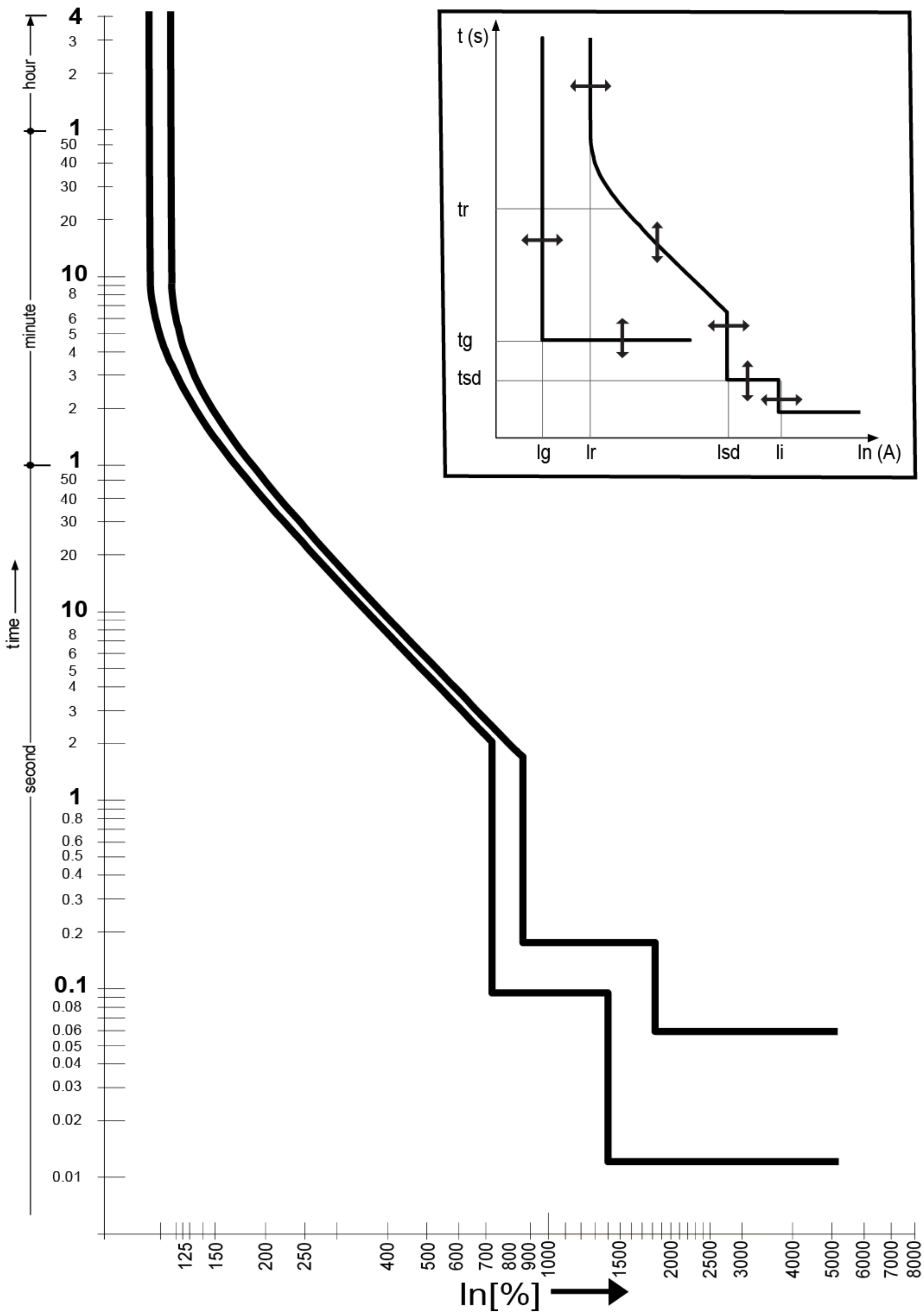
Annex A – Dimensions

P630 Dimensions



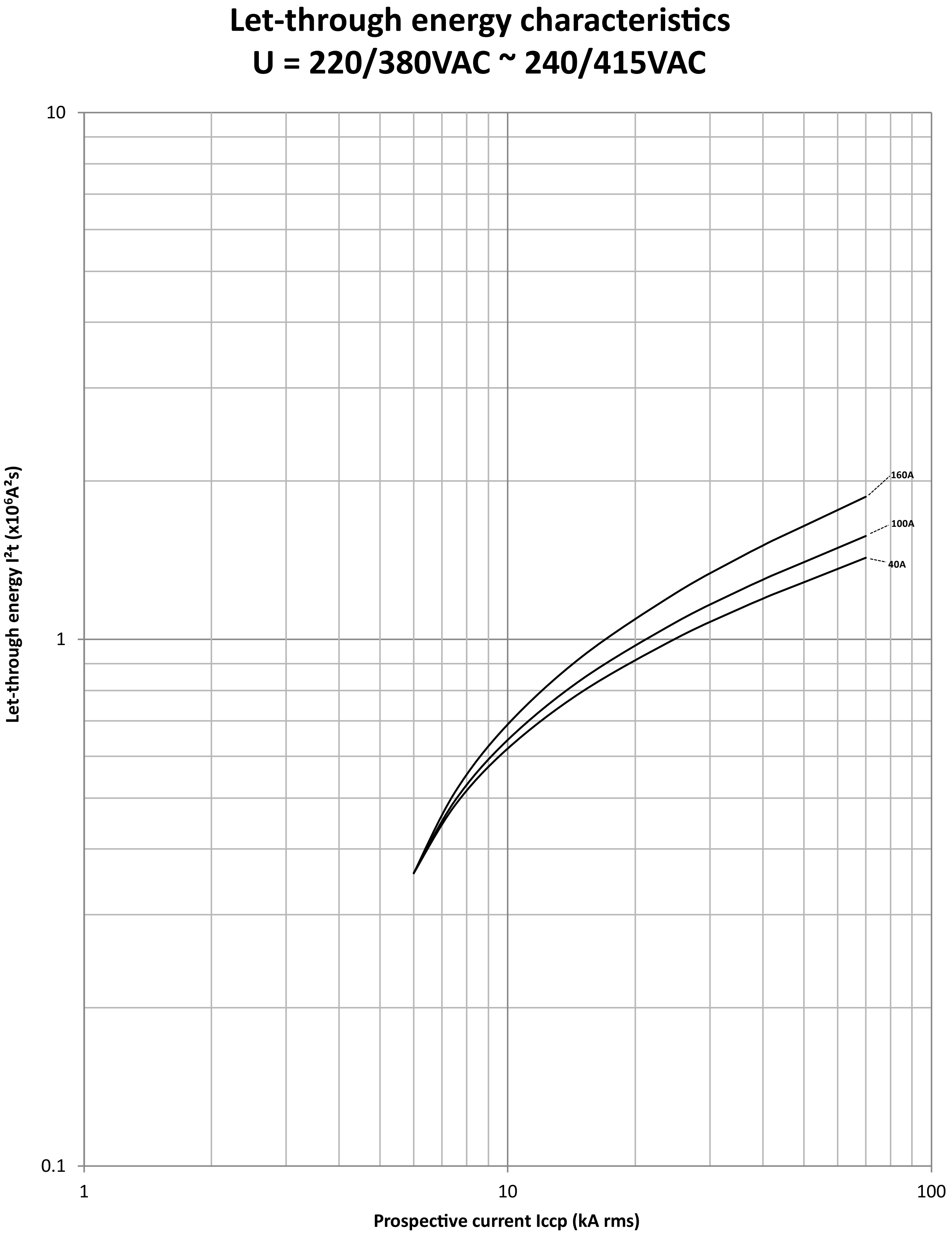
Annex B – Trip Curves

Notice: The below trip curve is representative only. The P_SE Trip Unit features fully configurable protection settings with fine adjustment to pick-up current and time delay for the various respective trip curves, which can change depending on the application. To aide in selectivity studies, a trip curve based on the actual settings used can be generated using the software package TemCurve. Contact NHP for details on TemCurve and Selectivity.



