DUAL / CT AND AUXILIARY VOLTAGE (V_X) POWERED OVERCURRENT RELAY

MiCOM P116

Firmware 1C

Technical Manual

(P116_EN_M_A11 v2.7)

(17th November 2013)

Schneider Electric

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

Any agreements, commitments, and legal relationships and any obligations on the part of Schneider Electric Energy including settlements of warranties, result solely from the applicable purchase contract, which is not affected by the contents of the technical manual.

This device MUST NOT be modified. If any modification is made without the express permission of Schneider Electric Energy, it will invalidate the warranty, and may render the product unsafe.

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SAFETY SECTION

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STANDARD SAFETY STATEMENTS AND EXTERNAL LABEL INFORMATION FOR SCHNEIDER ELECTRIC ENERGY T&D EQUIPMENT

1. INTRODUCTION

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

The technical data in this Safety Section is typical only, see the technical data section of the relevant equipment documentation for data specific to a particular item of equipment.

Before carrying out any work on the equipment the user should be familiar with the contents of this Safety Section and the ratings on the equipment's rating label.

Reference should be made to the external connection diagram before the equipment is installed, commissioned or serviced.

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

2. HEALTH AND SAFETY

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

It is assumed that everyone who will be involved with the equipment is familiar with the contents of this Safety Section, or the Safety Guide (SFTY/4L M).

When electrical equipment is in operation, dangerous voltages are present in certain parts of the equipment. Failure to observe warning notices, incorrect use, or improper use may endanger personnel and equipment and also cause personal injury or physical damage.

Before working in the terminal strip area, the equipment must be isolated.

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

Qualified personnel are individuals who:

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

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

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3. SYMBOLS AND LABELS ON THE EQUIPMENT

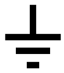
For safety reasons the following symbols which may be used on the equipment or referred to in the equipment documentation, should be understood before it is installed or commissioned.

3.1 Symbols

Caution: refer to equipment documentation

Caution: risk of electric shock

Protective Conductor (*Earth) terminal



Functional/Protective Conductor (*Earth) terminal

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

*NOTE: THE TERM EARTH USED THROUGHOUT THIS TECHNICAL MANUAL IS THE DIRECT EQUIVALENT OF THE NORTH AMERICAN TERM GROUND.

3.2 Labels

See Safety Guide (SFTY/4L M) for typical equipment labeling information.

4. INSTALLING, COMMISSIONING AND SERVICING

Equipment connections

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

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

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

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

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

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

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

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

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

Protection Class I Equipment

- Before energizing the equipment it must be earthed using the protective conductor terminal, if provided, or the appropriate termination of the supply plug in the case of plug connected equipment.

- The protective conductor (earth) connection must not be removed since the protection against electric shock provided by the equipment would be lost.
- When the protective (earth) conductor terminal (PCT) is also used to terminate cable screens, etc., it is essential that the integrity of the protective (earth) conductor be checked after the addition or removal of such functional earth connections. For M4 stud PCTs the integrity of the protective (earth) connections should be ensured by use of a locknut or similar.

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

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

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

Before energizing the equipment, the following should be checked:

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

Accidental touching of exposed terminals

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

Equipment use

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

Removal of the equipment front panel/cover

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

UL and CSA listed or recognized equipment

To maintain UL and CSA approvals the equipment should be installed using UL and/or CSA listed or recognized parts of the following type: connection cables, protective fuses/fuse holders or circuit breakers, insulation crimp terminals, and replacement internal battery, as specified in the equipment documentation.

Equipment operating conditions

The equipment should be operated within the specified electrical and environmental limits.

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Current transformer circuits

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

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

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

External resistors, including voltage dependent resistors (VDRs)

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

Battery replacement

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

Insulation and dielectric strength testing

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

Insertion of modules and pcb cards

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

Insertion and withdrawal of extender cards

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

External test blocks and test plugs

Great care should be taken when using external test blocks and test plugs hazardous voltages may be accessible when using these. *CT shorting links must be in place before the insertion or removal of test plugs, to avoid potentially lethal voltages.

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

Fiber-optic communication

Where fiber-optic communication devices are fitted, these should not be viewed directly. Optical power meters should be used to determine the operation or signal level of the device.

Cleaning

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

Maintenance and installation

For safety reason, no work must be carried out on the P116 until all power sources to the unit have been disconnected

5. DE-COMMISSIONING AND DISPOSAL

De-commissioning

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

Disposal

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

6. TECHNICAL SPECIFICATIONS FOR SAFETY

Where UL Listing of the equipment is not required the recommended fuse type is a high rupture capacity (HRC) type with a maximum current rating of 16 Amps and a minimum DC rating of 250 Vdc, for example the Red Spot NIT or TIA type.

To maintain UL and CUL Listing of the equipment for North America a UL Listed fuse shall be used. The UL Listed type shall be a Class J time delay fuse, with a maximum current rating of 15 A and a minimum DC rating of 250 Vdc, for example type AJT15.

The protective fuse should be located as close to the unit as possible.

6.1 Protective fuse rating

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

6.2 Protective class

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

6.3 Installation category

IEC 60255-27: 2005	Installation category III (Overvoltage Category III):
EN 60255-27: 2005	Distribution level, fixed installation.
	Equipment in this category is qualification tested at 5 kV peak, 1.2/50 µs, 500 Ω, 0.5 J, between all supply circuits and earth and also between independent circuits.

6.4 Environment

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

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

IEC 60255-27:2005

EN 60255-27: 2005

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INTRODUCTION

Date:	**17th November 2013**
Hardware Suffix:	**A**
Software Version:	**1C**
Connection Diagrams:	**10P11602**

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FIGURES

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1. MiCOM DOCUMENTATION STRUCTURE

The manual provides a functional and technical description of the MiCOM protection relay and a comprehensive set of instructions for the relay's use and application.

The section contents are summarized below:

P116/EN IT Introduction

A guide to the MiCOM range of relays and the documentation structure. Also a general functional overview of the relay and brief application summary are given.

P116/EN TD Technical Data

Technical data including setting ranges, accuracy limits, recommended operating conditions, ratings and performance data. Compliance with norms and international standards is quoted where appropriate.

P116/EN GS Getting Started

A guide to the different user interfaces of the protection relay describing how to start using it. This section provides detailed information regarding the communication interfaces of the relay, including a detailed description of how to access the settings database stored within the relay.

P116/EN ST Settings

List of all relay settings, including ranges, step sizes and defaults, together with a brief explanation of each setting.

P116/EN OP Operation

A comprehensive and detailed functional description of all protection and non-protection functions.

P116/EN AP Application Notes

This section includes a description of common power system applications of the relay, calculation of suitable settings, some typical worked examples, and how to apply the settings to the relay.

P116/EN MR Measurements and Recording

Detailed description of the relays recording and measurements functions.

P116/EN CM Commissioning

Instructions on how to commission the relay, comprising checks on the calibration and functionality of the relay.

P116/EN MT Maintenance

A general maintenance policy for the relay is outlined.

P116/EN TS Troubleshooting

Advice on how to recognize failure modes and the recommended course of action. Includes guidance on whom at SCHNEIDER ELECTRIC ENERGY to contact for advice.

P116/EN SG Symbols and Glossary

List of common technical abbreviations found within the product documentation.

P116/EN IN Installation

Recommendations on unpacking, handling, inspection and storage of the relay. A guide to the mechanical and electrical installation of the relay is provided, incorporating earthing recommendations. All external wiring connections to the relay are indicated.

P116/EN CM Communication Database

This section provides an overview regarding the SCADA communication interfaces of the relay.

P116/EN VH Firmware and Service Manual Version History

History of all hardware and software releases for the product.

2. INTRODUCTION TO MiCOM

MiCOM is a comprehensive solution capable of meeting all electricity supply requirements. It comprises a range of components, systems and services from SCHNEIDER ELECTRIC ENERGY T&D.

Central to the MiCOM concept is flexibility.

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

The components within MiCOM are:

– P range protection relays;

– C range control products;

– M range measurement products for accurate metering and monitoring;

– S range versatile PC support and substation control packages.

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

For up-to-date information on any MiCOM product, visit our website:

www.schneider-electric.com

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3. PRODUCT SCOPE

The P116 is a 3 phase and earth fault non-directional overcurrent CT-powered and/or auxiliary voltage-powered protection relay which has been designed to control, protect and monitor industrial and distribution installations. Refer to section 3.2.

The scope of P116 applications includes:

- industry and distribution MV and HV networks,
- back-up protection in HV applications.

The relay protects one, two or three-phase applications against earth fault and phase-to-phase short-circuit faults. It was especially developed for compact MV switchboards with circuit breakers. Thanks to a built-in USB port, disturbance records, fault records, events and relay settings can be downloaded to a local PC.

Settings for the protection elements are entered using the front panel keyboard and can be checked on the local display or using the MiCOM S1 or S1 Studio setting software.

3.1 Key for the manual

The P116 relays are available in two base hardware versions: Model A and Model L (light). Each model has several hardware versions offering different numbers of flag indicator outputs, case types, rated currents (1 A or 5 A), auxiliary voltage ranges, etc.

Model L is CT powering only. Model A is dual powered.

Please refer to the commercial publication for further information on the product features and application arrangements.

3.2 Functional overview

The P116 relay offers a wide variety of protection functions.
The protection features are summarized below:

PROTECTION FUNCTIONS OVERVIEW	
50/51	Three non-directional overcurrent stages are provided for each phase. The first (I>) and the second stage (I>>) may be set to Inverse Definite Minimum Time (IDMT) or Definite Time (DT); the third stage (I>>>) may be set to DT only.
50N/51N	Three non-directional overcurrent stages are provided. The first stage (IN_1) may be set to Inverse Definite Minimum Time (IDMT) or Definite Time (DT); the second and third stage (IN>> and IN_3) may be set to DT only.
SOTF (Model A)	Switch On To Fault Phase Overcurrent Stage.
BOL (Model A)	The Blocked Overcurrent Logic is available for each protection element. This consists of a start signal and protection block timer that can for instance be used to implement busbar blocking schemes.
SOL (Model A)	The Selective Overcurrent Logic provides the capability of temporarily altering (i.e. lengthen) the time-delay settings for stages 2 and 3 of the phase overcurrent and earth fault elements.
CLP (Model A)	Cold Load Pick-up may be used to transiently raise the settings, for both overcurrent and earth fault protection elements, following closure of the circuit breaker.
46 (Model A)	One stage is provided to be used as backup protection for both phase-to-earth and phase-to-phase faults.
49	RMS thermal overload (single time constant) protection with thermal characteristics, suitable for both cables and transformers. Both Alarm and trip stages are provided.
37	A phase undercurrent element is available.

PROTECTION FUNCTIONS OVERVIEW	
(Model A)	
46BC (Model A)	Broken conductor (open jumper) used to detect open circuit faults using the I2/I1 ratio.
50BF	Circuit breaker failure element with undercurrent detection.
79 (Model A)	Four-shot three-pole auto-recloser with external initiation and sequence coordination capability.
	Second harmonic blocking that can be associated with all the protection elements.

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The P116 also offers the following relay management functions in addition to the functions listed above.

- Up to 20 Fault Records
- 5 Instantaneous Records, 5 Alarm Records, 200 Events available via the USB port or rear optional communication port RS485 (when the available space is exhausted, the oldest record is automatically overwritten by the new one) (Model A)
- Readout of actual settings available via the USB port or rear communication port RS485 (Model A)
- CB Control via a rear communication port (RS485), the front panel menu or dedicated binary input (Model A)
- Model A: 6 binary inputs; Model L: no binary inputs
- Model A: 7 output contacts; Model L: 2 output contacts
- 2 alternative setting groups (Model A)
- 4 timers (AUX) (Model A)
- Energy output for the CB low energy coil
- Energy output for flag indicator (Model A)
- 3 phase current inputs
- Earth fault current input
- Model A: Up to 5 internal flag indicators; Model L: 1 internal flag indicator
- Counters (Model A)
- Circuit breaker control, status & condition monitoring (Model A)
- Trip circuit and coil supervision (Model A)
- Comprehensive disturbance recording (waveform capture)
- Programmable allocation of digital inputs (Model A) and outputs
- Control inputs (Model A)
- Multi-level password protection

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Application overview

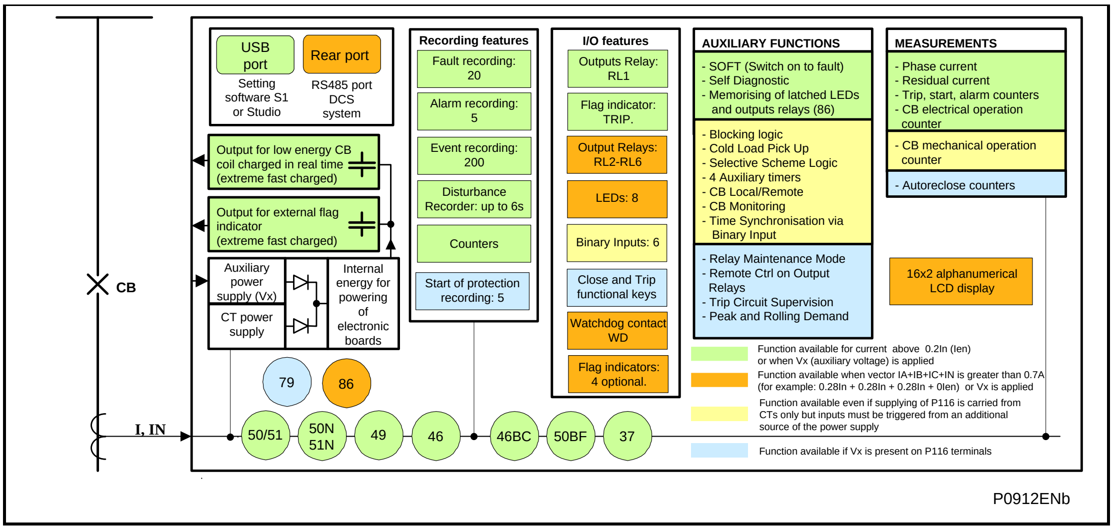

Figure 1: Functional diagram of the P116A.. with all ordering options included

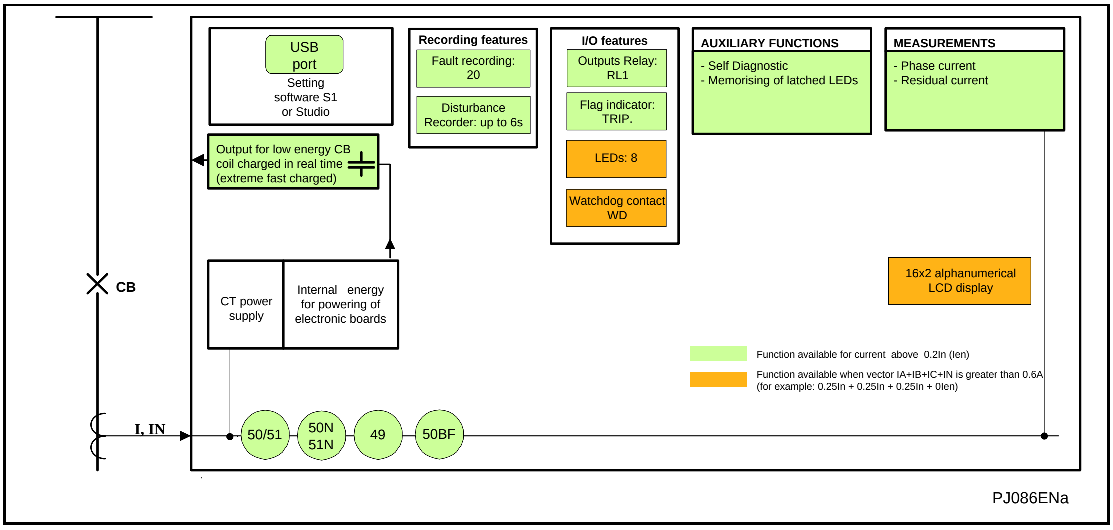

Figure 2: Functional diagram of the P116L… with all ordering options included

3.3 Ordering options Information (Required with Order)

P116 CT-Powered Overcurrent	P116		1	N		N						1	1	1	
Three Phase and Earth Fault Overcurrent Protection, 4 CT inputs, 8 LEDs, USB port, 2x16 LCD display, **Universal Advanced Trip Energy Output for CB coil/striker: 12VDC-24VDC/0.1J or for MiTOP.**															
Model															
Model A: (Dual Powered; 6 Binary Inputs; 7 Outputs Contacts)		A													
Model L: (CT Powered; 0 Binary Inputs; 2 Outputs Contacts)		L													
Earth current input															
Ion = 1 A; 0.002 – 1 Ion					1										
Ion = 1 A; 0.01 – 8 Ion					2										
Ion = 1 A; 0.1 – 40 Ion					3										
Ion = 5 A; 0.002 – 1 Ion					4										
Ion = 5 A; 0.01 – 8 Ion					5										
Ion = 5 A; 0.1 – 40 Ion					6										
Phase current inputs															
In=1A; 0.1 – 40 In							1								
In=5A; 0.1 – 40 In							2								
Auxiliary Supply															
Model L: CT Powered only (Without auxiliary voltage supply)								3							
Model A: Dual Powered (CT and Vx Auxiliary Voltage); Vx=24-60Vac/dc								4							
Model A: Dual Powered (CT and Vx Auxiliary Voltage); Vx=60-240Vac/60-250Vdc								5							
Type of binary inputs; Auxiliary voltage range for binary inputs															
Model L: Without Binary Inputs									N						
Model A: Binary Inputs: 24-240Vac or 24-250Vdc (standard)									1						
Model A: DC Binary Inputs with settable switching thresholds: 110Vdc/129Vdc/220Vdc									2						
Rear communication port / protocol															
Model L: Without RS485										N					
Model A: RS485 with settable switching between Modbus or IEC103 via HMI										1					
Electro-magnetic flags on the front panel															
Model L, A: Standard: A one TRIP flag indicator											1				
Model A: Additional 4 electro-magnetic flags (total: 5 flags)											5				
Language															
Language: English/ German/ French/ Spanish/ Portuguese/ Russian/ Turkish/ Regional													1		
Case (Mounting solution)															
Basic flush mounting case															N
Basic flush mounting case with the cassette for withdraw-able solution															W
Basic flush mounting case with the cassette for withdraw-able solution and the front seal to prevent unauthorised access															P
Basic flush mounting case with the cassette for wall mounting solution															S

MiCOM P116 ordering variants available in SE International Distribution Center (IDC)

Type	Catalog No.	Type	Catalog No.
P116A1N1N15115111N	REL10200	P116A1N1N15115111W	REL10210
P116A1N1N14115111N	REL10201	P116A1N1N14115111W	REL10211
P116A1N2N15115111N	REL10202	P116A1N2N15115111W	REL10212
P116A1N2N14115111N	REL10203	P116A1N2N14115111W	REL10213
P116A1N5N25115111N	REL10204	P116A1N5N25115111W	REL10214
P116A1N5N24115111N	REL10205	P116A1N5N24115111W	REL10215

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TD

TECHNICAL DATA

Date:	**17th November 2013**
Hardware Suffix:	**A**
Software Version:	**1C**
Connection Diagrams:	**10P11602**

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CONTENT

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Reference condition for technical data:

Quantity	Reference condition	Test tolerance
Ambient temperature	20°C	±2°C
Atmospheric pressure	86kPa to 106kPa	-
Relative humidity	45 to 75%	-
Frequency	50 Hz or 60 Hz	±0.5%
Auxiliary supply	Nominal range	±5%

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1. Mechanical specification

1.1 Case

Design	Flush mounting case (wall optional)
Weight	approx. 3.1 kg (with optional cassette: approx. 4.2 kg)

1.2 Terminals

AC Current Input Terminals

Located on heavy duty (black) terminal block:

Threaded M4 terminals, for ring lug connection.

CT inputs have integral safety shorting, upon removal of the terminal block.

General Input/Output Terminals

Flush mounting case (basic case or flush mounting cassette):

For power supply, binary inputs, contact output contacts and COM for rear communications.

Threaded M3 screw-type plug-in terminals (MSTB 2.5/xx-ST-5.08)

(i) 0.2 - 4 mm^2 single-core

(ii) 0.2 - 2.5 mm^2 finely stranded

Wall mounting cassette:

For power supply, binary inputs, contact output contacts and COM for rear communications.

Threaded M2.5 screw-type plug-in terminals (FRONT-MSTB 2.5/xx-STF-5.08), with wire protection for conductor cross-section

(i) 0.2 – 2.5 mm^2 single-core

(ii) 0.2 - 2.5 mm^2 finely stranded

Local communication

USB port

Cable Type: USB 2.0
Connectors:
PC: type A male
P116: type mini B 5-pin male
USB Cable: minimum 1P*28AWG/2C*24AWG, max : 2m

Rear Communications Port

EIA(RS)485 signal levels, two wire
Connections located on general purpose block (see above)
For screened twisted pair cable, distance to be bridged: multi-endpoint link: max. 100 m
Isolation to SELV level.

2. RATINGS

2.1 Power Supply

Nominal auxiliary voltage Vx (ordering options)	24 – 60 Vdc/ 24 – 60 Vac (50/60 Hz) 60 – 250 Vdc/ 60 – 240 Vac (50/60 Hz)
Operating range	19 – 72 V (dc), 19 – 66 V (ac) 48 – 300 V (dc), 48 – 264 V (ac)
Tolerable AC ripple	Up to 12% for a dc supply, per IEC 60255-11: 2008

Nominal Burden Auxiliary Power Supply Vx

Note: (i) Initial position: no output nor LED energized.
(ii) Active position: all outputs and LEDs energized.

For AC max. approx.:

Vx range	Vx	S	
	V	VA	
		Initial position	Active position
24 – 60 Vac	24	3.1	5.5
	48	2.8	6.0
60 – 240 Vac	60	2.7	5.2
	100/110	3.1	5.7
	220/230	5.1	7.4
	264	6.1	8.4

For dc Vx voltage max. approx:

Vx range	P	
	W	
	Initial position	Active position
24 – 60 Vdc	1.5	3.7
60 – 240 Vdc	1.5	3.7

Auxiliary Power Supply Voltage Interruption (without powering by CT)	IEC 60255-11: 2008	Within the auxiliary supply range: - 48-250Vdc, the relay will withstand a 50 ms; - 24-48Vdc, the relay will withstand a 20 ms; Interruption of the DC auxiliary supply without de-energizing.
	EN 61000-4-11: 1997	Within the auxiliary supply range: - 48-250Vac, the relay will withstand a 50 ms; - 24-48Vac, the relay will withstand a 20 ms; Interruption of the AC auxiliary supply without de-energizing.
Power-up Time for Auxiliary Supply Voltage only (not includes charging of the energy outputs)		Time to power up via auxiliary supply only (not powered by CT): < 0.04 s

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2.2 Nominal Frequency for Current Inputs

Nominal frequency	50 or 60 Hz (selectable in P116 menu)

2.3 Current Inputs

Phase current inputs:

Nominal current (In)	1 or 5 A (ordering option)
RMS measurement in range	40 Hz – 1 kHz
Fundamental harmonic measurement in range	40 Hz – 70 Hz
Operating range	0.1 – 40 In
Nominal Burden at In (without tripping condition)	< 2.3 VA (for In = 1 A) < 2.1 VA (for In = 5 A)
Rp at 30In (Impedance of relay phase current input at 30In and tripping condition)	0.240 Ohms @ 30 x In (for In = 1 A) (see point 2.5) 0.016 Ohms @ 30 x In (for In = 5 A) (see point 2.5)
Thermal withstand	1 s @ 100 x rated current (In) 2 s @ 40 x rated current (In) 10 s @ 30 x rated current (In) continuous @ 3 x rated current (In)
Connection	Refer to section 12 of P116 Installation chapter (P116/EN IN)
Current transformer requirements	Detailed information and CT requirements are given in the Application chapter (P116/EN AP)

Earth current inputs:

Nominal current (Ien):	1 or 5 A (ordering option)
Fundamental harmonic measurement in range	40 Hz – 70 Hz
Operating range	Selected at order (Cortec)
Nominal Burden at In (without tripping condition)	< 2.3 VA (for Ien = 1 A) < 2.1 VA (for Ien = 5 A)
Rn at 30In (Impedance of relay neutral current input at 30In and tripping condition)	0.240 Ohms @ 30 x In (for In = 1 A) (see point 2.5) 0.016 Ohms @ 30 x In (for In = 5 A) (see point 2.5)
Thermal withstand	1 s @ 100 x rated current (Ien) 2 s @ 40 x rated current (Ien) 10 s @ 30 x rated current (Ien) continuous @ 3 x rated current (Ien)
Connection	Refer to section 12 of P116 Installation chapter (P116/EN IN)
Current transformer requirements	Detailed information and CT requirements are given in the Application chapter (P116/EN AP)

2.4 Minimum Level of Current Required for Relay Powering

Phase current / Earth current range which gives reduced functionality: Outputs relays: RL1 only, Energy Outputs: Sensitive Tripping Coil and External Flag Indicator Flags: "Trip" flag only. Note: LCD, RL2-RL6, WD, LEDs and RS485, 2-5 Flags are inactive up to full functionality stage (see below)	at least in a one phase or earth[1)] > 0.2 In and $\lvert \underline{I}_A - \underline{I}_B \rvert + \lvert \underline{I}_C + \underline{I}_N^{1)} \rvert \leq 0.65$ In
Full functionality of P116 powered from current only	at least in a one phase or earth[1)] > 0.65 In or $\lvert \underline{I}_A - \underline{I}_B \rvert + \lvert \underline{I}_C + \underline{I}_N^{1)} \rvert > 0.65$ In

Note: 1. Depending on the terminal connections and configuration in menu, the earth fault input supplies the P116 (connection to terminals A7 and A8) or does not supply the P116 (connection to terminals A9 and A10) (refer to chapter: P116/EN IN)

2. If the vector sum of the currents that power the P116 is below 0.65 In (example: 2 phase: A-B where $\underline{I}_A = -\underline{I}_B$, the sum equal to 0.65In $=\underline{I}_A$:0.325In - $\underline{I}_B$: 0.325In), the LED indications, Electromagnetic Flag indicators (Front Panel): 2 - 5, the display and the RS485 comms. are switched off and RL2, RL3, RL4, RL5 and RL6, WD are not energized. Depending on the setting, the earth current is included or not in the above sum (refer to Settings chapter: P116/EN ST).

[1)] – Powering of P116 from earth input is selectable by using proper terminals (A7-8: with powering or A9-10: without powering) and additionally by configuration in P116 menu (GLOBAL SETTINGS/CT RATIO/IN connection). Detailed information is given in the Setting chapter (P116/EN ST) and Installation chapter (P116/EN IN).

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2.5 Phase and Earth Current Transformers Consumption

The P116's current input resistance depends on the value of the current. The table below shows the resistance for a single current input of the P116: In = 1 A / 5 A. If e/f input supply P116, for phase-earth fault analysis it is necessary to take into account a double value of the resistance, as shown in Table below.

P116 current input resistance:

Current	Imput resistance (Rp) for single current input in tripping condition							
	CT powering only (no Vx auxiliary supply)				With auxiliary supply (Vx)			
	In (Ien) = 1 A		In (Ien) = 5 A		In (Ien) = 1 A		In (Ien) = 5 A	
	Rp	Vp	Rp	Vp	Rp	Vp	Rp	Vp
In (Ien)	Ω	V	Ω	V	Ω	V	Ω	V
0.04	n/a	n/a	n/a	n/a	71.656	2.87	4.687	0.94
0.06	n/a	n/a	n/a	n/a	77.306	4.64	3.994	1.20
0.08	n/a	n/a	n/a	n/a	61.648	4.93	2.436	0.98
0.10	n/a	n/a	n/a	n/a	34.815	3.48	1.820	0.91
0.12	n/a	n/a	n/a	n/a	24.108	2.89	1.347	0.81
0.14	n/a	n/a	n/a	n/a	13.452	1.88	0.990	0.69
0.16	n/a	n/a	n/a	n/a	12.150	1.94	1.026	0.82
0.18	n/a	n/a	n/a	n/a	8.937	1,610	0.346	0.31
0.20	31.063	6.21	1.219	1.22	7.373	1.47	0.313	0.31
0.22	27.683	6.09	1.074	1.18	6.376	1.40	0.247	0.27
0.24	24.395	5.85	0.938	1.13	4.552	1.09	0.177	0.21
0.30	21.82	6.55	0.646	1.00	3.172	0.95	0.118	0.18
0.40	12.274	4.91	0.351	0.70	1.508	0.60	0.074	0.15
0.50	7.629	3.81	0.225	0.56	0.949	0.47	0.047	0.12
0.60	5.320	3.19	0.250	0.75	0.902	0.54	0.036	0.11
0.70	5.833	4.08	0.186	0.65	0.679	0.48	0.033	0.12
0.80	4.440	3.55	0.148	0.59	0.595	0.48	0.029	0.12
0.90	3.564	3.21	0.123	0.55	0.513	0.46	0.028	0.13
1.0	2.898	2.90	0.099	0.49	0.450	0.45	0.026	0.13
1.2	1.852	2.22	0.074	0.44	0.366	0.44	0.021	0.13
1.4	1.415	1.98	0.062	0.44	0.321	0.45	0.021	0.15
1.6	1.123	1.80	0.045	0.36	0.305	0.49	0.020	0.16
1.8	0.940	1.69	0.040	0.36	0.273	0.49	0.018	0.16
2	0.791	1,58	0.035	0.35	0.261	0.52	0.018	0.18
3	0.475	1.43	0.024	0.36	0.240	0.72	0.018	0.28
4	0.328	1.31	0.019	0.38	0.235	0.94	0.017	0.34
5	0.317	1.58	0.019	0.47	0.238	1.19	0.016	0.41
10	0.250	2.50	0.016	0.81	0.235	2.35	0.015	0.75
15	0.240	3.60	0.016	1.20	0.235	3.53	0.015	1.11
20	0.235	4.70	0.016	1.57	0.234	4.67	0.015	1.45
25	0.238	5.94	0.016	1.96	0.237	5.94	0.015	1.82
30	0.241	7.23	0.016	2.36	0.240	7.19	0.015	2.19

Detailed information and CT requirements are given in the Application chapter (P116/EN AP)

2.6 Binary Inputs

Binary inputs type: Independent optically isolated inputs

<table>
<tr><th rowspan="2">Ordering Code</th><th rowspan="2">Setting in menu</th><th rowspan="2">Filtering time</th><th colspan="6">Binary Inputs</th></tr>
<tr><th>Nominal Voltage range</th><th>Voltage operating range</th><th>Minimum polarisation voltage</th><th>Maximum polarisation current</th><th>Maximum holding current after 2 ms</th><th>Maximum continuous withstand</th></tr>
<tr><td rowspan="3">1</td><td>dc</td><td>5 ms</td><td>24 – 250 Vdc</td><td>19.5 – 300 Vdc</td><td>19.5 Vdc</td><td>35 mA</td><td>2.3 mA</td><td>300 Vdc</td></tr>
<tr><td>ac</td><td>7.5 ms
(at 50 Hz)
6.25 ms
(at 60 Hz)</td><td>24 – 240 Vac</td><td>19.5 – 264 Vac</td><td>19.5 Vac</td><td>35 mA</td><td>20 mA
(see table below)</td><td>264 Vac</td></tr>
<tr><td>ENA
(ac/dc)</td><td>15 ms
(at 50 Hz)
12.5 ms
(at 60 Hz)</td><td>24 – 250 Vdc
48 – 240 Vac</td><td>19.5 – 300 Vdc
39.4 – 264 Vac</td><td>19.5 Vdc
39.4 Vac</td><td>35 mA</td><td>dc : 2.3 mA
ac : 20 mA
(see table below)</td><td>300 Vdc
264 Vac</td></tr>
<tr><td rowspan="3">2</td><td>220 Vdc</td><td>5 ms</td><td>220 Vdc</td><td>154 – 264 Vdc</td><td>154 Vdc</td><td colspan="2">3.5 mA (at 220 Vdc)</td><td>264 Vdc</td></tr>
<tr><td>129 Vdc</td><td>5 ms</td><td>129 Vdc</td><td>105 – 145 Vdc</td><td>105 Vdc</td><td colspan="2">3.5 mA (at 129 Vdc)</td><td>264 Vdc</td></tr>
<tr><td>110 Vdc</td><td>5 ms</td><td>110 Vdc</td><td>77 – 132 Vdc</td><td>77 Vdc</td><td colspan="2">3.5 mA (at 110 Vdc)</td><td>264 Vdc</td></tr>
</table>

Binary input energy consumption (holding current)	
Logic input burden for dc, ac, ENA (ordering code 1)	< 18 mA per input (at 24 Vac) RMS value < 15 mA per input (at 48 Vac) RMS value < 10 mA per input (at 110 Vac) RMS value < 8 mA per input (at 127 Vac) RMS value < 2.5 mA per input (at 230 Vac) RMS value <2.3 mA per input (at 24-240 Vdc)
Logic input burden for 220Vdc, 129Vdc, 110Vdc (ordering code 2)	< 3.5 mA per input (at nominal voltage)
Logic input recognition time	As filtering time + 5 ms ± 5 ms

An example of energy consumption calculation:

Ordering Code	Setting in menu	Nominal voltage	Calculation	Burden per one input
1	dc	24 Vdc	24 Vdc x 2.3 mA = 0.055 W	< 0.055 W
		220 Vdc	220 Vdc x 2.3 mA = 0.506 W	< 0.51 W
	ac	24 Vac	24 Vac x 18 mA = 0.372 VA	< 0.4 VA
		230 Vac	230 Vac x 2.5 mA = 0.489 VA	< 0.5 VA
	ENA (ac/dc)	24 Vdc	24 Vdc x 2.3 mA = 0.0552 W	< 0.06 W
		220 Vdc	220 Vdc x 2.3 mA = 0.506 W	< 0.51 W
		48 Vac	48 Vac x 15 mA = 0.595 VA	< 0.6 VA
		230 Vac	230 Vac x 2.5 mA = 0.490 VA	< 0.5 VA
2	110 Vdc	110 Vdc	110 Vdc x 3.5 mA = 0.385 W	<0.39 W
	129 Vdc	129 Vdc	129 Vdc x 3.5 mA = 0.4515 W	<0.45 W
	220 Vdc	220 Vdc	220 Vdc x 3.5 mA = 0.77 W	<0.77 W

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2.7 Output Relay Characteristics

Contact ratings	
Contact relay	Dry contact, Ag Ni
Carry capability	5 A continuous
Rated Voltage	250 Vac
Breaking characteristics for RL1, RL2	
Short-duration capacity	25 A for 3 s
Making capacity	150 A for 30 ms
AC breaking capacity	1250 VA resistive (cos ϕ = unity) 1250 VA inductive (cos ϕ = 0.7)
DC breaking capacity	250 Vdc; 50 W resistive 35 W inductive (L/R = 40 ms)
Operation time	<10 ms
Durability	
Loaded contact	10 000 operations minimum
Unloaded contact	100 000 operations minimum
Breaking characteristics for RL3, RL4	
AC breaking capacity	1000 VA resistive (cos ϕ = unity) 1000 VA inductive (cos ϕ = 0.7)
Short-duration capacity	10 A for 3 s
Making capacity	50 A for 30 ms
DC breaking capacity	250 Vdc; 30 W resistive 15 W inductive (L/R = 40 ms)
Operation time	< 10 ms
Durability	
Loaded contact	10 000 operations minimum
Unloaded contact	100 000 operations minimum
Breaking characteristics for RL5, RL6, RL0 (WD)	
AC breaking capacity	1250 VA resistive (cos ϕ = unity) 1250 VA inductive (cos ϕ = 0.7)
Short-duration capacity	20 A for 3 s
Making capacity	100 A for 30 ms
DC breaking capacity	250 Vdc; 50 W resistive 25 W inductive (L/R = 40 ms)
Operation time	<10 ms
Durability	
Loaded contact	10000 operations minimum
Unloaded contact	100000 operations minimum

2.8 Impulse Output for the Trip Coil

Required parameters for sensitive tripping coil	
Required nominal parameters of sensitive CB coils or strikers connected to Energy output	Nominal voltage 12 to 24 Vdc; E ≤ 0.1 J or MiTOP

Note: 1. The trip energy for the trip coil is stored by a capacitor built into the protection relay. The capacitors are charged by a current input or the auxiliary voltage. The duration of the trip pulse is 50 ms (if output is not burden). The pause between the individual pulses depends on the impedance of the trip coil and on the current level. The pulse lasts as long as the activation threshold is exceeded. During the trip pulse, the capacitor is unplugged from the charging source so the voltage level of the energy output depends on the discharging time.

2. The length of connecting wires between Impulse Output and low energy CB tripping coil/Striker/MiTOP must be less than 3m.

2.9 Impulse Output for Flag Indicator or Auxiliary Relay

Trip energy	
Trip energy	E ≥ 0.01 J, 24 Vdc

Note: 1. The trip energy for the flag indicator is stored by a capacitor built into the protection relay. The capacitors are charged by a current input or the auxiliary voltage. The duration of the trip pulse is 50 ms (if output is not burden). The pause between the individual pulses depends on the impedance of the flag indicator and on the current level. The pulse lasts as long as the activation threshold is exceeded.

2. The length of connecting wires between Impulse Output and Flag Indicator must be less than 3m.

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3. INSULATION

Insulation resistance	EN 60255-5: 2001	> 500 MΩ at 500 Vdc (Using only electronic/brushless insulation tester).
High Voltage (Dielectric) Withstand	EN 60255-27: 2005	2 kV rms AC, 1 minute: Between all case terminals connected together and the case earth. Between all terminals of independent circuits with terminals on each independent circuit connected together.
Impulse Voltage Withstand Test	EN 60255-27:2005	Front time: 1.2 µs, Time to half-value: 50 µs, Peak value: 5 kV Source Characteristics: 500 Ohm, 0.5 J. Common and differential mode: power supply, terminal block (excluding RS485), binary inputs, relays
Creepage Distances and Clearances	EN 60255-27:2005	Pollution degree 2, Overvoltage category III, Impulse test voltage 5 kV.

4. EMC TESTS

1 MHz Oscillatory Waves Immunity Test	EN 60255-22-1: 2008	*(For input and output ports, auxiliary power supply port)* Common mode test voltage: 2.5 kV; Differential mode test voltage: 1.0 kV; *(For communication port)* Common mode test voltage: 1.0 kV; *(Additional parameters)* Frequency: 1MHz; Tr time: 75ns; Repetition frequency: 400Hz; Source impedance: 200Ω;
Electrostatic Discharges Immunity Test	EN 60255-22-2: 2008	*(Class 3)* Air discharge 8kV Contact discharge 6kV
Electrical Fast Transient /Burst Immunity Test	EN 60255-22-4: 2008	*(Class A)* *(For input and output ports, auxiliary power supply port)* Peak voltage: 4kV; *(For communication port)* Peak voltage: 2kV; *(Additional parameters)* Tr/Th parameter: 5/50ns; Repetition frequency: 5kHz;

Surge Immunity Test	EN 60255-22-5: 2002	*(For input and output ports)* Line-to-line charge voltage: 2kV; Line-to-earth charge voltage: 4kV; Source impedance: 2Ω; Coupling resistor: 40Ω; Coupling capacitor: 0.5uF; *(For auxiliary power supply port)* Line-to-line charge voltage: 2kV; Line-to-earth charge voltage: 4kV; Source impedance: 2Ω; Coupling resistor: 10Ω; Coupling capacitor: 9uF; *(For communication port)* Line-to-earth charge voltage: 2kV; Source impedance: 2Ω; Coupling resistor: 40Ω; Coupling capacitor: 0.5uF; *(Additional parameters)* Tr/Th parameter: 1.2/50us – for voltage; Tr/Th parameter: 8/20us – for current;
High Frequency Electromagnetic Field Immunity Test	EN 60255-22-3: 2008	Frequency ranges: (80÷1000) and (1400÷2700)MHz 10V/m unmodulated, rms; Amplitude modulated: 80%, f=1kHz, sinus wave; Frequency: 900MHz 10V/m unmodulated, rms; Amplitude modulated: 100%, f=200Hz, square wave;
Immunity to Conducted Disturbances Induced by Radio Frequency Fields	EN 60255-22-6: 2004	*(Level 3)* Frequency range: (0.15÷80)MHz 10V/m unmodulated, rms; Source impedance: 150Ω; Amplitude modulated: 80%, f=1kHz, sinus wave; *(Level 3)* Spot frequencies: 27MHz and 68MHz; 10V/m unmodulated, rms; Source impedance: 150Ω; Amplitude modulated: 80%, f=1kHz, sinus wave;
Network Frequency Electromagnetic Fields Immunity Test	EN 61000-4-8:2010	*(Level 5)* 100A/m (continuous); 1000A/m (3s);
Power Frequency Immunity Tests	EN 60255-22-7: 2005	*(Class A)* *(For input ports)* Common mode test voltage: 300V rms; Frequency 50Hz and 60Hz; Coupling resistor: 220Ω; Coupling capacitor: 470nF;

Radiated Disturbance Emission	EN 55022: 2010	Class A
Pulse Magnetic Field Immunity Test	EN 61000-4-9: 2001	Tr/Th parameter: 6.4/16us; Magnetic pulse: 1000A/m;
Dumped Oscillatory magnetic Field Immunity Test	EN 61000-4-10: 2001	Frequency: 0.1MHz and 1.0MHz; Magnetic pulse: 100A/m;
Conducted Emission	EN 55022: 2010	Class A
Immunity to supply fading and dropping	EN 61000-4-11 2004	Criterion B 100% reduction, drop 5ms, 10ms, 20ms, 50ms, 100ms, 200ms.

5. ENVIRONMENT

Ambient Temperature Range	EN 60255-1: 2010	Operating temperature range: -20°C to +60°C (–4°F to +140°F), Temporarily permissible temperature (2/24 hours): –40°C to +85°C (–40°F to +185°F) with double errors Storage and transit: –25°C to +70°C (–13°F to +158°F).
Ambient Humidity Range	EN 60068-2-78: 2001	56 days at 93% relative humidity and +40°C.
	EN 60068-2-30: 2005	Damp heat cyclic, six (12 + 12) hour cycles, 93% RH, +25 to +55°C
Vibration Test	EN 60255-21-1:1995	Response Class 1 Endurance Class 1
Shock and Bump	PN-EN 60255-21-2:2000	Shock response Class 1 Shock withstand Class 1 Bump Class 1
Seismic	EN 60255-21-3:1995	Class 2
Enclosure Protection	EN 60529:1991/A1:2000	IP 40 Protection for relay housing IP 20 Protection for terminals. IP 54 Protection (front panel) against dust and dripping water for flash mounted case.

6. EU DIRECTIVE

6.1 EMC Compliance

CE 2014/30/EU

Compliance with the European Commission's EMC Directive.

Product Specific Standards were used to establish conformity:

– EN 60255-26: 2013

– EN 60255-1: 2010

6.2 Product Safety

CE 2014/35/EU

Compliance with the European Commission's Low Voltage Directive. Compliance is demonstrated by reference to generic safety standards:

– EN60255-27:2014

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7. DEVIATIONS OF THE PROTECTION ELEMENTS

Glossary

I	:	Phase current
Is	:	I>, I>>, I>>>, SOTF, I<
I2	:	I2>
Ies	:	IN_1 (IN>), IN_2 (IN>>), IN_3 (IN>>>)
DT	:	Definite time
IDMT	:	Inverse definite minimum time

TYPICAL OPERATION TIME (protection time-delay set to 0 ms; the injection current is greater than two times the setting value) The P116 is supplied from Vx or the current is above 0.2 In (Ien).		
Operation time:	All types of faults	≤ 40ms
TYPICAL OPERATION TIME (protection time-delay set to 0 ms; the injection current is greater than two times the setting value) The pre-fault current is below 0.2 In (Ien) in all phases and that there is no Vx on the B1 – B2 terminals. The case: CB switch on to fault without auxiliary voltage supply. Typically: ≤ 70ms. Detailed calculation below:		
Operation time calculation:	$\frac{K}{\left\|\vec{I}_A-\vec{I}_B\right\|+\left\|\vec{I}_C+\vec{I}_N\right\|-S}+C\ [ms]$, **but not less than 50 ms**	
The trip coil and the flag indicator energy outputs are disabled.	$K=7;\ S=0.1;\ C=60;$	
The flag indicator energy output is enabled. The trip coil energy output is disabled.	$K=18;\ S=0.15;\ C=45;$	
The trip coil energy outputs is enabled Note: the flag indicator energy output (disabling/enabling) has not significant effect on the tripping time for this case	$K=55;\ S=0.14;\ C=25;$	

An example:

The trip coil and the flag indicator are enabled in the ***SETTING GROUP 1 (2) / OUTPUT RELAYS CONFIGURATION G1 (G2)*** menu.