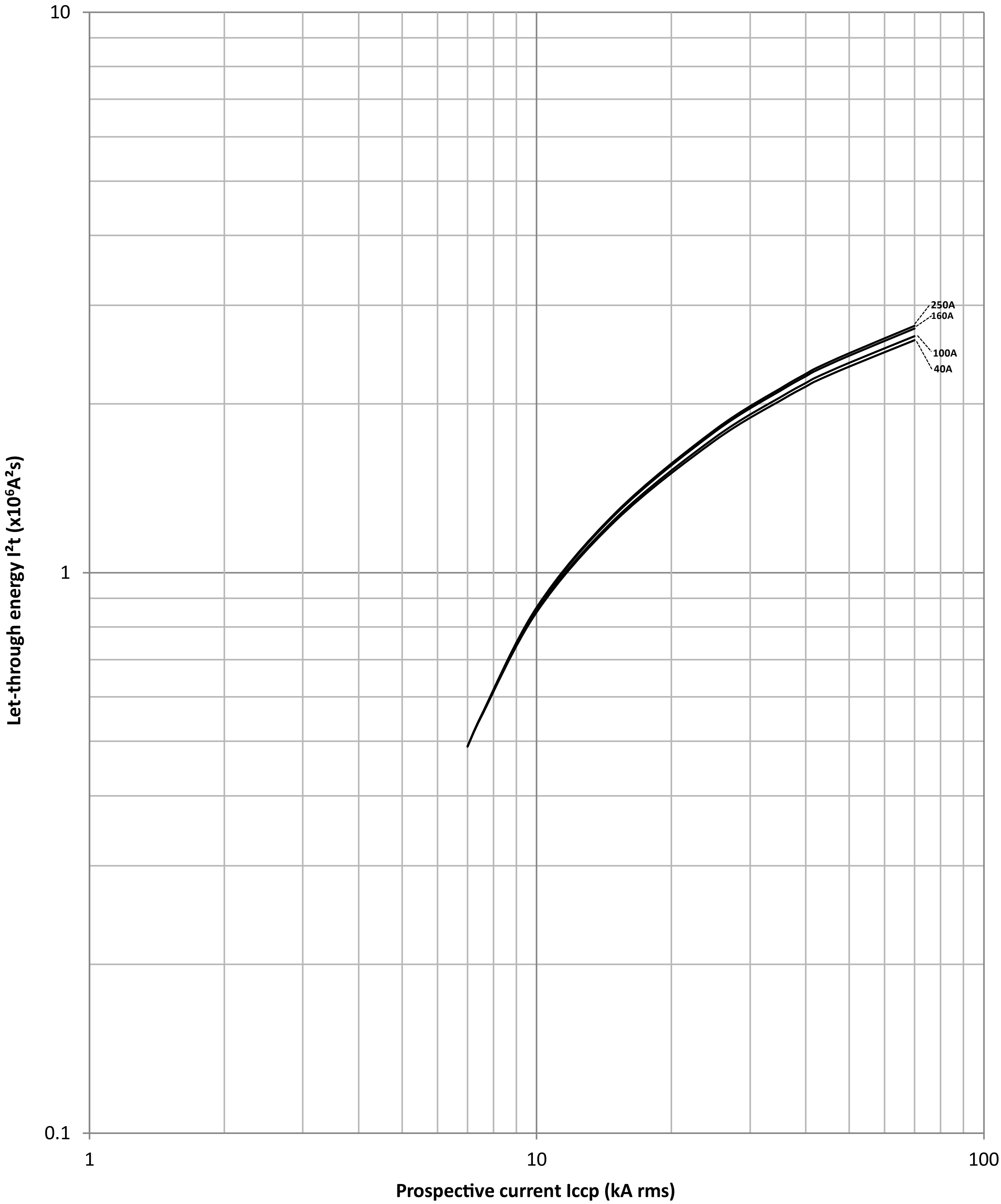
Annex C – I^2t Let-Through Curves

P160_SE



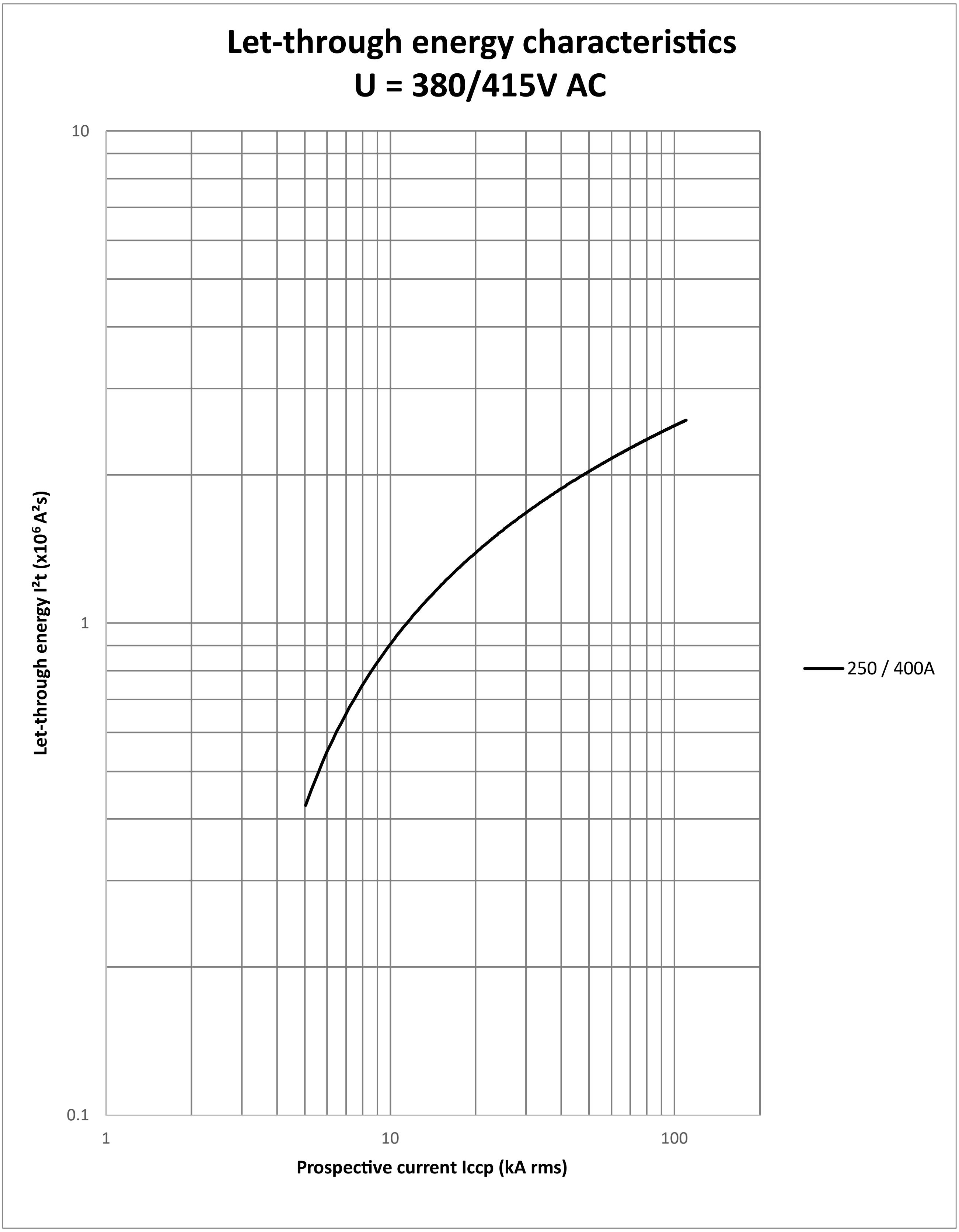
Annex C – I^2t Let-Through Curves