Three-phase fault with current value of 0.5 In:

$$\vec{I}_A=0.5e^{j0\deg}\ In;\ \vec{I}_B=0.5e^{-j120\deg}\ In;\ \vec{I}_C=0.5e^{j120\deg}\ In;\ \vec{I}_N=0.0e^{j0\deg}\ Ien$$

Calculation:

$$\left|\vec{I}_A-\vec{I}_B\right|=\sqrt{(0.5\cdot\cos(0\deg)-0.5\cos(-120\deg))^2+(0.5\cdot\sin(0\deg)-0.5\sin(-120\deg))^2}=0.866In$$

$$\left|\vec{I}_C+\vec{I}_N\right|=\sqrt{(0.5\cdot\cos(120\deg)+0\cos(0\deg))^2+(0.5\cdot\sin(120\deg)+0\sin(0\deg))^2}=0.5In$$

Operation time:

$$\frac{55}{\left|\vec{I}_A-\vec{I}_B\right|+\left|\vec{I}_C+\vec{I}_N\right|-0.14}+25\ ms=\frac{55}{0.866+0.5-0.14}+25\ ms=70ms$$

Operation time = 70 ms

PROTECTION ACCURACY					
Element	**Range**	**Deviation**	**Trigger**	**Reset**	**Time deviation**
Phase overcurrent elements (I> & I>> & I>>> & SOTF)	0.1 to 40 In	±3%±0.01In	DT: Is ± 2%±0.01In IDMT: 1.1Is ±2% ±0.01In	0.95 Is ±2%±0.01In 1.05 Is ±2%±0.01In	±2% +20…50 ms ±5% +20…50 ms
Earth fault overcurrent elements (IN_1 & IN_2 & IN_3)	0.002 to 1Ien 0.01 to 8 Ien 0.1 to 40 Ien	±3%±0.001Ien ±3%±0.002Ien ±3%±0.01Ien	DT: Ies ± 3%±0.001Ien ±3%±0.002Ien ±3%±0.01Ien	0.95 Ies ± 3%±0.001Ien ±3%±0.002Ien ±3%±0.01Ien	±2% +20…50 ms
	0.002 to 1Ien 0.01 to 8 Ien 0.1 to 40 Ien	±3%±0.001Ien ±3%±0.002Ien ±3%±0.01Ien	IDMT: 1.1Ies ± 3%±0.001Ien ±3%±0.002Ien ±3%±0.01Ien	1.05 Ies ±3% ± 3%±0.001Ien ±3%±0.002Ien ±3%±0.01Ien	±5% +20…50 ms
Negative sequence phase overcurrent elements (I2>)	0.1 to 4 In	± 3%±0.01In	DT: I2s ± 3%±0.01In IDMT: 1.1 I2s ±3%±0.01In	0.95 I2s ±3%±0.00In 1.05 I2s ±3%±0.01In	±2% +20…50 ms ±5% +20…50 ms
Phase undercurrent element (I<)	0.1 to 2 In	± 3%±0.01In	DT: I< ± 2%±0.005A	0.95 I< ±2%±0.01In	±2% +20…50 ms
Broken conductor (I2/I1).	20 to 100%	± 5%±0.01In	DT: I2/I1 ± 5%±0.01In	0.95 I2/I1 ±5%±0.01In	±2% +20…50 ms
Thermal overload (I_{therm}, θ Alarm, θ Trip)	0.10 to 3.0 In	± 3%±0.01In	I_{therm} ± 3%±0.01In	0.97 I_{therm} ±3%±0.01In	–5% +20…50 ms (ref. IEC 60255-8)

Note: For e/f settings below 0.1In it is strongly recommend to use screened cable between e/f CT and P116 terminals. Without using screened cable the accuracy can be worse than given in the table above (additional errors caused by external disturbances should be taken into account).

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8. DEVIATIONS OF AUTOMATION FUNCTIONS TIMERS

Function	Deviation
Auto-reclose timers tDs, tR, tI	±2% +10…30 ms
CB fail & CB monitoring timers	±2% +10…30 ms
Auxiliary timers tAUX1, tAUX2, tAUX3, tAUX4	±2% +10…30 ms
Cold load pickup	±2% +20…50 ms
SOTF	±2% +20…50 ms

9. DEVIATIONS OF MEASUREMENTS

Measurement	Range	Deviation
Phase current	0.1 to 40 In	Typical ±2% at In
Earth current	0.002 to 1 Ien	Typical ±2% at Ien
	0.01 to 8 Ien	Typical ±2% at Ien
	0.1 to 40 Ien	Typical ±2% at Ien

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10. PROTECTION SETTING RANGES

10.1 [50/51] Phase Overcurrent

– Phase current Fundamental only

Note: When I> or I>> is associated with an IDMT curve, the maximum recommended setting is 2 In.

10.1.1 Protection Setting Ranges

[50/51] Phase OC	Setting Range		
	Min.	Max.	Step
I> ?	Disabled, Trip, Alarm, Trip with Inrush blocking, Trip with Latching		
I>	0.1 In	3 In (IDMT) 40 In (DMT)	0.01 In
Delay type	DT or IDMT (IEC_SI, IEC_VI, IEC_EI, IEC_LTI, IEC_STI, C02_P20, C08, IEEE_MI, IEEE_VI, IEEE_EI, RXIDG, BPN EDF, RI, RECT, C02_P40 curve)		
tI>	0.05 s	200 s	0.01 s
I> TMS	0.02	1.50	0.01
I> TD	0.02	100	0.01
I> Reset Delay Type	DT or IDMT (refer to Operation chapter)		
DT I> tReset	0.00 s	600 s	0.01 s
K (RI)	0.1	10	0.1
I>> ?	Disabled, Trip, Alarm, Trip with Inrush blocking, Trip with Latching		
I>>	0.1 In	3 In (IDMT) 40 In (DMT)	0.01 In
Delay type	DT or IDMT (IEC_SI, IEC_VI, IEC_EI, IEC_LTI, IEC_STI, C02_P20, C08, IEEE_MI, IEEE_VI, IEEE_EI, RXIDG, BPN EDF, RI, RECT, C02_P40 curve)		
tI>>	0.05 s	200 s	0.01 s
I>> TMS	0.02	1.50	0.01
I>> TD	0.02	100	0.01
I>> Reset Delay Type	DT or IDMT (refer to Operation chapter)		
DT I>> tReset	0.00 s	600 s	0.01 s
K (RI)	0.1	10	0.01
I>>> ?	Disabled, Trip, Alarm, Trip with Inrush blocking, Trip with Latching		
I>>>	1 In	40 In	0.01 In
tI>>>	0 s	200 s	0.01 s

10.2 Switch on to fault (SOTF)

– Phase current Fundamental only

10.2.1 Protection Setting Ranges

[50/51] SOTF	Setting Range		
	Min.	Max.	Step
SOTF ?	Disabled, Trip, Alarm, Trip with Inrush blocking, Trip with Latching		
SOTF	1 In	40 In	0.01 In
tSOTF	0 s	600 s	0.01 s

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10.3 Undercurrent Protection

– Undercurrent: Fundamental only

10.3.1 Protection Setting Ranges

[37] Under Current	Setting ranges		
	Min	Max	Step
I< ?	Disabled, Trip, Alarm, Trip with Inrush blocking, Trip with Latching, Trip with Inhibition on 52A, Alarm with Inhibition on 52A		
I<	0.1 In	2 In	0.01 In
tI<	0.05 s	200 s	0.01 s

10.4 [49] Thermal Overload Protection

– Phase Current: RMS

10.4.1 Protection Setting Ranges

[49] Therm. OL	Setting ranges		
Therm. OL ?	Disabled, Enabled		
Itherm	0.1 In	3.0 In	0.01In
Te (heating)	1 mn	200 mn	1mn
Tr (cooling)	1 mn	999 mn	1mn
Theta Trip	50%	200%	1%
Theta Reset Ratio	20%	99%	1%
Theta Alarm ?	Disabled, Enabled		
Theta Alarm	20%	200%	1%

10.5 [50N/51N] Earth fault protection

– Earth fault current: Fundamental only

– Earth fault current ranges: See following table

Note: When IN> are associated to an IDMT curve, the maximum recommended setting is the highest in the range divided by 20.

10.5.1 Protection Setting Ranges

[50/51N] Earth OC	Setting Range		
	Min.	**Max.**	**Step**
High sensitivity current set	Cortec code P116x1N**1**Nxxxxxxx1x (1 A) or P116x1N**4**Nxxxxxxx1x (5 A)		
IN_1 (IN>)	0.002 Ien	0.1 Ien (IDMT) 1.0 Ien (DMT)	0.001 Ien
IN_2 (IN>>)	0.025 Ien	1.0 Ien	0.001 Ien
IN_3 (IN>>>)	0.025 Ien	1.0 Ien	0.001 Ien
Med. sensitivity current set	Cortec code P116x1N**2**Nxxxxxxx1x (1A) or P116x1N**5**Nxxxxxxx1x (5A)		
IN_1 (IN>)	0.01 Ien	0.4 Ien (IDMT) 8 Ien (DMT)	0.01 Ien
IN_2 (IN>>)	0.2 Ien	8 Ien	0.01 Ien
IN_3 (IN>>>)	0.2 Ien	8 Ien	0.01 Ien
Low sensitivity current set	Cortec code P116x1N**3**Nxxxxxxx1x (1 A) or P116x1N**6**Nxxxxxxx1x (5 A)		
IN_1 (IN>)	0.1 Ien	3 Ien (IDMT) 40 Ien (DMT)	0.01 Ien
IN_2 (IN>>)	1 Ien	40 Ien	0.01 Ien
IN_3 (IN>>>)	1 Ien	40 Ien	0.01 Ien
IN_1 stage ?	Disabled, IN> Trip, IN> Alarm, IN> Trip with Inrush blocking, IN> Trip with Latching		
Delay type	DT or IDMT (IEC_SI, IEC_VI, IEC_EI, IEC_LTI, IEC_STI, C02_P20, C08, IEEE_MI, IEEE_VI, IEEE_EI, RXIDG, BPN EDF, RI, RECT, C02_P40 curve))		
tIN_1	0.05 s	200 s	0.01 s
K (RI)	0.1	10	0.1
IN_1 TMS	0.02	1.5	0.01
IN_1 TD	0.02	100	0.01
IN_1 Reset Delay Type	DT or IDMT (refer to Operation chapter)		
DT IN_1 tReset	0.00 s	600 s	0.01 s
IN_2 stage ?	Disabled, IN>> Trip, IN>> Alarm, IN>> Trip with Inrush blocking, IN>> Trip with Latching		
tIN>>	0 s	200 s	0.01 s
IN_3 stage ?	Disabled, IN>>> Trip, IN>>> Alarm, IN>>> Trip with Inrush blocking, IN>>> Trip with Latching		
tIN_3	0 s	200	0.01 s

10.6 Negative Sequence Overcurrent Protection

– Phase current: Fundamental only

Note: When I2> is associated with an IDMT curve, the maximum recommended setting is 2 In.

10.6.1 Protection Setting Ranges

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[46] Neg.Seq. OC	Setting ranges		
	Min.	Max.	Step
I2> ?	Disabled, Trip, Alarm, Trip with Inrush blocking, Trip with Latching		
I2>	0.1 In	4 In	0.01 In
Delay Type	DT or IDMT (IEC_SI, IEC_VI, IEC_EI, IEC_LTI, IEC_STI, C02_P20, C08, IEEE_MI, IEEE_VI, IEEE_EI, RXIDG, BPN EDF, RI, RECT, C02_P40 curve)		
tI2>	0.05 s	200s	0.01s
I2> TMS	0.02	1.5	0.01
I2> Reset Delay Type	DT or IDMT (refer to Operation chapter)		
DT I2> tReset	0.00 s	600 s	0.01 s

10.7 [46BC] Broken Conductor Protection

Principle used: I2/I1

Functionality available for:

(IA or IB or IC) > (“GLOBAL SETTINGS/O/C ADVANCED / [46BC] Brkn.Cond I< Block.”) (Factory setting: 0.1In)

10.7.1 Protection Setting Ranges

[46BC] Broken Conductor	Setting ranges		
	Min.	Max.	Step
Broken Cond. ?	Disabled, Trip, Alarm, Trip with Inrush blocking, Trip with Latching		
Ratio I2/I1	20%	100%	1%
tBCond	0.05 s	600s	0.01s
GLOBAL SETTINGS/ O/C ADVANCED	**Setting ranges**		
	Min.	**Max.**	**Step**
[46BC] Brkn.Cond I< Block.	0.1 In	1.00 In	0.01 Ien

10.8 [50BF] CB Fail Protection

– Undercurrent: Fundamental only

10.8.1 Protection Setting Ranges

[50BF] Under Current	Setting ranges		
	Min.	Max.	Step
CB Fail ?	Disabled, Retrip, Alarm		
CB Fail Time tBF	0.1 s	10 s	0.01 s
I< CBF	0.1 In	2 In	0.01 In
High sensitivity current setting	Cortec: P116x1N**1**Nxxxxxxx1x (1 A) or P116x1N**4**Nxxxxxxx1x (5 A)		
IN< CBF	0.01 Ien	1.0 Ien	0.001 Ien
Medium sensitivity current setting	Cortec: P116x1N**2**Nxxxxxxx1x (1 A) or P116x1N**5**Nxxxxxxx1x (5 A)		
IN< CBF	0.05 Ien	2 Ien	0.01 Ien
Low sensitivity current setting	Cortec: P116x1N**3**Nxxxxxxx1x (1 A) or P116x1N**6**Nxxxxxxx1x (5 A)		
IN< CBF	0.1 Ien	2 Ien	0.01 Ien
Block I>?	No, Yes		
Block IN>?	No, Yes		

10.9 Multishot Autoreclose Function

Main shots: 4 independent shots.

External Binary inputs: 6 inputs (CB Faulty External Signal, CB status 52A, CB status 52B, blocking Autoreclose).

Internal programmable trigger from phase and earth fault on all re-closing cycles.

External trigger from logic input (using AUX timer)

Programmable dead times and reclaim time setting.

10.9.1 Multishot auto-recloser Settings

[79] Autoreclose G1/G2	Setting range		
	Min.	Max.	Step
Autoreclose ?	Disabled, Enabled		
Dead time			
tD1	0.01 s	600 s	0.01 s
tD2	0.01 s	600 s	0.01 s
tD3	0.1 s	600 s	0.1 s
tD4	0.1 s	600 s	0.1 s
Reclaim time			
Reclaim Time tR	0.02 s	600 s	0.01 s
Phase O/C			
Fast tripping shots	5 4 3 2 1	Settings	
Fast O/C Trip (I>, I>>, I>>>)	0 0 0 0 0	0 – delay O/C protection element 1 – with Fast Trip delay (see below)	
Fast O/C Trip Delay setting	0.00 s	9.99 s	10 ms
E/GND			
Fast tripping shots	5 4 3 2 1	Settings	
Fast E/Gnd Trip (IN_1, IN_2, IN_3)	0 0 0 0 0	0 – Timeelay E/GND protection element 1 – with Fast Trip delay	
Fast E/Gnd Trip Delay setting	0.00 s	9.99 s	10 ms
Close Shot	4 3 2 1	Settings	
tI>	0 0 0 0	0 or 1	
tI>>	0 0 0 0	0 or 1	
tI>>>	0 0 0 0	0 or 1	
tIN_1 (tIN>)	0 0 0 0	0 or 1	
tIN_2 (tIN>>)	0 0 0 0	0 or 1	
tIN_3 (tIN>>>)	0 0 0 0	0 or 1	
tAux1	0 0 0 0	0 or 1	
tAux2	0 0 0 0	0 or 1	

[79] Autoreclose G1/G2	Setting range		
	Min.	Max.	Step
Inhibit Trip on [79] close shot	**4 3 2 1**	**Settings**	
Inhibit Trip tI> Shot:	0 0 0 0	0 or 1	
Inhibit Trip tI>> Shot:	0 0 0 0	0 or 1	
Inhibit Trip tI>>> Shot:	0 0 0 0	0 or 1	
Inhibit Trip tIN_1 (tIN>) Shot:	0 0 0 0	0 or 1	
Inhibit Trip tIN_2 (tIN>>) Shot:	0 0 0 0	0 or 1	
Inhibit Trip tIN_3 (tIN>>>) Shot:	0 0 0 0	0 or 1	
Inhibit Trip tAux1 Shot:	0 0 0 0	0 or 1	
Inhibit Trip tAux2 Shot:	0 0 0 0	0 or 1	

Cycles:
0 = no action on auto-recloser: definitive trip
1 = trip on protection element pick-up, followed by a reclose cycle
Inhibit Trip on Shot:
0 = no inhibit function
1 = auto-reclose without protection trip (trip command inhibited for protection element - no trip command from the auto-reclose function).

[79] Autoreclose Advanced Settings	Setting range		
	Min.	Max.	Step
CB Faulty Monitor.?	Yes or No		
Block via Input ?	Yes or No		
Start Dead t on	Protection Reset or CB trips		
Rolling demand ?	Yes or No		
Maximum cycle No. Rol. Demand	2	100	1
Time period Rol. Demand	1 mn	24 h	1 mn
Inhibit Time on Close tI	0.0 s	600 s	0.01 s
Signaling Reset	No or Close via 79		

10.9.2 Further Time-delays

Timeout upon lack of CB opening signal after a trip:
tOpen Pulse (*) + 0.1 s (not settable)

tClose Pulse (*): from 0.1 to 10.00 s in steps of 0.01 s
(*) Setting available in the CIRCUIT BREAKER menu.

Timeout upon lack of CB closing signal after a close control and its associated dead time: tOpen Pulse (*) + 0.1 s (not settable)

tClose Pulse (*): from 0.1 to 10.00 s in steps of 0.01 s
(*) Setting available in the CIRCUIT BREAKER menu.

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11. AUTOMATION CONTROL FUNCTIONS

11.1 Trip Commands

The following protection elements may be set to *'Disabled'* or *'Trip'* or *'Alarm'* or *'TRIP-Inrush Bl'* or *'TRIP- Latch'* I>, I>>, I>>>, IN_1 (IN>), IN_2 (IN>>), IN_3 (IN>>>), SOTF, I2>, I<, Brkn Cond, AUX1, AUX2, AUX3, AUX4.

The trip command is enabled with the following protection options:

– TRIP

– TRIP with Inrush Blocking

– TRIP with Latch

Thermal Overload can be set to *'Enabled'* (the trip command is enabled by the second stage if the thermal state is above 100% of thermal state) or *'Disabled'*.

The first Thermal stage is for Alarm the second one is for trip.

CB Fail can be set to *'Disabled'* or *'Retrip'* (the trip command is enabled after 'CB Fail Time tBF" delay) or *'Alarm'*

11.2 Latch Functions

The following protection elements may be set to *'Disabled'* or *'Trip'* or *'Alarm'* or *'TRIP-Inrush Bl'* or *'TRIP- Latch'* I>, I>>, I>>>, IN_1 (IN>), IN_2 (IN>>), IN_3 (IN>>>), SOTF, I2>, I<, Brkn Cond, AUX1, AUX2, AUX3, AUX4.

The latched trip command function is enabled with the following option:

– ***TRIP- Latch***

Thermal Overload can be latched using the Theta Reset threshold setting.

11.3 Blocking Logic

The following time-delayed stages may be blocked by using binary inputs (setting: SETTING GROUP 1(2)/INPUT CONFIGURATION G1(G2) column of menu):

– tI>, tI>>, tI>>>, tSOTF, tIN_1, tIN_2, tIN_3, tI<, tI2>, tBrkn Cond, tAUX1, tAUX2, tAUX3, tCB Fail, [79] (Note: the high state of mapped to this function logic input blocks (disables) the auto-reclose element with lockout is blocking occurs while it is running), Itherm (Note: the high state of mapped to this function logic input sets to zero the value at the thermal equivalent current used in the thermal algorithm).

11.4 Inrush blocking Logic

Inrush blocking is based on second harmonic criteria.

The following protection elements may be set to *'Disabled'* or *'Trip'* or *'Alarm'* or *'TRIP-Inrush Bl'* or *'TRIP- Latch'* I>, I>>, I>>>, IN_1 (IN>), IN_2 (IN>>), IN_3 (IN>>>), SOTF, I2>, I<, Brkn Cond, AUX1, AUX2, AUX3, AUX4.

The trip command with Inrush Blocking function is enabled with the following option:

– ***Trip-Inrush Bl***

There are two methods available:

– Permanent action based on a 2nd harmonic ratio threshold (***Inrush Blocking? 1: Yes***). The "Inrush Reset Time" setting is available to this effect.

– Activation 2nd harmonic after CB closing for defined time period (***Inrush Blocking? 1: Closing***). The "Unblock Inrush Time" setting is available to this effect.

For more details please refer to the Application chapter of this manual.

Blocking Inrush	Setting range		
	Min.	**Max.**	**Step**
Blocking inrush	No, Yes, Closing		
2nd Harmonic Ratio	10%	50%	1%
Inrush Reset Time	0 s	200 s	10 ms
Unblock Inrush Time	0 s	200 s	10 ms

11.5 Logic Selectivity

Logic selectivity 1 and logic selectivity 2: This function is used to assign a time-delay to the protection elements mapped to the “Log Sel” inputs.

Logic Selectivity G1/G2	Setting range		
	Min.	**Max.**	**Step**
Sel1?	Disabled or Enabled		
t Sel1	0 s	600 s	10 ms
Sel2?	Disabled or Enabled		
t Sel2	0 s	600 s	10 ms

The inputs can be mapped to the following protection elements: I>>, I>>>, IN_2 (IN>>), IN_3 (IN>>>).

11.6 Output Relays

11.6.1 Output Relays Assignation

Assignable functions: Protection Trip, Protection Trip (pulse), Trip CB Order, Close CB Order, Alarm, Start Phase A, Start Phase B, Start Phase C, I>, I>>, I>>>, SOTF, IN_1 (IN>), IN_2 (IN>>), IN_3 (IN>>>), I<, I2>, Start Broken Conductor, AUX1, AUX2, AUX3, AUX4, AUX5, AUX6, tI>, tI>>, tI>>>, tSOTF, tIN_1 (tIN>), IN_2 (tIN>>), tIN_3 (tIN>>>), tI<, tI2>, tBrkn Cond, Thermal Trip, Thermal Alarm, CB Fail, tAUX1, tAUX2, tAUX3, tAUX4, Communication Order 1, Communication Order 2, [79] in Progress, [79] Final Trip, [79] Lockout, [79] Blocked, [79] Success., Trip Circuit Supervision (TCS 52 Fail), CB Alarm, Trip Pulse tP, tCB Faulty Ext Signal, Active Setting Group 1(2).

11.6.2 Latch of the auxiliary Output Relays

These output relays can be latched: Output 1 to 6

11.6.3 Reverse Output Relay Logic

The logic of the output relays can be reversed: Output 1 to 6

Note: Reverse logic means that if a function assigned to outputs is disabled the contact is closed. If the function is enabled the contact is opened.

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11.7 Energy Output for external flag indicator

Configuration is made in the same place of menu as for Output Relays (in P116 menu, the symbol for this output is called: '**F**')

Assignable functions: Protection Trip, Trip CB Order, Alarm, tI>, tI>>, tI>>>, tSOTF, tIN_1 (tIN>), IN_2 (tIN>>), tIN_3 (tIN>>>), tI<, tI2>, tBrkn Cond, Thermal Trip, Thermal Alarm, CB Fail, tAUX1, tAUX2, tAUX3, tAUX4, Communication Order 1, Communication Order 2, [79] Final Trip, [79] Lockout, [79] Blocked, [79] Success., Trip Circuit Supervision (TCS 52 Fail), CB Alarm, tCB Faulty Ext Signal.

Note: If flag indicator is set to reverse logic above assigning is ignored and on the output is permanently available voltage with trip energy.

11.8 Trip Energy Output for sensitive tripping coil or striker

Configuration is made in the same place of menu as for Output Relays (in P116 menu, the symbol for this output is called: '**T**')

Assignable functions: Protection Trip, Trip CB Order, tI>, tI>>, tI>>>, tSOTF, tIN_1 (tIN>), IN_2 (tIN>>), tIN_3 (tIN>>>), tI<, tI2>, tBrkn Cond, Thermal Trip, tAUX1, tAUX2, tAUX3, tAUX4, Communication Order 1, Communication Order 2, [79] Final Trip.

Note: by default no any function is assigned to this trip energy output. If the energy output is used it must be configured to required to the function listed above. For typical application this output is assigned to 'Protection Trip' (if this output has to be energized by protection trip only) or additionally to 'Trip CB Order' (if this output has to be energized by manual trip too: via RS485, binary input or from P116 front panel. It will be executed if relay has any source of supplying only: Vx or enough energy from CTs)

11.9 Inputs

11.9.1 Input Assignation

A single function or multiple automation functions can be assigned to 6 logic inputs:

None, Maintenance Mode, Reset Latched Signaling, Reset Latched Outputs, Block tI>, Block tI>>, Block tI>>>, Block tSOTF, Block tIN_1 (tIN>), Block tIN_2 (tIN>>), Block tIN_3 (tIN>>>), Block tI<, Block tI2>, Block tBrkn Cond, , Block Itherm, Block AUX1, Block AUX2, Block AUX3, Block. CB Fail, Block [79], Sel1 tI>>, Sel1 tI>>>, Sel1 tIN_2 (tIN>>), Sel1 tIN_3 (tIN>>>), Sel2 tI>>, Sel2 tI>>>, Sel2 tIN_2 (tIN>>), Sel2 tIN_3 (tIN>>>), AUX1, AUX2, AUX3, AUX4, AUX5, AUX6, Cold Load PU, Start tBF, CB status 52a, CB status 52b, CB Faulty External Signal, Setting Group 2, Manual Close, Manual Trip, Trip Circuit Supervision, Reset Theta Value, Start Disturbance Recorder, Local CTRL Mode, Time Synchronization.

11.9.2 Reverse Input Logic

The logic of the inputs can be reversed: Output 1 to 6

Note: Reverse logic means that if an input is energized, the function assigned to this input is disabled. If the input is not energized, the function is enabled.

11.10 Optional Flag Indicators Configuration

Assignable functions: tI>, tI>>, tI>>>, tSOTF, tIN_1 (tIN>), IN_2 (tIN>>), tIN_3 (tIN>>>), tI<, tI2>, tBrkn Cond, Thermal Trip, CB Fail, tAUX1, tAUX2, tAUX3, tAUX4, [79] Final Trip, [79] Lockout, [79] Success.

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11.11 Auxiliary Timers

Auxiliary timers G1/G2	Setting range		
	Min.	Max.	Step
Aux1 ?	Disabled, Trip, Alarm, Trip with Inrush blocking, Trip with Latching, Load Shedding (LS), AR after LS Hi (Hi state – activates), AR after LS Lo (Lo state – activates)		
Time-delay tAux1	0	600 s	10 ms
Aux2 ?	Disabled, Trip, Alarm, Trip with Inrush blocking, Trip with Latching, Load Shedding (LS), AR after LS Hi, AR after LS Lo		
Time-delay tAux2	0	600 s	10 ms
Aux3 ?	Disabled, Trip, Alarm, Trip with Inrush blocking, Trip with Latching, Load Shedding (LS), AR after LS Hi, AR after LS Lo		
Time-delay tAux3	0	600 s	10 ms
Aux4 ?	Disabled, Trip, Alarm, Trip with Inrush blocking, Trip with Latching, Load Shedding (LS), AR after LS Hi, AR after LS Lo		
Time-delay tAux4	0	600 s	10 ms

11.12 Cold Load Pickup

Cold Load PU G1/G2	Setting range		
	Min.	Max.	Step
Cold Load PU ?	Disabled or Current+Input or Input		
Cold load PU Level	20%	999%	1%
Cold load PU tCL	0s	6000 s	100 ms
CLPU I>	Yes or No		
CLPU I>>	Yes or No		
CLPU I>>>	Yes or No		
CLPU IN_1 (IN>)	Yes or No		
CLPU IN_2 (IN>>)	Yes or No		
CLPU IN_3 (IN>>>)	Yes or No		
CLPU Brkn Cond	Yes or No		
CLPU Itherm	Yes or No		
CLPU I2>	Yes or No		

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11.13 Circuit Breaker

11.13.1 CB Time Setting Ranges

CB Control Time	Setting range		
	Min.	Max.	Step
tOpen Pulse min	0.1 s	10 s	0.01 s
tClose Pulse	0.1 s	10 s	0.01 s
Time-delay for Close	0.0 s	200 s	0.01 s
tP pulse	1 mn	65000 mn	1 mn

11.13.2 Time-delay for Faulty CB External Signal

CB Faulty External Monitoring	Setting range		
	Min.	Max.	Step
tCB FLT Ext. Sign.	1 s	200 s	1 s

11.13.3 Remote Control Mode

Remote Control Mode	Setting range
Remote CTRL Mode	Remote only Remote + Local

11.13.4 Unblock SOTF Time pulse after CB Close

Unblock SOTF Time	Setting range		
	Min.	Max.	Step
52 Unblock SOTF Time	0 s	200 s	0.01 s

11.13.5 Trip Circuit Supervision Setting Ranges

TC Supervision	Setting range		
	Min.	Max.	Step
TC Supervision ?	No or Yes or Yes-52A		
TC Supervision tSUP	0.1 s	10 s	0.01 s

11.13.6 Circuit Breaker Control and Monitoring Setting Ranges

CB Supervision	Setting range		
	Min.	Max.	Step
CB Time Supervision?	Yes or No		
Max CB Open time	0.01 s	10 s	0.01 s
Max CB Close time	0.01 s	10 s	0.01 s
CB Diagnostic ?	Yes or No		
Max CB Open No.	1	50000	1
Max Sum Amps^n	0 MA	655.34 MA^n	0.1MA^n
AMPS's n=	1	2	1

11.14 Communication Orders

Command via RS485.
Output contacts can be configured to tCOM1 or tCOM2

Communication Orders	Setting range		
	Min.	Max.	Step
Pulse Time tCOM1	0	200s	10ms
Pulse Time tCOM2	0	200s	10ms
COM2 Order Conf.	***RS485*** or ***RS485+Button_C*** or ***Button_C*** This configuration allows adding to ***Comm.Order 2:*** pressing of the 'C' clear key located on the front panel of P116. Setting option: ***RS485+Button_C*** means that if command tCOM2 (Communication Order 2) via RS485 is executed or 'C' Clear key on the front panel is pressed, the output contact assigned to ***Comm.Order 2*** will be energized via set pulse time		

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12. RECORDING FUNCTIONS

12.1 Event Records

Capacity	200 events
Time-tag	1 millisecond
Triggers	Any selected protection alarm and threshold Logic input change of state Logic output change of state Self test events

12.2 Fault Records

Capacity	20 faults
Time-tag	1 millisecond
Triggers	Any selected protection which trip CB
Data	Fault date Fault time Protection thresholds Active Setting Group Fault Origin (faulty phase/earth) Fault measurements

12.3 Instantaneous Recorder (available if P116 is powered from Vx only)

Capacity	5 starting information (instantaneous)
Time-tag	1 millisecond
Triggers	Any selected protection which trip CB
Data	Date, hour origin (any protection)

12.4 Alarm Recorder

Capacity	5 alarm information
Time-tag	1 millisecond
Triggers	Any selected protection which is selected for signalling only (set to Alarm)
Data	Date, hour origin (any protection alarm)

12.5 Disturbance Records

12.5.1 Triggers, Data, Setting Ranges

Disturbance Records	Total record: up to 6s, but not more than 5 records			
Triggers	Any selected protection alarm and threshold, logic input, remote command			
Data	AC input channels digital input and output states frequency value			
	Default value	Setting range		
		Min.	Max.	Step
Pre-fault Time	0.1	0.1	6	0.01
Post-fault Time	0.1	0.1	1	0.01
Max Record time	3	0.1	6.0	0.01
Disturb rec Trig	on Inst	on Trip or on Inst.		
Trigger	Protection selected for tripping, Logic input assigned to ‘Start Distur.R.’			

13. COMMUNICATION

Type Port	Physical Link	Connectors	Data Rate	Comms. mode	Protocol
RS485	Screened twisted pair	Screws or snap-on	4.8 or 9.6 or 19.2 or 38.4 or 57.6 or 115.2 kbits/s (default:19.2 kbit/s)	Data Bit: 8 Stop bit: 1 or 2 Parity: ‘No parity’ or ‘Odd parity’ or ‘Even parity’ (default: No parity) Address: 1 to 254 (default: 254)	Modbus RTU or IEC60870-5-103 (selectable in menu) (default: IEC103)
USB	USB2.0	PC: type A male P116: type mini B male	115.2 kbits/s **(fixed)**	Data Bit:8 Stop bit: 1 Parity: None Adress: 1	Modbus RTU

14. CURVES

14.1 General

Although the curves tend towards infinite when the current approaches Is (general threshold), the minimum guaranteed value of the operating current for all the curves with the inverse time characteristic is 1.1 Gs (with a tolerance of ± 0.05 Gs). In menu of P116 it is possible to select if the curve has no limitation for greater current value, is blocked via DMT stages or is cut (the same time delay as for 20 x Gs point for current above 20 x Gs, where Gs - current setting). Setting parameter: ***GLOBAL SETTINGS/ O/C ADVANCED*** / ***IDMT interlock by DMT***. Above setting is common for all IDMT stages.

14.1.1 Inverse Time Curves

The first phase (or earth) overcurrent stage can be selected with an inverse definite minimum time (IDMT) characteristic. The time-delay is calculated using a mathematical formula.

In all, there are eleven IDMT characteristics available.

The mathematical formula applicable to the first ten curves is:

$$t = TMS \times \left(\frac{k}{\left(\frac{G}{Gs}\right)^{\alpha} - P} + c \right)$$

Where:

t Operation time

k, c, α, P Constant (see table)

G Value of measured current

Gs Value of the programmed threshold (pick-up value)

TMS Time multiplier setting (for IEC: TMS; IEEE: TD)

Type of curve (according to IEC60255-151 std definition)	Standard	k	c	α	P
IEC Standard inverse (SI)	IEC/A	0.14	0	0.02	1
IEC Very inverse (VI)	IEC/B	13.5	0	1	1
IEC Extremely inverse (EI)	IEC/C	80	0	2	1
Long time inverse (LTI)	IEC	120	0	1	1
FR Short time inverse (STI)	FR	0.05	0	0.04	1
US Short time inverse	C02 P20	0.02394	0.01694	0.02	1
US Short time inverse	C02 P40	0.16758	0.11858	0.02	1
Long time inverse	C08	5.95	0.18	2	1
Moderately Inverse	IEEE (IEC/D)	0.0515	0.114	0.02	1
Very inverse	IEEE (IEC/E)	19.61	0.491	2	1
Extremely inverse	IEEE (IEC/F)	28.2	0.1217	2	1
UK Rectifier protection	RECT	45900	0	5.6	1
BNP (EDF)	EDF	1000	0.655	2	1
RI		-4.2373	0	-1	1.43644

Note: For RI curve the equation is valid for the range: $1.1 \leq G/Gs \leq 20$

RXIDG Curves

RXIDG curves can be selected on P116 with medium earth current sensitivity (corresponding to Cortec model number P116xxx2xxxxxxxxxx)

The first earth thresholds can be selected with dedicated RXIDG curves.

The curves available follow the formula:

t = 5.8 – 1.35 * ln (1/ (k * Gs/G))

Where:

t = tripping time

k = coefficient (from 0.3 to 1, by steps of 0.01)

Gs = value of the programmed threshold (Pick-up value)

G = value of measured current

In order to be compliant with the Netmanagement specifications the relay must be used with:

- An earth current range 0.01 Ion to 8 Ion
- A rated current wiring 1A
- A core balanced CT with a ratio 25/1.

14.1.2 Reset Timer

The first phase and earth overcurrent stages and the second phase overcurrent stage are provided with a timer hold facility: "t Reset".

The value that is set for this reset timer corresponds to the minimum time during which the current value needs to be lower than 95% of the phase (or earth) threshold before the corresponding phase (or earth) time-delay is reset.

Note: There is an exception to this rule when the protection triggers. In fact, in that case, the time-delays (tI> and tIe>) are immediately reset.

The value of the Reset Timer depends on the type of timer associated with the pick-up of the first phase (or earth) stage.

Type of timer associated with the first & second phase O/C stages and the first earth fault stage	Reset Timer	
	DMT Reset characteristic	IDMT characteristic
DMT, Rectifier, LTI, STI, Rectifier, BNP EDF, RXIDG	Settable from 0 to 600 ms	Not available. If IDMT is selected: reset timer is set to 0s (see table below: K=0)
IDMT IEC or RI	Settable from 0 to 600 ms	Based on RTMS value (refer to Operation chapter)
IDMT IEEE or CO	Settable from 0 to 600 ms	Based on RTD value (refer to Operation chapter)

Reset timer:

The first phase, earth and negative sequence overcurrent stages are provided with a timer hold facility: "t Reset".

It may be set to a definite time value or to an inverse definite minimum time characteristic (IEC/IEEE/ANSI curves only). This may be useful in certain applications, for example when grading with upstream electromechanical overcurrent relays that have inherent reset time-delays.

The second and third earth fault stages have only a definite time reset.

A possible situation where the reset timer may be used is to reduce fault clearance times where intermittent faults occur.

An example may occur in a cable with plastic insulation. In this application it is possible that the fault energy melts the cable insulation, which then reseals after clearance, thereby eliminating the cause for the fault. This process repeats itself to give a succession of fault current pulses, each of increasing duration with reducing intervals between the pulses, until the fault becomes permanent.

When the reset time of the overcurrent relay is set to its minimum, the relay will be repeatedly reset and will not be able to trip until the fault becomes permanent. By using the reset timer hold function the relay will integrate the fault current pulses, thereby reducing the fault clearance time.

The mathematical formula applicable to the five curves is:

$$t = RT \times \left(\frac{tr}{1 - \left(\frac{G}{Gs} \right)^p} \right)$$

Where:

t Reset time

tr, p Constant (see table)

G Value of the measured current

Gs Value of the programmed threshold (pick-up value)

RT Reset time multiplier (RTMS for IEC or RTD for IEEE/US) setting between 0.025 and 1.5.

Type of curve	Standard	tr	p
US Short time inverse	C02_P40	2.261	2
US Short time inverse	C02_P20	0.323	2
Long time inverse	C08	5.950	2
IEEE Moderately inverse (MI)	IEEE	4.850	2
IEEE Very inverse (VI)	ANSI/IEEE	21.600	2
IEEE Extremely Inverse (EI)	ANSI/IEEE	29.100	2
IEC Standard Inverse Time (SI)	IEC/A	8.2	6.45
IEC Very Inverse Time (VI)	IEC/B	50.92	2.4
IEC Extremely Inverse Time (EI)	IEC/C	44.1	3.03
IEC Long Time Inverse (LTI)	IEC	40.62	0.4
FR Short Time Inverse (STI)	FR	0	2
UK Rectifier (Rect)	UK	0	2
BNP EDF	BNP EDF	0	2
RXIDG	RXIDG	0	2
RI	RI	0	2

14.2 Thermal Overload Curves

The thermal time characteristic is given by:

$$e^{\left(\frac{-t}{\tau}\right)} = \frac{\left(I^2 - (1.05 \cdot I_{therm})^2\right)}{\left(I^2 - I_P{}^2\right)}$$

Where:

t	=	Tripping time, following application of the overload current, I
τ	=	Heating and cooling time constant of the protected plant
I	=	Highest phase current
I_{therm}	=	Setting value of thermal model. It is the full load current rating (I_{FLC}) multiplied by a safety factor (for example 1.05, which allows continuous operation up to < 1.05 I_{FLC})
I_P	=	Steady state pre-loading current before application of the overload

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

The thermal overload time characteristic curves are given in the Technical Data chapter.

If the current in any phase is above 0.1 x I_{therm} setting value the mathematical formula is following:

$$\text{t Trip} = \text{Te In}\left(\frac{\left|\text{K}^2 - \theta_p\right|}{\left|K^2 - \theta_{t\,rip}\right|}\right)$$

Where:

t Trip	=	Tripping time (in seconds)
T_e	=	Thermal time constant of the protected plant (in seconds)
K	=	Thermal overload equal to $\dfrac{I_{eq}}{1.05 \cdot I_{therm}}$
I_{eq}	=	Equivalent current corresponding to the RMS value of the highest phase current
I_P	=	Steady state pre-loading current before application of the overload
I_{therm}	=	Setting value. It is the full load current rating
θ_P	=	Steady state pre-loading thermal state before application of the overload
θ_{alarm}	=	Initial thermal state. If the initial thermal state = 30% then θ =0.3
θ_{trip}	=	Trip thermal state. If the trip thermal state is set at 100%, then θ trip = 1

The settings of these parameters are available in the various menus. The calculation of the thermal state is given by the following formula:

$$\Theta_{\tau+1} = \left(\frac{I_{eq}}{1.05 \cdot I_{therm}}\right)^2 \left[1 - e^{\left(\frac{-t}{Te}\right)}\right] + \Theta_\tau e^{\left(\frac{-t}{Te}\right)}$$

θ is calculated every 10 ms.

TD

If all the phase currents are above 0.1 x I_{therm} the value of Tr (time constant for cooling) is used instead of Te (time constant for heating).

In a typical application (transformer, cable, ...) Tr should be equal to Te. Different setting values of Te and Tr are only used in motor applications.

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GETTING STARTED

Date:	**17th November 2013**
Hardware Suffix:	**A**
Software Version:	**1C**
Connection Diagrams:	**10P11602**

GS

CONTENTS

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FIGURES

BEFORE CARRYING OUT ANY WORK ON THE EQUIPMENT, THE USER SHOULD BE FAMILIAR WITH THE CONTENTS OF THE SAFETY GUIDE SFTY/4L M/E11 OR LATER ISSUE, OR THE SAFETY AND TECHNICAL DATA SECTION OF THE TECHNICAL MANUAL AND ALSO THE RATINGS ON THE EQUIPMENT RATING LABEL.

For safety reasons, no work must be carried out on the P116 until all power sources to the unit have been disconnected.

1. RELAY POWER UP

Follow the following instructions carefully in order to correctly power up the relay.

1.1 System Connections

Check the wiring scheme of your installation.

Check that the output relay contacts are included in your trip circuit.

1.2 Auxiliary Power Supply Connections (Model A)

Connect a DC or AC (according to nominal supply rating V_{AUX}) voltage power supply.

Positive V_{AUX} to terminal B1
Negative V_{AUX} to terminal B2
DO NOT FORGET TO CONNECT THE EARTH REFERENCE WIRE TO THE SCREW TERMINAL (SEE FIGURE 2)!

Turn on the auxiliary power supply and set to approximately the rated voltage as shown on the relay's front panel.

The display should show:

```
1.00 A    1.00 A
1.00 A    1.00 A
```

Displays:
- first line: phases A and B currents,
- second line: phase C current and earth current,

taking into account the phase CT ratio (GLOBAL SETTINGS/CT RATIO submenu).

The **LEDs** should be configured as follows:

– The green LED "Healthy" (watchdog) is illuminated

The configuration of the remaining LEDs depends on the relay's history before powering (if the LEDs are configured as latching their state is stored in memory, therefore after repowering they are illuminated again until they are manually reset).

1.3 Powering up from the USB port

Only some of the relay's electronic circuits, for the HMI communications, are supplied from the USB port.

Note: Since the I/O boards are not supplied from the USB port the inputs' status is set to default value.
Additionally, output contacts are not operational therefore it is impossible to execute any commands.

1.4 Powering up from the measured currents only

Phase current / Earth current range which gives reduced functionality: Outputs relays: RL1 only, Energy Outputs: Sensitive Tripping Coil and External Flag Indicator Flags: "Trip" flag only. Note: LCD display, RL2-RL6, WD, LEDs and RS485, 2-5 Flags are inactive up to full functionality stage (see below)	at least in a one phase or earth[1)] > 0.2 In and $\lvert\underline{I}_A - \underline{I}_B\rvert + \lvert\underline{I}_C + \underline{I}_N^{1)}\rvert \le 0.65$ In 1) Powering of P116 from earth input is selectable by using proper terminals (A7-8: with powering or A9-10: without powering) and additionally by configuration in P116 menu (GLOBAL SETTINGS/CT RATIO/IN connection). Refer to the Settings (P116/EN ST) and the Installation chapter (P116/EN IN).
Full functionality of P116 powered from current only	at least in a one phase or earth[1)] > 0.65 In or $\lvert\underline{I}_A - \underline{I}_B\rvert + \lvert\underline{I}_C + \underline{I}_N^{1)}\rvert > 0.65$ In

2. USER INTERFACES AND MENU STRUCTURE

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

2.1 Introduction to the relay

2.1.1 Front panel

The front panel of the relay is shown in Figure 1.

The front panel of the relay includes:

– a 16-character by 2-line alphanumeric liquid crystal display (LCD)

– a 9-key keypad comprising 4 arrow keys (, , ,), an **OK** key, a clear key ( ), a read key ( ), a trip command key ( ) and a close command key ( ).

– 8 LEDs

– a USB port for local communications

2.1.2 Special symbols on the LCD display

The following special symbols may appear on the LCD display:

▲ - It is possible to move up by pressing the key.

◄ - It is possible to move left by pressing the key.

▼ - It is possible to move down by pressing the key.

► - It is possible to move right by pressing the key.

- The last menu cell in the column. If the key is pressed here the cursor will reach the first cell in the column.

- It is possible to edit the displayed values.

<0.1 40> - Setting range: from 0.1 to 40.

0.01 - Setting value step: 0.01.

- On the last line: Setting group 1 is displayed.

- On the last line: Setting group 2 is displayed.

- Edition of values on the display password-protected

- Edition of setting value is possible (the level correct password has been entered)

2.1.3 Indications

Fixed Function LEDS:

Healthy – Powering of microprocessor and no hardware problems detected (green LED)

Trip – Any trip caused by protection criteria

And 6 programmable LEDS for the following functions (OR logic):

Protect.Trip –	Trip by protection elements
Alarm –	Alarm signal
General Start –	Start of protection elements set to trip the CB
Start Phase A –	Start of the phase overcurrent element (set to trip) in phase A
Start Phase B –	Start of the phase overcurrent element (set to trip) in phase B
Start Phase C –	Start of the phase overcurrent element (set to trip) in phase C
Start I> –	Start of the first phase overcurrent stage
Start I>> –	Start of the second phase overcurrent stage
Start I>>> –	Start of the third phase overcurrent stage
Start SOTF –	Start of the Switch On To Fault overcurrent element (Model A)
Start IN_1 –	Start of the first earth fault overcurrent stage
Start IN_2 –	Start of the second earth fault overcurrent stage
Start IN_3 –	Start of the third earth fault overcurrent stage
AUX1 –	Trigger of AUX1 timer (via a binary input) (Model A)
AUX2 –	Trigger of AUX2 timer (via a binary input) (Model A)
AUX3 –	Trigger of AUX3 timer (via a binary input) (Model A)
AUX4 –	Trigger of AUX4 timer (via a binary input) (Model A)
AUX5 –	Trigger of AUX5 function (via a binary input) (Model A)
AUX6 –	Trigger of AUX6 function (via a binary input) (Model A)
tI> –	The first phase o/c stage time-delay is elapsed (if flashing: start)
tI>> –	The second phase o/c stage time-delay is elapsed (if flashing: start)
tI>>> –	The third phase o/c stage time-delay is elapsed (if flashing: start)
tSOTF –	SOTF element time-delay is elapsed (if flashing: start) (Model A)
tIN_1 –	The first earth fault o/c stage time-delay is elapsed (if flashing: start)
tIN_2 –	The second earth fault o/c stage time is elapsed (if flashing: start)
tIN_3 –	The third earth fault o/c stage time-delay is elapsed (if flashing: start)
tI< –	Trip by the undercurrent element time is elapsed (if flashing: start) (Model A)
tI2> –	The negative sequence o/c element time is elapsed (if flashing: start) (Model A)
t Brkn Cond –	Trip by Broken Conductor protection time is elapsed (if flashing: start) (Model A)
Thermal Trip –	Trip by Thermal Overload protection (if flashing: alarm)
Thermal Alarm –	Thermal Overload protection alarm
CB Fail –	Circuit Breaker Failure protection time-delay elapsed
tAUX1 –	tAUX1 time-delay elapsed (if flashing: start) (Model A)

tAUX2 – tAUX2 time-delay elapsed (if flashing: start) (Model A)

tAUX3 – tAUX3 time-delay elapsed (if flashing: start) (Model A)

tAUX4 – tAUX4 time-delay elapsed (if flashing: start) (Model A)

[79] in Progress – The auto-reclose function is running (Model A)

[79] F. Trip – Auto-reclose not successful: Final trip (Model A)

[79] Lockout – Lockout of the auto-reclose function (Model A)

[79] Blocked – The auto-reclose function is blocked (Model A)

[79] Success. – The auto-reclose operation is successful (the CB remains closed) (Model A)

Local CTRL Mode – Local Mode for CB control (Model A)

CB Alarm – Circuit Breaker condition alarm signal (CB Open NB, Sum Amps(n), TCS 52 Fail, CB Open Time and CB Close Time) (Model A)

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Mainten. Mode – Maintenance Mode (outputs are disconnected from all functions)

tCB FLT Ext.Sign. – An input mapped to this function detects CB problems that may influence control possibilities (for example spring problem, insufficient pressure, etc.). Signaling is active during a settable time (*GLOBAL SETTINGS/CIRCUIT BREAKER/tCB FLT Ext.Sign.*) (Model A)

Setting Group n – Setting Group n active (n= 1, 2) (Model A)

Every LED can be configured to be latched or self-resetting (***SETTING GROUP 1/ LEDS CONFIGURATION G1/ Latched LEDs***).

Note: Model L has only one setting group

If a LED is configured as latching, the manner in which it will be reset is selectable:

- Resetting of LEDs via manual reset (***GLOBAL SETTINGS/LOC/LEDs Reset 0: Manual only***)
- Resetting of LEDs via any protection start (set for CB tripping) or via manual reset (***GLOBAL SETTINGS/LOC/LEDs Reset 1: Start protect.)***
- Resetting of LEDs via manual close command (RS485, HMI or Input) or via manual reset (***GLOBAL SETTINGS/LOC/LEDs Reset 2: Close Command)*** (Model A)

External fault indication can be provided via an external Flag Indicator which should be connected to terminals C3-C4 (Model A).

The energy (24 V / 0.01 J) necessary to trip the Flag Indicator is taken from a capacitor charged via the CT currents and the auxiliary voltage. The Flag Indicator output is programmable (special symbol" "F" in first line ***SETTING GROUP 1(2)OUTPUT RELAY CONFIGURATION G1(2)*** *column)* (Model A):

Protection Trip – Trip by protection elements set to trip the CB

Trip CB Order – Manual trip via a Binary Input, the Front Panel user interface or a Close Command via RS485 communications

Alarm – Alarm signal (protection stage set to signal alarms, ***CB alarm***, ***CB FLT Ext.Sign.***, ***TCS 52 Fail***, ***Thermal Alarm***)

tI> – Trip by the first phase overcurrent stage (if flashing: start)

tI>> – Trip by the second phase overcurrent stage (if flashing: start)

tI>>> – Trip by the third phase overcurrent stage (if flashing: start)

tSOTF –	Trip by SOTF element (if flashing: start)
tIN_1 –	Trip by the first earth fault overcurrent stage (if flashing: start)
tIN_2 –	Trip by the second earth fault overcurrent stage (if flashing: start)
tIN_3 –	Trip by the third earth fault overcurrent stage (if flashing: start)
tI< –	Trip by the undercurrent element (if flashing: start) (Model A)
tI2> –	Trip by the negative sequence overcurrent element (if flashing: start) (Model A)
t Brkn Cond –	Trip by Broken Conductor protection (if flashing: start) (Model A)
Therm Trip –	Trip by Thermal Overload protection (if flashing: alarm)
Therm Alarm –	Thermal Overload protection alarm
CB Fail –	Circuit Breaker Failure protection time-delay elapsed
tAUX1 –	**tAUX1** time-delay elapsed (if flashing: start) (Model A)
tAUX2 –	**tAUX2** time-delay elapsed (if flashing: start) (Model A)
tAUX3 –	***tAUX3*** time-delay elapsed (if flashing: start) (Model A)
tAUX4 –	***tAUX4*** time-delay elapsed (if flashing: start) (Model A)
Comm.Order 1 –	Order received via RS485 communications (Model A)
Comm.Order 2 -	Order received via RS485 communications (Model A)
[79] F.Trip –	Auto-reclose not successful: Final trip (Model A)
[79] Lockout –	Lockout of the auto-reclose function (Model A)
[79] Success. –	The auto-reclose operation is successful (the CB remains closed) (Model A)
[79] Blocked –	The auto-reclose function is blocked (Model A)
TCS 52 Fail –	Trip Circuit Supervision has detected a fault in the CB's circuit (Model A)
CB Alarm –	Circuit Breaker Alarm function signal (***Max CB Open No***., ***Max Sum Amps^n***,***TCS 52 Fail***, ***Max CB Open Time*** and ***Max CB Close Time***) (Model A)
tCB FLT Ext.Sign. –	An input mapped to this function detects CB problems that may influence control possibilities (for example spring problem, insufficient pressure, etc.). Signaling is active after settable time-delay (***GLOBAL SETTINGS/CIRCUIT BREAKER/ tCB FLT ext***) (Model A)

There are up to five (Model A) or one (model L) electromagnetic flag indicators on the front panel (one as standard; the additional four as an ordering option). Flag indicators can be reset using the Ⓒ key on the front panel or a signaling command (via RS485 communications, a binary input or the USB port) depends on the configuration:

- Resetting of LEDs via manual reset (***GLOBAL SETTINGS/LOC/LEDs Reset 0: Manual only***)
- Resetting of LEDs via any protection start (set for CB tripping) or via manual reset (***GLOBAL SETTINGS/LOC/LEDs Reset 1: Start protect.)***
- Resetting of LEDs via manual close command (RS485, HMI or Input) or via manual reset (***GLOBAL SETTINGS/LOC/LEDs Reset 2: Close Command)***.

Note:

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- In Model A it is impossible to reset the electromagnetic flag indicators without powering (Vx or CTs) of P116. Therefore if such a function is required an external flag indicator must be used instead of the electromagnetic flag indicators.
- In Model A it is not possible to reset the electromagnetic flag indicators if P116 is powered from USB only
- In Model L it is possible to reset the electromagnetic flag indicators if P116 is powered from CTs or USB.

In Model A, the electromagnetic Optional Flag Indicators are programmable (***GLOBAL SETTINGS/OPTIONAL FLAG INDICATORS CONF.)***:

Flag Ind. tI> – Trip by the first phase overcurrent stage (if flashing: start)

Flag Ind. tI>> – Trip by the second phase overcurrent stage (if flashing: start)

Flag Ind. tI>>> – Trip by the third phase overcurrent stage (if flashing: start)

Flag Ind. tSOTF - Trip by SOTF element (if flashing: start)

Flag Ind. tIN_1 – Trip by the first earth fault overcurrent stage (if flashing: start)

Flag Ind. tIN_2 – Trip by the second earth fault overcurrent stage (if flashing: start)

Flag Ind. tIN_3 – Trip by the third earth fault overcurrent stage (if flashing: start)

Flag Ind. tI< - Trip by the undercurrent element (if flashing: start)

Flag Ind. tI2> – Trip by the negative sequence overcurrent element (if flashing: start)

Flag Ind. t Brkn Cond -Trip by the Broken Conductor protection (if flashing: start)

Flag Ind. Therm Trip -Trip by Thermal Overload protection (if flashing: alarm)

Flag Ind. CB Fail – Circuit Breaker Failure protection time-delay elapsed

Flag Ind. tAUX1 – Time delay tAUX1 elapsed (if flashing: start)

Flag Ind. tAUX2 – Time delay tAUX2 elapsed (if flashing: start)

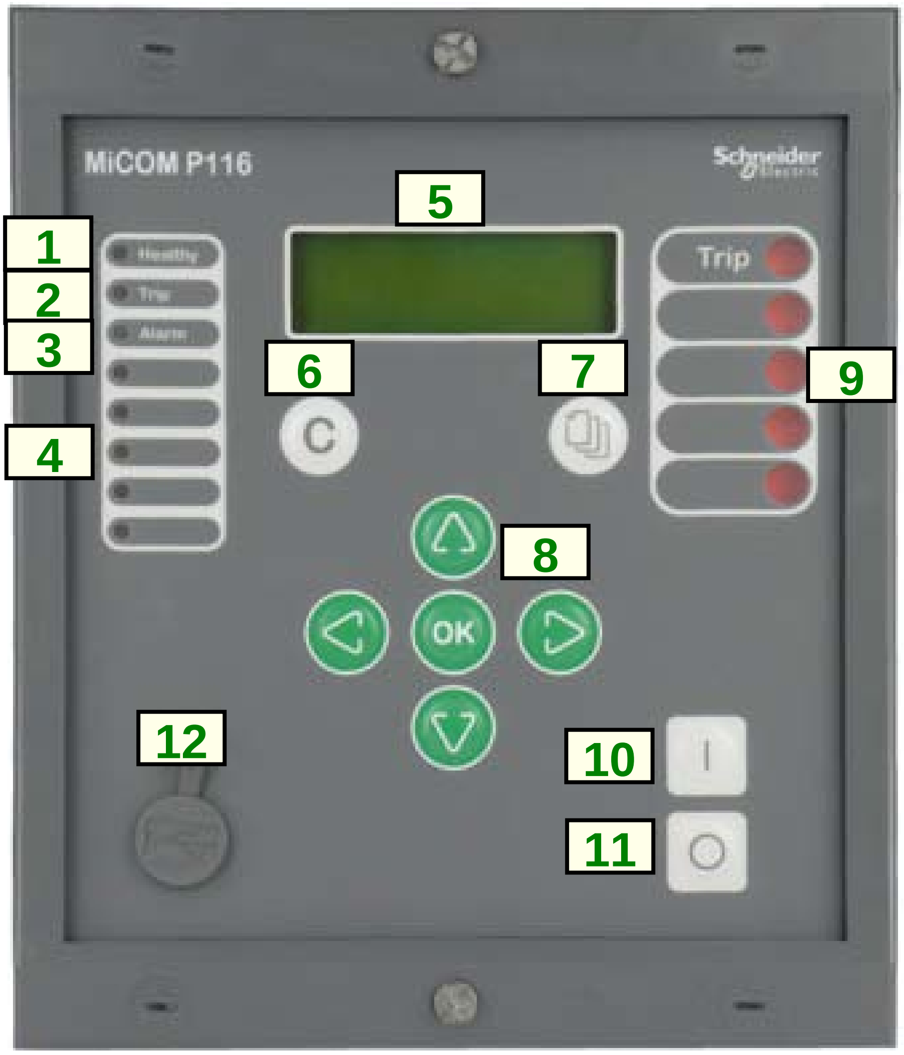
Flag Ind. tAUX3 – Time delay tAUX3 elapsed (if flashing: start)

Flag Ind. tAUX4 – Time delay tAUX4 elapsed (if flashing: start)

Flag Ind. [79] F. Trip – Auto-reclose not successful: Final trip.

Flag Ind. [79] Lockout – Lockout of the auto-reclose function.

Flag Ind. [79] Success.- The auto-reclose operation is successful (the CB remains closed)



1 – Green “Healthy” LED: Watchdog
2 – Red “Trip” LED: Protection trip
3 – Yellow “Alarm” LED: Alarm signaling
4 – Five red programmable LEDs
5 – 16-character by 2-line alphanumeric liquid crystal display (LCD)
6 – Clear key
7 – Read key (jump to **RECORDS** column)
8 – 4 arrow keys, an enter key
9 – Electromechanical flag indicators (Model L has one only)
10 – CB Close key
11 – CB Open key (model A)
12– USB port for local connection

Figure 1: P116 Front Panel (max hardware version)

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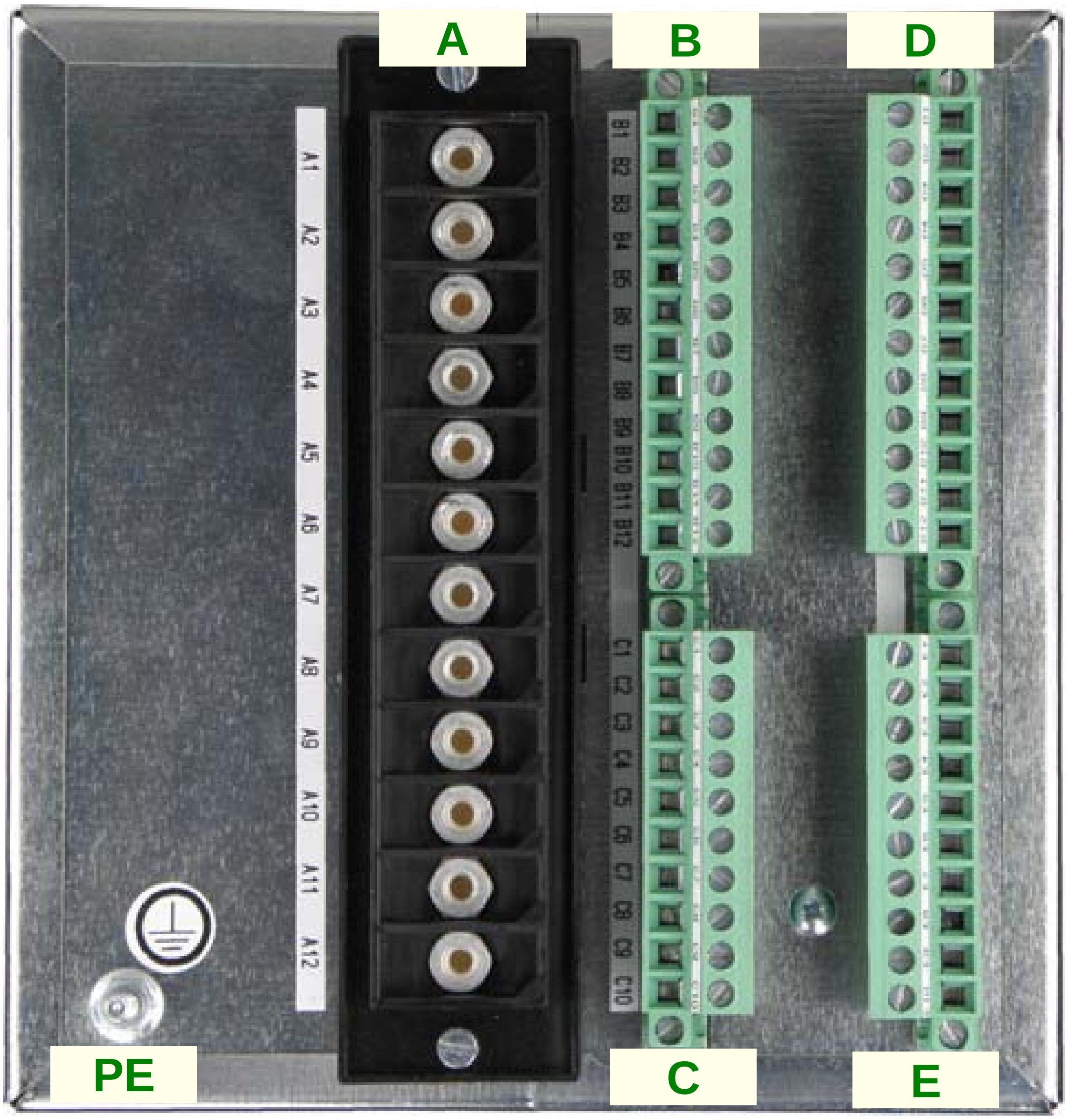
Basic Flush Mounting Case Model A



A – Current ring terminal block A: Current analogue inputs (phases and earth)
B – Terminal block B: Model A - Auxiliary voltage Vaux and contact outputs
C – Terminal block C: Energy outputs (sensitive trip coil, Model A- Flag indicator) and Model A - RS485
D – Terminal block D: Binary inputs (Model A)
E – Terminal block E: Contact outputs (Model A)
PE – PCT Protective (Earth) Conductor terminal

P116 + Flush mounting Cassette:

P116+Wall mounting Cassette:

Figure 2: Terminals View of the P116 (Model A)

2.2 Relay connection and power-up

The relay can be powered from the following sources:

- Current input phase A
- Current input phase B
- Current input phase C
- E/F Current input (N) (depends on terminal connections and configuration in P116 menu)
- Auxiliary voltage Vaux (terminals B1-B2) (Model A)
- USB port (only some electronic boards: to ensure HMI and USB communications)

2.2.1 Auxiliary Supply Voltage (Vx) connection (Model A)

Before applying the auxiliary supply voltage to the relay, check that the rated nominal ac or dc voltage is appropriate for the application and that it will be connected to the correct terminals (B1&B2). The relay's serial number, current rating, and power rating information can be viewed on the upper side of the case. The ac or dc supply voltage must be within the corresponding nominal range of the device, as indicated in the table below, for the appropriate nominal rating of the equipment:

Nominal ranges of auxiliary voltage Vx	Operative dc range	Operative ac range
24 to 60 Vac/dc	19 to 72 Vdc	19 to 66 Vac
60 to 250 Vdc and 60 to 240 Vac	48 to 300 Vdc	48 to 265 Vac

Once the ratings have been verified for the application, connect the equipment to an external power source capable of delivering the requirements specified on the label, to perform the relay familiarization procedures. Please refer to the wiring diagrams in the Installation section for complete installation details, ensuring that the correct polarities are observed in the case of dc supply.

Note: The label specifies the auxiliary voltage for the P116 supply input and binary inputs (dependent on ordering options).

2.2.2 Current inputs

The measuring current inputs of the P116 should be connected to the secondary wires of the power system CTs as shown in the connection diagrams in section 8 of P116 Installation chapter P116/EN IN.

The parameters of the CTs that can be connected to the P116’s current input terminals are detailed in section 3 of chapter P116/EN AP – CT REQUIREMENTS .

2.2.3 Trip coil energy output

Terminals C1 and C2 (terminal block C) are used for connection to the CB's sensitive/very sensitive trip coil/striker with nominal parameters:

- Nominal voltage of the tripping coil or striker : from 12Vdc to 24 Vdc
- Required trip energy ≤ 0.1 J

or MITOP (Schneider Electric CBs) trip coil.

The trip energy is provided by capacitors built into the P116. The trip command is a 50 ms pulse and its repetition depends on the trip coil's impedance and on the current value. Repetition continues until the tripping current criteria are reset.

The tripping voltage on terminals C1 and C2 depends on the tripping coil parameters.

The value of voltage is changed during trip execution.

Note: Be sure of polarity on the P116 and MITOP terminals. C1 must be connected to “+” and C2 to “-“.

Functions may be assigned to the trip coil output in the ***SETTING GROUP x/OUTPUT CONFIGURATION*** column of menu (special symbol" "T" in first line ***SETTING GROUP 1(2)OUTPUT RELAY CONFIGURATION G1(2****) column)*

2.2.4 Flag indicator output (Model A)

Terminals C3 and C4 (terminal block C) are used for connection to an external flag indicator.

The flag indicator can be used for trip signaling. The flag indicator output is supplied from a built-in capacitor separate from the trip coil output (terminals C3 and C4).

The trip command is a 50 ms pulse; its repetition depends on the external relay's impedance (flag indicator coil) and on the current value. Repetition continues until the tripping current criteria are reset.

The voltage on terminals C3 and C4 is greater than 24 Vdc. The trip energy is greater than 0.01 J.

Functions may be assigned to the Flag Indicator output in the ***SETTING GROUP x/OUTPUT CONFIGURATION*** column of menu (special symbol" "F" in first line ***SETTING GROUP 1(2)OUTPUT RELAY CONFIGURATION G1(2****) column)*.

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2.2.5 Earthing

Screw terminal is the Protective (Earth) Conductor Terminal which must be permanently connected for safety reasons (refer to Figure 2).

Output contacts

P116 Model A has 6 output contacts + 1 configurable WD (watchdog).

P116 Model L has 1 output contacts + 1 WD (watchdog).

P116 is delivered with the following default factory settings for the outputs:

- Output RL1 (N/O: B3-B4, N/C: B4-B5) is not configured.
- Output RL2 (N/O: B6-B7, N/C: B7-B8) is not configured (Model A)
- Output RL3 (N/O: B9-B10) is not configured. (Model A)
- Output RL4 (N/O: B11-B12) is not configured. (Model A)
- Output RL5 (N/O: E2-E4, N/C: E3-E4) is not configured. (Model A)
- Output RL6 (N/O: E5-E7, N/C: E6-E7) is not configured. (Model A)

Output WD

- Model A: (N/O: E8-E10, N/C: E9-E10) is configured to ***GLOBAL SETTINGS/LOC/Out. WD Hard.Sign.: 0: Opened*** (after powering remains open. In case of any P116 internal fault will be closed).
- Model L: (N/O: B6-B7, N/C: B7-B8) is not configured

To modify the outputs' configuration, refer to section 2.2 and 3.1 of chapter P116/EN ST - Settings.

The output connection diagram is shown in section 9 of chapter P116/EN IN - Installation.

2 Binary inputs (Model A)

The P116 has 6 binary inputs (terminal block D):

- Input L1: D1-D2 terminals
- Input L2: D3-D4 terminals
- Input L3: D5-D6 terminals
- Input L4: D7-D8 terminals

- Input L5: D9-D10 terminals
- Input L6: D11-D12 terminals

There are two types of inputs (ordering option):

- **Standard Binary Inputs**: 24-240 Vac or 24-250 Vdc (standard) (Cortec Order Ref. P116xxxxxxx1xxxxxx)
- **DC Binary Inputs** with settable switching thresholds: 110 Vdc / 129 Vdc / 220 Vdc (Cortec Order Ref. P116xxxxxxx2xxxxxx)

Standard Binary Inputs can operate with an AC or DC auxiliary voltage supply but the voltage type (AC or DC) must be selected for each input in the menu (***GLOBAL SETTINGS/GENERAL INPUTS CONFIGURATION***):

- ***Input 1*** (2 ... 6) **Filtering**: ***0: dc/ac***
- ***Input 1*** (2 ... 6) **Filtering**: ***1: ac***
- ***Input 1*** (2 ... 6) **Filtering**: ***2: dc***

GS

dc/ac option: Binary Input operates with both AC (48Vac-240Vac) or DC (24Vdc-250Vdc) auxiliary voltage from 39Vac or 19Vdc but in order to switch its state from low to high the input needs a current above 35 mA for about 0.5 ms. This feature protects the Binary Input (with very low voltage stage: 19 Vdc or 39Vac) against disturbances on wire connections. After about 2 ms the consumption of current is reduced to about 2.3 mA for dc and 2.5mA -20mA for ac (depends on the auxiliary voltage level – see Technical Data chapter). Higher current levels (35mA) do not depend on the auxiliary voltage value.

The ***dc/ac*** option has a 15 ms filtering time.

ac option: AC filtering is applied to reduce the DC component in the auxiliary voltage. The filtering time is about 7.5 ms.

dc option: DC filtering is applied to reduce the AC component in the auxiliary voltage. The filtering time is about 5 ms.

The P116 is delivered with the following default factory settings for Input filtering: ***dc/ac*** (universal AC or DC auxiliary voltage) and no inputs (L1-L6) are mapped to any functions.

To modify the inputs' configuration, refer to section 2.3 and 3.9 of chapter P116/EN ST - Settings.

The input connection diagram is shown in section 8 of chapter P116/EN IN - Installation.

DC Binary Inputs with settable switching thresholds can be used with DC auxiliary voltage only with nominal voltages:

- 110 Vdc
- 129 Vdc
- 220 Vdc

The nominal auxiliary voltage is set in the ***GLOBAL SETTINGS/GENERAL INPUTS CONFIGURATION*** column of menu.

Note: DC Binary Inputs cannot see the AC component so make sure that DC auxiliary voltage is connected to the input terminals.

The P116 is delivered with the following default factory settings for Input filtering: ***110 Vdc*** and no inputs (L1-L6) are mapped to any functions.

To modify the inputs' configuration, refer to section 2.3 and 3.9 of chapter P116/EN ST - Settings.

The input connection diagram is shown in section 8 of chapter P116/EN IN - Installation.

2.3 Introduction to the user interfaces and setting options

The relay has a USB user interface for use with MiCOM S1 and S1 Studio setting software.

With this interface it is possible to download the setting values, latest faults and events as well as disturbance records and fully configure the P116.

Note: After connection to the USB port the ***Healthy*** LED is lit. If the LED is not lit refer to chapter P116/EN TS - Troubleshooting.

The USB port integrates electronic boards only to allow communications with the P116 via the HMI /USB interfaces.

2.4 Changing parameters via the front panel user interface (HMI)

Changing of all parameters is password-protected.

After restart or powering up, the P116 is in ***Protection Mode***. This means that all settings are the same as in the relay's operation system and are available on the front panel user interface.

To change any parameters, it is necessary to switch the P116 to the ***SETTING CHANGE MODE****.*

The ***SETTING CHANGE MODE***, for entered password level which changes setting parameters, is indicated by the sequential flashing of the programmable LEDs (from 4 up to 8 LEDs) on the front panel.

Until it is switched back from the ***SETTING CHANGE MODE*** to the ***PROTECTION MODE****,* or restarted by disconnecting then reconnecting the power supply, the P116 uses the setting parameters that were active before the ***SETTING CHANGE MODE*** was entered (previous settings).

Press the OK navigation key, after changing a chosen parameter (confirmation of change). The new value is saved in FRAM memory but the P116 still uses the setting value that was active before the ***SETTING CHANGE MODE*** was entered (previous settings). The new value will be available in the operation system only after the firmware has been reset. When the firmware is reset, all the settings are loaded into the P116 system.

When switching from the ***SETTING CHANGE MODE*** to the ***PROTECTION MODE****, a* warm reset is applied.

The P116 therefore applies the new parameters to the relay's operation system.

Afterwards, the settings available on the front panel and those used by the operation system are consistent.

Note: 1. While the LEDs are flashing (***SETTING CHANGE MODE*** *by entering* ***Administrator*** *or* ***Protection setting*** password) there can be a mismatch between the settings displayed on the front panel and those used by the operating system.

2. When "***Control only***" rights password is entered there is no any LED signaling like for ***Administrator*** *or* ***Protection setting*** password. Additionally all changes are executed and recorded immediately. After any control action made in the menu or after 10 minutes, P116 switches back automatically from the ***SETTING CHANGE MODE*** to the ***PROTECTION MODE***.

The password protection of the relay comprises three levels:

– Administrator (***Without limits***)

– Protection setting (***Protection only***)

– Control only (***Test control***) – this level is used for tests and/or control execution only (no changing of setting parameters) so signaling of ***SETTING CHANGE MODE*** differs from above. On this password level there is no the sequential flashing of the programmable LEDs (from 3 up to 8 LEDs). On the control windows is the special sign: which informs that control is allowed.

Administrator rights: all the menu settings may be changed (violet color on Fig.10-21).

Protection setting rights: it is possible to change settings in the ***PROTECTION*** column; ***CTRL Default Windows (CB status CTRL, L/R status CTRL, [79] CTRL)*** and ***COMMISSIONING/Maintenance Mode*** windows are also possible (green color on Fig.10-21).

Control rights: ***CTRL Default Windows (CB status CTRL, L/R status CTRL, [79] CTRL)*** and ***COMMISSIONING/Maintenance Mode*** windows from the front panel only (yellow color on Fig.10-21).

For each level the password consists of 4 digits (**0** to **9**)

NOTE:

1. **The default password is 0000 for every password protection level.**
2. **For communication via Setting Software (MiCOM S1 Studio or MiCOM S1) the administrator password must be entered – the same as was entered in the relay.**
3. **S1 recognizes password as characters. If the password is 0001 (in the password window of P116's menu, 4 digits are displayed) it is necessary to enter 0001 in S1 (all four digits have to be put). For above case: 1 or 01 or 001 will be rejected. 0001 will be accepted only.**
4. **After 10 minutes without pushing navigation keys P116 returns to *Public* rights.**

It is recommended to change default password from 0000 to unique value for every password level.

If the first password is different, this means that the *Administrator* password has been changed.

The *Protection setting* password is still **0000**. Therefore, to protect settings against unauthorized access it is necessary to change the *Protection setting* password by first entering **0000** then a new value.

The Control password is still **0000**. Therefore, if it is necessary to change it, first enter 0000 then the new value (*Control* right) of the password.

Notes:

1. If the *Protection setting* rights have not been changed, or if it has been set to the default value (**0000**), it is possible to change all the settings in the ***PROTECTION*** column, reset the counters and control the CB without entering a password, simply by pressing the OK navigation key. This makes it possible to change a chosen parameter by automatically switching the P116 to the ***SETTING CHANGE MODE*** (the programmable LEDs are flashing).
   This means that even after changing only one parameter it is necessary to switch the P116 back to ***PROTECTION MODE*** in order to activate the new settings (warm restart).

2. If the Control rights password has not been changed or if it has been set to the default value (0000) it is possible to control the CB in menu without password protection.

3. If the *Control* rights password is entered if control command is applied via menu, execution of this control command will return to *Public* rights (exit from *Control* to *Public* rights).

4. **Maintenance Mode** can be reached by entering at least *Control* password. *Control* password is valid up to exit from Maintenance Mode, after 10 minutes counted from entrance or after execution of any control command via menu.. Control rights are not indicated via flashing of programmable LEDs, so to avoid confusing it is recommended to assign **ALARM** LED to **Maintenance Mode** function (see LED configuration)

2.4.1 *SETTING CHANGE MODE*

The ***SETTING CHANGE MODE*** should be used to change settings.

Using the ***SETTING CHANGE MODE*** ensures that all changed parameters will be applied simultaneously so as to avoid any problems caused by possible setting inconsistencies.

The ***SETTING CHANGE MODE*** makes it possible to change settings while the relay is active without any risk (the P116 continues to use the previous settings).

After exiting the ***SETTING CHANGE MODE*** a warm restart of firmware is applied so that all the protection counters are reset.

Note: Latched LEDs and outputs are not reset (stored values are not cleared during a P116 reset)

To switch the P116 to the ***SETTING CHANGE MODE*** navigate to the ***SETTING CHANGE MODE*** main header (see Figure 9), then press the key:

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```
Edit settings?
Enter PSWD
```

Press the OK navigation key.

```
Edit settings?
Enter PSWD 0000
```

The **0** digit furthest to the right is flashing.

Enter the password:

1. If the digit is flashing, change the digit to the required value by pressing the key or the key.
2. Change the flashing digit by pressing the key or key.
3. Continue as above to set the whole password (4 digits)
4. If the correct password is set, press the OK navigation key

The LCD displays 'OK' during approximately 1 second, then the new ***SETTING CHANGE*** cell is displayed:

If the password entered is for:

- *Administrator* rights:

```
Setting change:
 Without limits
```

To indicate that the P116 is in ***SETTING CHANGE MODE*** on the level: ***"Without limits"*** the programmable LEDs are flashing

- *Protection* settings:

```
Setting change:
 Protection only
```

To indicate that the P116 is in ***SETTING CHANGE MODE*** on the level: ***"Protection only"*** the programmable LEDs are flashing

- *Control* only:

```
Setting change:
 Test control
```

There is no any indication that this level is entered. ***SETTING CHANGE MODE*** is active by 10 minutes only. Exit from this mode is after applying any control from the front panel protected by "Test control" password.

The screen displays the scope of the current modification rights..

At this time it is possible to start changing the setting parameters.

Note: The parallel pressing: and key it makes jump from any place to:

```
Edit settings?
 Enter PSWD
```

the menu cell in which the password can be entered (hot key).

If all settings are changed, it is necessary to return to ***PROTECTION MODE*** to apply a warm reset.

GS

Press the and keys simultaneously to jump to the following cell:

```
Edit settings?
Exit:press ENTER
```

Press the OK navigation key to apply a warm reset and display the following cell:

```
Setting change:
       Protected
```

The programmable LEDs do not flash sequentially. The P116 is in ***PROTECTION MODE***

Note: In ***SETTING CHANGE MODE*** all functions use the previously stored settings (before the ***SETTING CHANGE MODE*** was entered).

<u>Changing of a single setting parameter</u>

Go to the required setting cell (see section 2.5.8).

Press the HMI OK key.

```
Edit settings?
Enter PSWD 0000
```

Using the , , , keys, enter the password.

Press OK navigation key to confirm the password and switch to ***SETTING CHANGE MODE***.

Press OK navigation key to enter the chosen setting parameter.

Using *the* , , , keys, set the required value.

Confirm the change by pressing the OK navigation key.

Switch from ***SETTING CHANGE MODE*** to ***PROTECTION MODE***.

For example, press the and keys simultaneously to display the following cell:

```
Edit settings?
Exit:press ENTER
```

Press the OK navigation key to switch from ***SETTING CHANGE MODE*** to ***PROTECTION MODE***.

The following cell should be displayed:

```
Setting change:
      Protected
```

The above cell confirms that settings are password-protected, and that the P116 is in ***PROTECTION MODE***.

Additionally the programmable LEDs do not flash sequentially.

Changing the password

To change the password, first enter the existing password to obtain the appropriate password protection rights.

Press the key to display the following cell:

```
Change Password
```

GS

Press *the* OK navigation key, to display:

```
Change Password
           0000
```

Using the , , , keys, enter the new password.

Press OK navigation key to confirm the new password and jump to the cell displaying information on protection rights

For example:

```
Setting change:
 Without limits
```

To exit the ***SETTING CHANGE MODE*** (apply a warm reset) press the and keys simultaneously to display the following cell:

```
Edit settings?
Exit:press ENTER
```

Press the OK navigation key to confirm switching from ***SETTING CHANGE MODE*** to ***PROTECTION MODE***.

The following cell should be displayed:

```
Setting change:
      Protected
```

The above cell confirms that the settings are password-protected and that the P116 is in ***PROTECTION MODE***. Additionally the programmable LEDs do not flash sequentially.

Lost password

If the password is lost please contact with Schneider Electric organization in the country or use the link below:

http://www.schneider-electric.com/sites/corporate/en/support/contact/customer-care-contact.page

For contact it is necessary to know MiCOM P116 serial number which can be read from the nominal plate on the case (for example: SN00036046) or in the main: “OP Parameters” column of the menu

For details – see chapter: “Troubleshooting” (**TS**).

2.5 P116 Menu description

2.5.1 Headers

The main headers are shown in Figure 3.

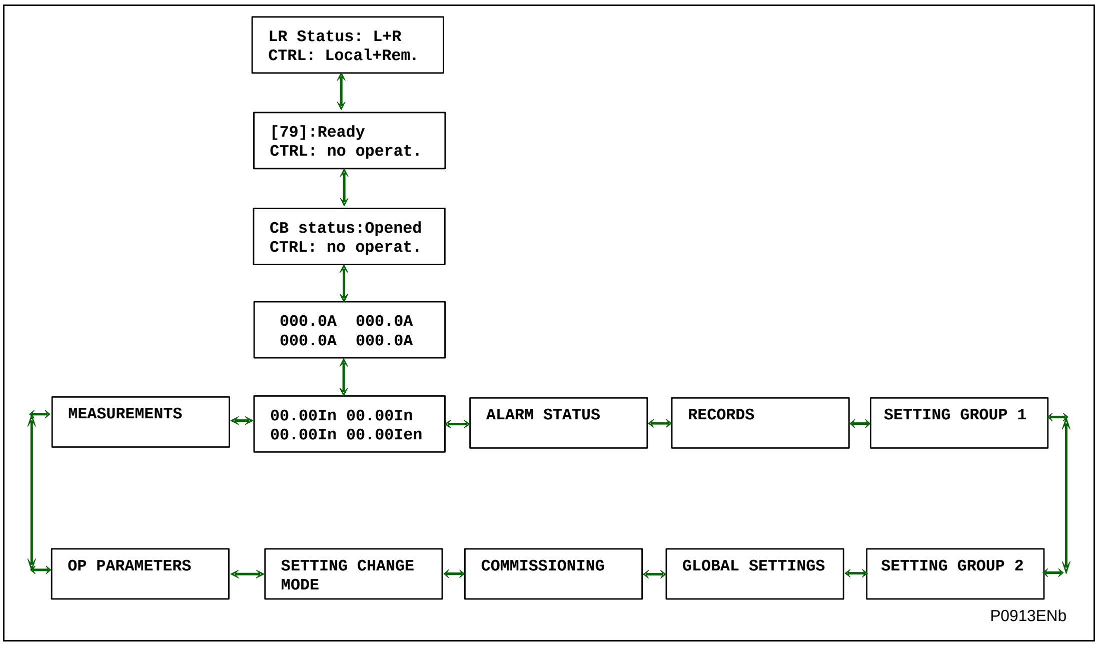

Figure 3: Column headers (Model A)

2.5.2 *ALARM STATUS* column (Model A)

ALARM STATUS (see Figure 4) information is available if the cause of alarm has been triggered. Therefore, if after pressing the key no the new cell is displayed, it means that no alarms have been detected.

Depending on the P116's configuration an alarm signal is self-resetting (no cause of alarm – no alarm signal; ***GLOBAL SETTINGS/LOC/Alarm Display 0: Self-reset***) or manually resettable (alarm signal latched; ***GLOBAL SETTINGS/LOC/Alarm Display 1: Latching***).

Default setting: ***0: Self-Reset.*** This means that if an alarm signal has disappeared no information is available in the ***ALARM STATUS*** column.

If set to ***Latching***, this means that if an alarm signal has disappeared information is still available in the ***ALARM STATUS*** column until it is reset in the ***ALARM STATUS/ Alarm Reset*** window.

Alarm information is always available in the event recorder. However, the programmable LEDs can be used to store causes of alarm if required.

Figure 4 shows all causes of alarms (if alarms have been enabled in the main configuration column of the protection function).

GS

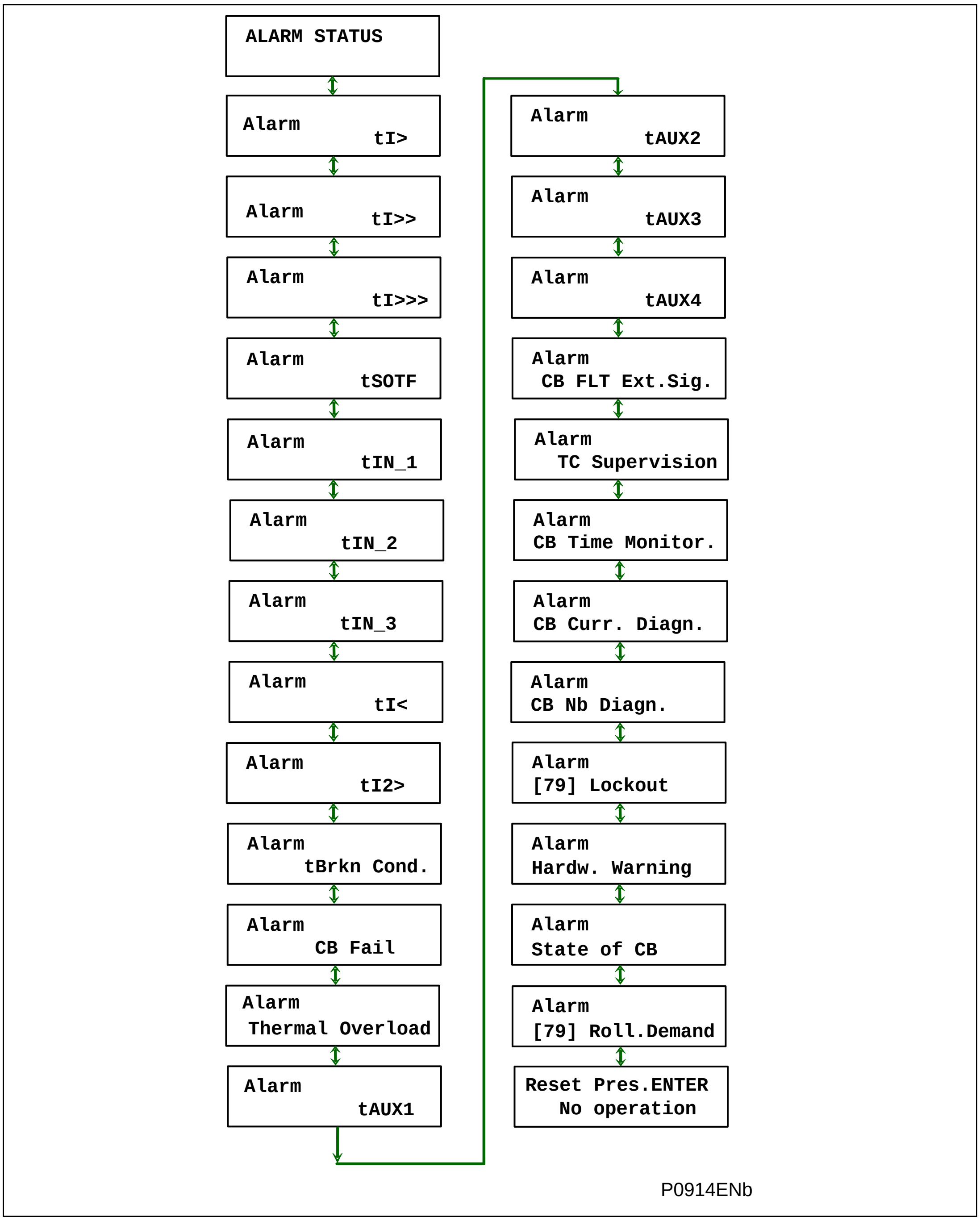

Figure 4: ALARM column (Model A)

2.5.3 ***RECORDS*** column

Twenty fault records are available in the P116.

Changing a record in the menu is possible in the ***Record Number*** menu cell, by pressing the OK navigation key then the ⮟ or ⮝ key. Once the required record is selected, press the HMI OK key to confirm the change. If the *Control* rights password has been set to the default value (0000), this operation does not require entering a password; otherwise it is necessary to enter the *Control* rights password.

Records in the ***Fault Recorder*** can be reset using the MiCOM S1 communication software or additionally (Model A) - via the RS485 link.

GS

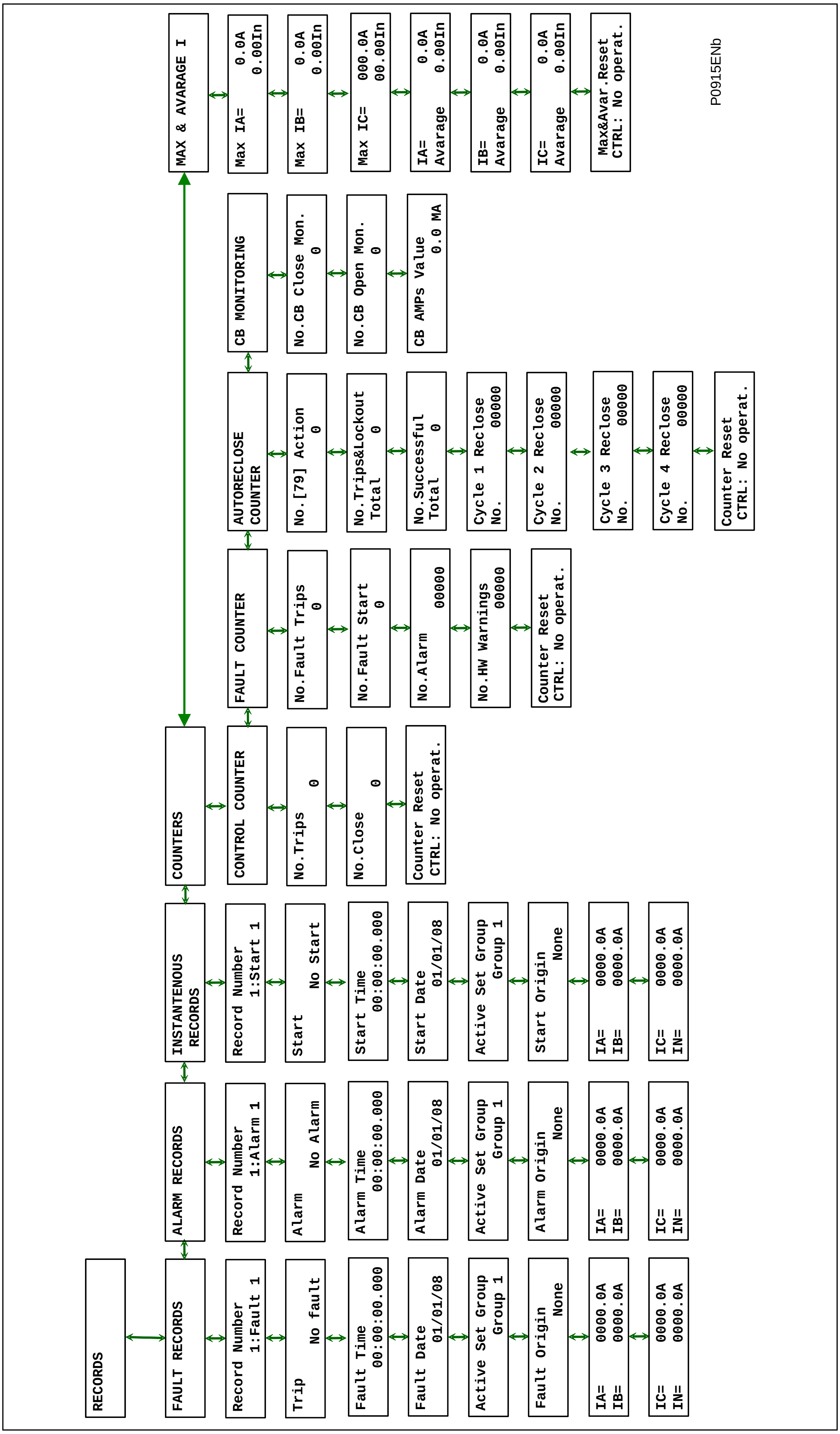

Figure 5: RECORDS column (Model A)

Counters can be reset in the ***Counter Reset*** cell of the menu, by pressing the **OK** key then the ⌵ or ⌃ key. Once the required record is selected, press the **OK** key to confirm the change. This operation requires entering a ***Administrator*** password (***Without limits***).

In addition, counters can be reset using the MiCOM S1 communication software or via the RS485 link.

2.5.4 ***SETTTING GROUP*** columns (model A)

The P116 has two setting groups. The relay is delivered with one setting group active only (factory default setting).

If two setting groups are to be used, the second setting group must be activated in the menu cell:

GLOBAL SETTINGS/SETTING GROUP SELECT/Setting Group Select*:*

Nb of Groups 0: One Group

GS

by changing its setting from ***0: One Group*** to ***1: Two Groups***

Each setting group includes:

- Protection settings
- Output relay configuration
- Binary input configuration
- Programmable LED configuration

Switching between setting groups is possible via:

- Configured binary inputs
- Menu (**GLOBAL SETTINGS/SETTING GROUP SELECT/Setting Group Select** cell)
- MiCOM S1 setting software
- Remotely via RS485

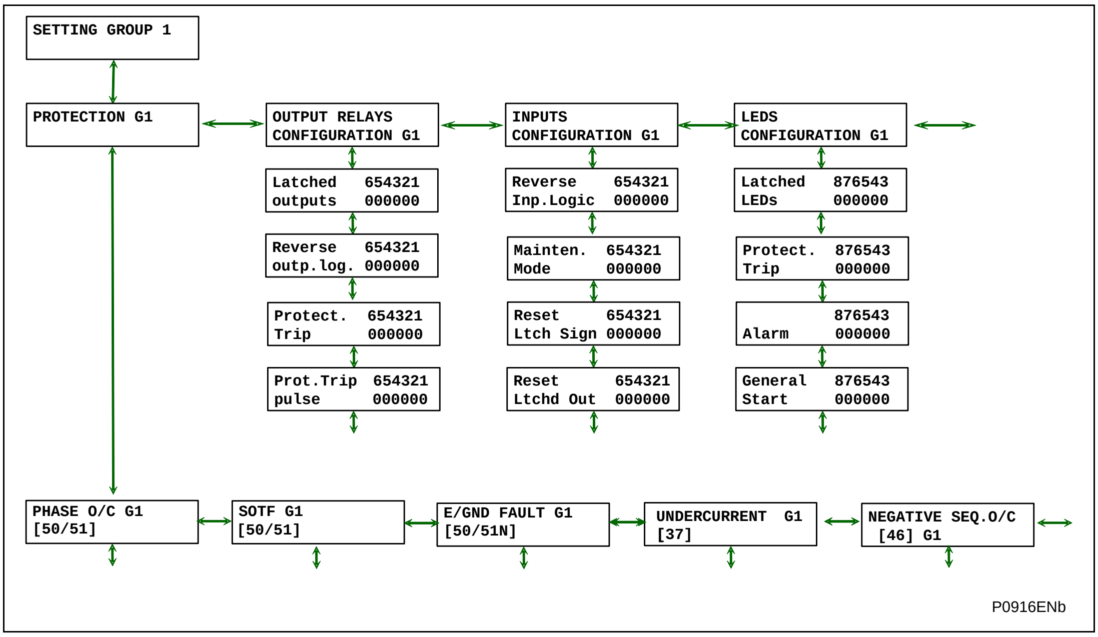

Figure 6: SETTING GROUP 1 columns (Model A)

Information about the active setting group is available in menu: **OP PARAMETERS/ Active Set Group** cell.

Information about the active setting group can be displayed via the programmable LEDs by configuring them to that function and via a special symbol on the LCD display.

Notes:

1. If setting groups are to be switched using a binary input, this binary input must be configured to setting group switch both in Setting Group 1 and Setting Group 2.

2. It is possible to copy all the parameters from Setting Group 1 to Setting Group 2 or vice versa (**GLOBAL SETTINGS/SETTING GROUP SELECT/Copy Settings** cell). It will then only be necessary to change the parameters' values.

3. After changing of setting group all latched LEDs and output contacts are reset.

2.5.5 ***GLOBAL SETTINGS*** column

Global Settings include all general settings, such as:

- Localization (***LOC***)
- Setting Group operation (***SETTING GROUP SELECT***) (Model A)
- Current transformer parameters (***CT RATIO***)
- Settings related to Circuit Breaker control or monitoring (***CIRCUIT BREAKER***)
- Advanced settings for the inrush blocking (***INRUSH BLOCKING)***
- Advanced settings for the over-current protection elements (***O/C ADVANCED)***
- Advanced settings for the Auto-reclose function (***[79] ADVANCED SETTINGS***) (Model A)
- Advanced settings for the communication orders via RS485 (***COMMUNICATION ORDERS***)(Model A)
- Configurationon of the optional flag indicators (***OPTIONAL FLAG INDICATORS CONF.***) (Model A)
- Configuration of the inputs, depending on the hardware option: voltage type (dc or ac filtering) or voltage stage for input energizing (***GENERAL INPUT CONFIGURATION***) (Model A)
- RS485 communication parameters (***COMMUNICATION***) (Model A)
- Definition of the time window for maximum and average recordings (***MAX & AVERAGE I CONFIGURATION***)
- Settings for the disturbance recorder (***DISTURBANCE RECORDER)***

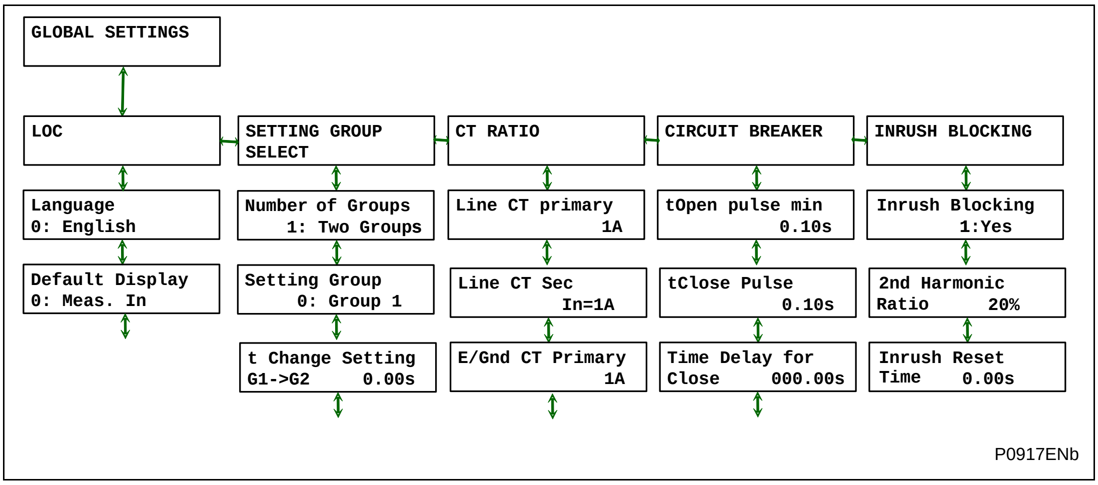

Figure 7: GLOBAL SETTINGS column (Model A)

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In Model A, it is possible to Copy all parameters from Setting Group 1 to Setting Group 2 and inversely in the ***Copy settings*** cell by pressing the OK navigation key. Choose the required operation by pressing the or key (***Copy G1 → G2*** or **Copy G2 → G1**). Confirm the change by pressing the OK navigation key.

Note: The setting group change's time-delay, from Setting Group 1 to Setting Group 2 (***t Change Setting*** cell), applies to changes effected via a binary input only.

2.5.6 ***COMMISIONING*** column

The settings available in the the *COMISSIONING* column are:

– ***Opto I/P status*** – which binary inputs are active (logic status) (Model A),

– ***Relay O/P status*** – which binary outputs are active (logic status),

– ***Maintenance mode*** – allows the user to check the operation of the protection functions without actually sending any external command (tripping or signaling),

– ***Test Pattern*** – allows the user to set outputs contacts for tests,

– ***Contact Test Time*** – defines the output's pulse length during the tests,

– ***Test outputs*** – if set to **1: *apply test***, pressing the OK navigation key will execute the test of the outputs,

– ***Functional Test*** – allows the user to set the protection criteria to be tested,

– ***Functional Test End*** – defines the end of the functional test: ***CB opened*** or ***Time (Model A)***

– ***Functional Test Time*** – defines the pulse length during the functional test,

– ***Functional Test*** – if set to ***CTRL: Operate***, pressing the OK navigation key will execute the functional test.

It is possible to set following ***Maintenance mode*** options :

- "***No***" - ***Maintenance mode*** is disabled. All window cells below are hidden (***Maintenance mode*** is the latest cell in ***COMMISIONING*** column)

- "***Yes,outp.trips***" - ***Maintenance mode*** is enabled. In this mode all test cells in ***COMMISIONING*** column are available (see Fig.8 below). During tests outputs are energized.

- "***Yes,outp.block***" - ***Maintenance mode*** is enabled and all test cells in ***COMMISIONING*** column are available (see Fig.8 below). In this mode, the high state of output functions are ignored (control of outputs are blocked).

This operation requires entering a ***Control*** rights password (***Test control***).

It is possible to set additional programmable LED for Maintenance Mode.

Note:

1. The Maintenance Mode is active up to 10 minutes only. After this time P116 automatically sets **- *Maintenance mode:*** “***No***”. It protects user against leaving the P116 in this mode after tests.

2. During ***Functional Test*** the rest protection stages are active, so in case of fault during test of a one protection element, the rest protection elements are ready to trip, if the fault current is above stage of protection element and the time delay is counted. The selected

3. If ***Functional Test*** is applied for the protection element which is disabled, there will be no any action, even if ***Functional Test*** is executed.

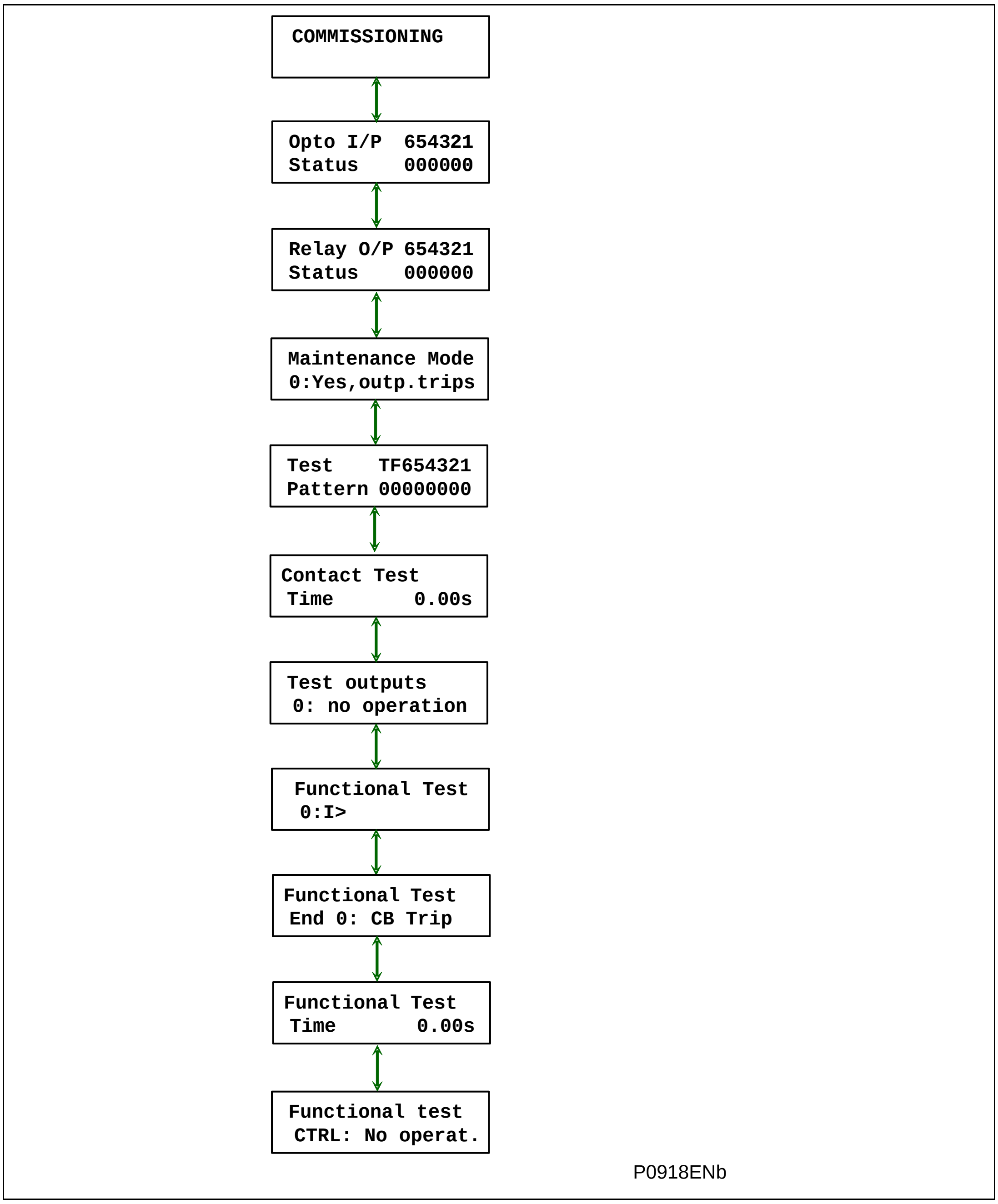

Figure 8: COMMISSIONING column (model A)

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2.5.7 *SETTING CHANGE MODE* column

The ***SETTING CHANGE MODE*** column is used to:

- Allow changing of all parameters in the menu (***SETTING CHANGE MODE).***
- Set a new password or change the existing password (Change Password)

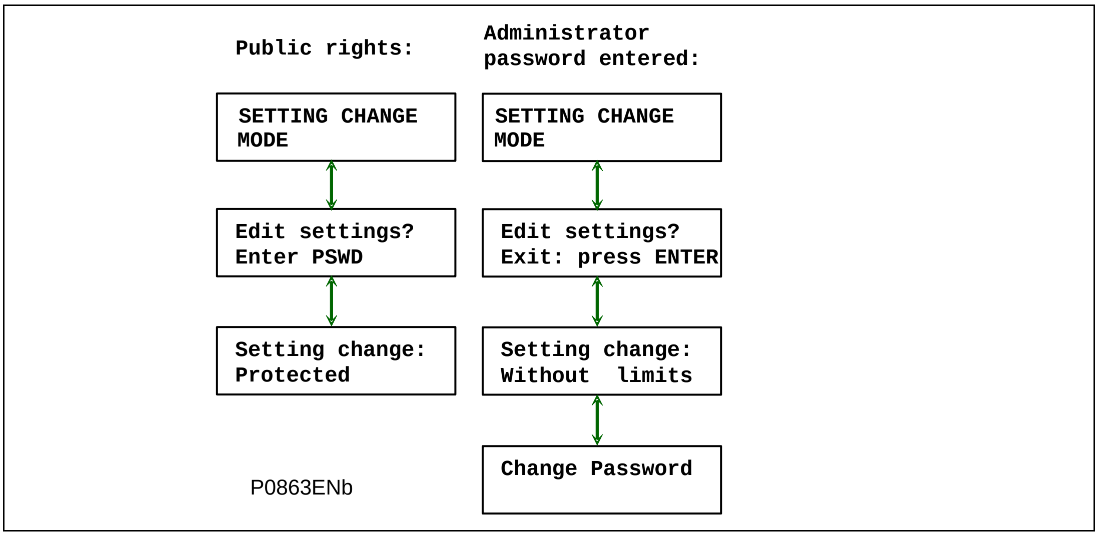

Figure 9: SETTING CHANGE MODE column

2.5.8 Menu Map

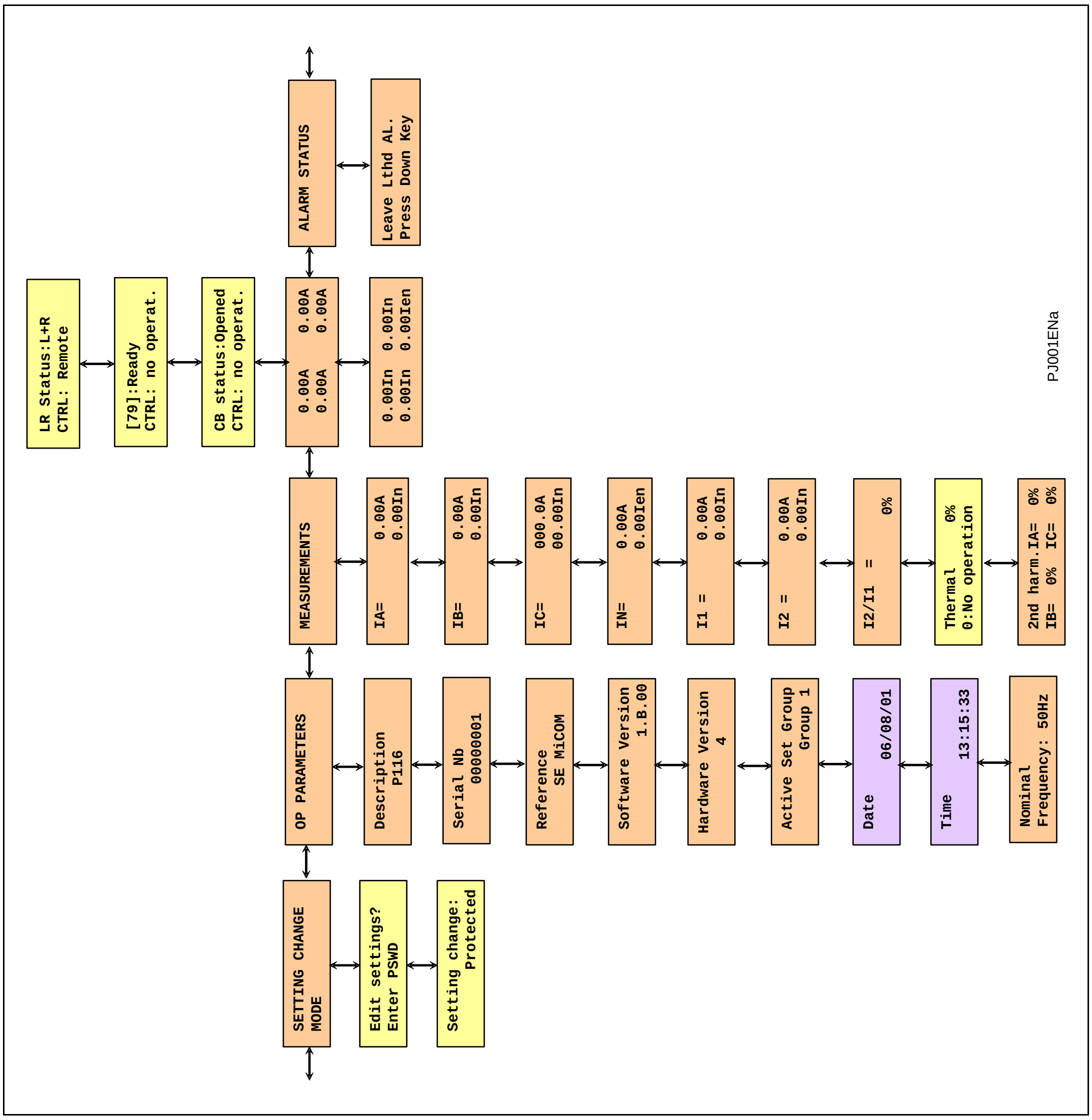

Figure 10: P116 Model A Menu Map 1 (Firmware: 1C)

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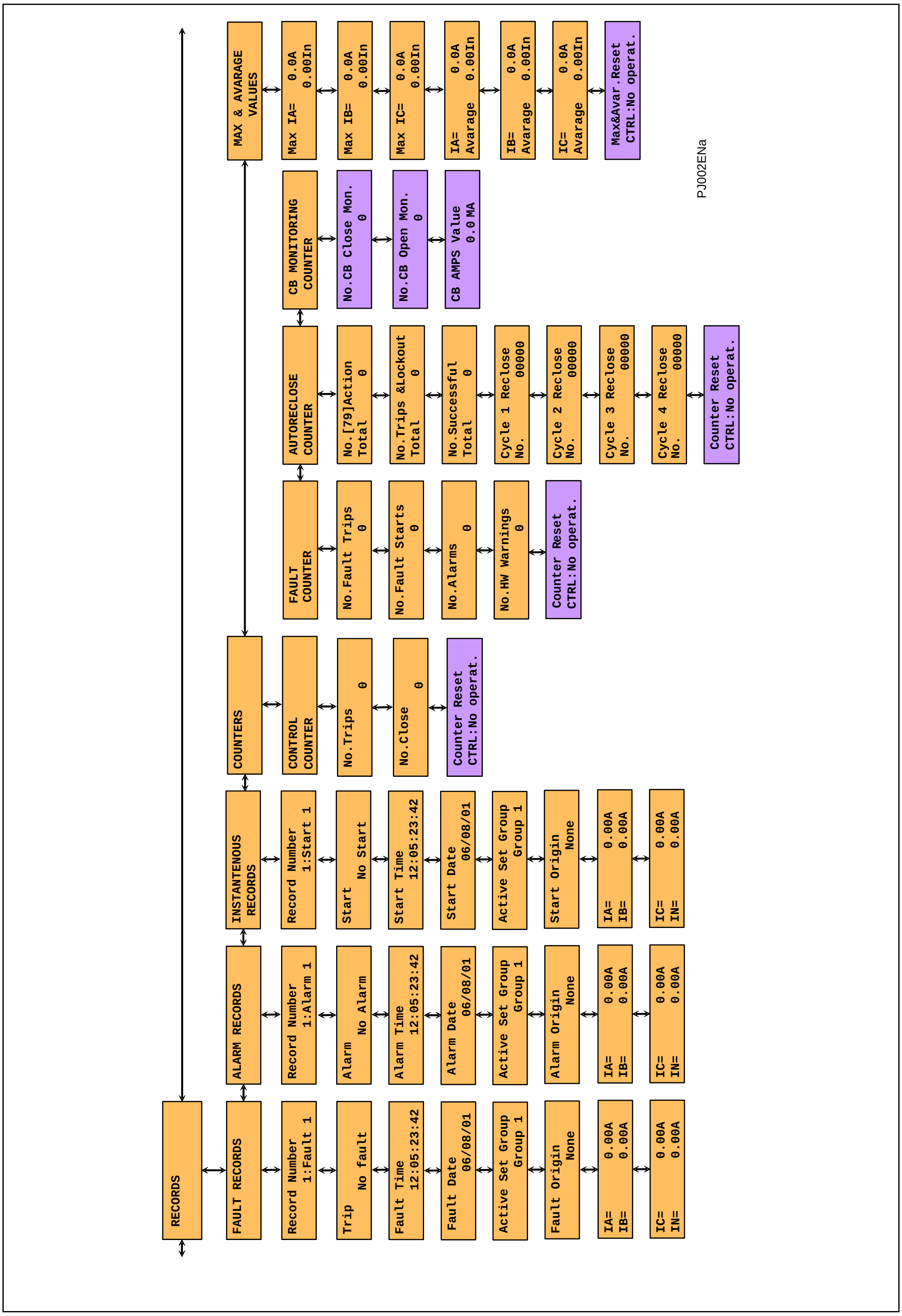

Figure 11: P116 Model A Menu Map 2 (Firmware: 1C)

GS

Figure 12: P116 Model A Menu Map 3 (Firmware: 1C)

GS

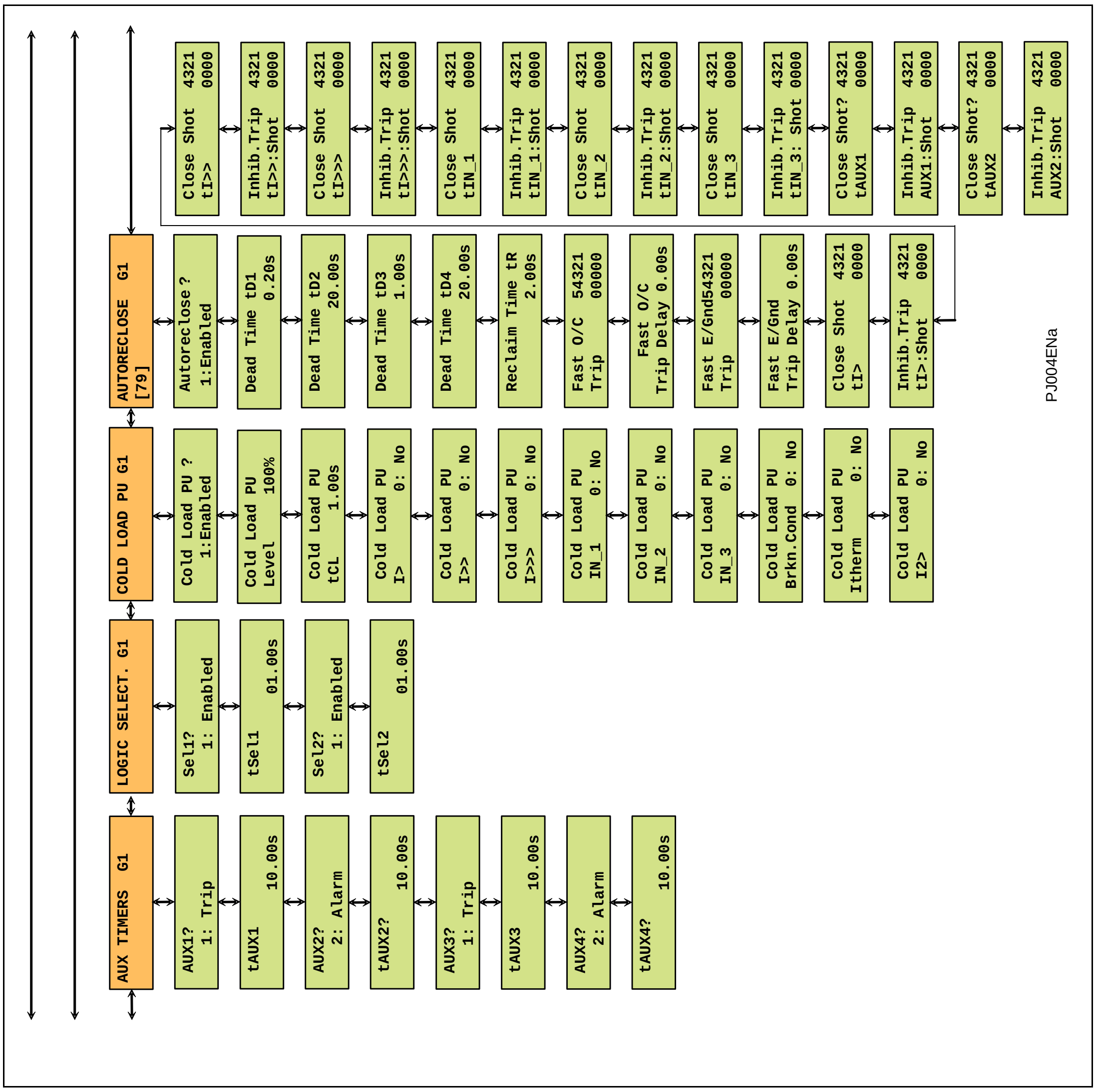

Figure 13: P116 Model A Menu Map 4 (Firmware: 1C)

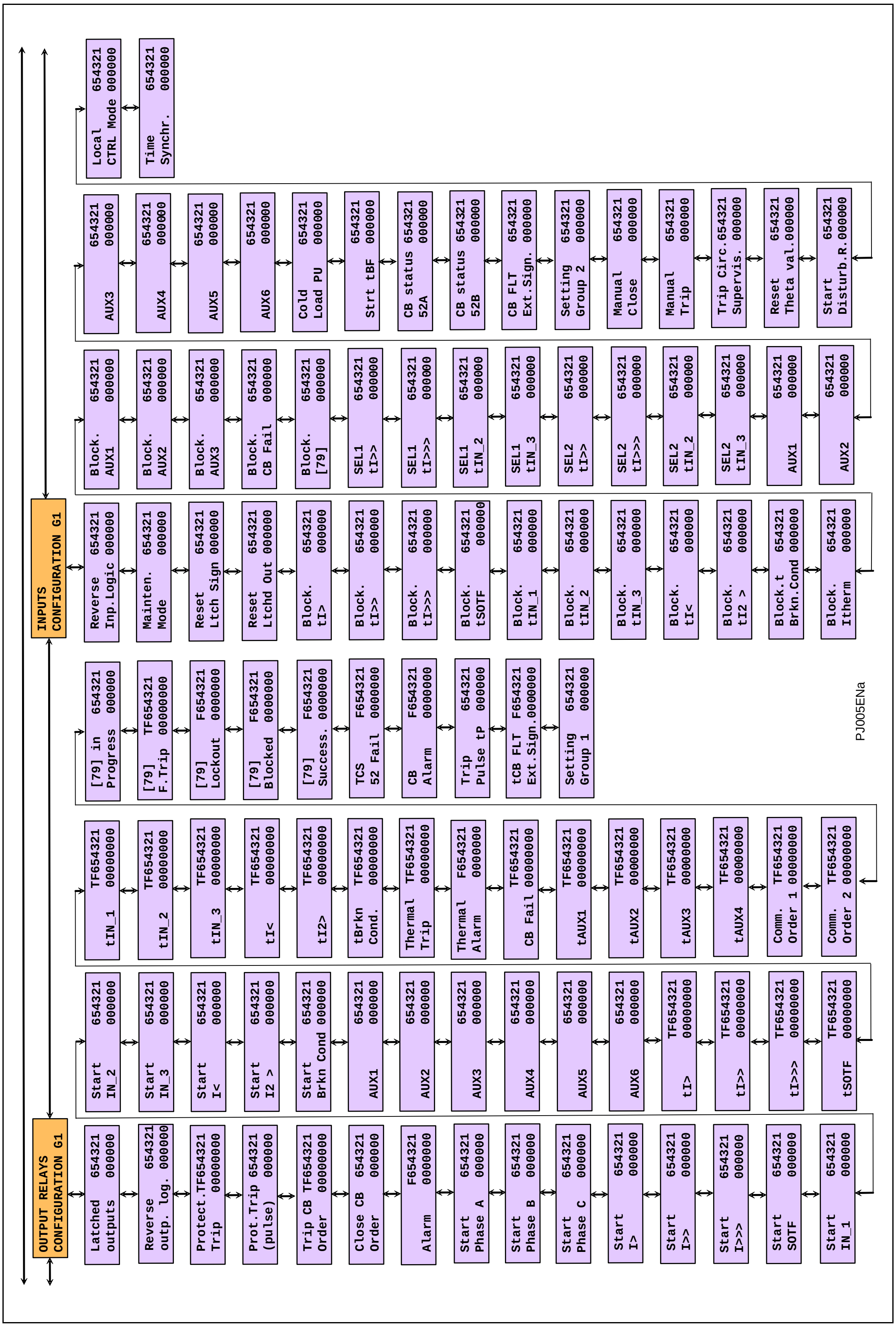

Figure 14: P116 Model A Menu Map 5 (Firmware: 1C)

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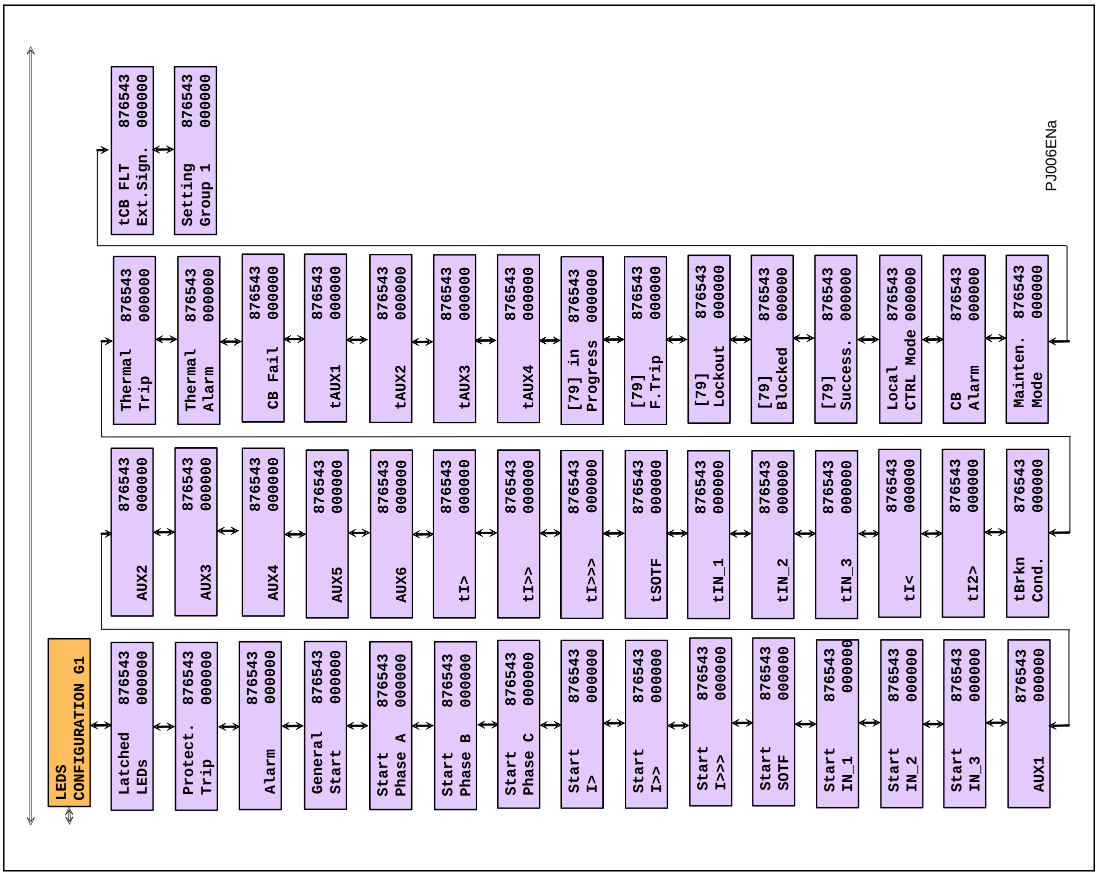

Figure 15: P116 Model A Menu Map 6 (Firmware: 1C)

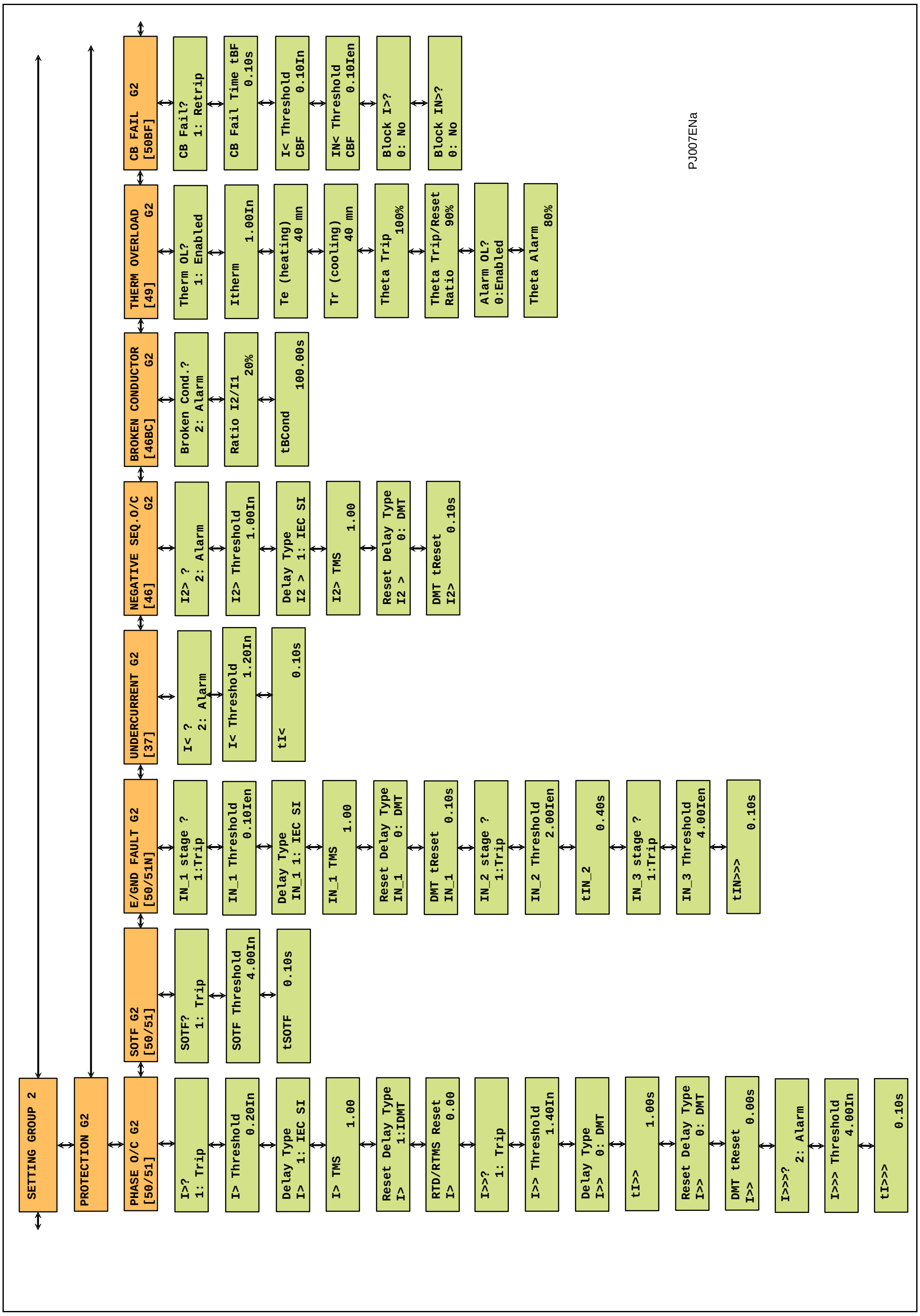

Figure 16: P116 Model A Menu Map 7 (Firmware: 1C)

GS

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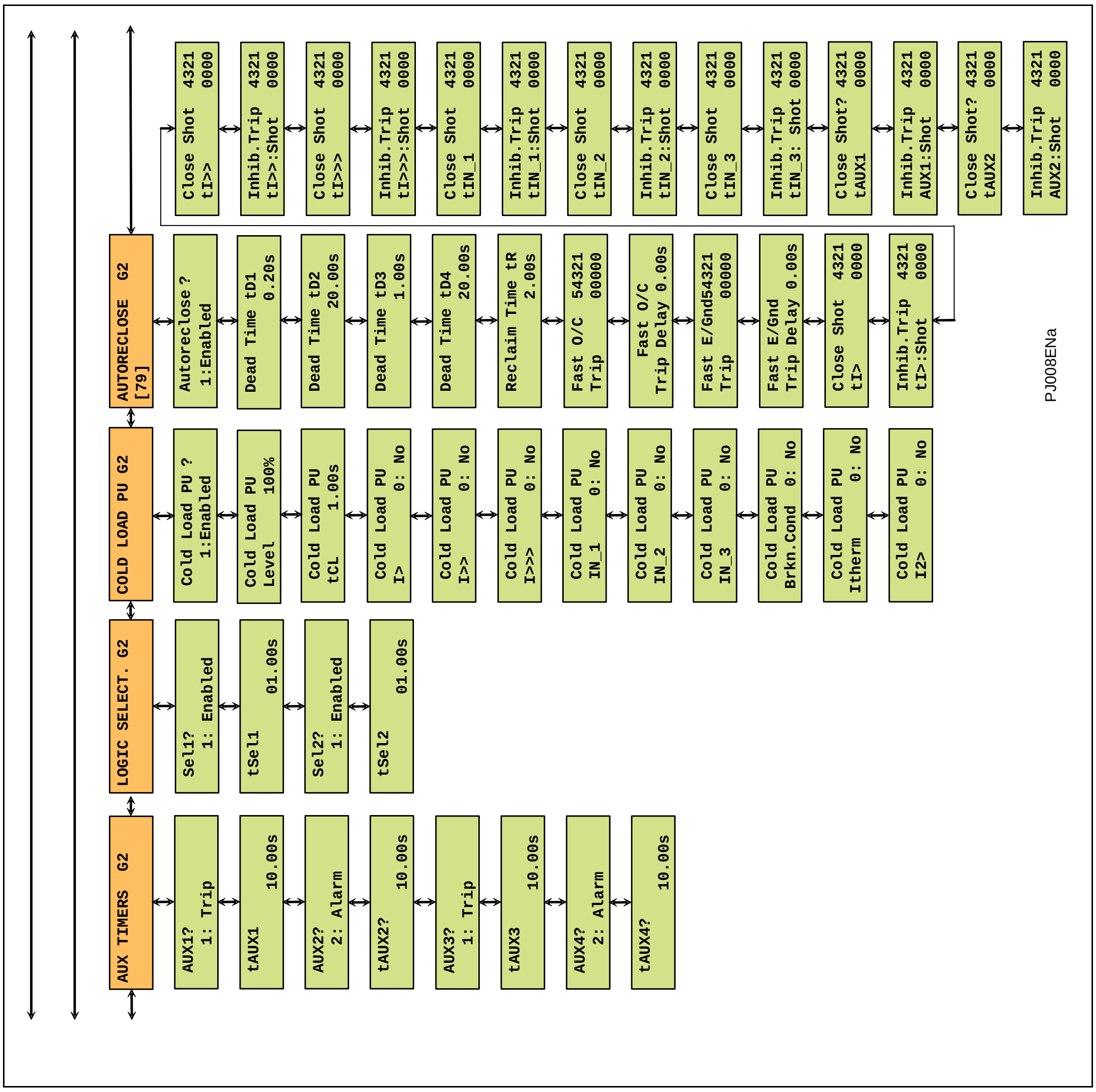
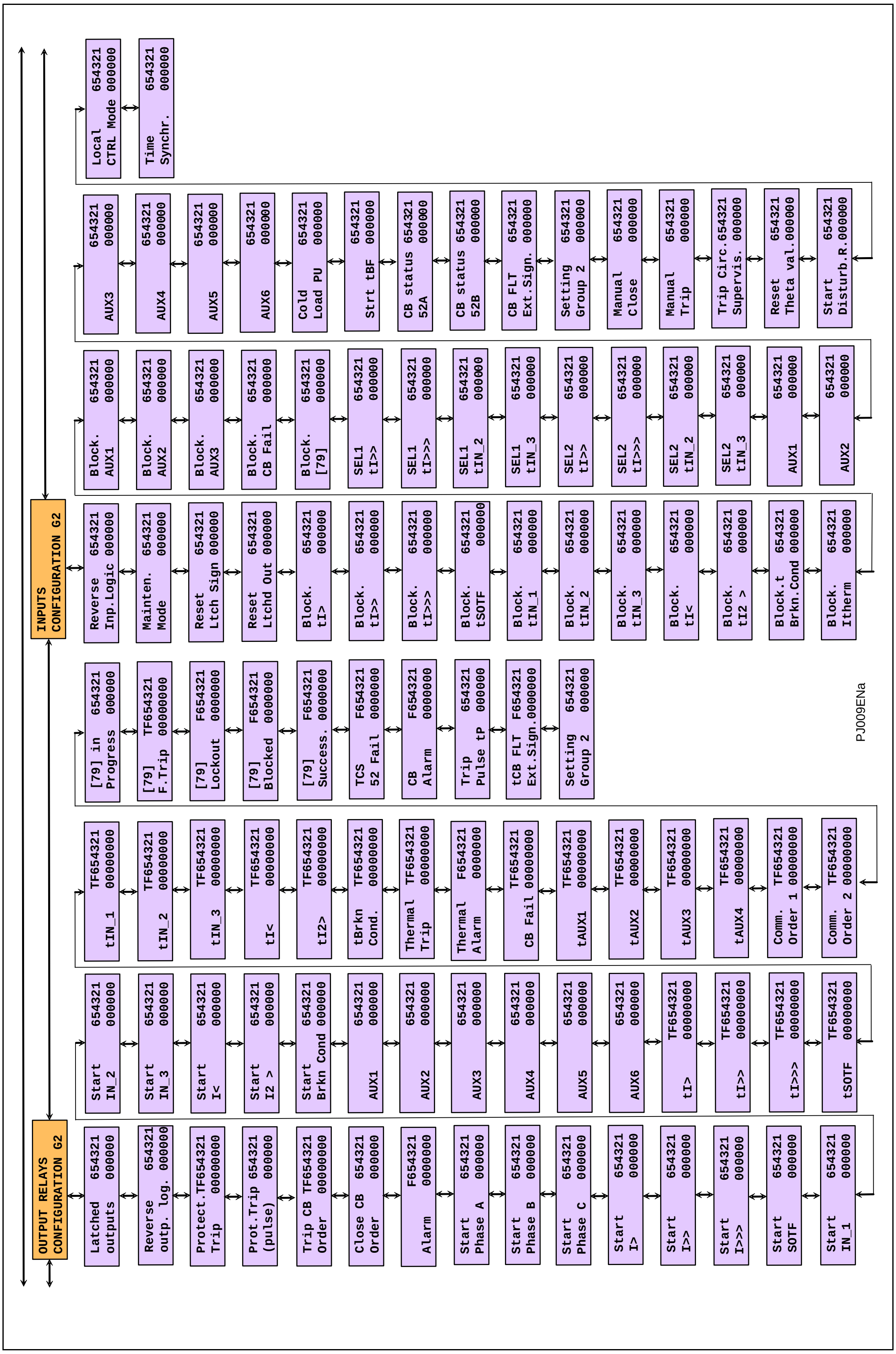


Figure 17: P116 Model A Menu Map 8 (Firmware: 1C)



GS

Figure 18: P116 Model A Menu Map 9 (Firmware: 1C)

GS

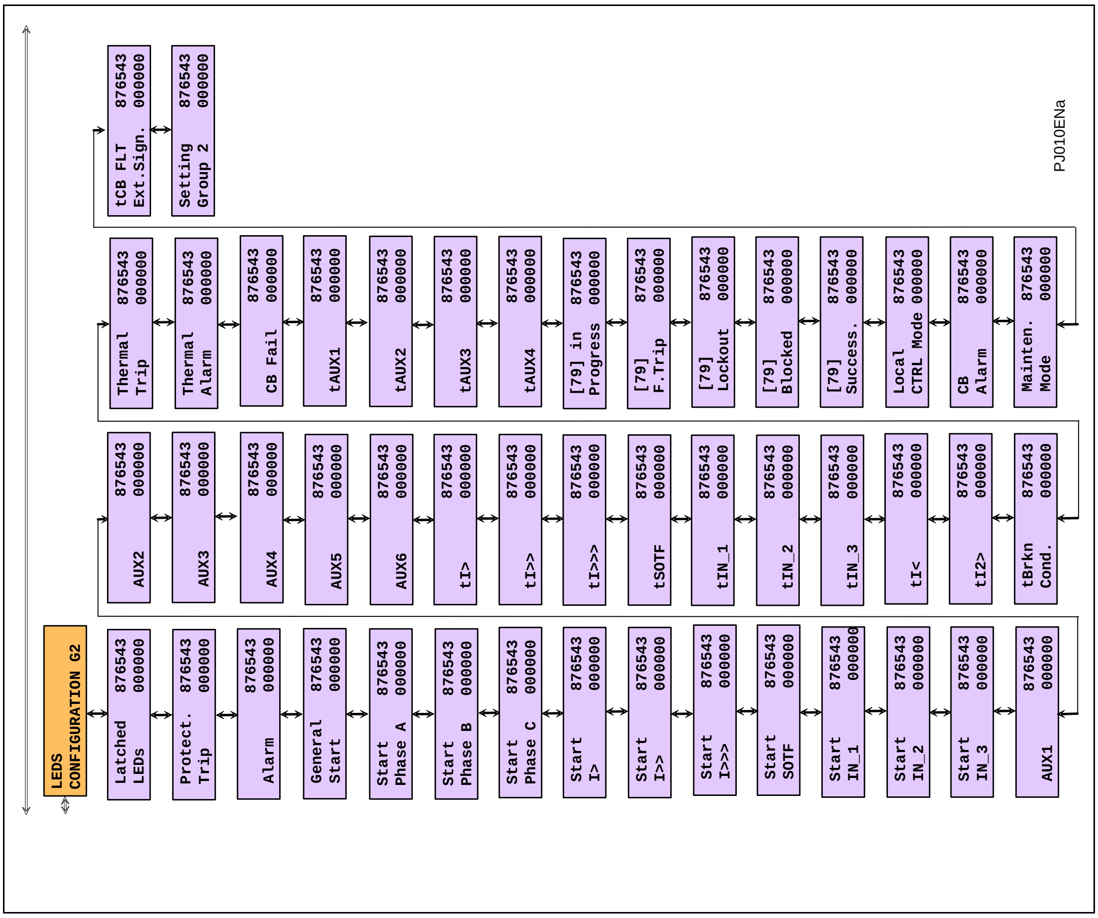


Figure 19: P116 Model A Menu Map 10 (Firmware: 1C)

GS

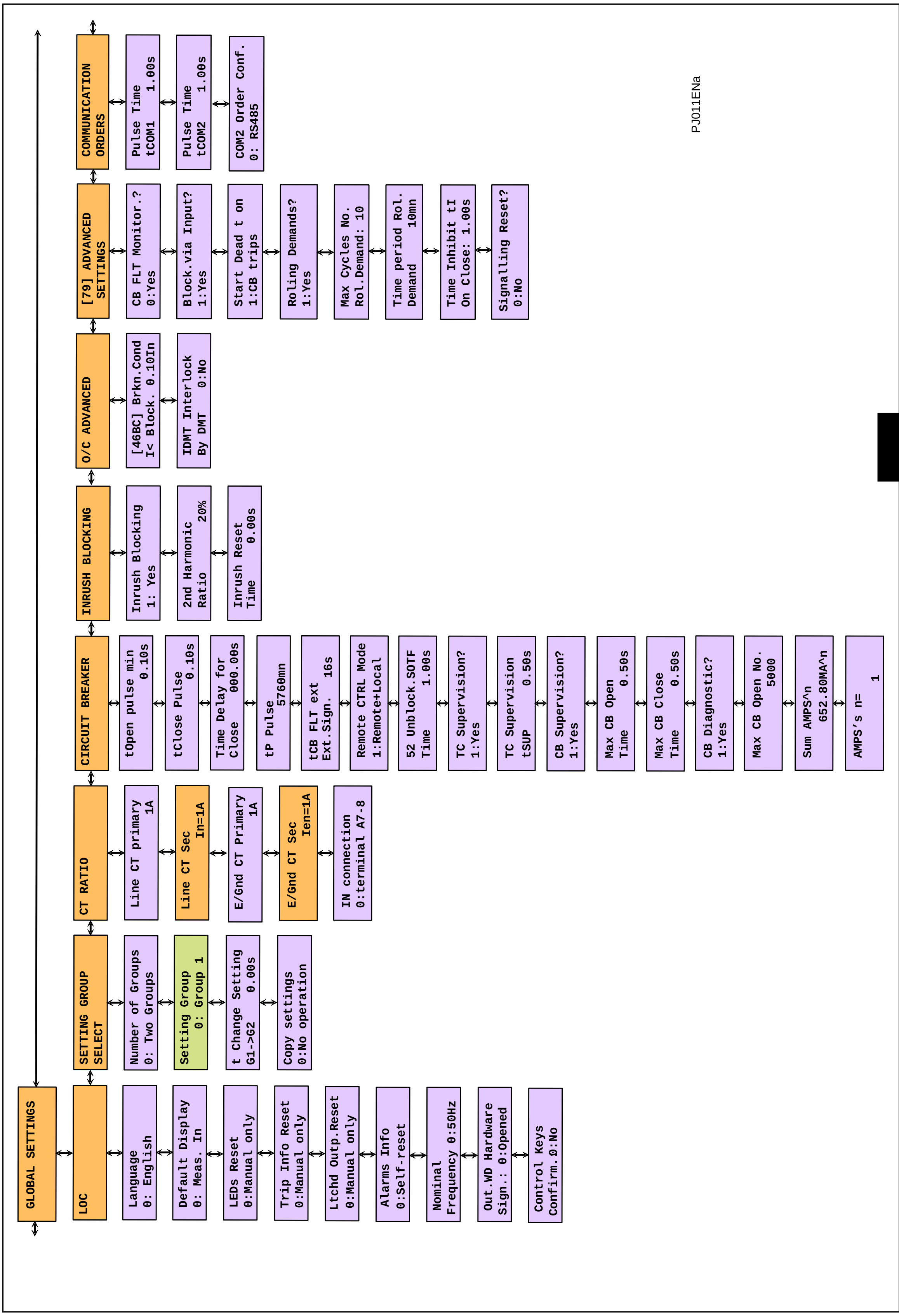


Figure 20: P116 Model A Menu Map 11 (Firmware: 1C)

GS

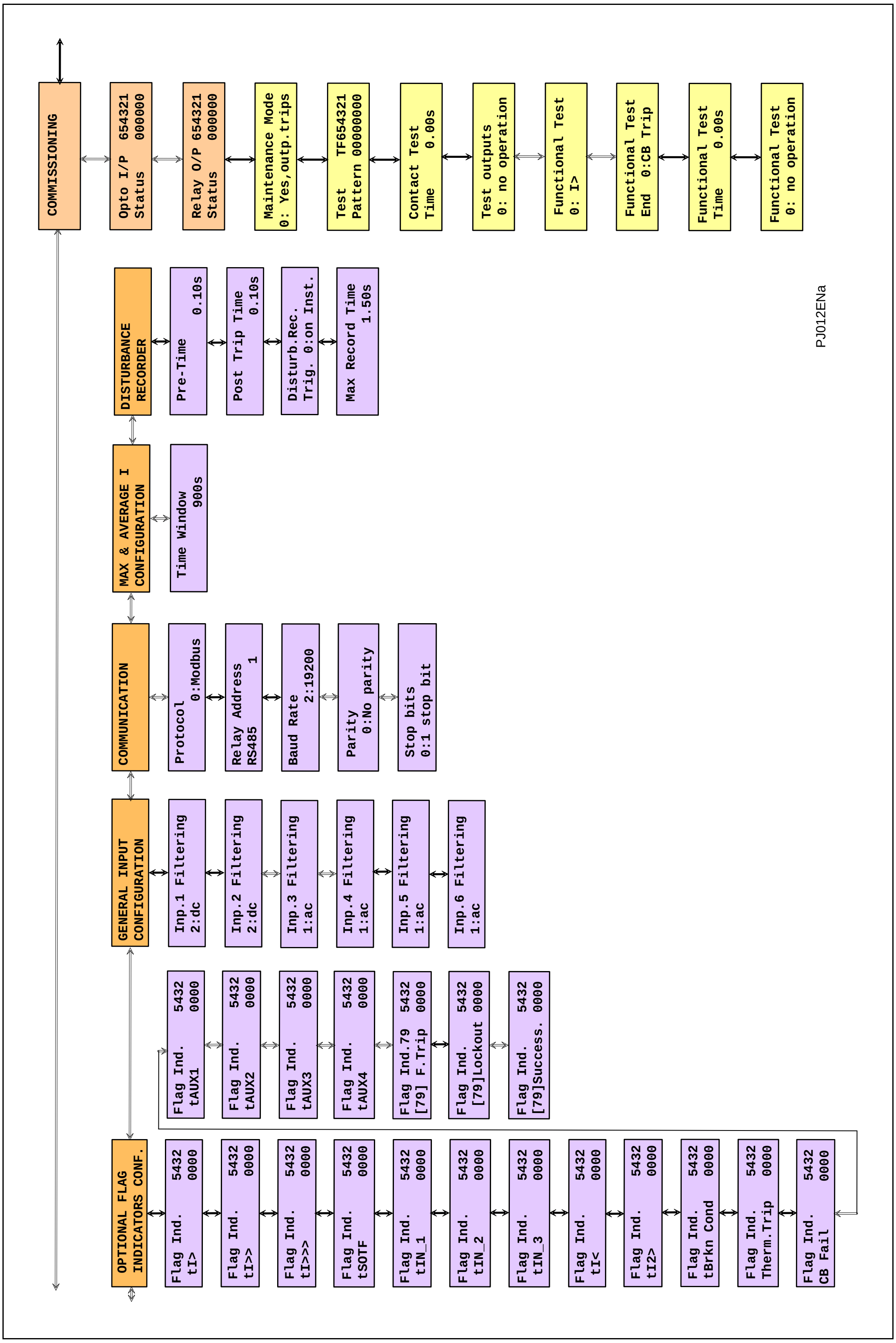


Figure 21: P116 Model A Menu Map 12 (Firmware: 1C)

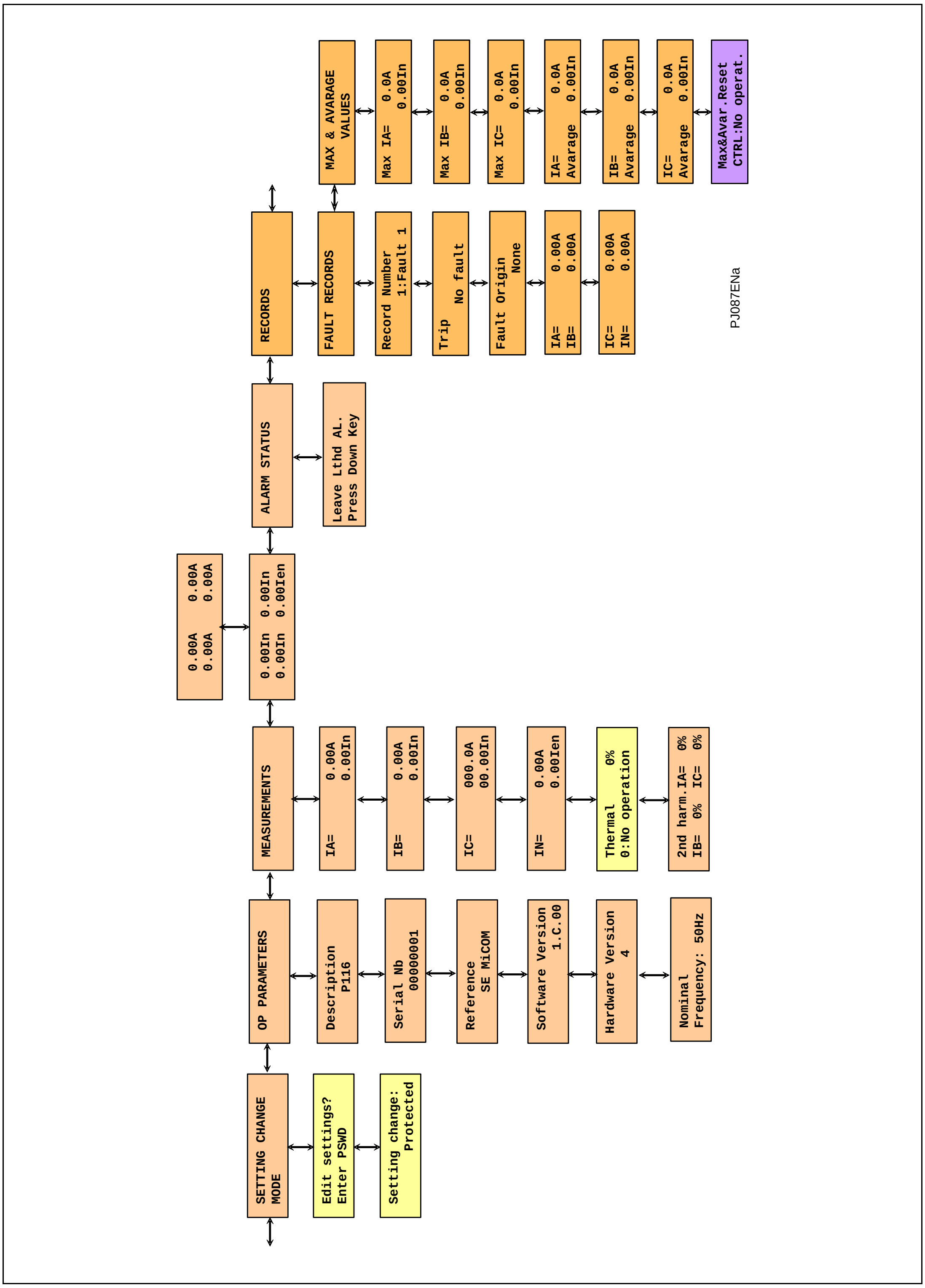


Figure 22: P116 Model L Menu Map 1 (Firmware: 1C)

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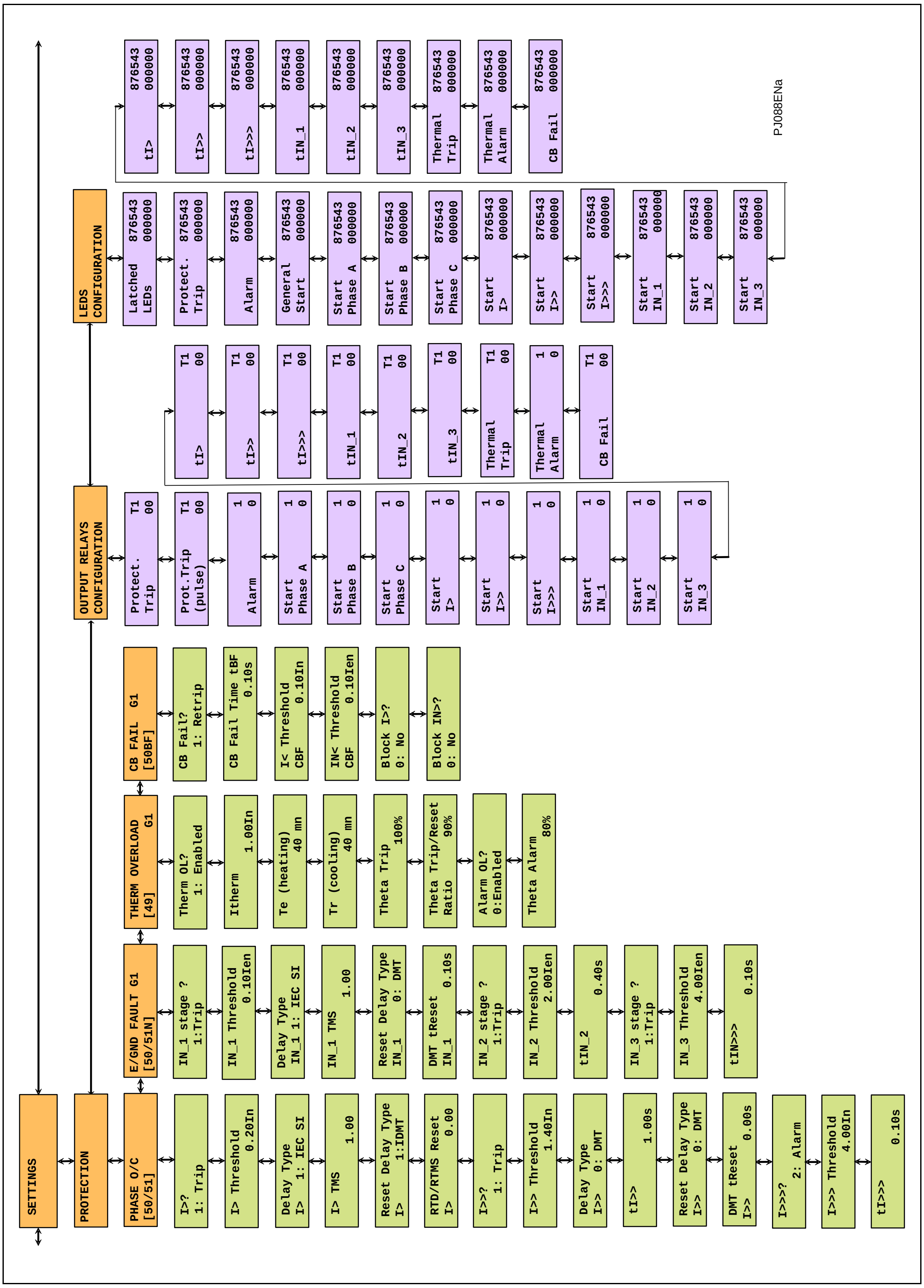

Figure 23: P116 Model L Menu Map 2 (Firmware: 1C)

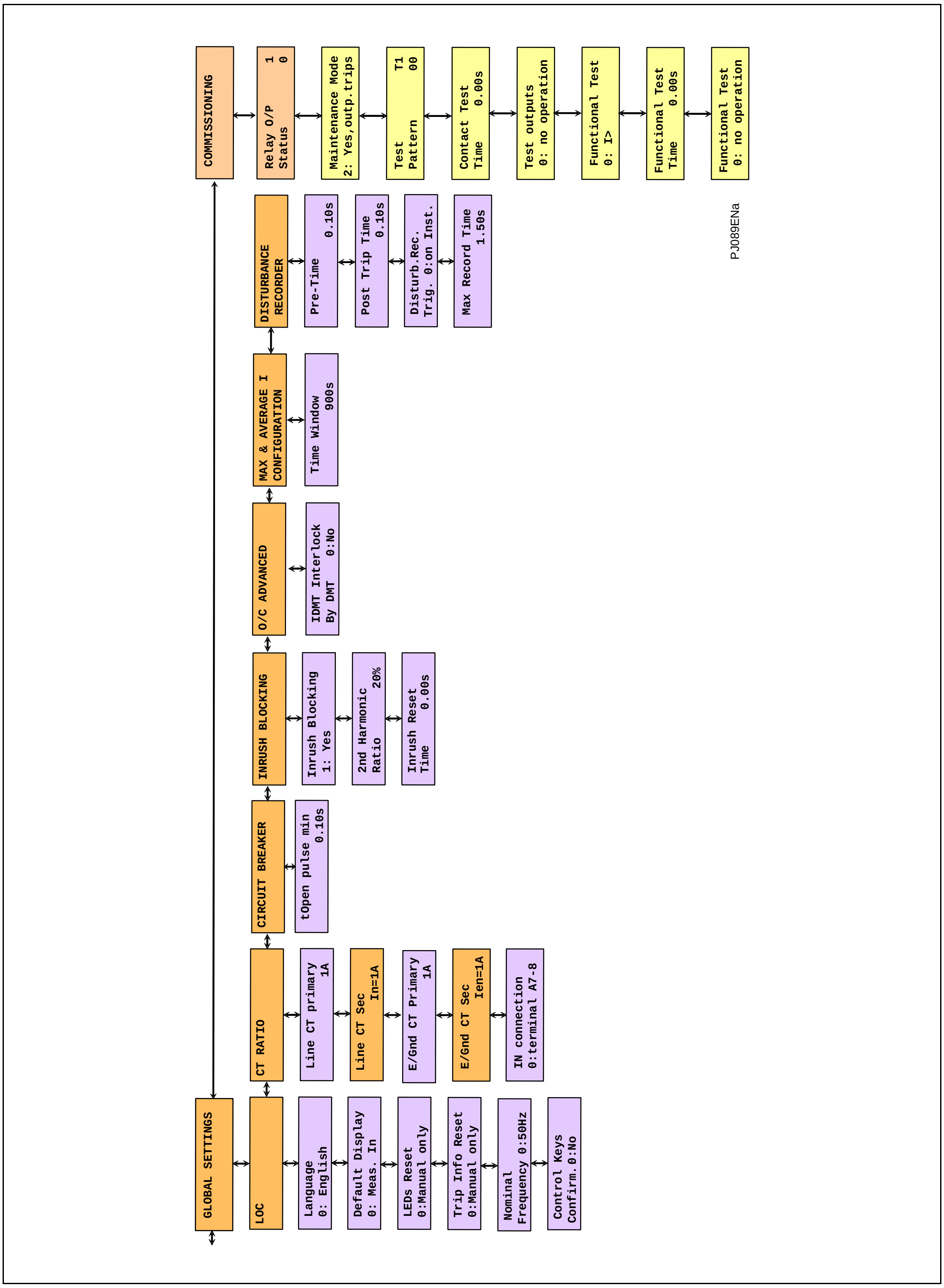

Figure 24: P116 Model L Menu Map 3 (Firmware: 1C)

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3. LOCAL CONNECTION TO A PC

3.1 Configuration

Local connection between a PC and the relay is made through a USB cable.

Note:

1. **Max current necessary to supply P116 from USB port is 450mA. USB standard offers 500mA for a one PC's USB controller, so it is not recommended to connect any additional devices to the same PC's USB controller. If the total power consumption from a one PC's USB controller is greater than 500mA, P116 can be in permanent rest (P116 display and the green *Healthy* LED will be flashing)**
2. **Before connection cable to USB socket it is necessary discharge static electricity from the body by touching a metal grounded object (such as an unpainted metal surface) to prevent against ESD damage**

Before communications can be established between a PC and a device fitted with a USB port, the device's Windows driver must first be installed and a virtual COM port created.

The latest MiCOM S1 STUDIO software has a built-in USB driver and virtual COM software, but if an older version of S1 STUDIO or MiCOM S1 are used it will be necessary to install the above in order to have communication facilities.

If the PC is connected both to the Internet and to the device, the USB driver and virtual COM software can be downloaded via Windows automatically from the web. Depending on firewall configuration, this may however not always be possible.

In such a case it is necessary to install the P11x USB driver and virtual COM software manually.

3.2 USB Driver and virtual COM software installation

Two installation methods are available:

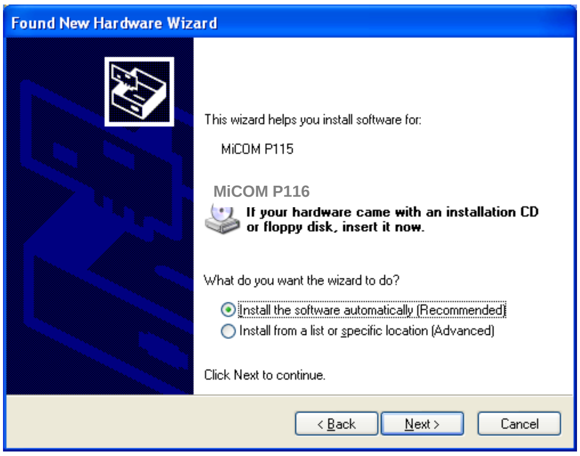
- Automatic installation using an Internet connection (installation files are not needed in this case),
- Setup file ("Setup P11x USB driver CDM 2.xx.xx.exe") which can be delivered via an Schneider Electric contact or downloaded from Schneider Electric website.

Note: The latest S1 STUDIO software includes all drivers therefore no action is needed.

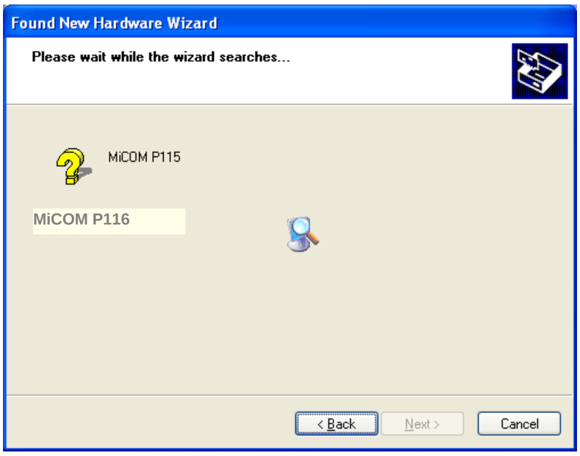
3.2.1 Automatic installation via an Internet connection (no setup files needed)

1. Connect the PC to the Internet.
2. Plug the USB cable into PC and the MiCOM P116. Windows automatically starts searching for drivers.
3. Select **Yes, this time only** then press ***Next >***.

4. Select ***Install the software automatically (Recommended)*** then press ***Next >***.



5. Wait until the wizard finishes searching of drivers on the Internet.



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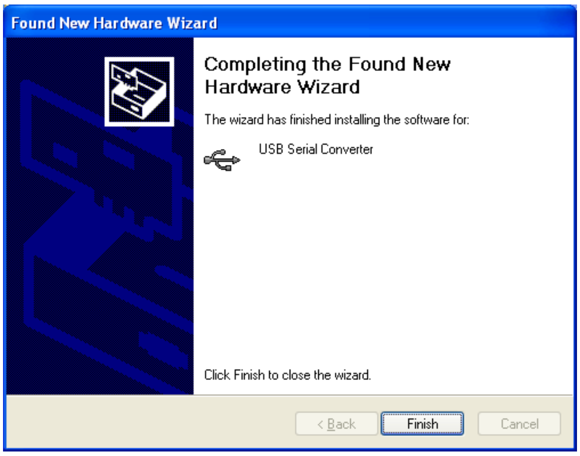
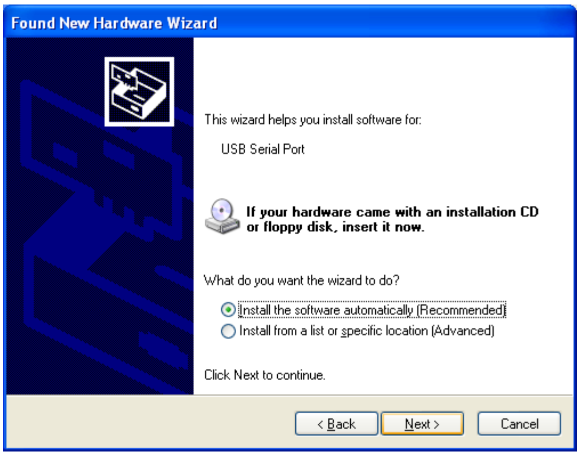
6. Press ***Finish*** (to complete the USB driver's installation).

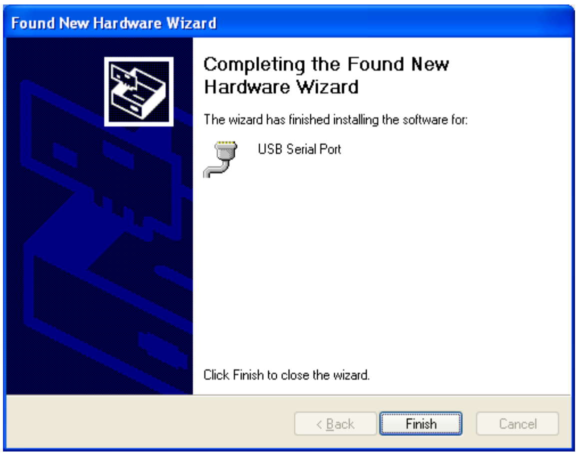


7. Select ***Yes, this time only*** then press ***Next >*** (to start the Virtual COM software installation).

8. Select ***Install the software automatically (Recommended)*** then press ***Next >***.

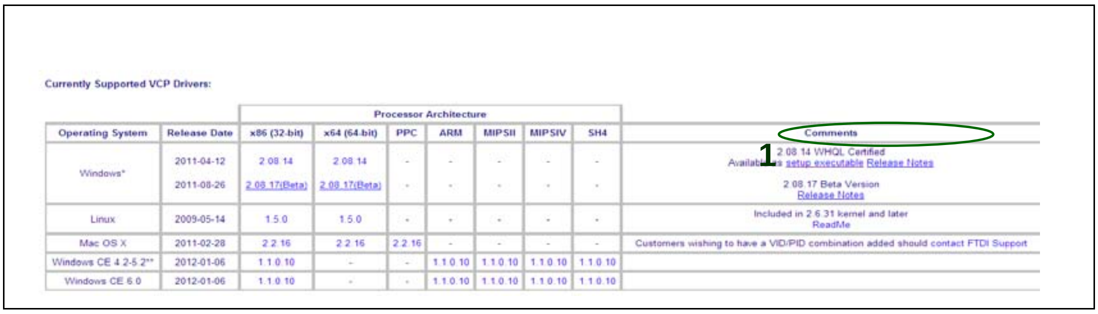


9. Press ***Finish*** then run the MiCOM S1 or S1 STUDIO setting software.



3.2.2 USB Driver and virtual COM software installation from the setup file

1. Obtain the ***Setup P11x USB driver CDM 2.xx.xx.exe*** file from your Schneider Electric support contact or ***CDMxxxxx.exe*** (for example: CDM20814_Setup.exe) from: http://www.ftdichip.com/Drivers/VCP.htm (for FT2232H, FT4232H, FT232R, FT245R, FT2232, FT232B, FT245B, FT8U232AM, FT8U245AM devices):

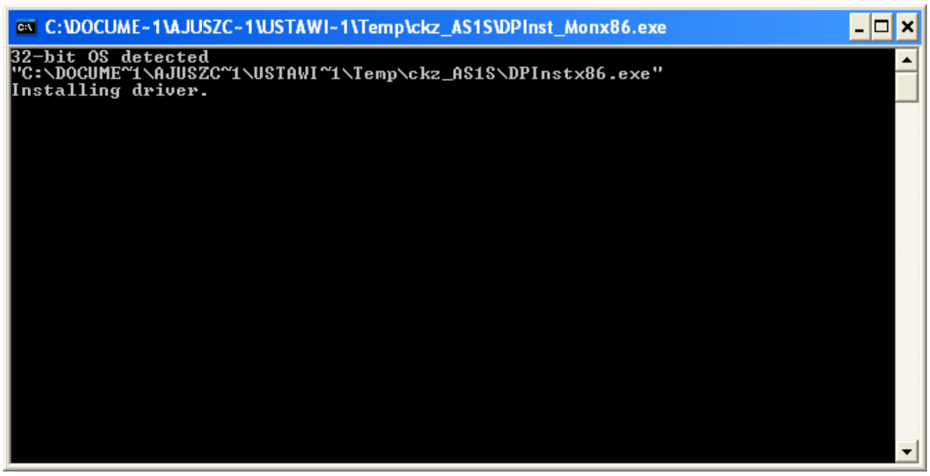


Currently Supported VCP Drivers:

		Processor Architecture							
Operating System	Release Date	x86 (32-bit)	x64 (64-bit)	PPC	ARM	MIPSII	MIPSIV	SH4	Comments
Windows*	2011-04-12	2.08.14	2.08.14	-	-	-	-	-	1 2.08.14 WHQL Certified Available as setup executable Release Notes
	2011-08-26	2.08.17(Beta)	2.08.17(Beta)	-	-	-	-	-	2.08.17 Beta Version Release Notes
Linux	2009-05-14	1.5.0	1.5.0	-	-	-	-	-	Included in 2.6.31 kernel and later ReadMe
Mac OS X	2011-02-28	2.2.16	2.2.16	2.2.16	-	-	-	-	Customers wishing to have a VID/PID combination added should contact FTDI Support
Windows CE 4.2-5.2**	2012-01-06	1.1.0.10	-	-	1.1.0.10	1.1.0.10	1.1.0.10	1.1.0.10	
Windows CE 6.0	2012-01-06	1.1.0.10	-	-	1.1.0.10	1.1.0.10	1.1.0.10	1.1.0.10	

2. Run ***Setup P11x USB driver CDM 2xxxx.exe*** (from the web) or the latest available (from the web).

3. The following window will appear for a few seconds and then close automatically.



4. The USB port is ready for connection via MiCOM S1.

5. Run the MiCOM S1 setting software for connection with the P11x.

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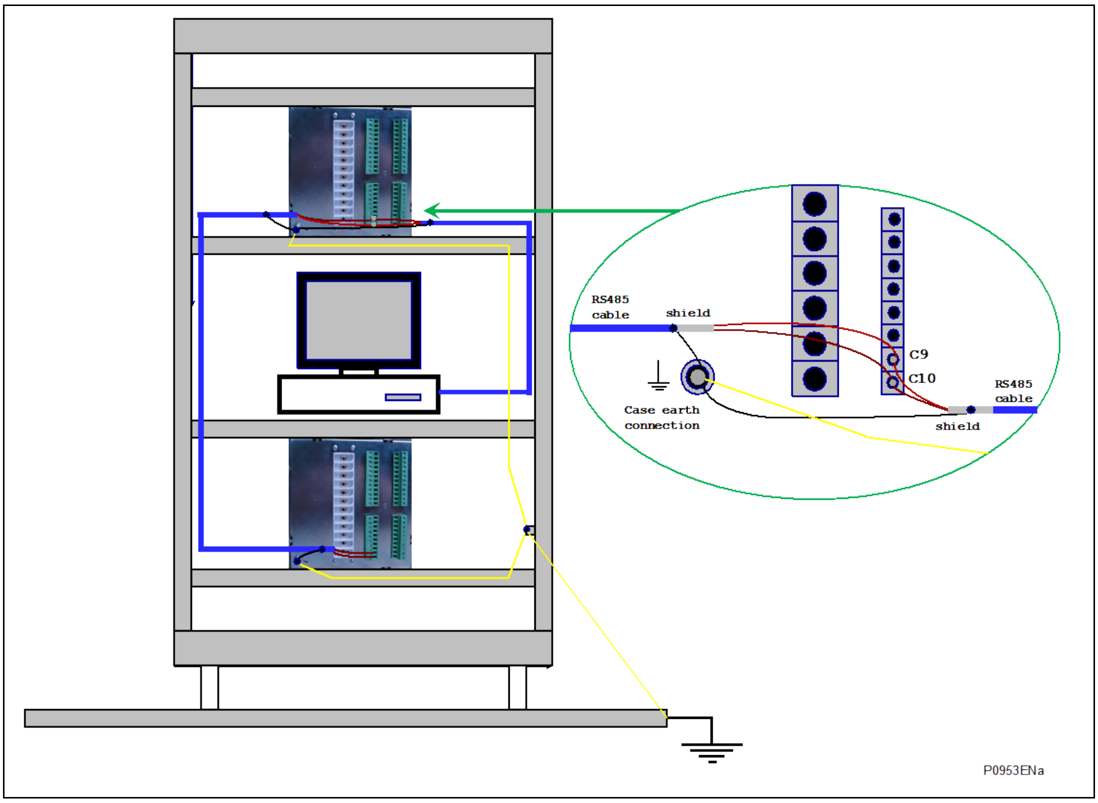
3.2.3 Remote connection

The figure shows the recommended way to connect an RS485 cable to the relay in order to build a local network.

3.3 Products plugged into the same panel



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3.4 MiCOM S1 and MiCOM S1 Studio relay communications basics

MiCOM S1 and MiCOM S1 Studio are the universal MiCOM IED Support Software packages which provide users with a direct and convenient access to all data stored in any MiCOM IED using the USB front communication port.

MiCOM S1 and MiCOM S1 Studio provide full access to:

– MiCOM Px10 Px20, Px20, Px30, Px40 relays

– MiCOM Mx20 measurements units

The following sections give the main procedures to connect to and to use MiCOM S1 and MiCOM S1 Studio.

Before starting, check that the USB serial cable is properly connected to the USB port on the front panel of the relay. Please follow the instructions given in section 3.1 in order to ensure proper connection between the PC and the relay before attempting to communicate with the relay.

This section is intended as a quick start guide to using MiCOM S1 and MiCOM S1 Studio, and assumes that you have a copy of MiCOM S1 or MiCOM S1 Studio installed on your PC. Please refer to the MiCOM S1 or MiCOM S1 Studio User Manual for more detailed information.

3.5 MiCOM S1 Studio

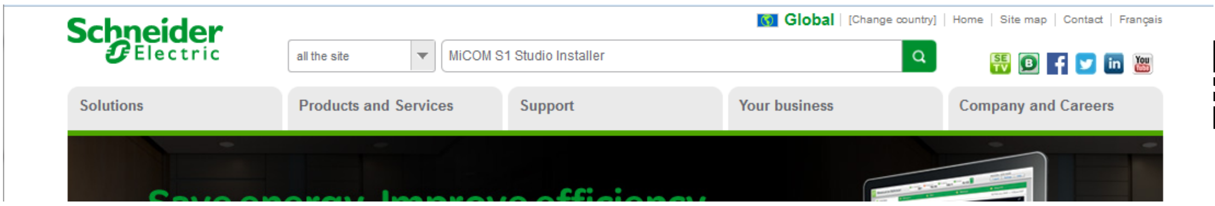
3.5.1 MiCOM S1 Studio downloading

The MiCOM S1 Studio can be downloaded from WEB site: http://www.schneider-electric.com/products/ww/en/2300-ied-user-software/2310-micom-user-software/61035-micom-s1-studio/

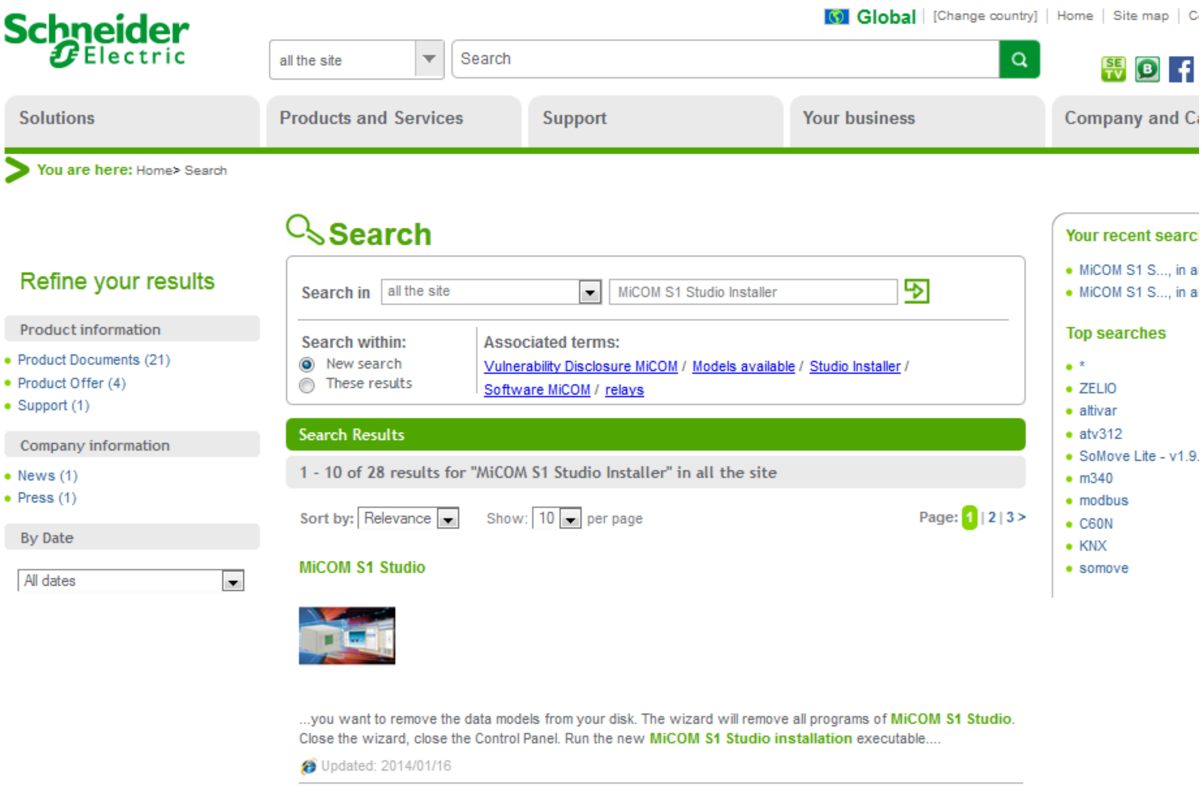
Or found on the WEB site:

www.schneider-electric.com

During typing “MiCOM S1 Studio Installer” an advice will appear as above (type slowly), so select “MiCOM S1 Studio Installer” than click: 



The new window will appear (see below):



Click on “MiCOM S1 Studio”: 