P250_SE

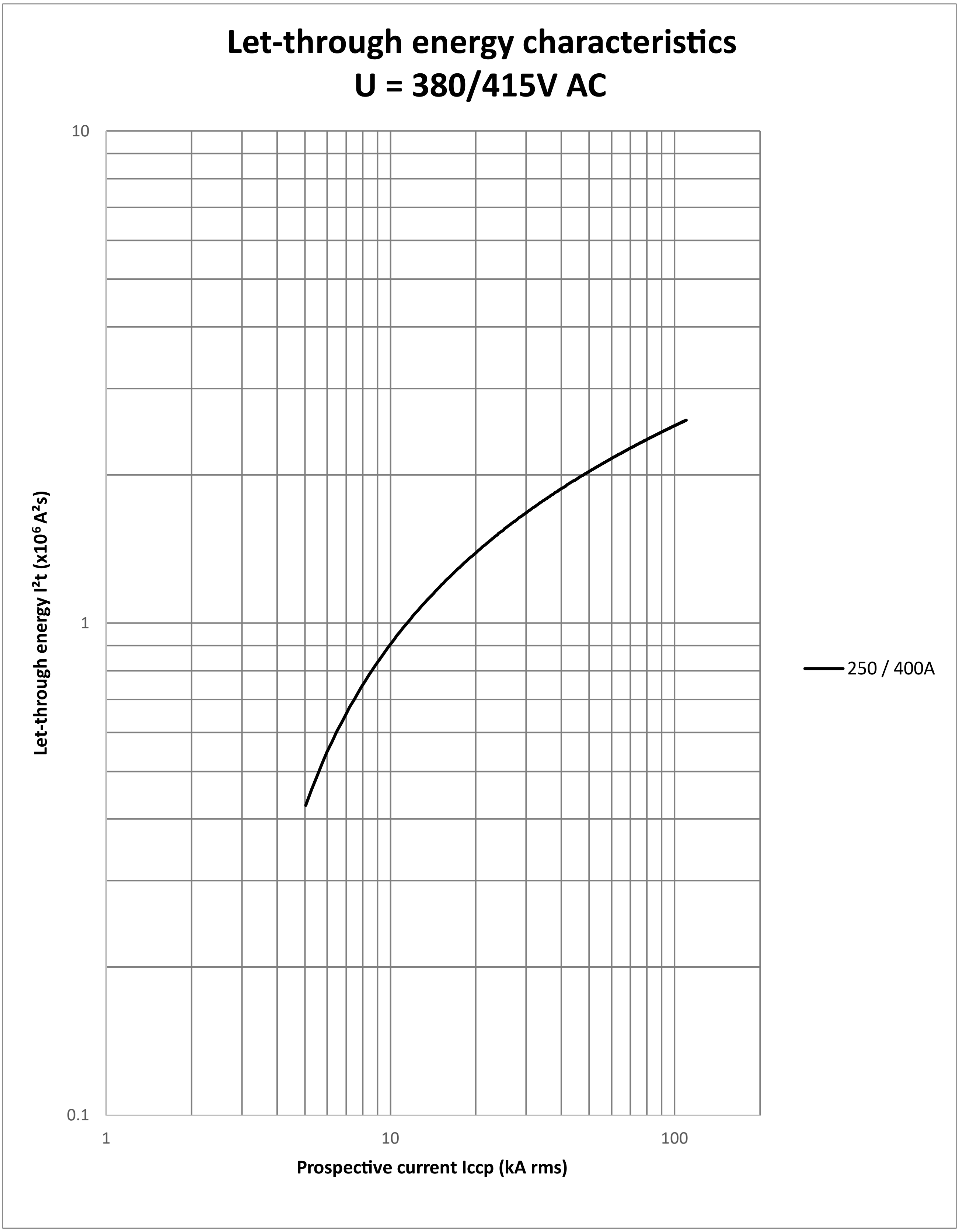


Annex C – I^2t Let-Through Curves

P400_SE

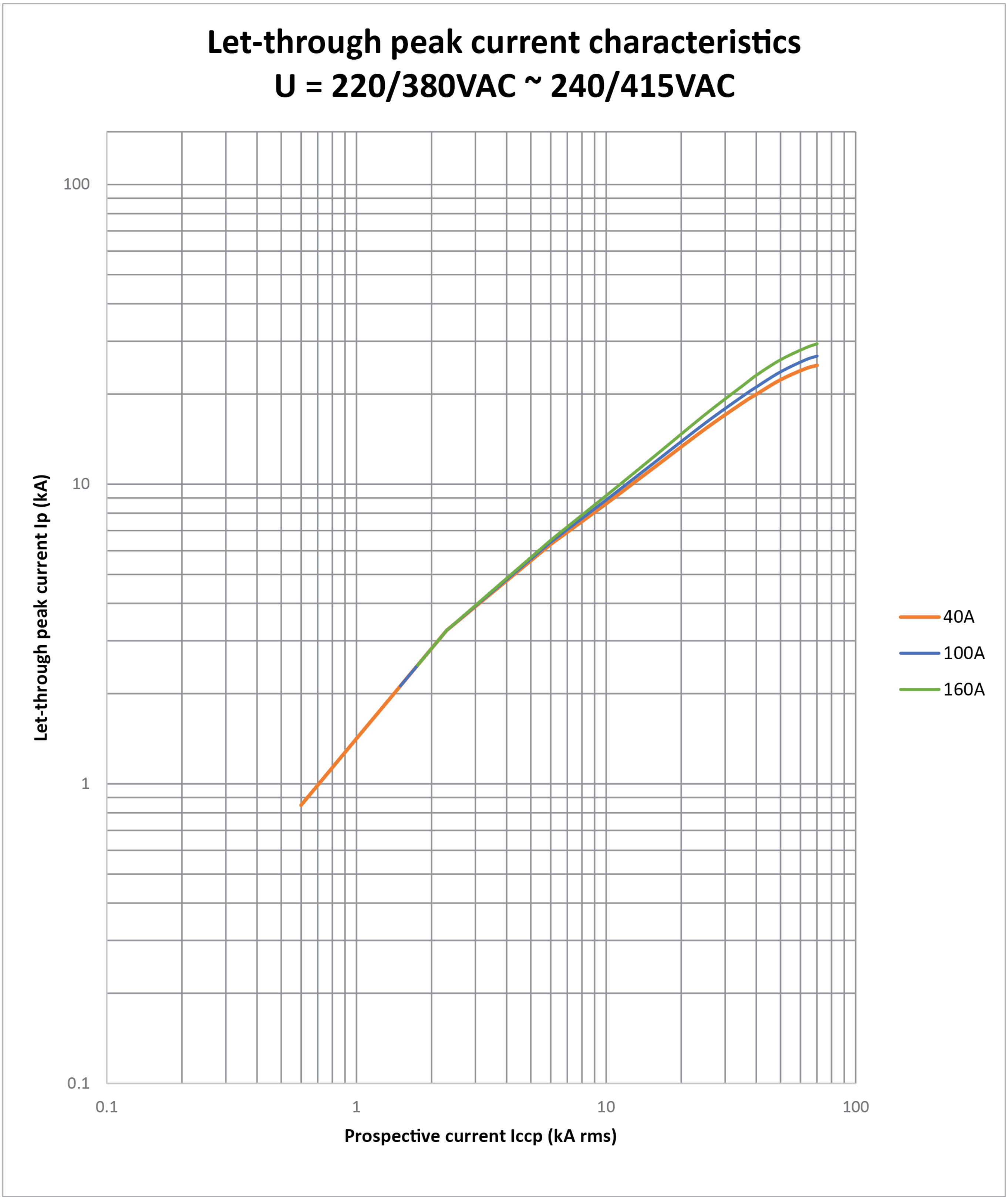


P630_SE


Let-through energy characteristics
U = 380/415V AC
10
1
0.1
Let-through energy I²t (x10⁶ A²s)
1
10
100
Prospective current Iccp (kA rms)
250 / 400A