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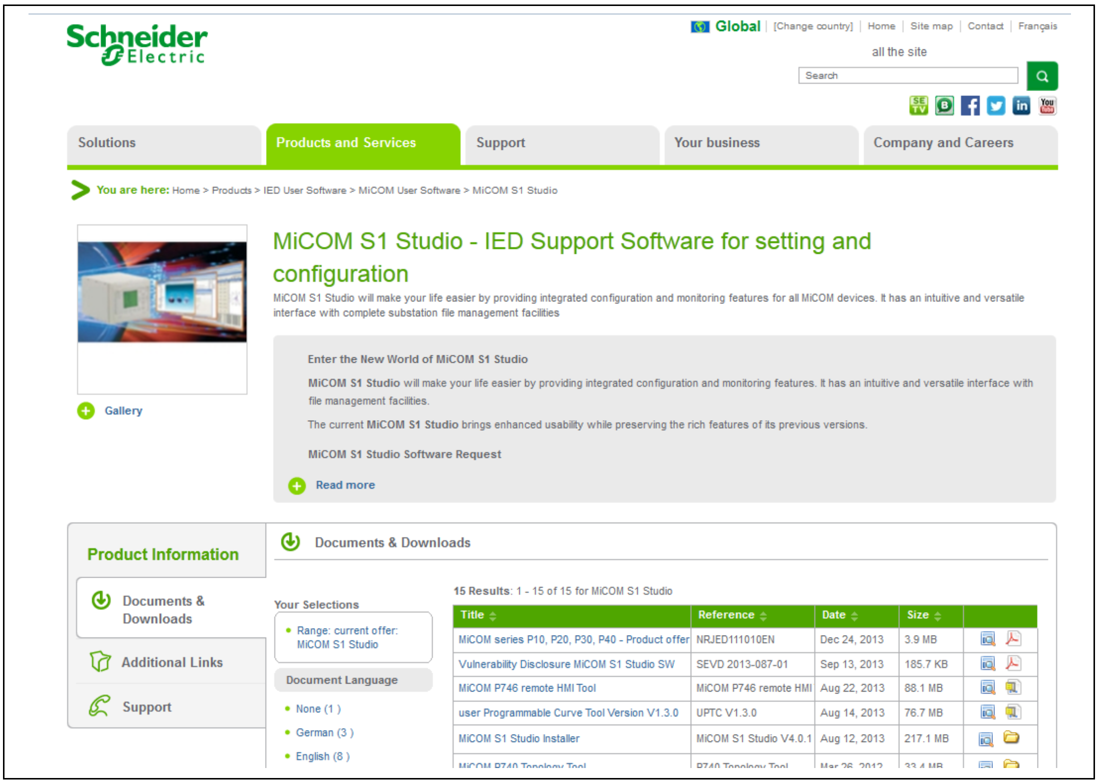
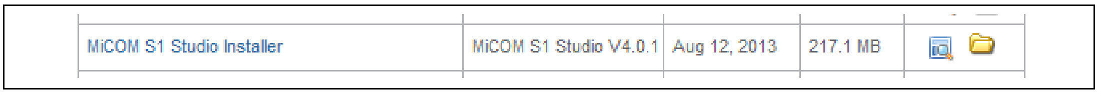
The new window will appear (see below):

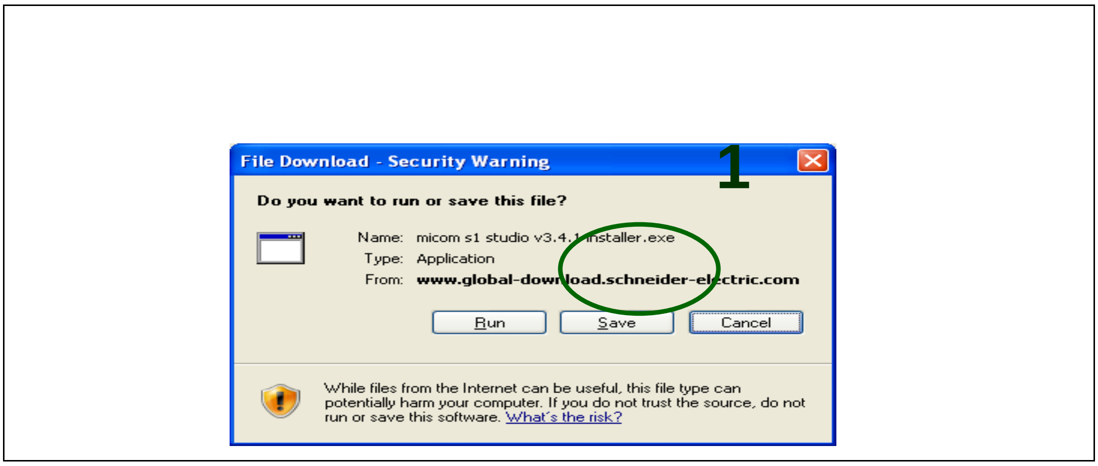


Click on MiCOM S1 Studio Installer



The new window will appear (see below). Click on MiCOM-S1-Studio-Vx.x.x-Installer.exe

The new window will appear (see below). Click “Save” than run exe file for starting of installation



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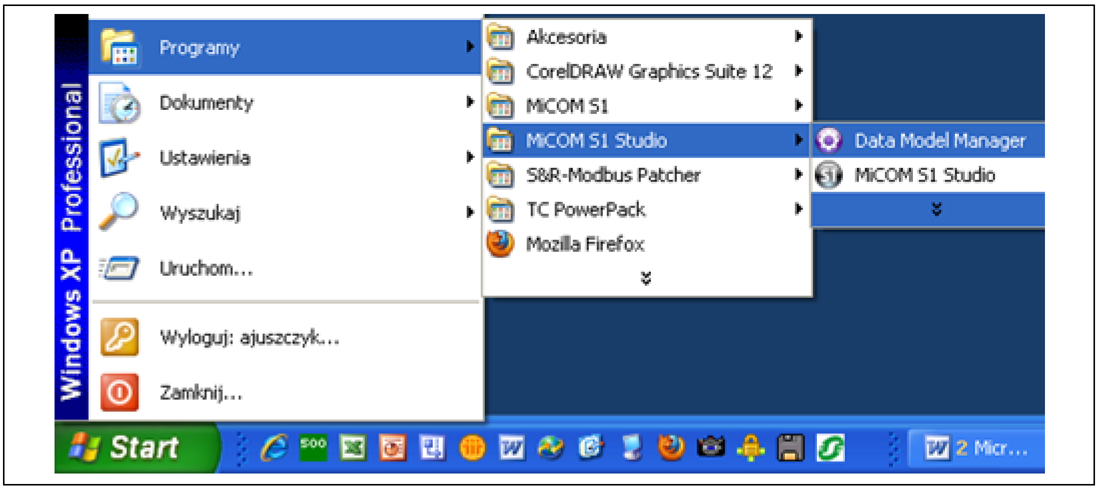
3.5.2 Data Model Management

The settings and parameters of the protection relay can be extracted from the relay or loaded using the Data Model manager. The Data Model Manager can load any model from a local file, a CD ROM or an Internet server (if connected).

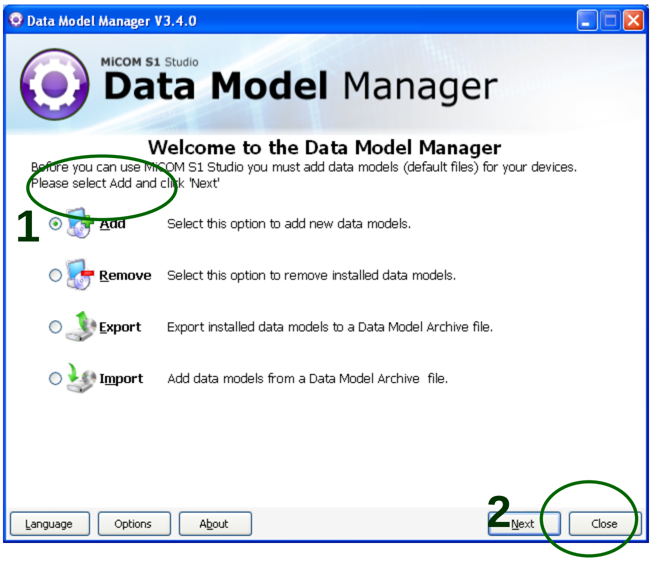
The Data Model Manager is used to add and remove data models, as well as to export and import data model files.

It is necessary to close MiCOM S1 Studio prior to launching the Data Model Manager.

To open the Data Model Manager, click on the icon:  Select " MiCOM S1 Studio" then "Data Model Manager" in the "Programs" menu.

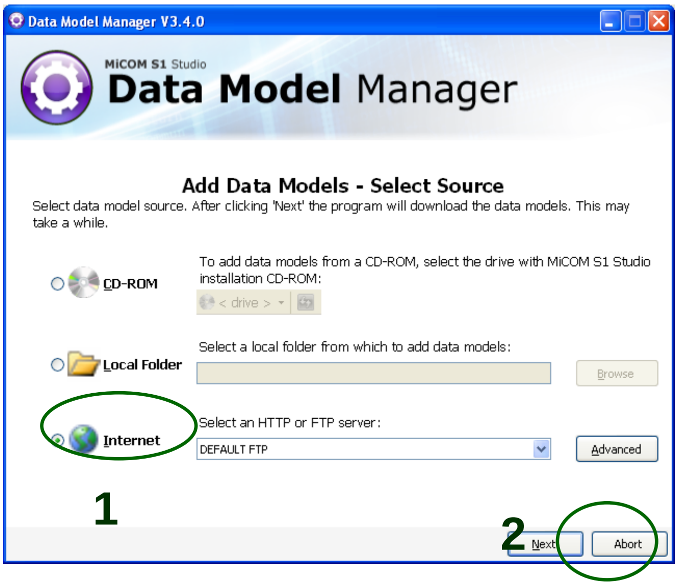


The following window is displayed:



Select the ***Add*** option to add the new data model then click on ***Next***.

The next window is used to select the data model's source (CD ROM, local folder or Schneider Electric FTP server). Select the data model's source then click on ***Next***.



Note: The procedure below assumes connection to Schneider Electric FTP server.

The Data Model Manager loads the data models' details then automatically displays the language selection panel. Select the menu language then click on ***Next***.

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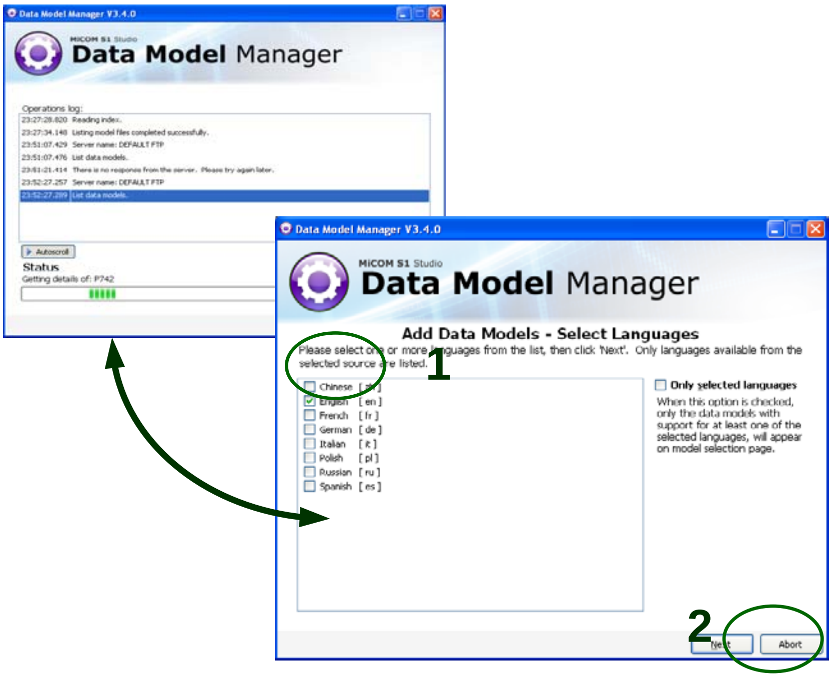

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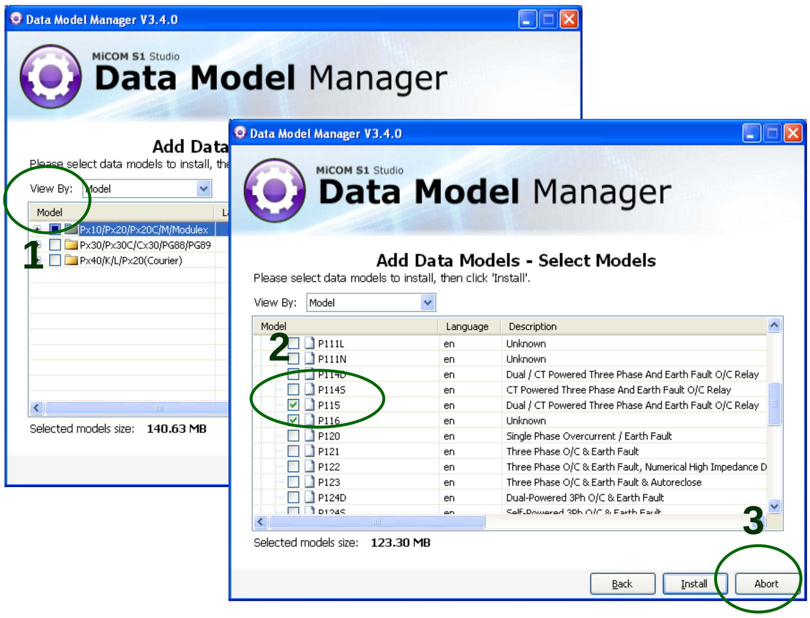
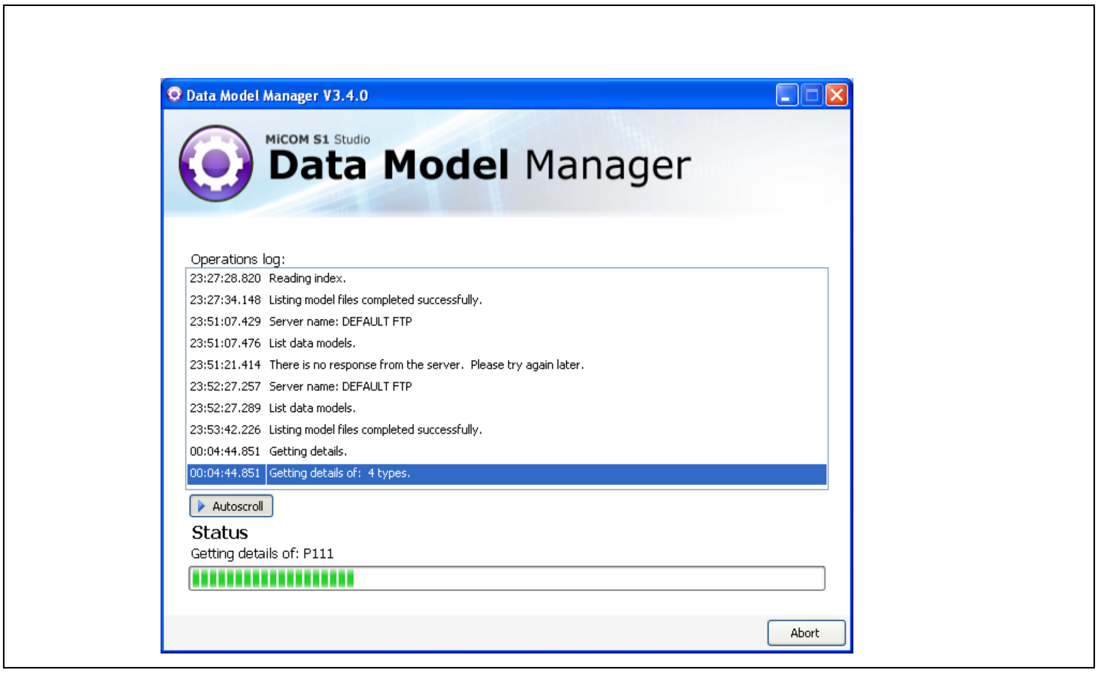
The data models panel is displayed. Select the data model relevant to your product (for instance, to download P10x data models, expand the ***Px10/Px20/Px20C/M/Modulex*** sub-menu (click on **+** then select the data model relevant to your product). Once the data models are selected, the Data Model Manager window displays the file size of the download.



Click on ***Install***. The data model files are downloaded and updated in your system.

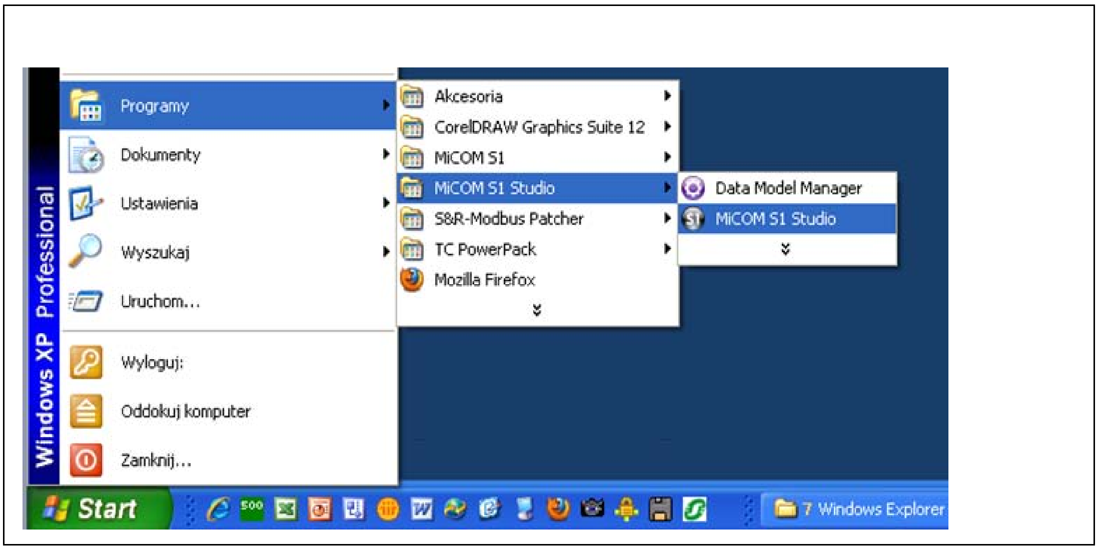


Once installation is complete, close the Data Model Manager. The downloaded Data Model will be used by MiCOM S1 Studio when a system file is opened or created. For more information on how to open this default setting file, refer to § 3.5.9.

3.5.3 "Quick Connection" to the relay using MiCOM S1 Studio

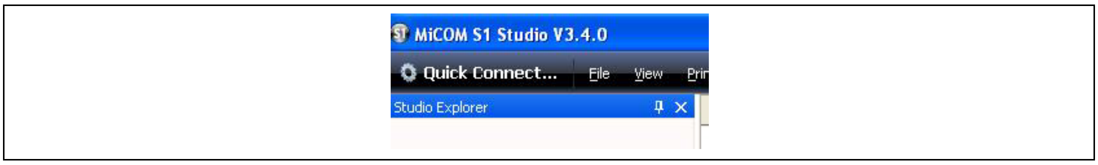
To start MiCOM S1 Studio, click on the icon: 

In the ***Programs*** menu, select Schneider Electric then ***MiCOM S1 Studio***.

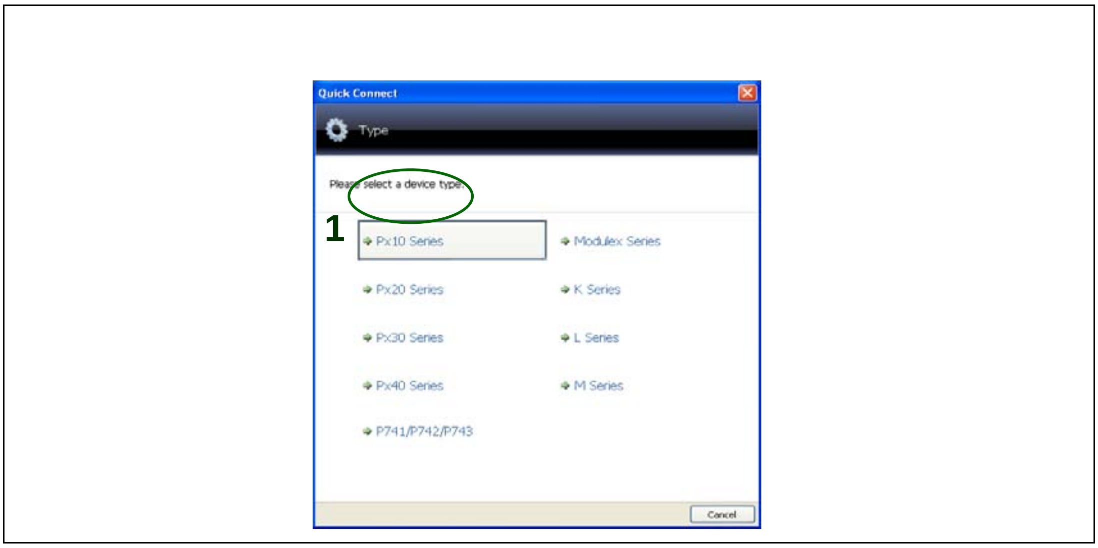


The MiCOM S1 Studio launcher screen is displayed:

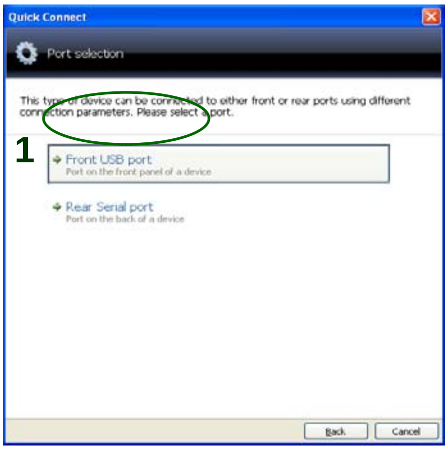
– Click on the Quick Connect button at the top left of the application's window.



– Select ***Px10 Series*** from the presented options.



– Select ***Front USB port***.



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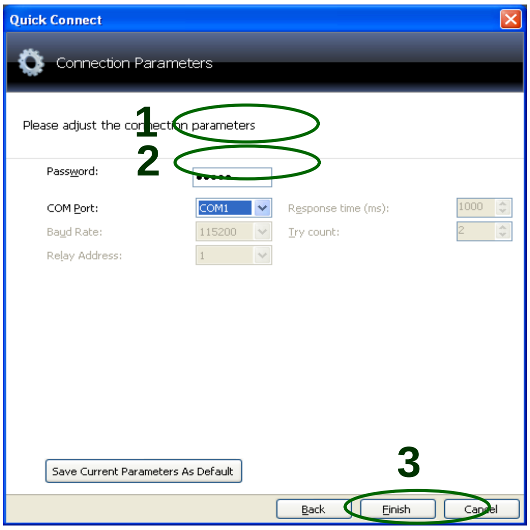
– Enter Password: administrator level (without limits) - the same as in the P116 which is connected via USB port. If the administrator password is not entered in the P116 – leave it as default. Note: the password could be unique for every P116 so if the password is forgotten – contact with SE service for help.

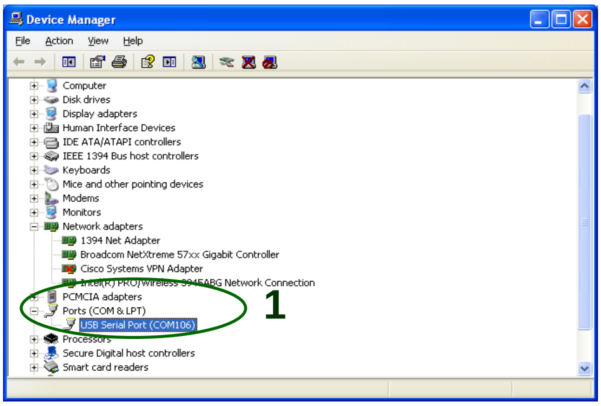
NOTE:

1. **The default password is 0000 for every password protection level.**
2. **For communication via Setting Software (MiCOM S1 Studio or MiCOM S1) the administrator password must be entered – the same as it was entered in the relay.**
3. **S1 recognizes the password as characters. If the password is 0001 (in the password window of P116's menu, 4 digits always are displayed) it is necessary to enter 0001 in S1 (all four digits have to be entered). For above case: 1 or 01 or 001 will be rejected. Only 0001 will be accepted.**

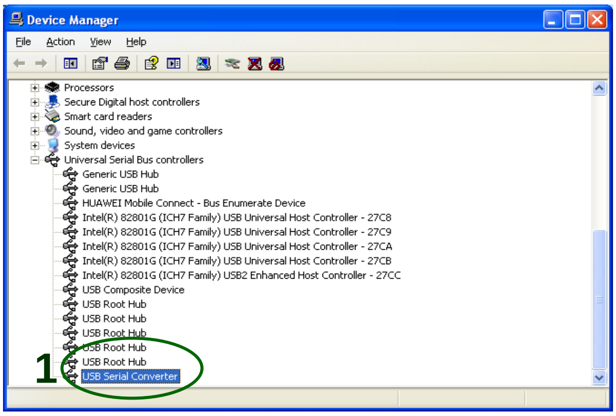
Select virtual COM (VCP) which was created by USB driver.



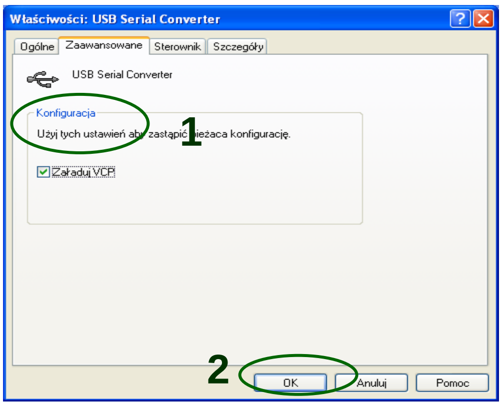
The virtual COM can be read in WINDOWS's “Device Manager” like below:



NOTE: If P116 is connected but no any USB Serial port is shown, it means that USB drivers are not installed or VCP (Virtual COM Port) option of USB Serial Converter is not selected. Check VCP option as below:

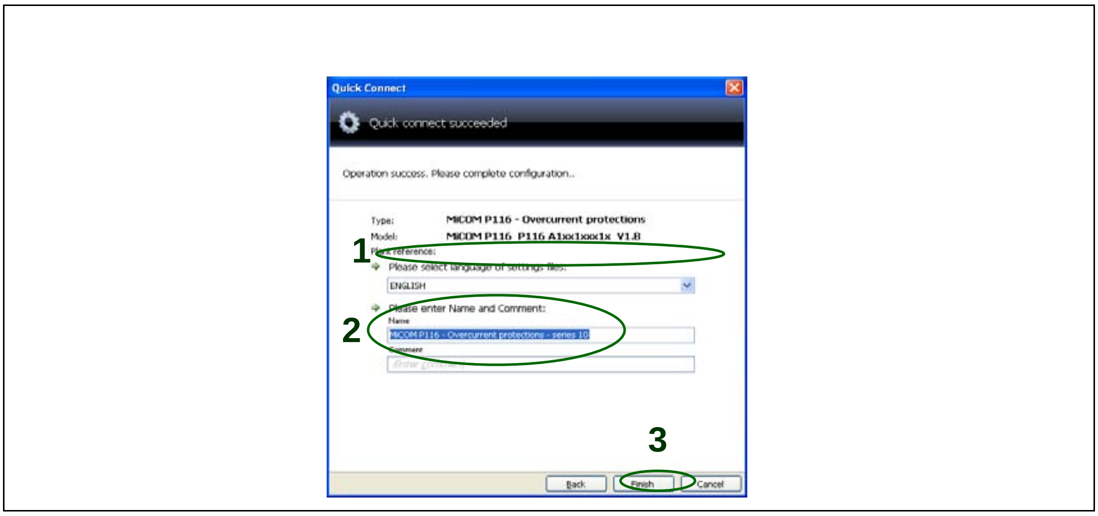


Right-click to open the contextual menu: Properties and Advanced:

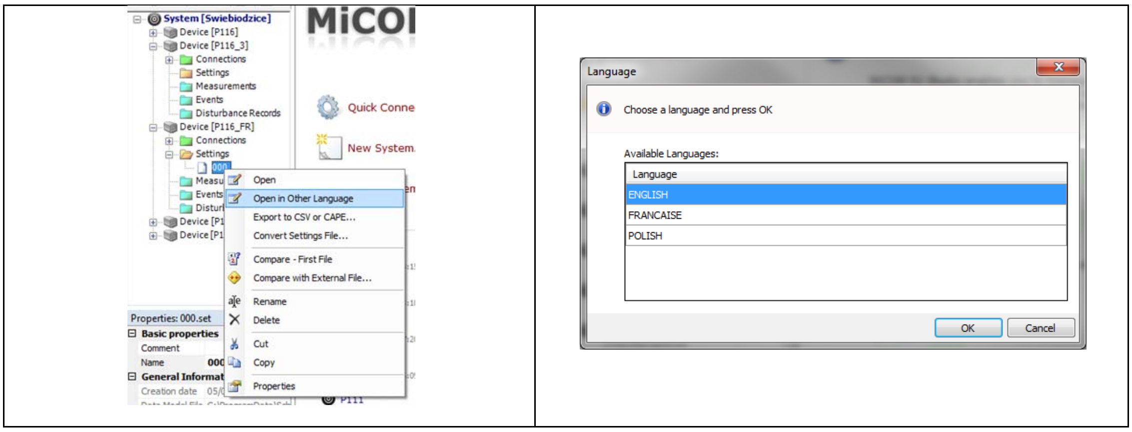


Unplug USB cable and plug in again. Restart S1 Studio and repeat the procedure.

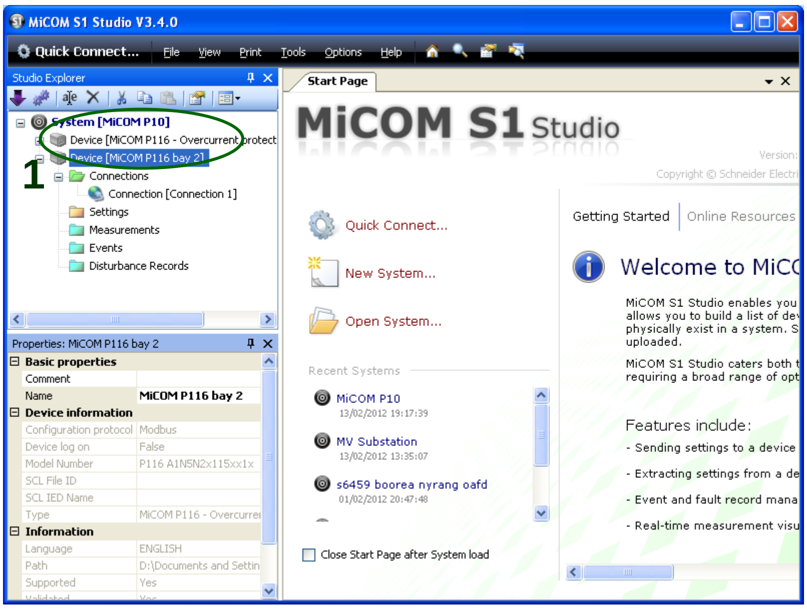
– Select ***Language***. Enter ***Name and Comment***.



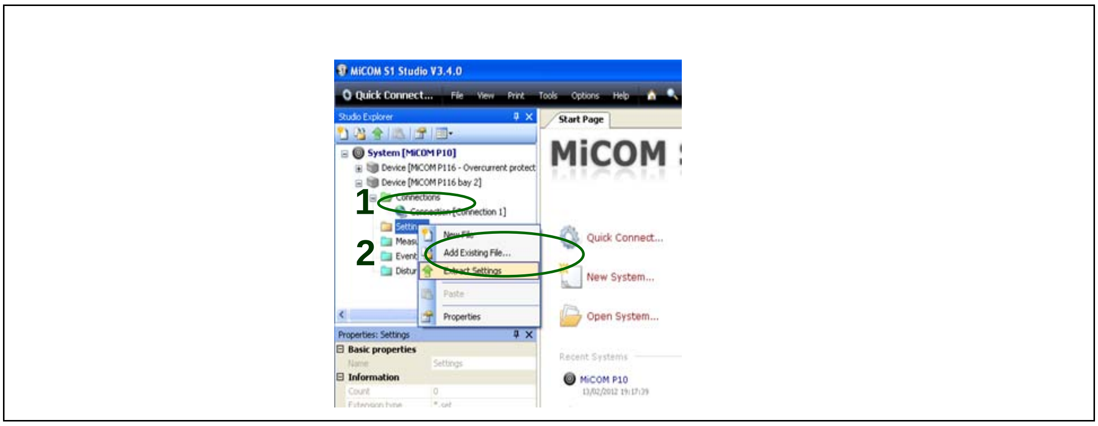
NOTE: If in Data Model (opened setting file) the language is English, even another language was selected, click left pushbutton of the mouse on the setting file (as below 000) and click right pushbutton of the mouse, select “Open in Other Language” then click left pushbutton of the mouse to see selection “Language” window as below. In “Language” window select required language version. Before above operation the setting file has to be closed.



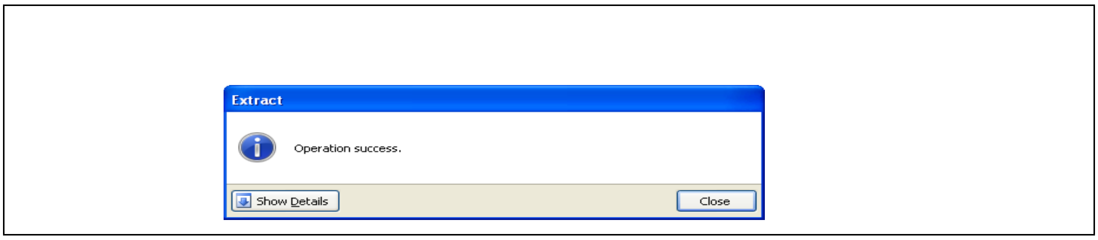
– The new Device is created:



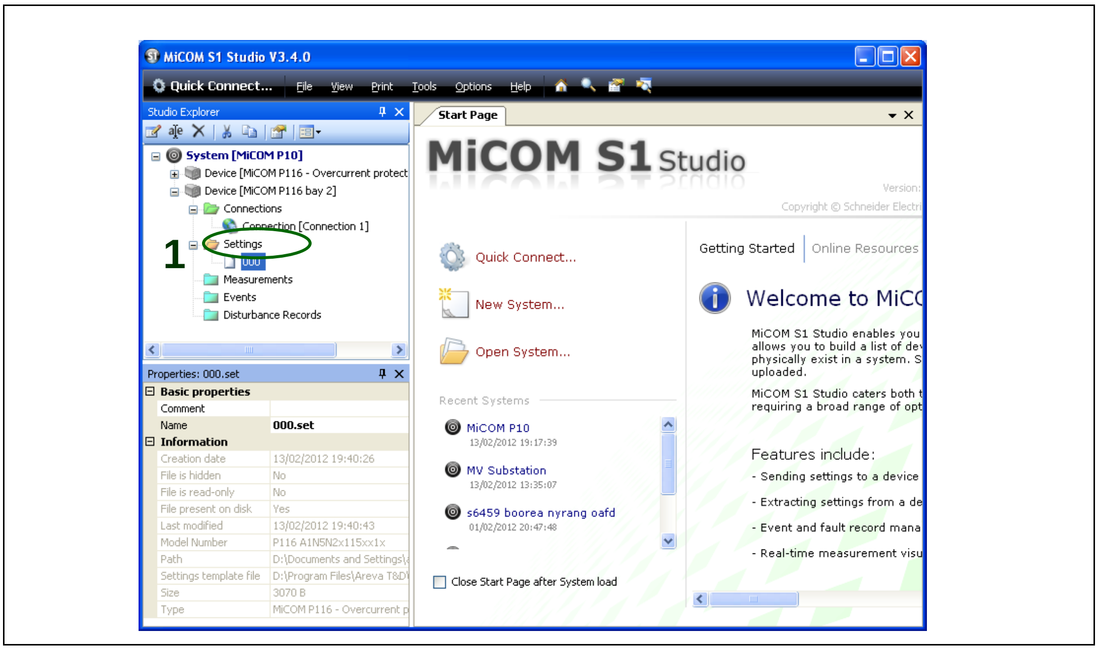
– Select ***Settings.*** Right-click to open the contextual menu: ***Extract Settings***:



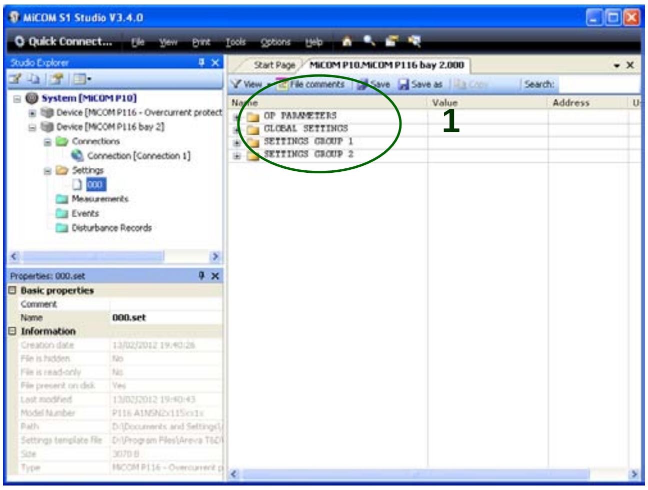
– Wait for the end of the process:



– P116 settings were saved on PC. The name of SET file is 000.set:

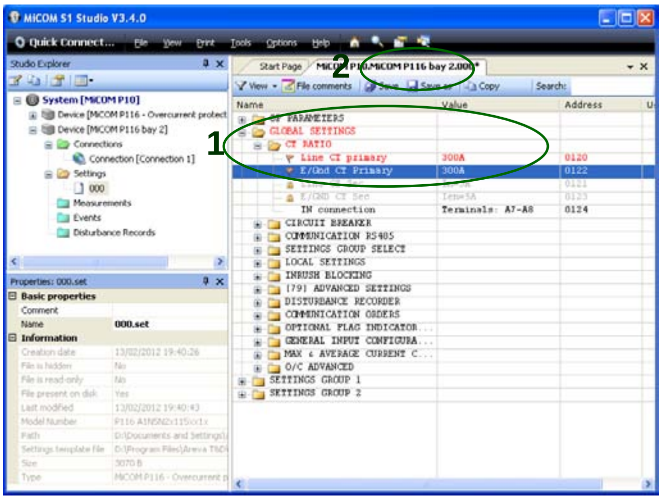


– Double Click on ***000.set*** SET file to see settings on the right window of MiCOM S1 Studio

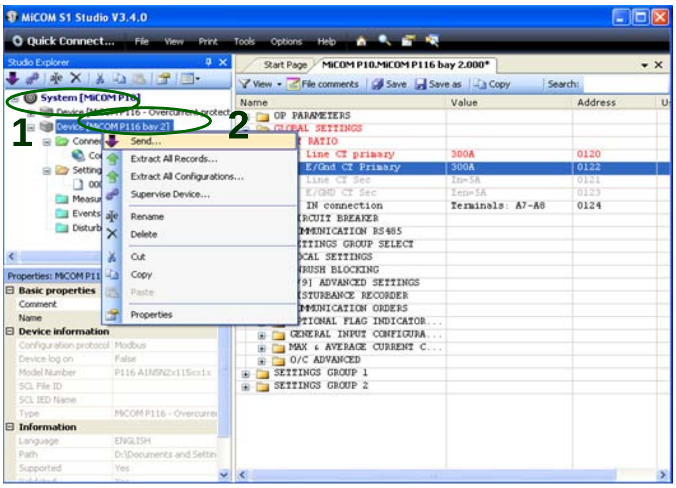


– Change settings. ***Save*** changes.

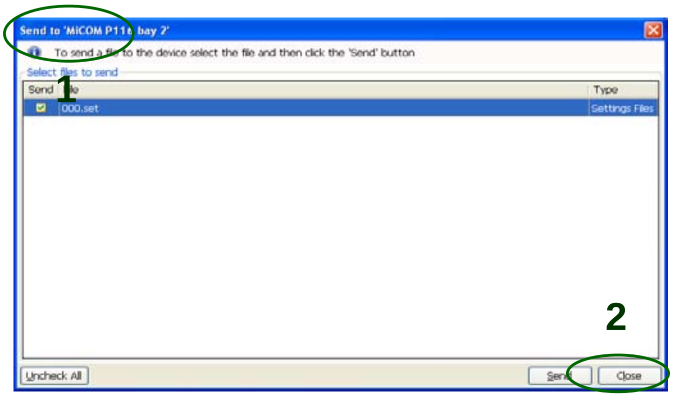
Note: If the changed settings are not ***Saved*** on hard disk of PC, MiCOM S1 Studio send setting file before changing. Be sure that Save icon was pressed.



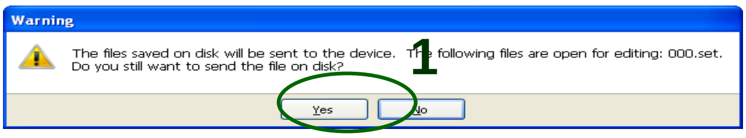
– Click on the name of ***Device*** and right-click to open the contextual menu: ***Send***:



– Select setting (***000.set***) file for sending. Press ***Send***.



– If ***000.set*** file was saved on the PC disc, press ***Yes***.



– Wait for the end of operation. Press ***Close***.

Settings were set to P116.

3.5.4 Create a system

In MiCOM S1 Studio, a System provides a root node in the Studio Explorer panel from which all subsequent nodes are created.

Add substations, bays, voltage levels and devices to the system.

If a system is no longer needed, delete it using the delete command.

The use of Quick Connect will automatically create a default system, if one does not already exist. Systems are not opened automatically, unless ***Reopen last System at start-up*** is checked in the Preferences menu.

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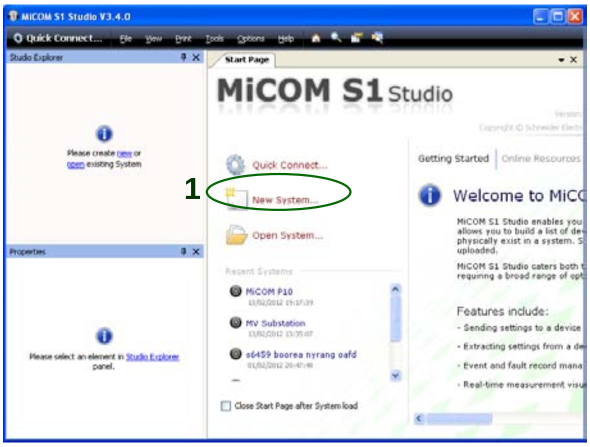
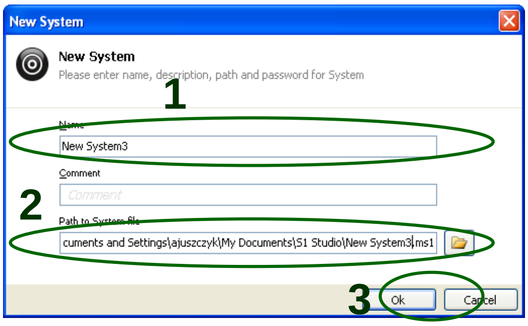
To create a new system:

– By default, the window displays the message “create new or open existing system”: click on "New" to create a new system.

– If a system is loaded in the “***Studio Explorer*** window, right-click on the panel's background and select "New System" or the corresponding icon on Studio Explorer's toolbar.

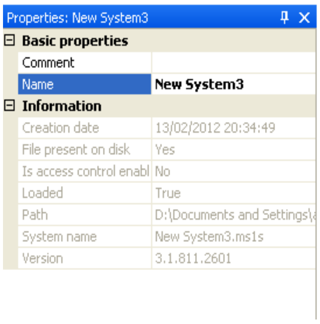


– The following window is displayed: Enter the name of the system, and the path to save the system file. Click ***OK***.



- The new System is displayed in the Studio Explorer panel:

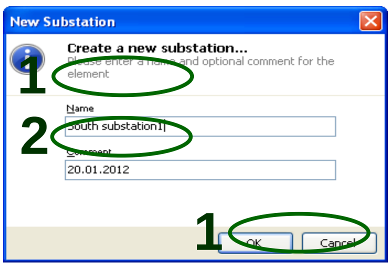
Note: If an item is selected in the Studio Explorer panel, its properties are displayed in the ***Properties*** panel.



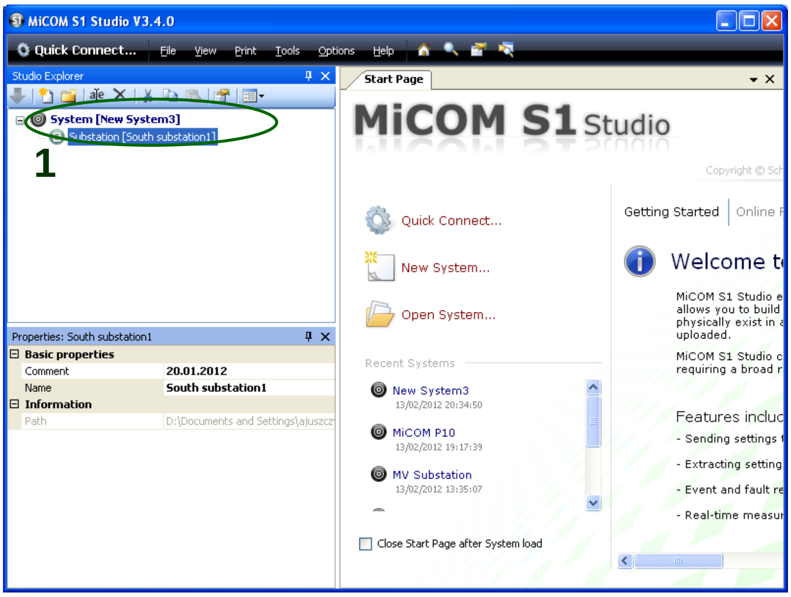
3.5.5 Create a new substation

Select the system: the menu bar is updated with the ***New device***, ***New substation***, ***Close***, ***Delete***, ***Paste***, ***Properties*** and ***Options*** icons.

Click on the ***New substation*** icon (or right-click to open the contextual menu). The following window is displayed:



The new substation is displayed and the menu bar is updated when a substation is selected:



Click on the ***Import SCL*** button to import a Substation Configuration File.

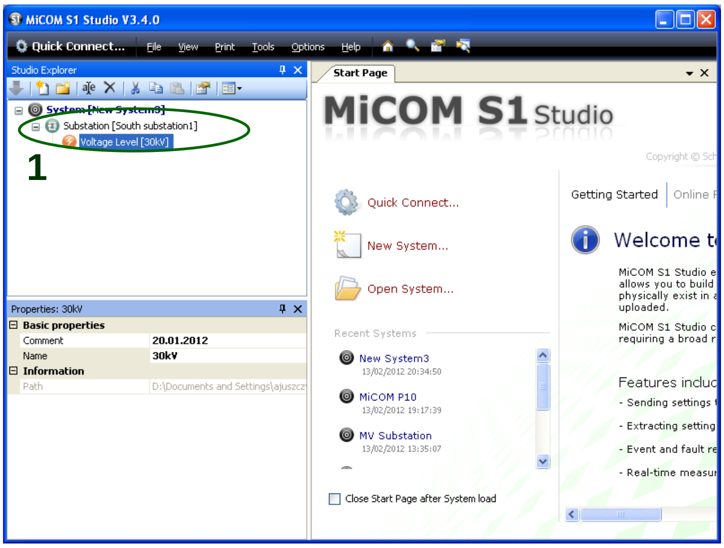
To create a substation configuration, click on the ***New voltage level*** button.

3.5.6 Create a new voltage level

Select the substation and click on the ***New station level*** button (or right-click to open the contextual menu).

In the ***Create a new voltage level***, enter the voltage level of the station.

The ***New voltage level*** is displayed and the ***New bay*** icon is displayed.

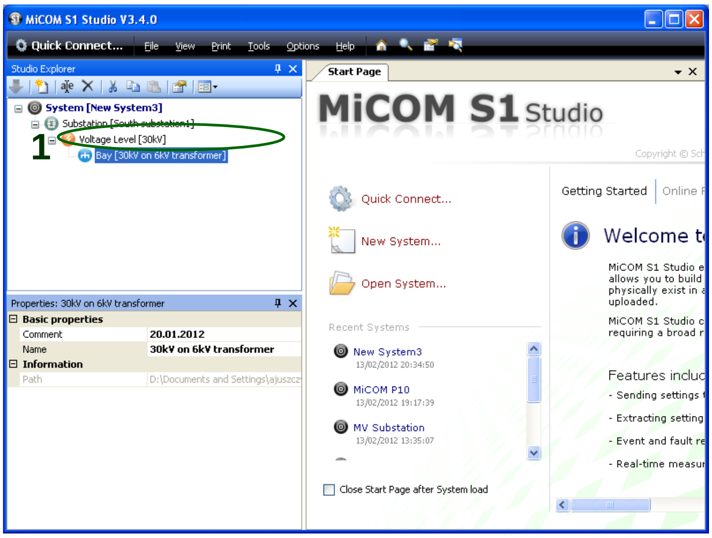


3.5.7 Create a new bay

Select the substation and click on the ***New bay*** button (or right-click to open the contextual menu).

In the ***Create new bay…*** window, enter the bay indication,

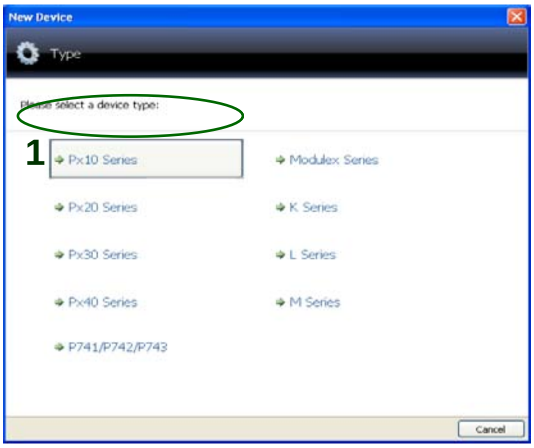
The new bay is displayed.



3.5.8 Create a new device

Click on the ***New device*** button (or right-click to open the contextual menu).

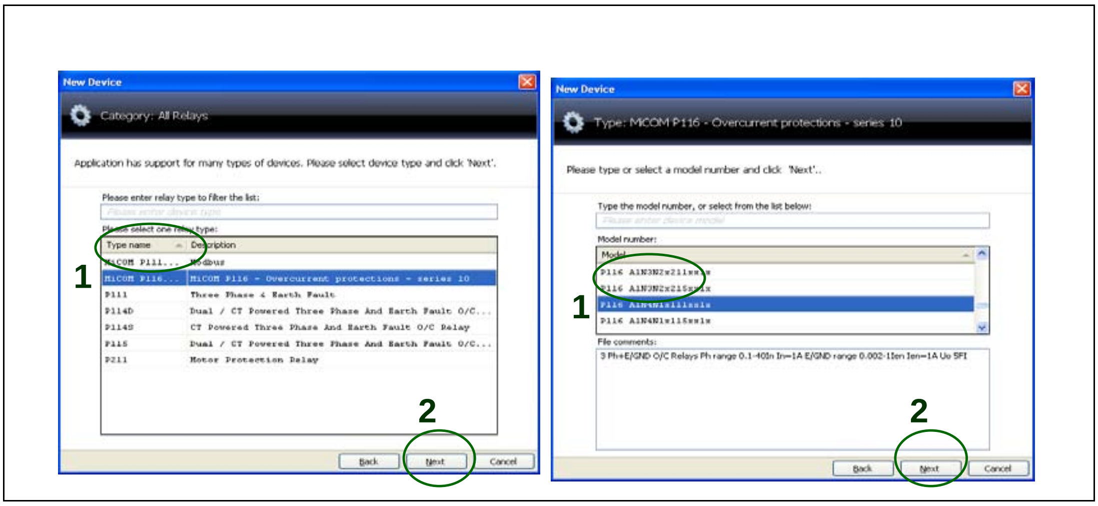
Select the device type.



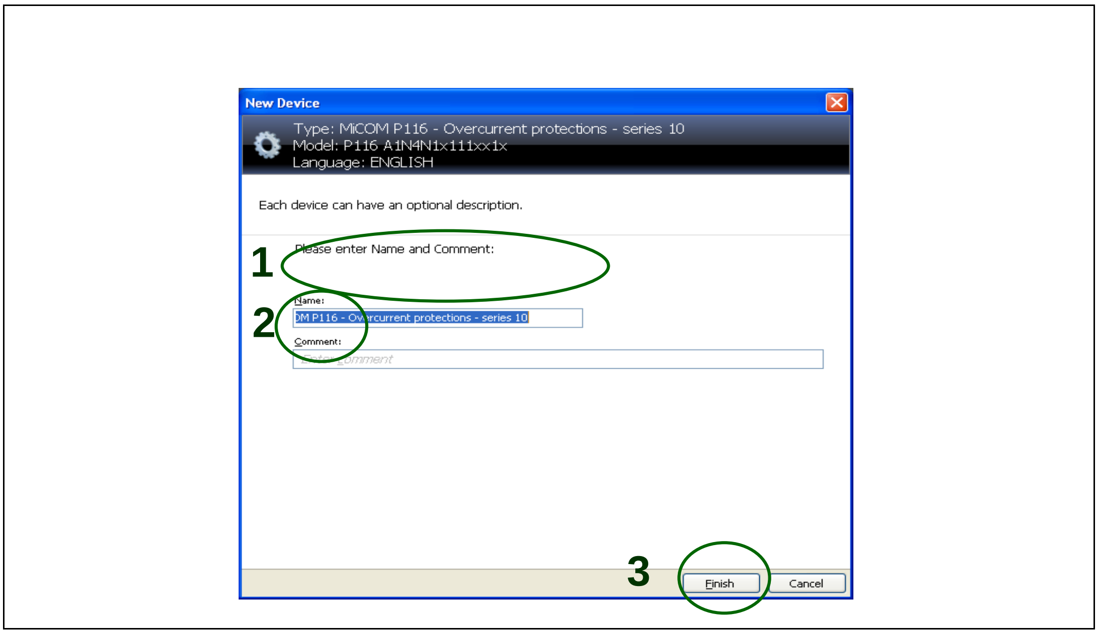
GS

Select the device type then click on ***Next***.

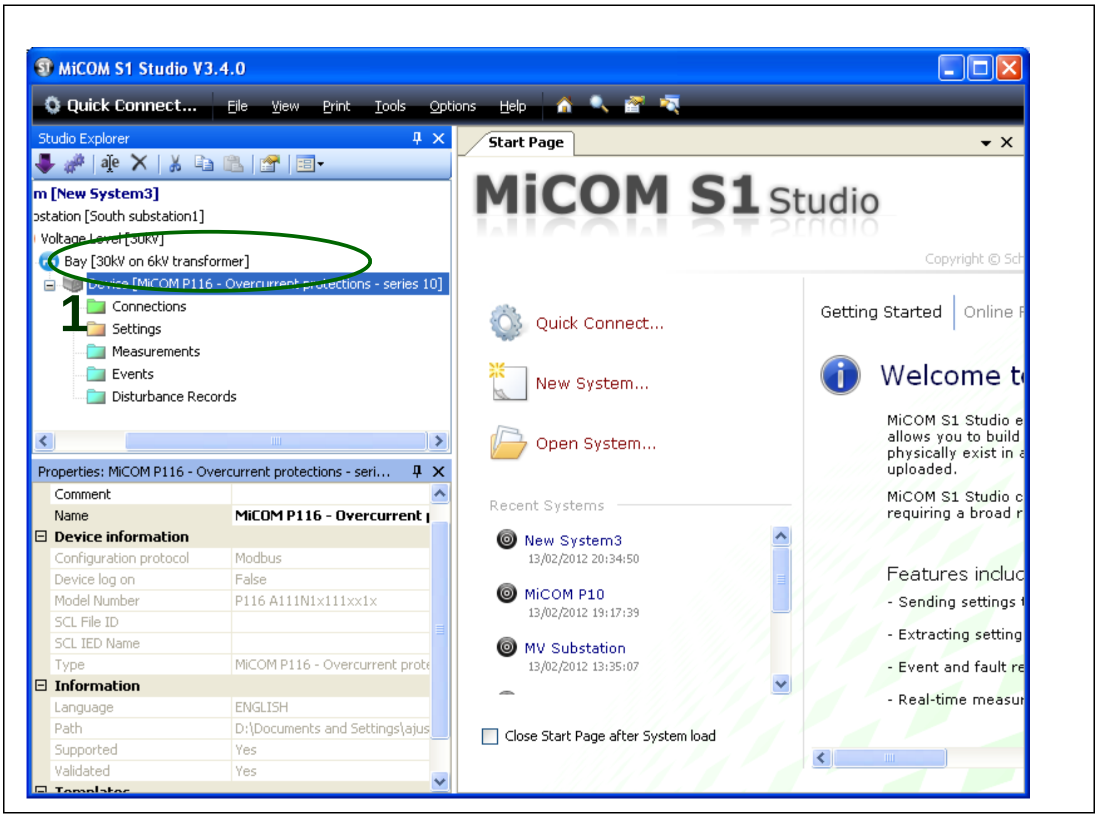
Select the model then click on ***Next***.



Enter the name and add a description to the device:



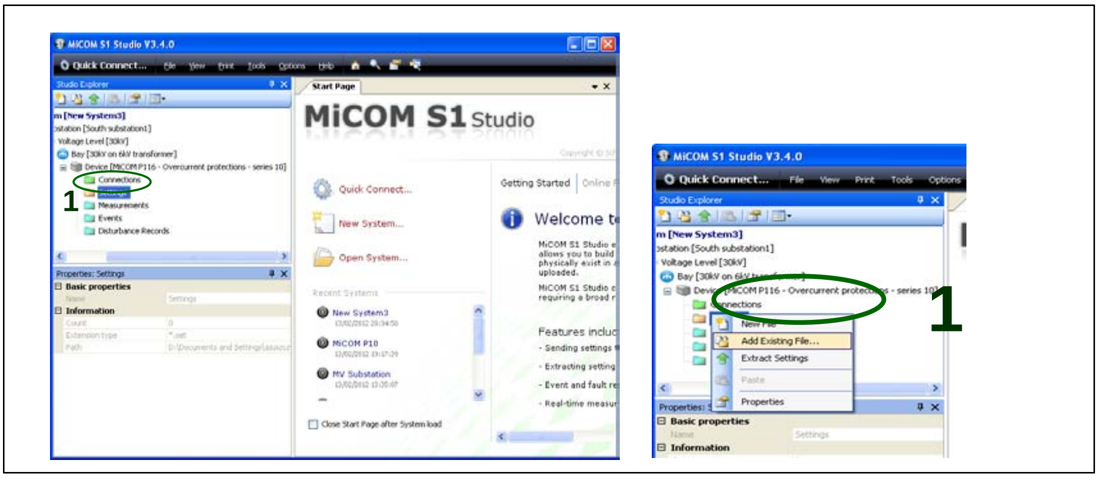
The new device is created and displayed.



3.5.9 Open a Settings File

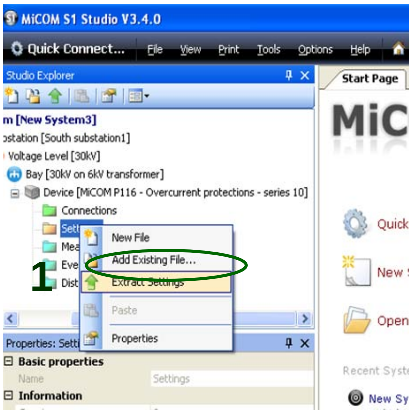
To open an existing file:

– If the file is saved or if the relay is not connected: Click on the ***Settings*** and right-click to open the contextual menu: ***Add Existing file***



GS

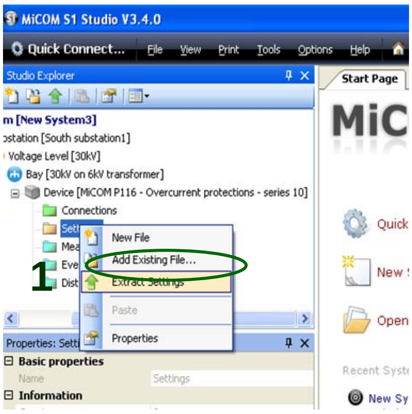
– If the relay is connected, extract its settings: Click on the ***Settings*** and right-click to open the contextual menu: ***Extract Settings***



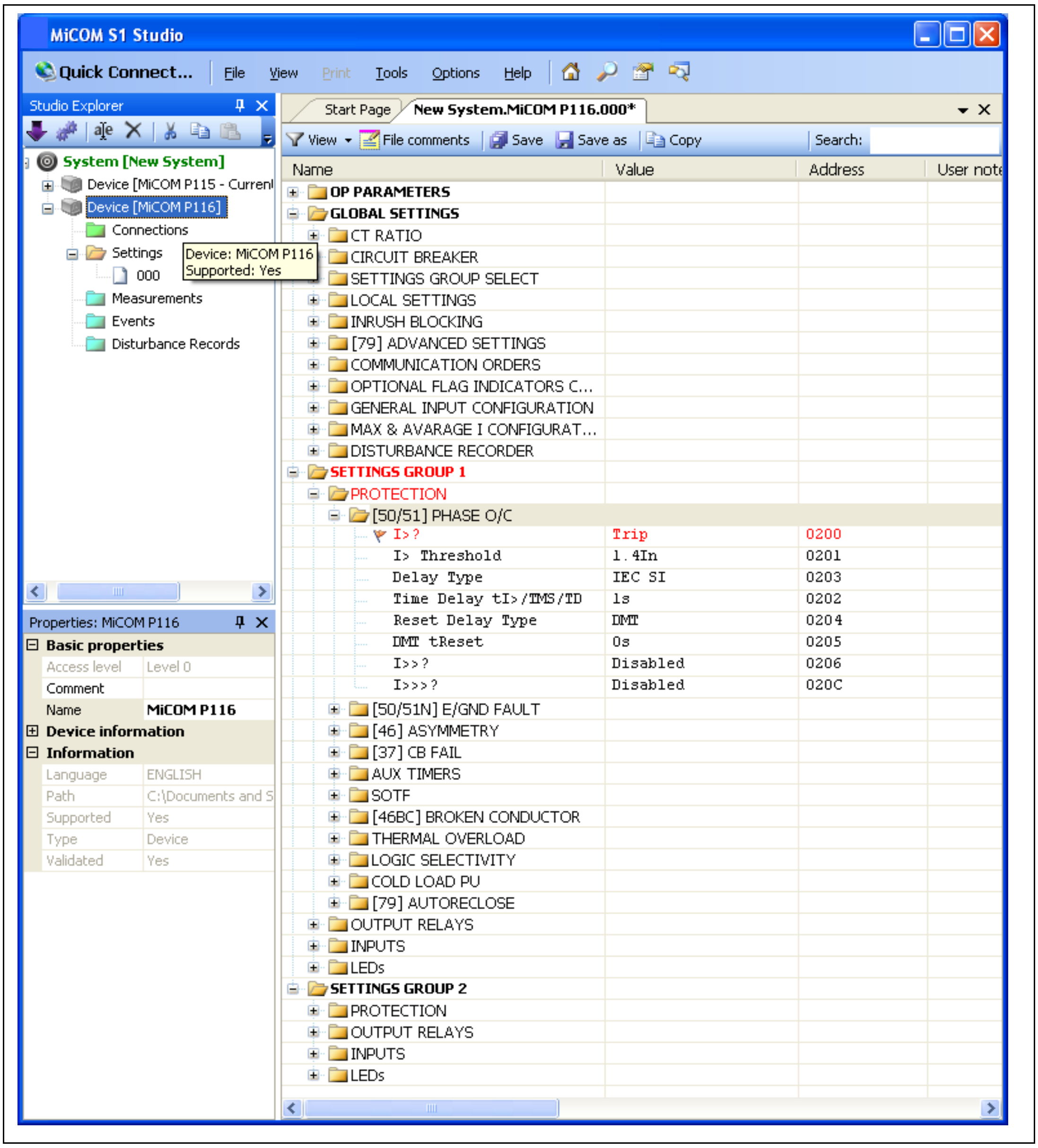
GS

To open default settings:

– Click on the ***Settings*** and right-click to open the contextual menu: ***New File***



– The new setting file ***000.set*** is created:



– Start working with MiCOM P116 relay.

NOTE:

1. **The default password is 0000 for every password protection level.**
2. **For communication via Setting Software (MiCOM S1 Studio or MiCOM S1) the administrator password must be entered – the same as was entered in the relay.**
3. **S1 recognizes password as characters. If the password is 0001 (in the password window of P116's menu, 4 digits are displayed) it is necessary to enter 0001 in S1 (all four digits have to be put). For above case: 1 or 01 or 001 will be rejected. 0001 will be accepted only.**

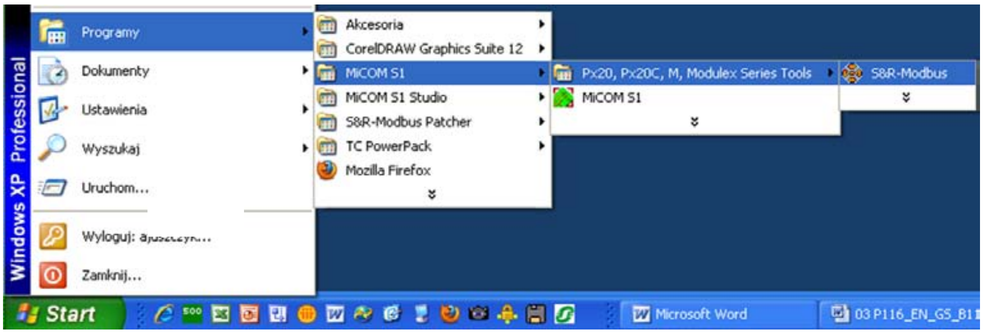
GS

3.6 MiCOM S1

3.6.1 Starting MiCOM S1

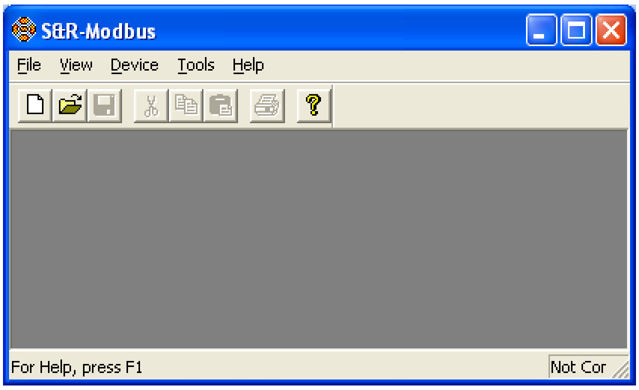
To start MiCOM S1 Studio, click on the icon: 

In the ***Programs*** menu, select ***MiCOM S1*** then ***PX20, Px20C, M, Modulex Series Tools*** then ***S&R-Modbus***



WARNING: Clicking on "Uninstall MiCOM S1", will uninstall MiCOM S1, as well as all data and records used in MiCOM S1.

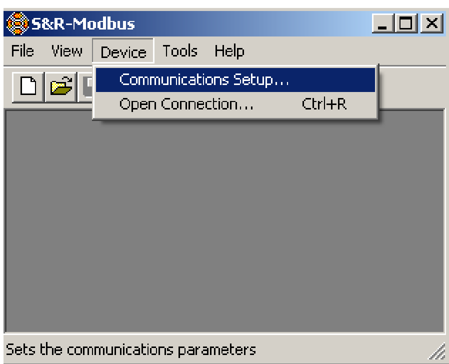
S&R-Modbus screen is displayed:



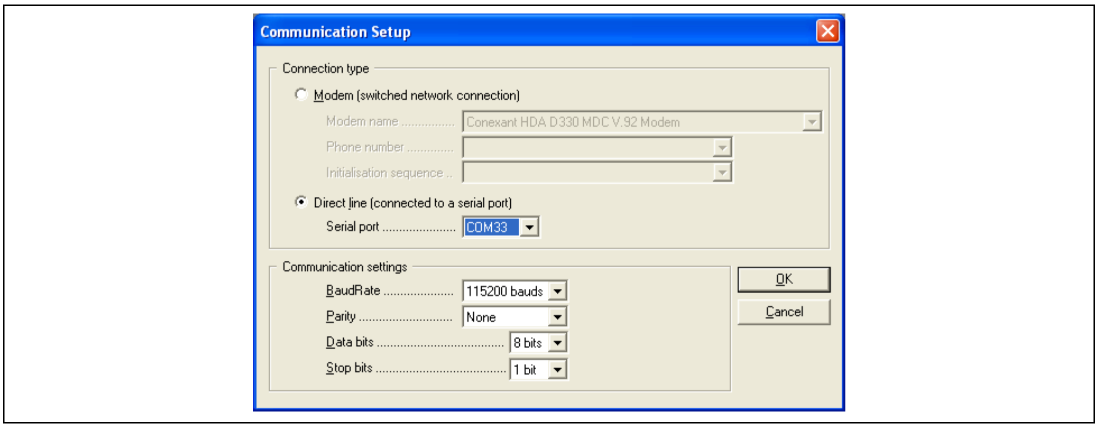
3.6.2 Open communication link with relay

To open the communications link from S1 to the relay, follow the following procedure:

First, if necessary, the communication setup must be adjusted. In the ***Device*** menu, select ***Communications Setup…***



This brings up the following screen:



COMMUNICATION SET-UP SCREEN

When the communications setup is correct the link with the relay can be initialized. In the "Device" menu, select "Open Connection…"

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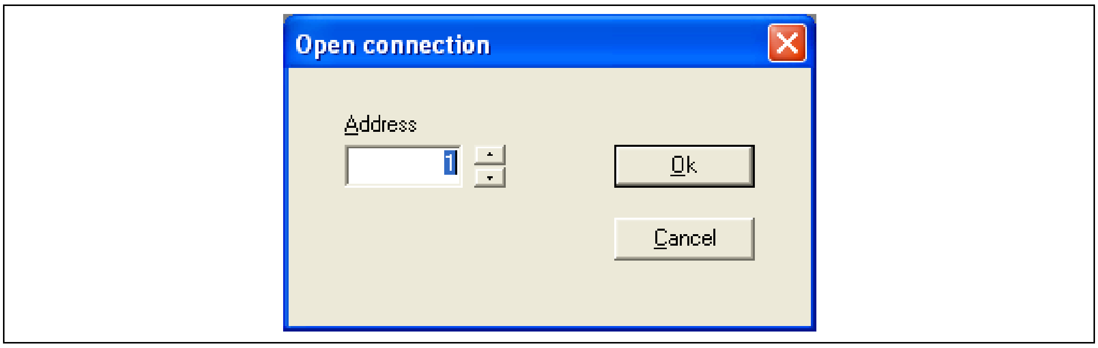
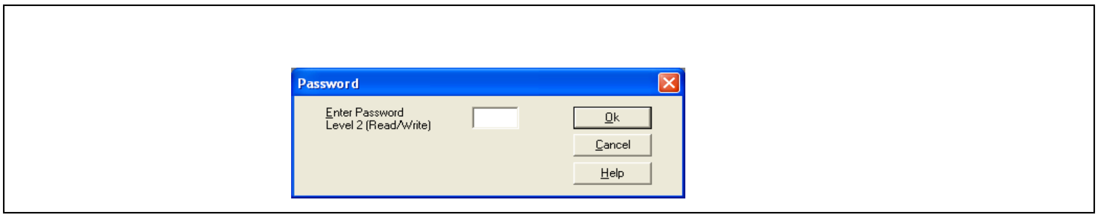
This brings up a prompt for the address of the relay to be polled.



When this has been entered a prompt for the password appears.

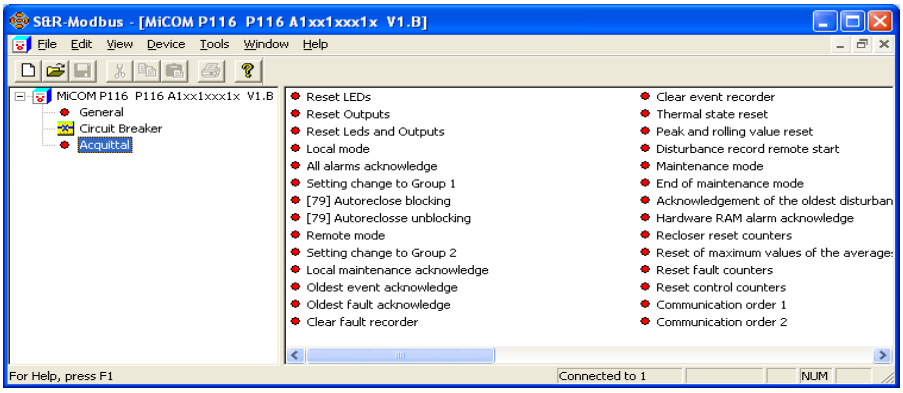
Enter Password: administrator level (without limits) - the same as in the P116 which is connected via USB port. If the administrator password is not entered in the P116 – leave it as default. Note: the password could be unique for every P116 so if the password is forgotten – contact with SE service for help.



NOTE:

1. **The default password is 0000 for every password protection level.**
2. **For communication via Setting Software (MiCOM S1) the administrator password must be entered – the same as it was entered in the relay.**
3. **S1 recognizes the password as characters. If the password is 0001 (in the password window of P116's menu, 4 digits always are displayed) it is necessary to enter 0001 in S1 (all four digits have to be entered). For above case: 1 or 01 or 001 will be rejected. Only 0001 will be accepted.**

When these have been entered satisfactorily the relay is then able to communicate with MiCOM S1. When a communication link has been established between the PC and a MiCOM IED, both are said to be online. Data and information can be directly transferred to and from the IED using the menu available under the ***DEVICE*** menu.

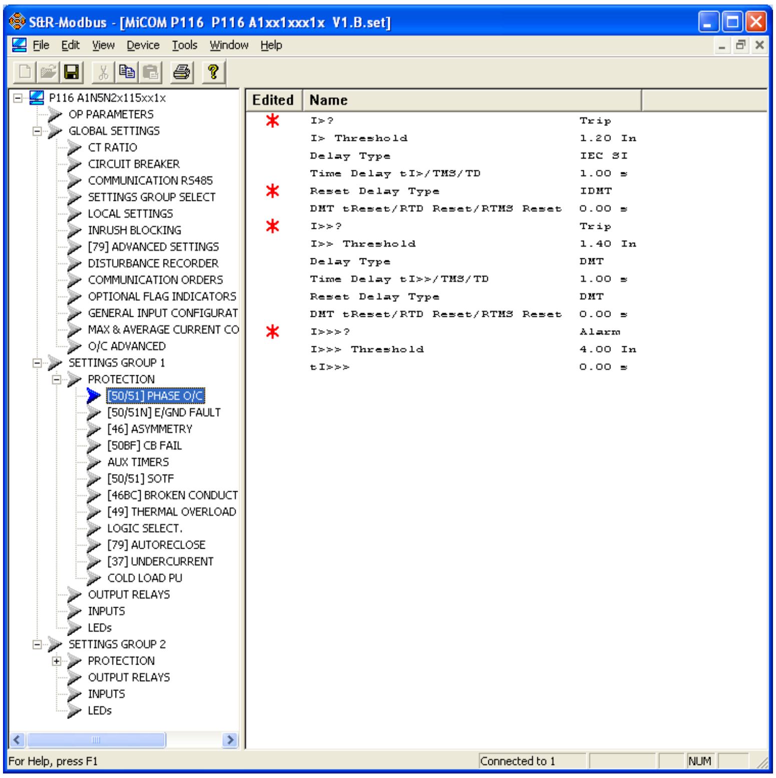


For further instruction on how to extract, download and modify settings files, please refer to the MiCOM S1 User Manual.

Select the main function in the right hand side window.

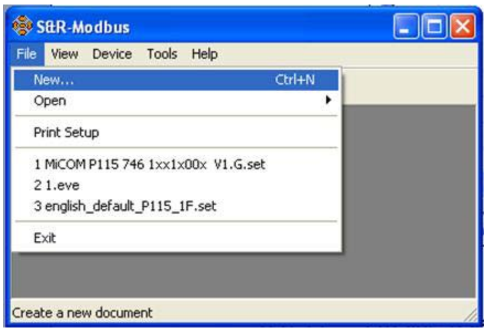
To modify a setting value, double click the corresponding line in the left hand side window. This opens a setting window.

A red star (∗) indicates that a setting value has been modified.

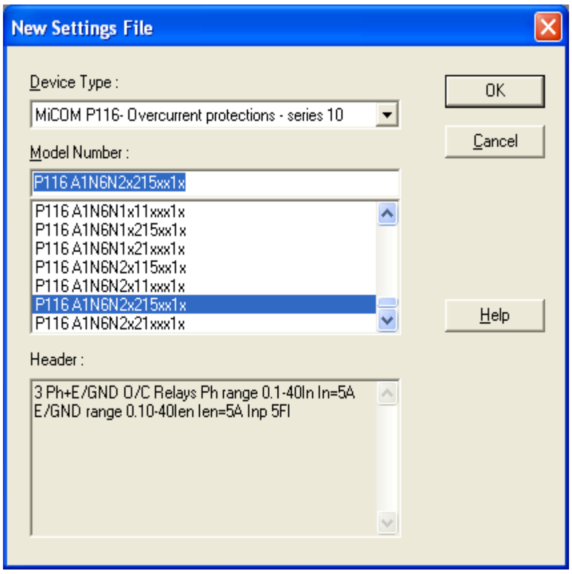


3.6.3 Off-line use of MiCOM S1

As well as being used for the on-line editing of settings, MiCOM S1 can also be used as an off-line tool to prepare settings without access to the relay. In order to open a default setting file for modification, select ***New*** and then ***Settings File…*** in the ***File*** menu.



This brings up a prompt for the relay model type where you can select the correct relay for your application:

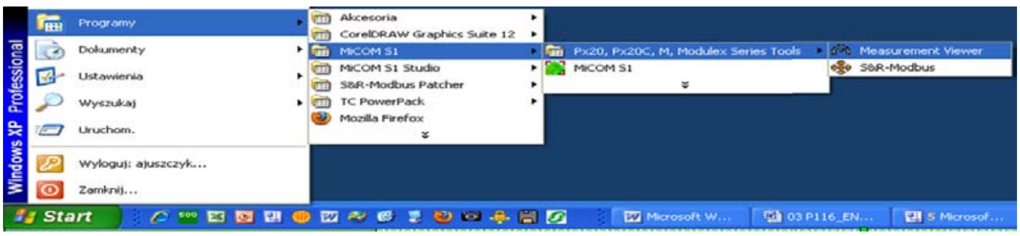


Clicking on ***OK*** will open the default file and you can start to edit settings. For further instruction on how to extract, download and modify settings files, please refer to the MiCOM S1 User Manual.

3.6.4 MiCOM monitoring

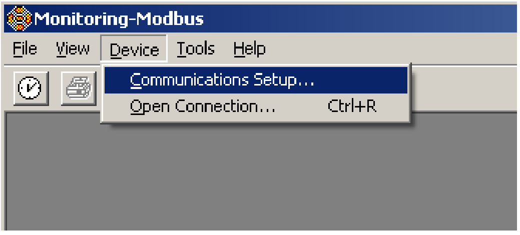
The monitoring module allows connection to the relay's front port so as to retrieve and monitor its measurements.

In the ***Programs*** menu, select ***MiCOM S1*** then ***PX20, Px20C, M, Modulex Series Tools*** then ***Measurement Viewer***



The monitoring module is displayed.

Use the ***Device*** menu to configure the communications and



The ***Communications setup…*** menu is used to select or set-up the communication settings.

The ***Open Connection…*** menu is used to retrieve data from the connected device.

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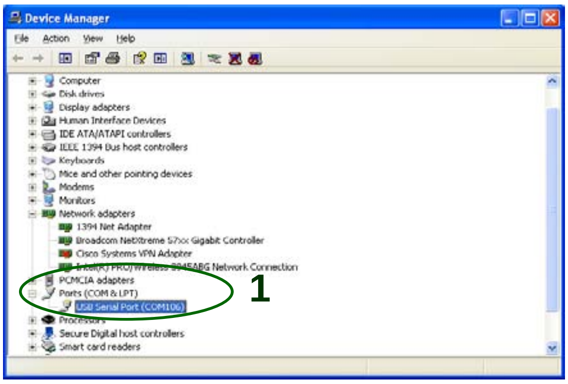
3.7 Troubleshooting USB connection

The virtual COM can be read in WINDOWS's "Device Manager" like below:



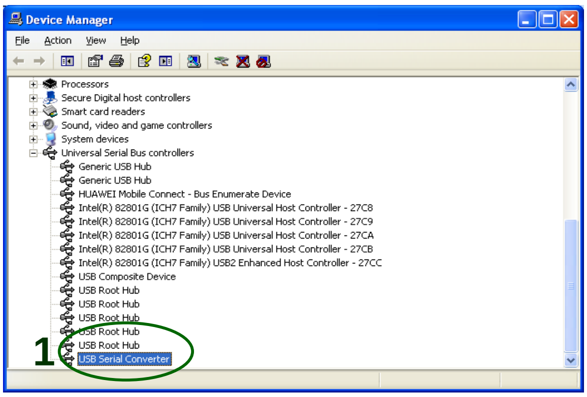
NOTE: If P116 is connected but no any USB Serial port is shown, it means that:

a) USB drivers are not installed

or

b) VCP (Virtual COM Port) option of USB Serial Converter is not selected.

USB drivers:

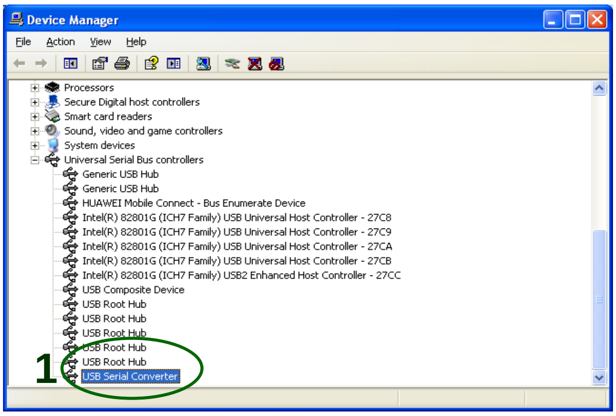


If you can't see "USB Serial Converter" it means that USB divers are not installed.

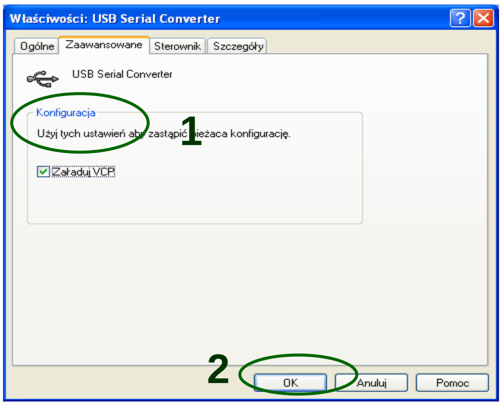
Refer section "3.2 USB Driver and virtual COM software installation"

VCP (Virtual COM Port)

On the window as below:



Check VCP option by right-click to open the contextual menu: Properties and Advanced:



Unplug USB cable and plug in again. Restart S1 Studio and repeat the procedure.

GS

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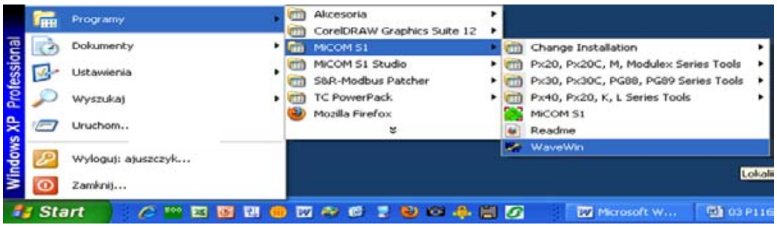
3.8 Presentation and analysis of disturbances

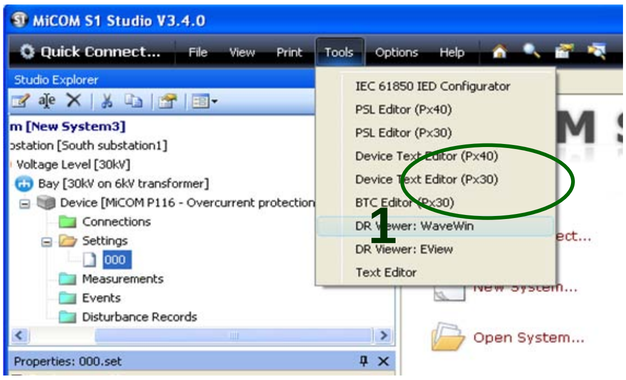
Reading and analysis of disturbance records is done using Wavewin.

To open Wavewin with MiCOM S1:

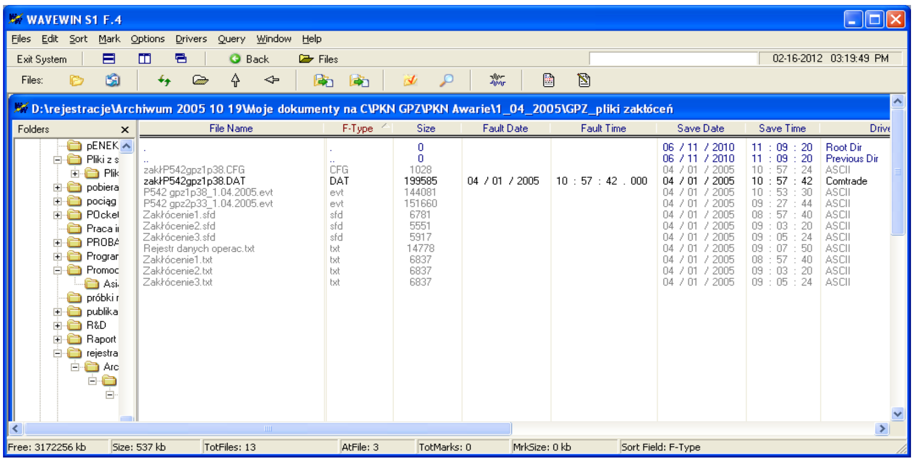
In the ***Programs*** menu, select ***MiCOM S1*** then ***PX20, Px20C, M, Modulex Series Tools*** then ***WaveWin***



Using MiCOM S1 Studio, open Wavewin using the ***Tools*** menu.



The Wavewin File Manager is displayed (refer to the Wavewin User's guide to operate Wavewin).



4. COMPANY CONTACT INFORMATION

If you need information pertaining to the operation of the MiCOM product that you have purchased, please contact your local Schneider Electric agent or the After Sales Service Department of Schneider Electric. Do not forget to give the serial number and reference of the MiCOM product.

The MiCOM product reference and serial numbers are documented under the upper hinged cover on the front of the relay. For more precise information, refer to the section "Relay Identification" in this chapter.

PLEASE PROVIDE THE FOLLOWING INFORMATION WHEN CONTACTING SCHNEIDER ELECTRIC:

– CORTEC code of the MiCOM relay

– Serial number of the MiCOM relay

– Schneider Electric order reference

– Schneider Electric operator reference

Schneider Electric Worldwide Contact Centre:

– Website: http://www.schneider-electric.com/CCC

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ST

SETTINGS

Date:	**17th November 2013**
Hardware Suffix:	**A**
Software Version:	**1C**
Connection Diagrams:	**10P11602**

CONTENTS

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1. GENERAL INFORMATION

The P116 must be configured to the system and application by means of the appropriate settings. This section gives instructions for determining the settings, which are located in the folder entitled, SCHNEIDER ELECTRIC ENERGY in the menu tree. The order in which the settings are listed and described in this chapter is: the protection settings control and configuration settings (see section P116/EN GS for the detailed relay menu map). The relay is supplied with a factory-set configuration of default settings

All current settings refer to nominal current (ordering option: 1 A or 5 A). The nominal current can be defined separately for phase (In) and earth (Ien) currents in the ordering process (ordering hardware option).

MiCOM S1 can be used to download and upload protection and configuration setting values via the relay's USB port.

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

– Protection element settings.

– Output settings

– Input settings (Model A)

– LED settings

In Model A, there are two groups of protection and I/O settings, with each group containing the same setting cells. One group of protection and I/O settings is selected as the active group, and is used by the protection elements. The settings for group 1 are shown. The settings are discussed in the same order in which they are displayed in the menu.

The menu structure is as follows:

- **DEFAULT WINDOW** (Currents in multiples of In, currents in Amps, CB Control window, Local/remote control window, au to-reclose window)

- ***ALARM STATUS***

- ***RECORDS***

    - ***FAULT RECORDS***

    - ***ALARM RECORDS*** ***(Model A)***

    - ***INSTANTANEOUS RECORDS*** ***(Model A)***

    - ***COUNTERS***

        - ***CONTROL COUNTER*** ***(Model A)***

        - ***FAULT COUNTER***

        - ***AUTORECLOSE COUNTER*** ***(Model A)***

        - ***CB MONITORING COUNTER*** ***(Model A)***

    - ***MAX&AVERAGE VALUES***

- ***SETTING GROUP 1***

    - ***PROTECTION G1***

        - ***PHASE O/C G1 [50/51]***

        - ***SOTF G1 [50/51]*** ***(Model A)***

        - ***E/GND FAULT G1 [50N/51N]***

        - ***UNDERCURRENT [37]*** ***(Model A)***

        - ***NEGATIVE SEQUENCE O/C G1 [46]*** ***(Model A)***

- ***BROKEN CONDUCTOR G1 [46BC] (Model A)***
- ***THERMAL OVERLOAD G1 [49]***
- ***CB FAIL G1 [50BF]***
- ***AUX TIMERS G1 (Model A)***
- ***LOGIC SELECTIVITY G1 (Model A)***
- ***COLD LOAD PICK UP G1 (Model A)***
- ***AUTORECLOSE G1 [79] (Model A)***

- ***OUTPUT RELAY CONFIGURATION G1***
- ***INPUTS CONFIGURATION G1 (Model A)***
- ***LEDS CONFIGURATION G1***

- ***SETTING GROUP 2 (Model A)***
  - ***PROTECTION G2***
    - ***PHASE O/C G2 [50/51]***
    - ***SOTF [50/51] G2***
    - ***E/GND FAULT G2 [50N/51N]***
    - ***UNDERCURRENT G2 [37]***
    - ***NEGATIVE SEQUENCE O/C G2 [46]***
    - ***BROKEN CONDUCTOR G2)***
    - ***THERMAL OVERLOAD G2 [49]***
    - ***CB FAIL G2 [50BF]***
    - ***AUX TIMERS G2***
    - ***LOGIC SELECTIVITY G2***
    - ***COLD LOAD PICK UP G2***
    - ***AUTORECLOSE G2 [79]***
  - ***OUTPUT RELAY CONFIGURATION G2***
  - ***INPUTS CONFIGURATION G2***
  - ***LEDS CONFIGURATION G2***
- ***GLOBAL SETTINGS***
  - ***LOC***
  - ***SETTING GROUP SELECT (Model A)***
  - ***CT RATIO***
  - ***CIRCUIT BREAKER***
  - ***INRUSH BLOCKING***
  - ***O/C ADVANCED***
  - ***[79] ADVANCED SETTINGS (Model A)***
  - ***COMMUNICATION ORDERS (Model A)***
  - ***OPTIONAL FLAG INDICATORS CONFIGURATION (Model A)***
  - ***GENERAL INPUT CONFIGURATION (Model A)***

- ***COMMUNICATION** **(Model A)***
- ***MAX & AVERAGE I CONFIGURATION***
- ***DISTURBANCE RECORDER***

- ***COMMISSIONING***
- ***SETTING CHANGE MODE***
- ***OP PARAMETERS***
- ***MEASUREMENTS***

ST

2. SETTINGS

2.1 Protection Settings

2.1.1 [50/51] Phase O/C

The overcurrent protection included in the P116 relay provides non-directional three-phase overcurrent protection with independent time-delay characteristics. All overcurrent settings apply to all of the three phases but are independent for each of the three stages.

The first two overcurrent stages have time-delayed characteristics which are selectable between inverse definite minimum time (IDMT) and definite time (DMT). The third stage has definite time characteristics (DMT) only.

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
I> ?	Disabled	Disabled, Trip, Alarm, Trip-Inrush Bl, Trip-Latch		
Setting to disable or enable the protection element. The protection element can be set to trip the CB (Enable ***Trip***), only issue an Alarm signal (Enable ***Alarm***), trip the CB with Inrush Blocking logic (***Trip-Inrush Bl***) or trip the CB with latching until LEDs / signaling reset (***Trip-Latch***). If the protection element is set to ***'Trip'*** or ***'Trip-Inrush Bl'*** or ***'Trip-Latch'*** it means that it is linked to the ***Protection trip*** (see LED and Output configuration) and ***Trip Command*** (see Output configuration) functions. Additionally this protection element will trigger fault recording, disturbance recording, as well as the ***Trip*** LED and the Flag indicator on the front panel. If the protection element is set to ***'Alarm'*** it means that it is linked to the ***Alarm*** function (see LED and Output configuration) and ***'ALARM STATUS'*** indication.				
I> Threshold	1.2 x In	0.1 x In	40.0 x In	0.01 x In
Pick-up setting for the first stage of the overcurrent element. If IDMT is used the recommended value is up to 3 x In because of the 20-times dependency of IDMT characteristics (the dynamic measuring range is up to 60 x In).				
I> Delay Type	IEC SI	DMT, IEC SI, IEC VI, IEC EI, UK LTI, UK STI, UK RC, RI, IEEE MI, IEEE VI, IEEE EI, US CO2-P20, US CO8, RXIDG, BNP EDF, CO2-P40		
Setting for the tripping characteristic for the first stage overcurrent element.				
tI>	1 s	0.05 s	200 s	0.01 s
Setting for the time-delay for the definite time setting if selected for first stage element.				
I> TMS	1	0.02	1.6	0.01
Setting for the time multiplier setting to adjust the operating time of the IEC, UK, and RI IDMT characteristics.				
I> Time Dial	1	0.02	200	0.01
Setting for the time multiplier setting to adjust the operating time of the IEEE/US IDMT curves.				
Reset Delay Type I>	DMT	DMT or IDMT		N/A
Setting to determine the type of reset/release characteristic of the IEEE/US curves.				
DMT tReset I>	0 s	0 s	200 s	0.01 s
Setting that determines the reset/release time for definite time reset characteristics.				
RTD/RTMS Reset I>	0.02 s	0.02 s	1.6 s	0.01 s
Setting that determines the reset/release time for IDMT time reset characteristics.				

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Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
I>> ?	Disabled	Disabled, Trip, Alarm, Trip-Inrush Bl, Trip-Latch		
See I>?				
I>> Threshold	1.4 x In	0.1 x In	40.0 x In	0.01 x In
Pick-up setting for the second stage of the overcurrent element. If IDMT is used the recommended value is up to 3 x In because of the 20-times dependency of IDMT characteristics (the dynamic measuring range is up to 60 x In).				
Delay Type I>>	IEC SI	DMT, IEC SI, IEC VI, IEC EI, UK LTI, UK STI, UK RC, RI, IEEE MI, IEEE VI, IEEE EI, US CO2-P20, US CO8, RXIDG, BNP EDF, US CO2-P40		
Setting for the tripping characteristic for this stage overcurrent element.				
tI>>	1	0.05	200	0.01
Setting for the time-delay for the definite time setting if selected for this stage element.				
I>> TMS	1	0.02	1.6	0.01
Setting for the time multiplier setting to adjust the operating time of the IEC, UK, and RI IDMT characteristics.				
I>> Time Dial	1	0.02	200	0.01
Setting for the time multiplier setting to adjust the operating time of the IEEE/US IDMT curves.				
Reset Delay Type I>>	DMT	DMT or IDMT		N/A
Setting to determine the type of reset/release characteristic of the IEEE/US curves.				
DMT tReset I>>	0 s	0 s	600 s	0.01 s
Setting that determines the reset/release time for definite time reset characteristics.				
RTD/RTMS Reset I>>	0.02 s	0.02 s	1.6 s	0.01 s
Setting that determines the reset/release time for IDMT time reset characteristics				
I>>> ?	Disabled	Disabled, Trip, Alarm, Trip-Inrush Bl, Trip-Latch		
See I>?				
I>>> Threshold	4 x In	1 x In	40.0 x In	0.01 x In
Pick-up setting for the third stage of the overcurrent element.				
tI>>>	0.1 s	0 s	200 s	0.01 s
Setting for the time-delay for the definite time setting if selected for this stage element.				

IDMT tripping can be blocked if any DMT stage is started, settings: ***IDMT interlock by DMT*** (***GLOBAL SETTINGS/O/C ADVANCED*** column). This settings is common for ***E/Gnd Fault [50N/51N]*** and ***Phase O/C [50/51]*** and ***[46] Negative Sequence*** (see point:

Menu Text	Default Setting	Setting Range	Step Size
IDMT interlock by DMT	No	No, Yes, 20Is	n/a

2.1.2 SOTF (Switch On To Fault function) (Model A)

With the **Switch On To Fault** (SOTF) submenu, it is possible to shorten the time to trip when for example the relay has detected a fault that is still present on a feeder after energizing.

The SOTF overcurrent element is activated after Manual Close command (communication port, binary input, front panel) up to ***52 Unblock SOTF Time (GLOBAL SETTINGS/CIRCUIT BREAKER)***. SOTF is blocked when the auto-recloser close CB.

<table>
<tr><td>SOTF?</td><td>Disabled</td><td colspan="3">Disabled, Trip, Alarm, Trip-Inrush Bl, Trip-Latch</td></tr>
<tr><td colspan="5">Setting to disable or enable the protection element.
The protection element can be set to trip the CB (Enable Trip), only issue an Alarm signal (Enable Alarm), trip the CB with Inrush Blocking logic (Trip-Inrush Bl) or trip the CB with latching until LEDs / signaling reset (Trip-Latch).
If the protection element is set to 'Trip' or 'Trip-Inrush Bl' or 'Trip-Latch' it means that it is linked to the Protection trip (see LED and Output configuration) and Trip Command (see Output configuration) functions. Additionally this protection element will trigger fault recording, disturbance recording, as well as the Trip LED and the Flag indicator on the front panel.
If the protection element is set to 'Alarm' it means that it is linked to the Alarm function (see LED and Output configuration) and 'ALARM STATUS' indication.</td></tr>
<tr><td>SOTF Threshold</td><td>4 x In</td><td>1 x In</td><td>40.0 x In</td><td>0.01 x In</td></tr>
<tr><td colspan="5">Pick-up setting for the third stage of the overcurrent element.</td></tr>
<tr><td>tSOTF</td><td>0.1 s</td><td>0 s</td><td>600 s</td><td>0.01 s</td></tr>
<tr><td colspan="5">Setting for the time-delay for the definite time setting if selected for this stage element.</td></tr>
</table>

ST

2.1.3 [50N/51N] E/Gnd Fault

The earth fault element operates from earth fault current that is measured directly from the system; either by means of a separate CT located in a power system earth connection or via a residual connection of the three line CTs.

All overcurrent settings are independent for each of the two stages.

The first stage of e/f non-directional overcurrent protection has time-delayed characteristics which are selectable between inverse definite minimum time (IDMT) and definite time (DMT). The second stage has definite time characteristics only.

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
IN_1 stage?	Disabled	Disabled, IN>Trip, IN> Alarm, IN> Trip-Inrush Bl, IN> Trip-Latch		
Setting to disable or enable the protection element. The protection element can be set to trip the CB (Enable ***Trip***), only issue an Alarm signal (Enable ***Alarm***), trip the CB with Inrush Blocking logic (***Trip-Inrush Bl***) or trip the CB with latching until LEDs / signaling reset (***Trip-Latch***). If the protection element is set to ***'Trip'*** or ***'Trip-Inrush Bl'*** or ***'Trip-Latch'*** it means that it is linked to the ***Protection trip*** (see LED and Output configuration) and ***Trip Command*** (see Output configuration) functions. Additionally this protection element will trigger fault recording, disturbance recording, as well as the ***Trip*** LED and the Flag indicator on the front panel. If the protection element is set to ***'Alarm'*** it means that it is linked to the ***Alarm*** function (see LED and Output configuration) and ***'ALARM STATUS'*** indication.				
IN_1 Threshold	0.2 x Ien	0.002 x Ien	1 x Ien	0.001 x Ien
Pick-up setting for the first stage e/f overcurrent element. If IDMT is used, the recommended value is up to 0.05 x Ien because of the 20-times dependency of IDMT characteristics (the dynamic measuring range is up to 1 x Ien). For dynamic range (ordering option): 0.002-1 Ien, where Ien: nominal current for e/f input				
IN_1 Threshold	0.2 x Ien	0.01 x Ien	8 x Ien	0.01 x Ien
Pick-up setting for first stage overcurrent element. If IDMT is used, the recommended value is up to 0.5 x In because of 20-times dependency of IDMT characteristics (the dynamic measuring range is up to 10 x Ien). For dynamic range (ordering option): 0.01-8 Ien, where Ien: nominal current for e/f input				
IN_1 Threshold	0.2 x Ien	0.1 x Ien	40 x Ien	0.01 x Ien
Pick-up setting for the first stage e/f overcurrent element. If IDMT is used, the recommended value is up to 3.0 x In because of 20 times dependence of IDMT characteristics (the dynamic measuring range is up to 60 x Ien). For dynamic range (ordering option): 0.1-40 Ien, where Ien: nominal current for e/f input				
Delay Type IN_1	IEC SI	DMT, IEC SI, IEC VI, IEC EI, UK LTI, UK STI, UK RC, RI, IEEE MI, IEEE VI, IEEE EI, US CO2-P20, US CO8, RXIDG, BNP EDF, US CO2-P40		
Setting for the tripping characteristic for the first stage e/f overcurrent element.				
tIN_1	1 s	0.05 s	200 s	0.01 s
Setting for the time-delay for the definite time setting if selected for first e/f stage element.				
IN_1 TMS	1	0.02	1.6	0.01
Setting for the time multiplier setting to adjust the operating time of the IEC, UK, and RI IDMT characteristics.				

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
IN_1 Time Dial	1	0.02	200	0.01
Setting for the time multiplier setting to adjust the operating time of the IEEE/US IDMT curves.				
Reset Delay Type IN_1	DMT	DMT or IDMT		N/A
Setting to determine the type of reset/release characteristic of the IEEE/US curves.				
RTD/RTMS Reset IN>	0.02	0.02	1.6	0.01
Setting that determines the reset/release time for IDMT time reset characteristics.				
DMT tReset IN>	0 s	0 s	200 s	0.01 s
Setting that determines the reset/release time for definite time reset characteristics.				
IN_2 ?	Disabled	Disabled, IN>> Trip, IN>> Alarm, IN>> Trip-Inrush Bl, IN>> Trip-Latch		
See IN_1 stage?				
IN_2 Threshold	0.05 x Ien	0.025 x Ien	1.0 x Ien	0.001 x Ien
Pick-up setting for the second stage of the e/f overcurrent element. For dynamic range (ordering option): 0.002-1 Ien, where Ien: nominal current for e/f input				
IN_2 Threshold	0.4 x Ien	0.2 x Ien	8.0 x Ien	0.01 x Ien
Pick-up setting for the second stage of the overcurrent element. For dynamic range (ordering option): 0.01-10 Ien, where Ien: nominal current for e/f input				
IN_2 Threshold	2.0 x Ien	1 x Ien	40.0 x Ien	0.1 x Ien
Pick-up setting for the second stage of the e/f overcurrent element. For dynamic range (ordering option): 0.1-40 Ien, where Ien: nominal current for e/f input				
tIN_2	0.2 s	0 s	200 s	0.01 s
Setting for the time-delay for the definite time setting if selected for this stage.				
IN_3 stage?	Disabled	Disabled, IN>>> Trip, IN>>> Alarm, IN>>> Trip-Inrush Bl, IN>>> Trip-Latch		
See IN_1 stage?				
IN_3 Threshold	0.2 x Ien	0.025 x Ien	1.0 x Ien	0.001 x Ien
Pick-up setting for the second stage of the e/f overcurrent element. For dynamic range (ordering option): 0.002-1 Ien, where Ien: nominal current for e/f input				
IN_3 Threshold	0.2 x Ien	0.1 x Ien	8.0 x Ien	0.01 x Ien
Pick-up setting for second stage of the overcurrent element. For dynamic range (ordering option): 0.01-8 Ien, where Ien: nominal current for e/f input				
IN_3 Threshold	0.2 x Ien	1 x Ien	40.0 x Ien	0.1 x Ien
Pick-up setting for the second stage of the e/f overcurrent element. For dynamic range (ordering option): 0.1-40 Ien, where Ien: nominal current for e/f input				
tIN_3	0.05 s	0 s	200 s	0.01 s
Setting for the time-delay for the definite time setting if selected for this stage.				

IDMT tripping can be blocked if any DMT stage is started, settings: ***IDMT interlock by DMT*** (***GLOBAL SETTINGS/O/C ADVANCED*** column). This settings is common for ***E/Gnd Fault [50N/51N]*** and ***Phase O/C [50/51]*** and ***[46] Negative Sequence***

Menu Text	Default Setting	Setting Range	Step Size
IDMT interlock by DMT	No	No, Yes, 20Is	n/a

2.1.4 [37] Undercurrent (Model A)

I< ?	Disabled	Disabled, Trip, Alarm, Trip-Inrush Bl, Trip-Latch, Trip-Inhib 52A, Alarm-Inhib 52		
Setting to disable or enable the protection element. The protection element can be set to trip the CB (Enable ***Trip***), only issue an Alarm signal (Enable ***Alarm***), trip the CB with Inrush Blocking logic (***Trip-Inrush Bl***), trip the CB with latching until LEDs / signaling reset (***Trip-Latch***), trip the CB with blocking of I< if the CB is not closed (***Trip-Inhib 52A***) or only issue an ***Alarm*** signal with blocking of I< if the CB is not closed (***Alarm-Inhib 52A***). If the protection element is set to ***'Trip'*** or ***'Trip-Inrush Bl'*** or ***'Trip-Latch'*** it means that it is linked to the ***Protection trip*** (see LED and Output configuration) and ***Trip Command*** (see Output configuration) functions. Additionally this protection element will trigger fault recording, disturbance recording, as well as the ***Trip*** LED and the Flag indicator on the front panel. If the protection element is set to ***'Alarm'*** it means that it is linked to the ***Alarm*** function (see LED and Output configuration) and ***'ALARM STATUS'*** indication.				