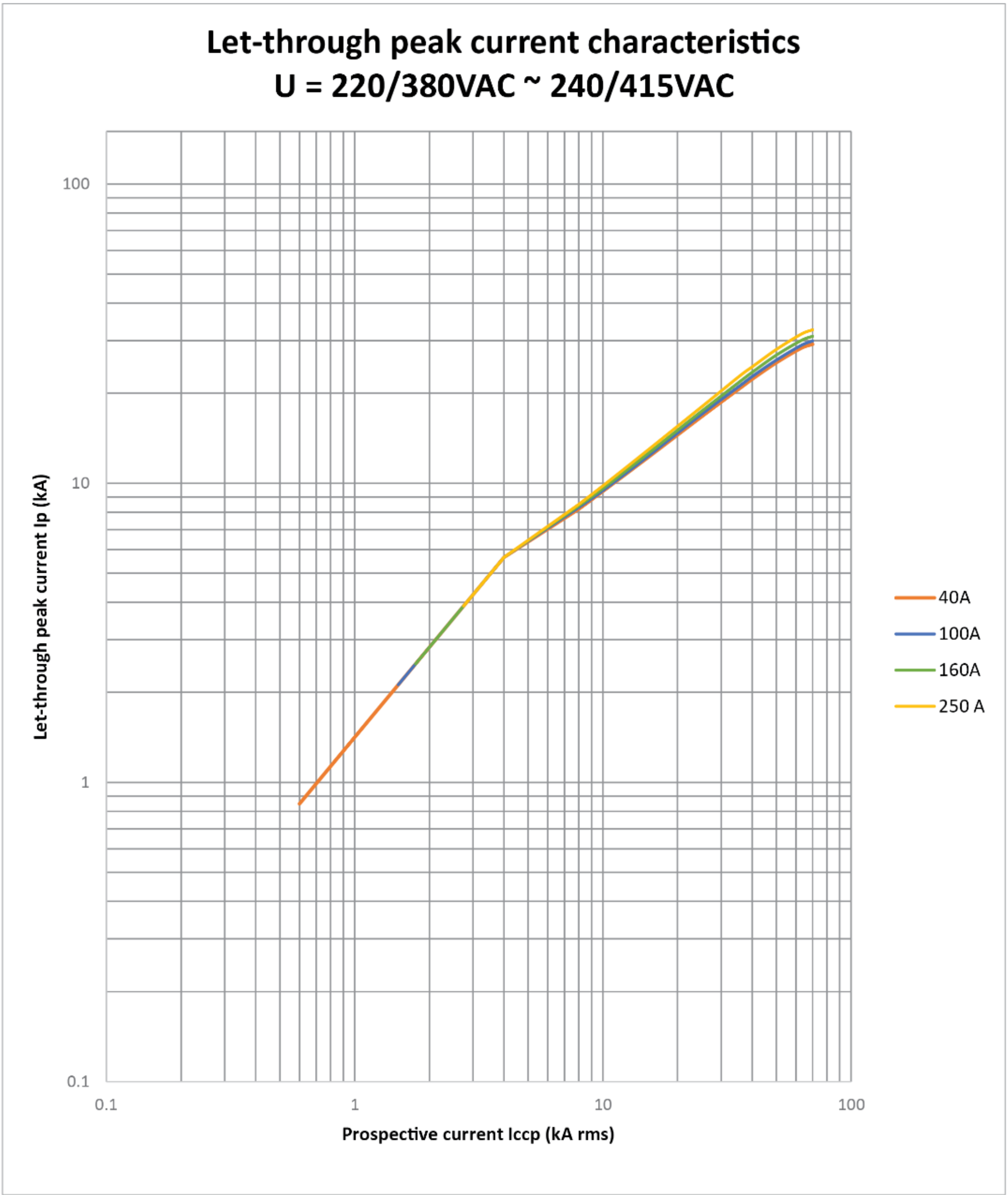
Annex D – Peak Let Through Curves

P160_SE



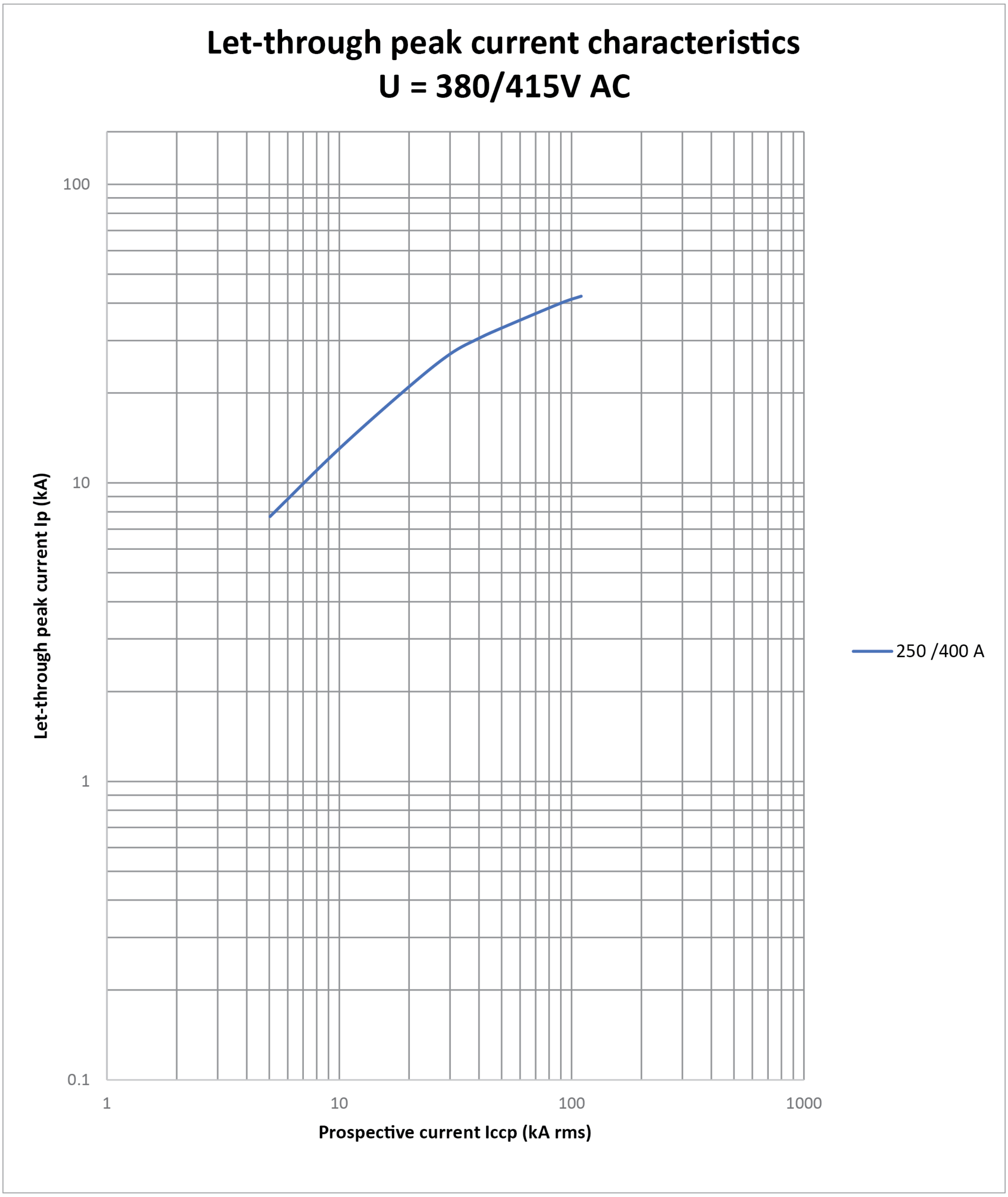
Annex D – Peak Let Through Curves

P250_SE



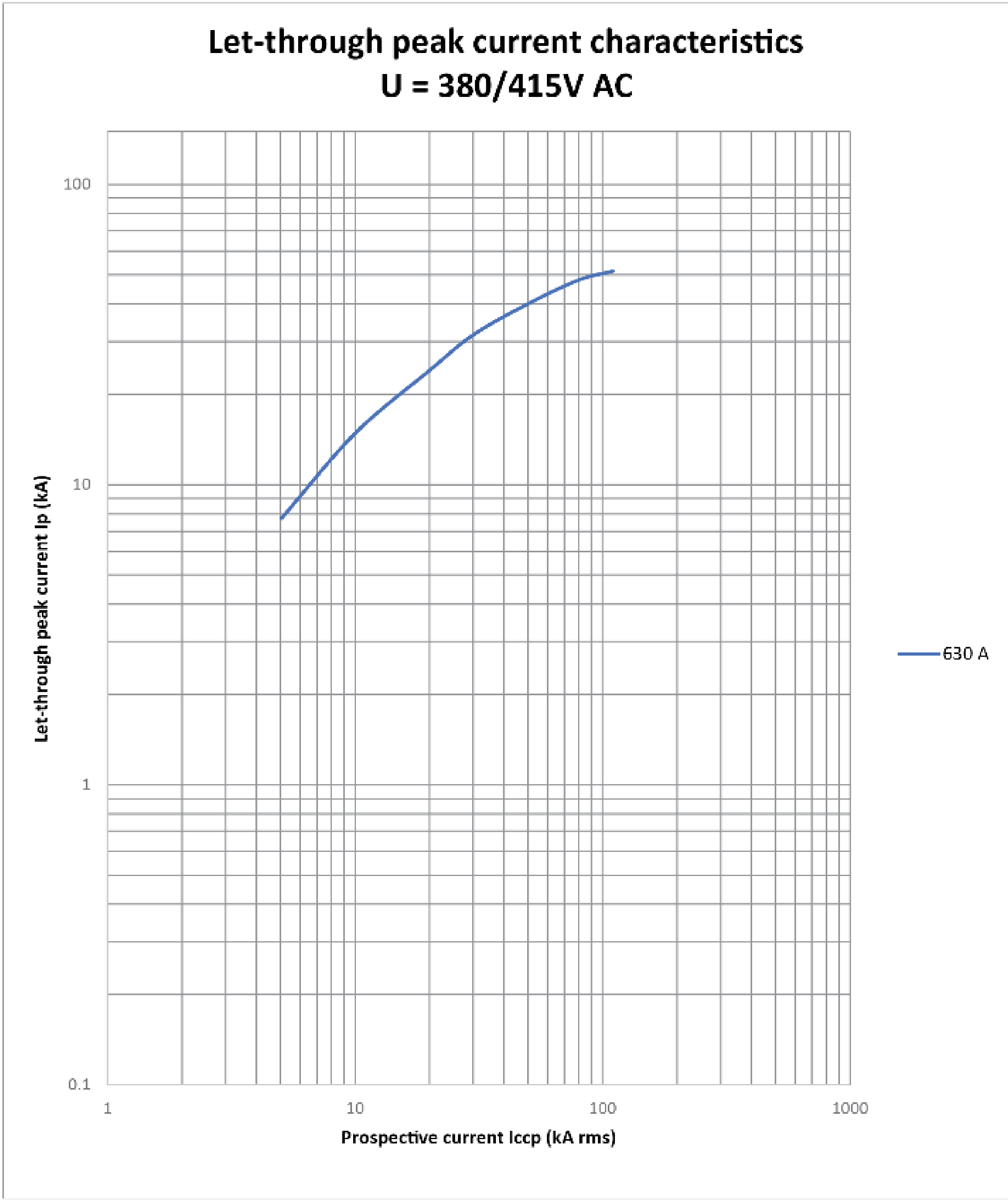
Annex D – Peak Let Through Curves

P400_SE



Annex D – Peak Let Through Curves

P630_SE



Annex E – Watts Loss

Impedance Watts Loss

Frame	Rating In (A)	Impedance per pole (mΩ)	Watts Loss per pole Based from Impedance (W)	Pole numbers	Watts Loss per product Based from Impedance (W)
P160_SE	40	0.35	0.6	3/4P	1.8
	100	0.35	3.5		10.5
	160	0.35	9.0		27
P250_SE	40	0.24	0.4	3/4P	1.2
	100	0.24	2.4		7.2
	160	0.24	6.1		18.3
	250	0.24	15.0		45
P400_SE	250	0.18	11.1	3/4P	33.3
	400	0.18	28.4		85.2
P630_SE	630	0.13	52.0	3/4P	156

Resistance Watts Loss

Frame	Rating In (A)	Resistance per pole (mΩ)	Watts Loss per pole Based from Resistance (W)	Pole numbers	Watts Loss per product Based from Resistance (W)
P160_SE	40	0.144	0.23	3/4P	0.69
	100	0.144	1.44		4.32
	160	0.144	3.69		11.07
P250_SE	40	0.127	0.2032	3/4P	0.6096
	100	0.127	1.27		3.81
	160	0.127	3.2512		9.7536
	250	0.127	7.9375		23.8125
P400_SE	250	0.128	8.0	3/4P	24
	400	0.128	20.5		61.5
P630_SE	630	0.064	25.4	3/4P	76.2

Annex F – Rated Temperature Tables

Maximum setting of the Ir at the nominated current at the specified ambient.
Values in bold are the maximum value for I_r, different combinations of I_{r1} and I_{r2} can be set if the combined settings are not greater than the I_r value advised.

P160 Electronic

MCCB Type	Connection Type	Trip Unit Type	Trip Unit Rating	Setting	Rated Current (A)						
					40⁰C	45⁰C	50⁰C	55⁰C	60⁰C	65⁰C	70⁰C
P160	Front Conn. Rear Conn. Plug-in Conn.	SE	40A	I_r (A)	**40**	**40**	**40**	**40**	**40**	**40**	**40**
			100A		**100**	**100**	**100**	**100**	**100**	**100**	**100**
	Front Conn. Rear Conn.		160A		**160**	**160**	**160**	**160**	**160**	**156**	**145**
	Plug-in Conn.				**125**	**125**	**125**	**125**	**125**	**120**	**112**

P250 Electronic

MCCB Type	Connection Type	Trip Unit Type	Trip Unit Rating	Setting	Rated Current (A)						
					40⁰C	45⁰C	50⁰C	55⁰C	60⁰C	65⁰C	70⁰C
P250	Front Conn. Rear Conn. Plug-in Conn.	SE	40A	I_r (A)	**40**	**40**	**40**	**40**	**40**	**40**	**40**
			100A		**100**	**100**	**100**	**100**	**100**	**100**	**100**
	Front Conn. Rear Conn.		160A		**160**	**160**	**160**	**160**	**160**	**160**	**155**
	Plug-in Conn.				**160**	**160**	**160**	**160**	**160**	**160**	**149**
	Front Conn. Rear Conn.		250A		**250**	**250**	**250**	**250**	**242**	**225**	**209**
	Plug-in Conn.				**250**	**250**	**250**	**243**	**228**	**214**	**198**

P400 Electronic

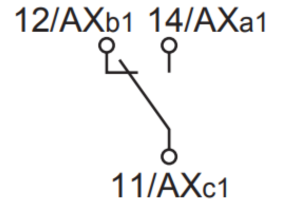
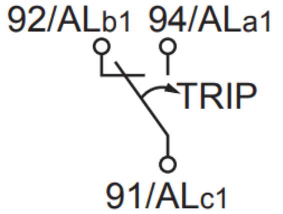
MCCB Type	Connection Type	Trip Unit Type	Trip Unit Rating	Setting	Rated Current (A)						
					40⁰C	45⁰C	50⁰C	55⁰C	60⁰C	65⁰C	70⁰C
P400	Front Conn. Rear Conn. Plug-in Conn.	SE	250A	I_r (A)	**250**	**250**	**250**	**250**	**250**	**250**	**250**
			400A	I_r (A)	**400**	**400**	**400**	**400**	**400**	**360**	**312**

P630 Electronic

MCCB Type	Connection Type	Trip Unit Type	Trip Unit Rating	Setting	Rated Current (A)								
					30⁰C	35⁰C	40⁰C	45⁰C	50⁰C	55⁰C	60⁰C	65⁰C	70⁰C
P630	Front Conn. Rear Conn.	SE	630A	I_r (A)	**630**	**630**	**630**	**630**	**630**	**615**	**560**	**497**	**434**
	Plug-in Conn.			I_r (A)	**570**	**570**	**570**	**570**	**546**	**500**	**455**	**400**	**372**