I< Threshold	2 x In	0.1 x In	2.0 x In	0.01 x In
Pick-up setting for third stage of the overcurrent element.				
tI<	0.1 s	0.05 s	200 s	0.01 s
Setting for the time-delay for the definite time setting if selected for this element.				

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2.1.5 [46] Negative Sequence O/C (Model A)

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
I2> ?	Disabled	Disabled, Trip, Alarm, Trip-Inrush Bl, Trip-Latch		
Setting to disable or enable the protection element. The protection element can be set to trip the CB (Enable ***Trip***), only issue an Alarm signal (Enable ***Alarm***), trip the CB with Inrush Blocking logic (***Trip-Inrush Bl***) or trip the CB with latching until LEDs / signaling reset (***Trip-Latch***). If the protection element is set to ***'Trip'*** or ***'Trip-Inrush Bl'*** or ***'Trip-Latch'*** it means that it is linked to the ***Protection trip*** (see LED and Output configuration) and ***Trip Command*** (see Output configuration) functions. Additionally this protection element will trigger fault recording, disturbance recording, as well as the ***Trip*** LED and the Flag indicator on the front panel. If the protection element is set to ***'Alarm'*** it means that it is linked to the ***Alarm*** function (see LED and Output configuration) and ***'ALARM STATUS'*** indication.				
I2> Threshold	1.0x In	0.1 x In	4.0 x In	0.01 x In
Pick-up setting for the first stage of the overcurrent element. If IDMT is used recommended value is up to 3xIn because of 20 time dependence of IDMT characteristics. (dynamic measuring range is up to 60xIn)				
I2> Delay Type	IEC SI	DMT, IEC SI, IEC VI, IEC EI, UK LTI, UK STI, UK RC, RI, IEEE MI, IEEE VI, IEEE EI, US CO2-P20, US CO8, RXIDG, BNP EDF, US CO2-P40		
Setting for the tripping characteristic for the first stage overcurrent element.				
tI2>	1 s	0.05 s	200 s	0.01 s
Setting for the time-delay for the definite time setting if selected for first stage element.				
I2> TMS	1	0.02	1.6	0.01
Setting for the time multiplier setting to adjust the operating time of the IEC, UK, and RI IDMT characteristic				
I2> Time Dial	1	0.02	200	0.01
Setting for the time multiplier setting to adjust the operating time of the IEEE/US IDMT curves.				
Reset Delay Type I2>	DMT	DMT or IDMT		N/A
Setting to determine the type of reset/release characteristic of the IEEE/US curves.				
DMT tReset I2>	0 s	0 s	600 s	0.01 s
Setting that determines the reset/release time for definite time reset characteristics.				
RTD/RTMS Reset I2>	0.02	0.02	1.6	0.01
Setting that determines the reset/release time for IDMT time reset characteristics.				

IDMT tripping can be blocked if any DMT stage is started, settings: ***IDMT interlock by DMT*** (***GLOBAL SETTINGS/O/C ADVANCED*** column). This settings is common for ***E/Gnd Fault [50N/51N]*** and ***Phase O/C [50/51]*** and ***[46] Negative Sequence O/C***

Menu Text	Default Setting	Setting Range	Step Size
IDMT interlock by DMT	No	No, Yes, 20Is	n/a

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2.1.6 [46BC] Broken Conductor

Menu Text	Default Setting	Setting Range		Step Size
Broken Cond.?	Disabled	Disabled, Trip, Alarm, Trip-Inrush Bl, Trip-Latch		
Setting to disable or enable the protection element. The protection element can be set to trip the CB (Enable ***Trip***), only issue an Alarm signal (Enable ***Alarm***), trip the CB with Inrush Blocking logic (***Trip-Inrush Bl***) or trip the CB with latching until LEDs / signaling reset (***Trip-Latch***). If the protection element is set to ***'Trip'*** or ***'Trip-Inrush Bl'*** or ***'Trip-Latch'*** it means that it is linked to the ***Protection trip*** (see LED and Output configuration) and ***Trip Command*** (see Output configuration) functions. Additionally this protection element will trigger fault recording, disturbance recording, as well as the ***Trip*** LED and the Flag indicator on the front panel. If the protection element is set to ***'Alarm'*** it means that it is linked to the ***Alarm*** function (see LED and Output configuration) and ***'ALARM STATUS'*** indication.				
Ratio I2/I1	20%	20%	100%	1%
Pick-up setting for the third stage of the overcurrent element.				
tBCond	100 s	0.05 s	600 s	0.01 s
Setting for the time-delay for the definite time setting if selected for this stage element.				

Broken Conductor [46BC] is disabled if the current: A and B and C is below the stage: ***[46BC] Brkn.Cond I< Block*** (***GLOBAL SETTINGS/O/C ADVANCED*** column)

Menu Text	Default Setting	Setting Range		Step Size
[46BC] Brkn.Cond I< Block	0.10In	0.10In	1.00In	0.01In

2.1.7 [49] Thermal Overload

Menu Text	Default Setting	Setting Range		Step Size
Therm OL?	Disabled	Disabled, Enabled		
Setting to disable or enable the protection element.				
Itherm	1.0 x In	0.1 x In	3 x In	0.01 x In
Base current for Thermal Replica. Typically the value should be set to: ***Itherm*** = I_{FLC}, In protection algorithm the base current is increased by k: safety factor then it is used for thermal replica calculation; If the safety factor should have greater value than 1.05, the setting value of base current or Theta Trip setting can be additionally increased. I_{FLC}: full load current (maximum permissible current which can flow without risk of reducing the protected object's life).				
Te (heating)	40 mn	1 mn	200 mn	1 mn
Heating Time Constant of the protected object (see Application chapter of this Manual).				
Tr (cooling)	40 mn	1 mn	999 mn	1 mn
Cooling Time Constant of the protected object (see Application chapter of this Manual). Typically for protected objects with no moving parts (such as motors) this value should be equal to the Heating Time Constant (Tr = Te)				
Theta Trip	100%	50%	200%	1%
Thermal stage for tripping. If the injected current has value is equal: k* ***Itherm*** (where k=1.05) this value is set to 100%,				
Theta Trip/Reset Ratio:	90%	20%	99%	1%
Setting for ***Theta Trip*** Reset stage. The reset stage is equal to: (***Theta Trip***) * (***Theta Trip/Reset Ratio***).				
Alarm OL?	Disabled	Disabled, Enabled		
Setting for ***Disabling*** or ***Enabling*** the alarm signaling stage of the Thermal Replica.				
Theta Alarm	100%	20%	200%	1%
Thermal stage for signaling (***Alarm***).				

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2.1.8 [50BF] CB Fail

This function consists of a circuit breaker fail function that can be initiated by:

Current based protection elements

External protection element: ***Strt tBF*** function (***SETTING GROUP x/INPUTS CONFIGURATION Gx/*** column).

For current-based protection, the reset condition is based on undercurrent operation to determine whether the CB has opened.

It is common practice to use low set undercurrent elements in protection relays to indicate that circuit breaker poles have interrupted the fault or load current, as required.

If an external protection is set to trigger the ***CB Fail*** element, the trip input must also be mapped to the ***Strt tBF function***. The resetting of the ***tBF*** timer is based on the ***I< Threshold CBF*** and ***IN< Threshold CBF*** criteria only. Therefore if an external protection issues a latched trip signal but currents fall below the undercurrent thresholds, ***CB Fail*** will not issue the CB Fail signal.

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
CB Fail ?	Disabled	Disabled, Retrip, Alarm		
Setting to enable or disable the circuit breaker supervision function. ***Retrip*** setting – the CBF function trips the local CB upon expiry of the ***tBF*** time-delay ***Alarm*** setting – the ***Alarm*** signal is issued upon expiry of the ***tBF*** time-delay				
CB Fail Time tBF	0.1 s	0.1 s	10 s	0.01 s
Setting for the circuit breaker fail timer stage for which the initiating condition must be valid.				
I< Threshold CBF	0.1 x In	0.1 x In	2 x In	0.01 x In
Setting that determines the circuit breaker fail timer reset current for overcurrent based protection circuit breaker fail initiation.				
IN< Threshold CBF	0.1 x Ien	0.01 x Ien	1 x Ien	0.01 x Ien
Setting that determines the circuit breaker fail timer reset current for earth fault current based protection circuit breaker fail initiation. For dynamic range (ordering option): 0.002-1 Ien, where Ien: nominal current for e/f input				
IN< Threshold CBF	0.1 x Ien	0.1 x Ien	2 x Ien	0.01 x Ien
Setting that determines the circuit breaker fail timer reset current for earth fault current based protection circuit breaker fail initiation. For dynamic range (ordering option): 0.01-8 Ien, where Ien: nominal current for e/f input				
IN< Threshold CBF	0.1 x Ien	0.1 x Ien	2 x Ien	0.01 x Ien
Setting that determines the circuit breaker fail timer reset current for earth fault current based protection circuit breaker fail initiation. For dynamic range (ordering option): 0.1-40 Ien, where Ien: nominal current for e/f input				
Block I> ?	No	No or Yes		
Select the possibility to block the instantaneous signal Phase O/C [50/51] stage in case of circuit breaker failure detection.				
Block IN> ?	No	No or Yes		
Select the possibility to block the instantaneous signal of any E/Gnd Fault [50N/51N] stage in case of circuit breaker failure detection.				

2.1.9 Auxiliary Timers (Model A)

<table>
<tr><th rowspan="2">Menu Text</th><th rowspan="2">Default Setting</th><th colspan="2">Setting Range</th><th rowspan="2">Step Size</th></tr>
<tr><th>Min.</th><th>Max.</th></tr>
<tr><td>AUX1 ?</td><td>0: Disabled</td><td colspan="2">0: Disabled,
1: Trip,
2: Alarm,
3: Trip-Inrush Bl,
4: Trip-Latch,
5: Load Shedding,
6: AR after LS Hi,
7: AR after LS Lo</td><td>N/A</td></tr>
<tr><td colspan="5">Setting to disable or enable the AUX element.
The element can be set to:
- trip the CB (Enable Trip),
- signal only (Alarm),
- trip the CB with Inrush Blocking logic (Trip-Inrush Bl)
- trip the CB with latching until reset (Trip-Latch)
- trip the CB when a binary input receives the information that the frequency of power system is too low (Load Shedding). This information is saved as long as the CB remains open or until the power system's frequency returns to its nominal value. The above information is based on the status of the binary input mapped to AUX (SETTING GROUP x/INPUT CONFIGURATION Gx/AUX) with AUX set to AR after LS Hi or to AR after LS Lo (tripping occurs upon expiry of the tAUX time-delay). The trip command is sent via the Trip CB order output (SETTING GROUP x/OUTPUT RELAYS CONFIGURATION Gx/Trip CB order).
- reclose after Load Shedding triggered by a high state of the AUX function (AR after LS Hi). Load shedding information is based on the status of the binary input mapped to AUX (SETTING GROUP x/INPUT CONFIGURATION Gx/AUX) with AUX set to Load Shedding. If the P116 has saved Load Shedding information and AUX indicates that the power system frequency has returned to its nominal value, the tAUX time-delay is started. At the end of tAUX the close command is issued. The close command is issued via the Close CB order output (SETTING GROUP x/OUTPUT RELAYS CONFIGURATION Gx/Close CB order).
- reclose after Load Shedding triggered via a low state of the AUX function (AR after LS Lo). Load shedding information is based on the status of the binary input mapped to AUX (SETTING GROUP x/INPUT CONFIGURATION Gx/AUX) with AUX set to Load Shedding. If the P116 has saved load shedding information and AUX indicates that the power system frequency has returned to its nominal value, the tAUX time-delay is started. At the end of tAUX the close command is issued. The close command is issued via the Close CB order output (SETTING GROUP x/OUTPUT RELAYS CONFIGURATION Gx/Close CB order).
If the protection element is set to 'Trip' or 'Trip-Inrush Bl' or 'Trip-Latch' it means that it is linked to the Protection trip (see LED and Output configuration) and Trip Command (see Output configuration) functions. Additionally this protection element will trigger fault recording, disturbance recording, as well as the Trip LED and the Flag indicator on the front panel.
If the protection element is set to 'Alarm' it means that it is linked to the Alarm function (see LED and Output configuration) and 'ALARM STATUS' indication.
Refer to P116 Operation chapter.</td></tr>
<tr><td>tAUX1</td><td>10</td><td>0 s</td><td>600 s</td><td>0.01 s</td></tr>
<tr><td colspan="5">Setting for the operating time-delay of the AUX1 function.</td></tr>
<tr><td>AUX2 ?</td><td>0: Disabled</td><td colspan="2">See AUX1?</td><td>N/A</td></tr>
<tr><td colspan="5">Same as AUX1</td></tr>
</table>

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
tAUX2	10 s	0 s	600 s	0.01 s
Setting for the operating time-delay of the ***AUX2*** function.				
AUX3 ?	0: Disabled	See AUX1?		N/A
Same as AUX1				
tAUX3	10 s	0 s	600 s	0.01 s
Setting for the operating time-delay of the ***AUX3*** function.				
AUX4 ?	0: Disabled	See AUX1?		N/A
Same as AUX1				
tAUX4	10 s	0 s	600 s	0.01 s
Setting for the operating time-delay of the ***AUX4*** function.				

2.1.10 Logic Selectivity (Model A)

With Logic Select. 1 or Logic Select. 2, the user can assign each time-delay threshold to the ***Log Sel*** input (refer ***SETTING GROUP x/INPUTS CONFIGURATION/***) in the Inputs menu).

<table>
<tr><th rowspan="2">Menu Text</th><th rowspan="2">Default Setting</th><th colspan="2">Setting Range</th><th rowspan="2">Step Size</th></tr>
<tr><th>Min.</th><th>Max.</th></tr>
<tr><td>Sel1?</td><td>0: Disabled</td><td colspan="2">Disabled, Enabled</td><td>N/A</td></tr>
<tr><td colspan="5">Setting to Disable or Enable the Selective Logic 1 element.
This function changes the time-delay setting of the protection elements: tI>>, tI>>>, tIN_2 or tIN_3 to the tSEL1 setting value. The time-delay's setting value is changed without resetting the timer.
In the SETTING GROUP x/INPUT CONFIGURATION Gx/ submenu it is possible to choose which protection element is linked to the Selective Logic 1 function:
Sel1 tI>> or/and Sel1 tI>>> or/and Sel1 tIN_2 or/and Sel1 tIN_3.</td></tr>
<tr><td>tSel1</td><td>0.4s</td><td>0 s</td><td>600 s</td><td>0.01 s</td></tr>
<tr><td colspan="5">Setting for the operating time-delay of the Sel1 function.</td></tr>
<tr><td>Sel2?</td><td>Disabled</td><td colspan="2">Disabled, Enabled</td><td>N/A</td></tr>
<tr><td colspan="5">Same as Sel1?</td></tr>
<tr><td>tSel2</td><td>0.4 s</td><td>0 s</td><td>600 s</td><td>0.01 s</td></tr>
<tr><td colspan="5">Setting for the operating time-delay of the Sel2 function.</td></tr>
</table>

ST

2.1.11 Cold Load Pick Up (Model A)

The ***Cold Load PU*** (CLP) submenu allows the user to enable the cold load pick-up function. Selected threshold values can be raised temporarily.

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
Cold Load PU ?	Disabled	Disabled, Current+Input, Input only		N/A
Setting to ***Disable*** or ***Current+Input*** or ***Input only*** the ***Cold Load PU*** element. This function increases or decreases the thresholds for ***Cold Load PU level*** via ***tCL pulse*** time. ***Input only: tCL*** is started by a binary input assigned to the ***Cold PU*** function. For example: Typically increasing of the threshold is applied when the CB changes position from 52b to 52a (closing CB), therefore the input mapped to ***CB status 52a*** should be assigned to the ***Cold PU*** function too. ***Current+Input: tCL*** is started by a binary input assigned to the ***Cold PU*** function (as above) or based on the current stages: 5%In and 10%In. If the current in all phases are below 5%In by over 10s, after increasing of current above 10%In at least in a one phase ***tCL*** is started (refer Operation chapter of this manual). If the Cold Load PU logic has to be triggered by current criteria only, ***Cold Load PU Input*** function must not be configured to any digital input. If this function is configured to selected input, both criteria will work in parallel way.				
Cold Load PU Level	100%	20%	999%	1%
Displays the scaling value, in percentage, of the cold load pick up assigned to the selected thresholds. This value is the amount by which the selected threshold is increased or decreased.				
Cold Load PU tCL	1 s	0.0 s	6000 s	0.01 s
Displays the delay timer setting (***tCL***) for the Cold Load Pick-up function. The timer ***tCL*** controls the time during which the protection elements are altered. When ***tCL*** has elapsed, the settings revert back to their original values. ***tCL*** is initiated thanks to a dedicated input signal (refer to the ***SETTING GROUP x/INPUT CONFIGURATION Gx*** menu), generated by connecting an auxiliary contact from the CB (52a or 52b) or starting device to the relevant logic input.				
Cold Load PU I>	No	No, Yes		N/A
The Cold Load PU function increases or decreases the I> threshold: No or Yes				
Cold Load PU I>>	No	No, Yes		N/A
The Cold Load PU function increases or decreases the I>> threshold: No or Yes				
Cold Load PU I>>>	No	No, Yes		N/A
The Cold Load PU function increases or decreases the I>>> threshold: No or Yes				
Cold Load PU IN_1	No	No, Yes		N/A
The Cold Load PU function increases or decreases the IN> threshold: No or Yes				
Cold Load PU IN_2	No	No, Yes		N/A
The Cold Load PU function increases or decreases the IN>> threshold: No or Yes				
Cold Load PU IN_3	No	No, Yes		N/A
The Cold Load PU function increases or decreases the IN>>> threshold: No or Yes				
Cold Load PU Brkn.Cond	No	No, Yes		N/A
The Cold Load PU function increases or decreases the Is2/Is1 threshold: No or Yes				

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
Cold Load PU Itherm	No	No, Yes		N/A
The Cold Load PU function increases or decreases the Itherm threshold: No or Yes				
Cold Load PU I2>	No	No, Yes		N/A