Annex G – Wiring Diagrams & Terminal Designations

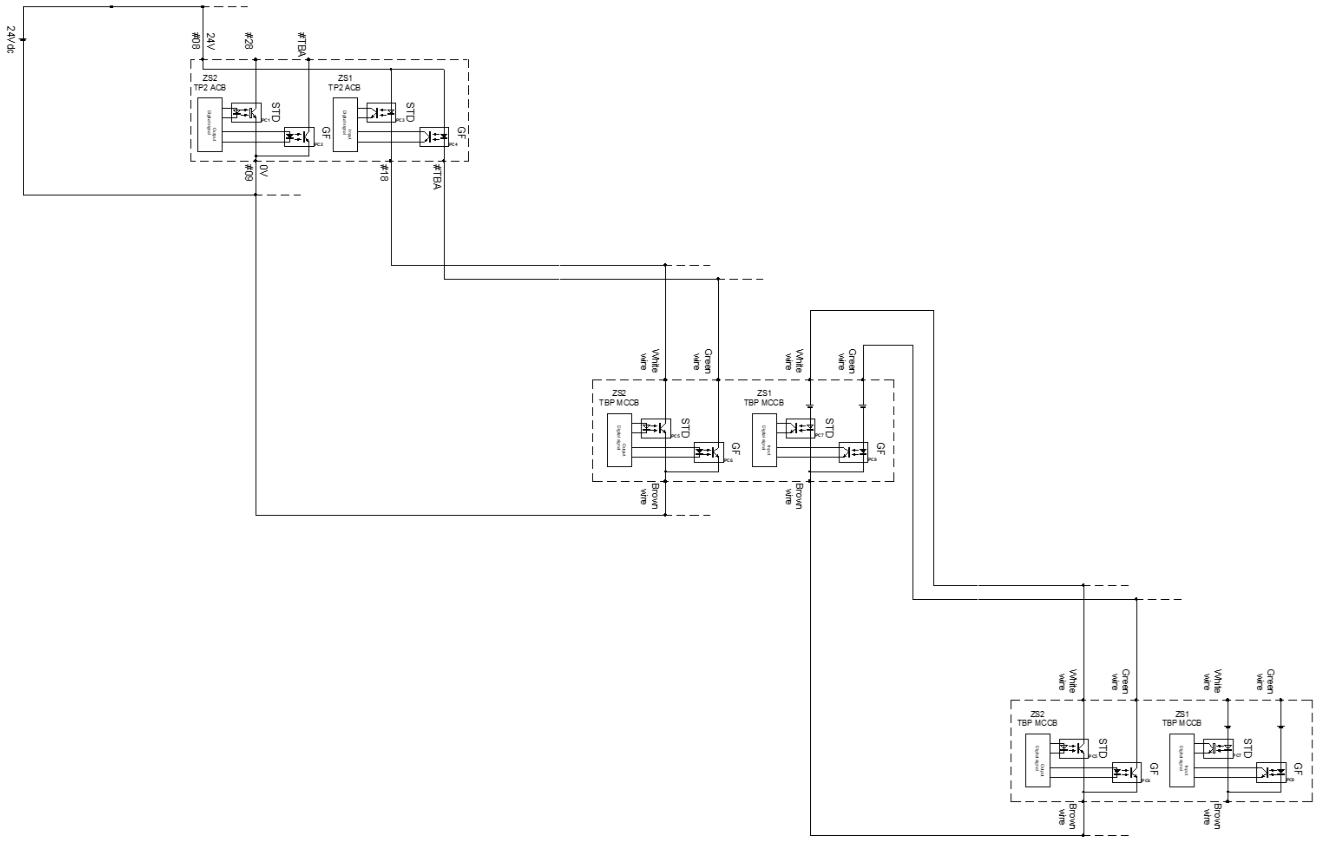
Internal Accessories

Accessory	Terminal Designations	Notes		
Auxiliary		MCCB Status "Closed" 11/AXc-14/AXa "Closed" 11/AXc-12/AXb "Open"	MCCB Status "Open" 11/AXc-14/AXa "Open" 11/AXc-12/AXb "Closed"	MCCB Status "TRIP" 11/AXc-14/AXa "Open" 11/AXc-12/AXb "Closed"
Alarm		MCCB Status "Closed" 91/ALc-94/ALa "Open" 91/ALc-92/ALb "Closed"	MCCB Status "Open" 91/ALc-94/ALa "Open" 91/ALc-92/ALb "Closed"	MCCB Status "TRIP" 91/ALc-94/ALa "Closed" 91/ALc-92/ALb "Open"
Shunt		Shunt trips are continuous rated and do not make use of an anti-burn out switch.		
UVT (AC)				
UVT (DC)				

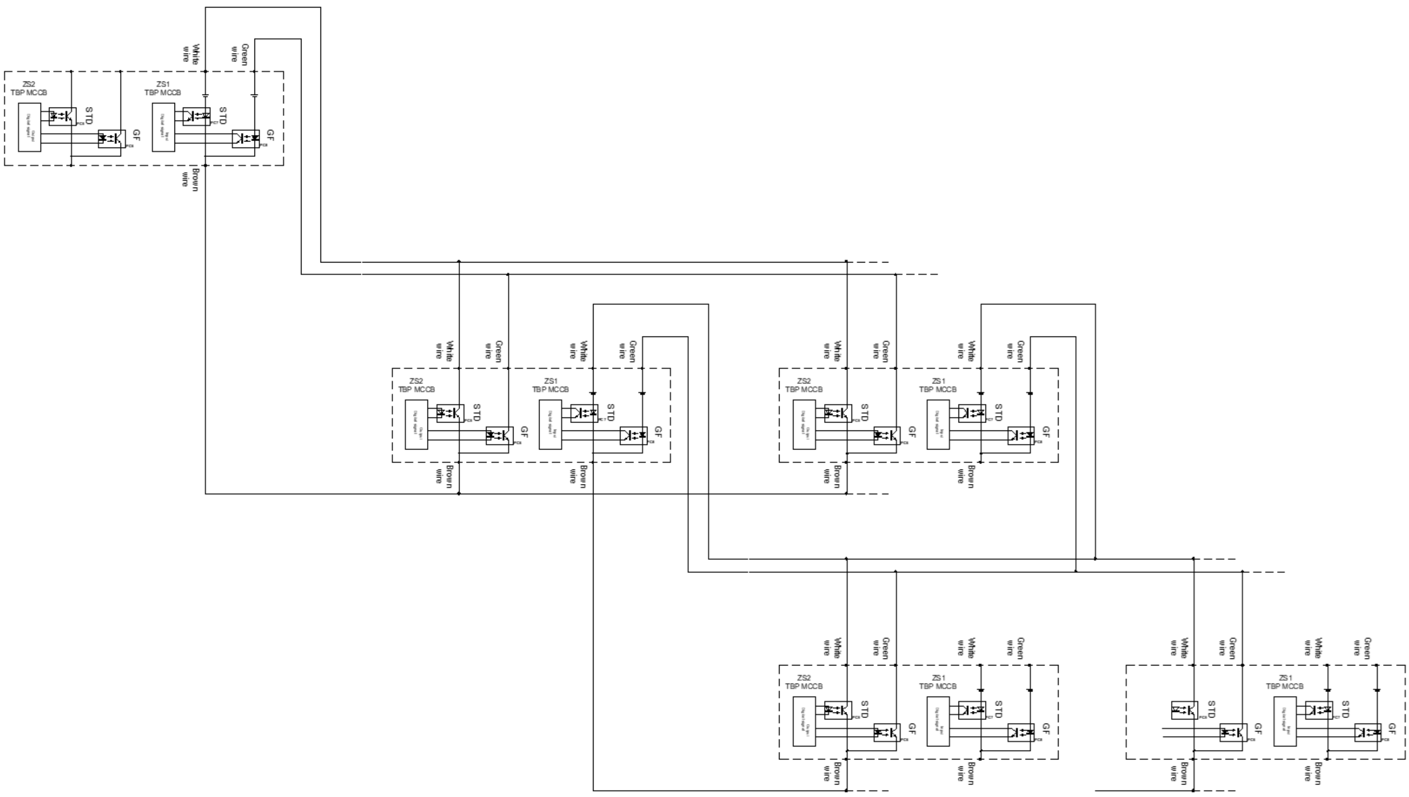
Annex G – Wiring Diagrams & Terminal Designations

ZSI Wiring

ACBs Upstream



MCCBs Upstream



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