The Cold Load PU function increases or decreases the I2> threshold: No or Yes				

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2.1.12 [79] Auto-reclose (Model A)

The auto-reclose function provides the ability to automatically control the recloser, with one, two, three, or four shot cycles. Each cycle implements a dead time and a reclaim time.

During the auto-reclosing cycle, if the relay receives a command to switch setting groups, this command is kept in memory, and will be executed only after the timer elapses.

The auto-reclose function is available if:

- a logical input is assigned to the 52a state (if the ***CB trips*** option is set in submenu: ***GLOBAL SETTINGS/[79] ADVANCED SETTINGS/Start Dead t on***),
- and the trip output relay is not latched to the earth and/or phase protection element.

In addition to these settings, the user can fully link the auto-reclose function to the protection function using the menus ***PROTECTION G1 / Phase OC*** and ***PROTECTION G1/ E/Gnd***.

<table>
<tr><th rowspan="2">Menu Text</th><th rowspan="2">Default Setting</th><th colspan="2">Setting Range</th><th rowspan="2">Step Size</th></tr>
<tr><th>Min.</th><th>Max.</th></tr>
<tr><td>Auto-reclose ?</td><td>Disabled</td><td colspan="2">Disabled, Enabled</td><td>N/A</td></tr>
<tr><td colspan="5">Setting to Disable or Enable the Auto-reclose element.</td></tr>
<tr><td>Dead Time tD1</td><td>0.2 s</td><td>0.0 s</td><td>600 s</td><td>0.01 s</td></tr>
<tr><td colspan="5">Sets the value for the Dead Time of the first shot (tD1). The Dead Time starts at the CB trip, when GLOBAL SETTINGS/[79] ADVANCED SETTINGS/:
- Start Dead t on: CB Trips is set: the 52a input is no longer energised.
- Start Dead t on: Protect.Reset is set: none of the protection criteria (which trip) are started.</td></tr>
<tr><td>Dead Time tD2</td><td>20 s</td><td>0 s</td><td>600 s</td><td>0.01 s</td></tr>
<tr><td colspan="5">Sets the value for the Dead Time of the second shot (tD2).</td></tr>
<tr><td>Dead Time tD3</td><td>1 s</td><td>0 s</td><td>600 s</td><td>0.01 s</td></tr>
<tr><td colspan="5">Sets the value for the Dead Time of the third shot (tD3).</td></tr>
<tr><td>Dead Time tD4</td><td>20 s</td><td>0 s</td><td>600 s</td><td>0.01 s</td></tr>
<tr><td colspan="5">Sets the value for the Dead Time of the fourth shot (tD4).</td></tr>
<tr><td>Reclaim Time tR</td><td>2 s</td><td>0.0 s</td><td>600 s</td><td>0.01 s</td></tr>
<tr><td colspan="5">After the reclaim time has elapsed, if the circuit breaker does not trip again, the auto-reclose function resets; otherwise, the relay either advances to the next shot that is programmed in the auto-reclose cycle, or, if all the programmed reclose attempts have been accomplished, it locks out.
If the protection element operates during the reclaim time following the final reclose attempt, the relay will lockout and the auto-reclose function is disabled until the lockout condition resets.</td></tr>
</table>

Menu Text	Default Setting	Setting Range Min.	Setting Range Max.	Step Size
Menu Text	**54321 trip shot**	**5,4,3,2,1 trip shot**		Step size
Fast O/C Trip	00000	0-1		1

This function allows faster tripping by phase overcurrent criteria when the auto-recloser is running.

The ***Fast Trip*** function increases the number of successful auto-reclosures.

The best result is obtained with fast tripping set to 0 s (instantaneous trip), but because of transient currents it is sometimes necessary to set a value greater than 0 s in order to avoid maloperation.

If bit “1” is set, the value for ***Fast O/C Trip Delay*** is used instead of the protection element's time-delay

Note: If the protection element's time-delay is shorter than the Fast Trip's time-delay, tripping occurs upon expiry of the protection element's time-delay (the shortest timer is used).

For example:

I> is configured for 4 shots auto-reclose (***SETTING GROUP x/PROTECTION Gx/ AUTORECLOSE [79] G1/I> Close Shot? 1111***)

tI> is set for 1 s (***SETTING GROUP x/PROTECTION Gx/PHASE O/C [50/51] G1/tI>=1.00 s***)

Delay for Ph O/C Fast Trip: 0.1 s (***SETTING GROUP x/PROTECTION Gx/ AUTORECLOSE [79] G1/ Fast O/C Trip Delay 0.1 s***)

For a permanent fault, the setting "00011" means that:

1. "1": the first trip occurs after the time-delay: 0.1 s (Fast Trip time-delay)
2. "1": the second trip occurs after the time-delay: 0.1 s (Fast Trip time-delay)
3. "0": the third trip occurs after the time-delay: 1 s (tI> time-delay)
4. "0": the fourth trip occurs after the time-delay: 1 s (tI> time-delay)
5. "0": the fifth trip occurs after the time-delay: 1 s (tI> time-delay)

Fast O/C Trip Delay	0 s	0 s	9.99s	0.01 s

Sets the value for the phase overcurrent **Fast Trip** time-delay

Menu Text	**54321 trip shot**	**5,4,3,2,1 trip shot**		Step size
Fast E/Gnd Trip	00000	0-1		1

This function allows faster tripping by earth fault overcurrent criteria when the auto-recloser is running.

The ***Fast Trip*** function increases the number of successful auto-reclosures.

If bit “1” is set, the value for ***Fast E/Gnd Trip Delay*** is used instead of the protection element's time-delay

Note: If the protection element's time-delay is shorter than the Fast Trip's time-delay, tripping occurs upon expiry of the protection element's DMT time-delay (the shortest timer is used).

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Menu Text	Default Setting	Setting Range Min.	Setting Range Max.	Step Size
Fast E/Gnd Trip Delay	0 s	0 s	9.99s	0.01 s
Sets the value for the phase overcurrent **Fast Trip** time-delay				
Menu Text	**4321 reclosing shot**	**4,3,2,1 reclosing shot**		Step size
Close Shot? tI>	0000	0-1		1
4321 are the cycles associated with the close command of the Auto-reclose function after tI> trip. "0011" are the actions (closing) to be executed after a tI> trip: 0 - no action by auto-recloser: final trip (the auto-recloser will switch to locked state), 1 - after tI> trip and dead time (fault clearance) the reclosing command will be executed.				
Menu Text	**4321 reclosing shot**	**4,3,2,1 reclosing shot**		Step size
Inhib.Trip tI>: Shot	0000	0-1		1
4321 are the cycles associated with the tI> trip 1101 are the actions to be executed after a reclosing shot and the tI> time-delay has elapsed: 0 = no inhibit 1 = no tI> trip: and this whatever the setting in the “SETTING GROUP x/PROTECTION Gx/PHASE O/C [50/51] Gx/I>? ” menu.				
Close Shot? tI>>	0000	0-1		1
See ***Close Shot? tI>***				
Inhib.Trip tI>>: Shot	0000	0-1		1
See ***Close Shot? tI>***				
Close Shot? tI>>>	0000	0-1		1
See ***Close Shot? tI>***				
Inhib.Trip tI>>>: Shot	0000	0-1		1
See ***Close Shot? tI>***				
Close Shot? tIN_1	0000	0-1		1
See ***Close Shot? tI>***				

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
Menu Text	**4321** **Close Shot**	**4,3,2,1** **reclosing shot**		Step size
Inhib.Trip tIN_1: Shot	0000	0-1		1
See ***Close Shot? tI>***				
Close Shot? tIN_2	0000	0-1		1
See ***Close Shot? tI>***				
Inhib.Trip tIN_2: Shot	0000	0-1		1
See ***Close Shot? tI>***				
Close Shot? tIN_3	0000	0-1		1
See ***Close Shot? tI>***				
Inhib.Trip tIN_3: Shot	0000	0-1		1
See ***Close Shot? tI>***				
Close Shot? tAUX1	0000	0-1		1
See ***Close Shot? tI>***				
Inhib.Trip tAUX1: Shot	0000	0-1		1
See ***Close Shot? tI>***				
Close Shot? tAUX2	0000	0-1		1
See ***Close Shot? tI>***				
Menu Text	**4321** **Close Shot**	**4,3,2,1** **reclosing shot**		Step size
Inhib.Trip tAUX2: Shot	0000	0-1		1
See ***Close Shot? tI>***				

Auto-reclose settings, common for Group 1 and Group 2, are available in column: ***GLOBAL SETTINGS / [79] Advanced Settings*** (see 3.6 ***[79] ADVANCED SETTINGS***).

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2.2 Output Relay Configuration

Output settings define which signals are mapped to the P116's outputs.
Matrix configuration allows free mapping of any one function to each output.

Menu Text	Default Setting	Setting Range	Step Size
Description of bits:	**Model A, RL: 6,5,4,3,2,1**	**Setting range:**	
Latched Outputs	000000	0-1	1

Each output can be configured with or without latching.

Default Setting: “00000” means that:

RL6: “0” – output RL6 is not latched. The high state of the function mapped to the output determines the high state of RL6. The low state of this function determines the low state of RL6.

RL5: “0” – see RL6

RL4: “0” – see RL6

RL3: “0” – see RL6

RL2: “0” – see RL6

RL1: “0” – see RL6

The high state of the function mapped to the output determines the high state of the output relay. The low state of this function does not change the state of the output relay. For the low state of output relay, it is necessary to activate the ***Reset of Latched Output*** function (via a binary input, from the front panel or via a communication port)

Menu Text	Default Setting	Setting Range	Step Size
Description of bits:	**Model A, RL: F,6,5,4,3,2,1**	**Setting range:**	
Reverse outp.log.	0000000	0-1	1

Reverse output logic gives more application flexibility. If reverse logic is chosen for the output, after the P116 is powered (current, auxiliary voltage) the output contacts close. Any high state function connected with this output will open the contacts of the output relay.

Default Setting: “0000” means that:

F: This setting is used for specific purpose only (typically should be “0”)

“0” – means that energy output works as the energy trip pulse output for external flag indicator, triggered via function assigned to this output.

“1” – means that energy on this output is permanently connected to terminals C3-C4 after powering of P116: CT – above 0.2In/Ien - or auxiliary voltage connected to B1-B2 terminals. It can be used to trigger P116 binary input (standard input board only), when the auxiliary voltage is not available

Note:

1. It’s additional burden for P116 powering, only a one binary input can be connected to this output

2.Additional burden can increase self-powering threshold and P116 tripping time. Influence on above parameters should be confirmed by commissioning tests after all settings done. CT self - powering stage and tripping time (switch on to fault w/o Vx) have to be measured and accepted by responsible person.. Maximum length of wires connected to the output must be lower than 3m.

3. Any function assigned to this energy output has no influence on the action of the energy output.

RL6: “0” – output RL6 is without reverse logic.
The state of the output is in line with the state of the function.

RL5, RL4, RL3, RL2,RL1: “0” – see RL6

Menu Text	Default Setting	Setting Range	Step Size
Description of bits:	**Mod.A: T,F,RL6,5,4,3,2,1** **Model L: T,1**	**Setting range:**	
Protection Trip	00000000	0-1	1
Protection Trip is high if any protection element configured to ***Trip*** is high (current-based protection elements and external protection elements: AUX1, AUX2, AUX3, AUX4, CBF re-trip). Default Setting: “110000” means that: T: “0” – the Low Energy Trip Coil output is assigned to the Protection trip function F: “0” – the Flag Indicator output is assigned to the Protection trip function RL6: “0” – output RL6 is not assigned to the Protection trip function RL5, RL4, RL3, RL2,RL1: “0” – see RL6 **Note: For typical application with the low energy tripping coil/striker, this function is used for tripping (“1xxxxxxx”)**			
Description of bits:	**Model A: 6,5,4,3,2,1** **Model L: 1**	**Setting range:**	
Prot.Trip pulse	000000	0-1	1
Protection Trip pulse is energized via ***Protection Trip*** (see above). This command has a pulse duration not less than **tOpen** time set at ***GLOBAL SETTINGS/CIRCUIT BREAKER/tOpen pulse min***. Default Setting: “0000” means that: RL6: “0” – output RL6 is not assigned to *Any Trip*. RL5, RL4, RL3, RL2,RL1: “0” – see RL6 Note: The Low Energy Trip Coil output and Flag Indicator output are not connected to this function. The above functions have to be assigned to the Protection Trip function.			
Description of bits:	**Mod.A: T,F,6,5,4,3,2,1** **Model L: T,1**	**Setting range:**	
Trip CB Order	00000000	0-1	1
The **Trip CB Order** function is high during the set time if the manual trip command is executed (communication port, front panel, binary inputs) (the trip pulse is set at ***GLOBAL SETTINGS/CIRCUIT BREAKER/ tOpen pulse min***)			
Description of bits:	**Model A: 6,5,4,3,2,1** **Model L: 1**	**Setting range:**	
Close CB Order	000000	0-1	1
The ***Close CB Order*** function is high during the set time if the manual close command or Auto-reclose function are executed (Communication port, binary input, front panel). The close pulse is set at ***GLOBAL SETTINGS/CIRCUIT BREAKER/ tClose Pulse***.			
Description of bits:	**Model A: F,6,5,4,3,2,1** **Model L: 1**	**Setting range:**	
Alarm	0000000	0-1	1
The ***Alarm*** function is high if any protection element configured to ***Alarm*** is high (current-based protection element and external protection elements: **AUX1**, **AUX2**, **AUX3**, **AUX4,**). Default Setting: “00000” means that: F: “0” – output for Flag Indicator is not assigned to the Alarm function RL6: “0” – output RL6 is not assigned to the *Alarm* function RL5, RL4, RL3, RL2,RL1: “0” – see RL6			
Description of bits:	**Model A: 6,5,4,3,2,1** **Model L: 1**	**Setting range:**	
Start Phase A	000000	0-1	1
Start Phase A is high if the phase overcurrent stage (set to trip) in phase A has started (phase A current above the phase current thresholds).			

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Menu Text	Default Setting	Setting Range	Step Size
Description of bits:	**Model A: 6,5,4,3,2,1** **Model L: 1**	**Setting range:**	
Start Phase B	000000	0-1	1
Start Phase B is high if the phase overcurrent stage (set to trip) in phase B has started (phase B current above the phase current thresholds).			
Description of bits:	**Model A: 6,5,4,3,2,1** **Model L: 1**	**Setting range:**	
Start Phase C	000000	0-1	1
Start Phase C is high if the phase overcurrent stage (set to trip) in phase C has started (phase C current above the phase current thresholds).			
Description of bits:	**Model A: 6,5,4,3,2,1** **Model L: 1**	**Setting range:**	
Start I>	000000	0-1	1
Start I> is high if the I> protection element has started (current above the set I>> threshold).			
Description of bits:	**Model A: 6,5,4,3,2,1** **Model L: 1**	**Setting range:**	
Start I>>	000000	0-1	1
Start I>> is high if the I>> protection element has started (current above the set I>> threshold).			
Description of bits:	**Model A: 6,5,4,3,2,1** **Model L: 1**	**Setting range:**	
Start I>>>	000000	0-1	1
Start I>>> is high if the I>>> protection element has started (current above the set I>>> threshold).			
Description of bits:	**Model A: 6,5,4,3,2,1**	**Setting range:**	
Start SOTF	000000	0-1	1
Start SOTF is high if the SOTF protection element has started (e/f current above the set SOTF threshold).			
Description of bits:	**Model A: 6,5,4,3,2,1** **Model L: 1**	**Setting range:**	
Start IN_1	000000	0-1	1
Start IN_1 is high if the IN_1 protection element (the first stage) has started (e/f current is above the set IN_1 threshold).			
Description of bits:	**Model A: 6,5,4,3,2,1** **Model L: 1**	**Setting range:**	
Start IN>_2	000000	0-1	1
Start IN_2 is high if the IN_2 protection element (the second stage) has started (e/f current above the set IN_2 threshold).			
Description of bits:	**Model A: 6,5,4,3,2,1** **Model L: 1**	**Setting range:**	
Start IN_3	000000	0-1	1
Start IN_3 is high if the IN_3 protection element (the third stage) has started (e/f current above the set IN_3 threshold).			
Description of bits:	**Model A: 6,5,4,3,2,1**	**Setting range:**	
Start I<	000000	0-1	1
Start I< is high if the I< protection element has started (current below the set I< threshold).			

Menu Text	Default Setting	Setting Range	Step Size
Description of bits:	**Model A: 6,5,4,3,2,1**	**Setting range:**	
Start I2>	000000	0-1	1
Start I2> is high if the I2> protection element has started (current below the set I2> threshold).			
Description of bits:	**Model A: 6,5,4,3,2,1**	**Setting range:**	
Start Brkn Cond	000000	0-1	1
Start Brkn Cond is high if the Broken Conductor protection element has started (Is2/Is1 above the set ratio threshold).			
Description of bits:	**Model A: 6,5,4,3,2,1**	**Setting range:**	
AUX1	000000	0-1	1
***AUX*1** is high if the input assigned to AUX1 is set high.			
Description of bits:	**Model A: 6,5,4,3,2,1**	**Setting range:**	
AUX2	000000	0-1	1
AUX2 is high if the input assigned to AUX2 is set high.			
Description of bits:	**Model A: 6,5,4,3,2,1**	**Setting range:**	
AUX3	000000	0-1	1
AUX3 is high if the input assigned to AUX3 is set high.			
Description of bits:	**Model A: 6,5,4,3,2,1**	**Setting range:**	
AUX4	000000	0-1	1
AUX4 is high if the input assigned to AUX4 is set high.			
Description of bits:	**Model A: 6,5,4,3,2,1**	**Setting range:**	
AUX5	000000	0-1	1
AUX5 is high if the input assigned to AUX5 is set high.			
Description of bits:	**Model A: 6,5,4,3,2,1**	**Setting range:**	
AUX6	000000	0-1	1
AUX6 is high if the input assigned to AUX6 is set high.			
Description of bits:	**Mod.A: T,F,6,5,4,3,2,1** **Model L: T,1**	**Setting range:**	
tI>	00000000	0-1	1
tI> is high if the set time-delay for the I> element has elapsed			
Description of bits:	**Mod.A: T,F,6,5,4,3,2,1** **Model L: T,1**	**Setting range:**	
tI>>	00000000	0-1	1
tI>> is high if the set time-delay for the I>> element has elapsed			
Description of bits:	**Mod.A: T,F,6,5,4,3,2,1** **Model L: T,1**	**Setting range:**	
tI>>>	00000000	0-1	1

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Menu Text	Default Setting	Setting Range	Step Size
tI>>> is high if the set time-delay for the I>>> element has elapsed			
Description of bits:	**Model A:T,F,6,5,4,3,2,1**	**Setting range:**	
tSOTF	00000000	0-1	1
tSOTF is high if the set time-delay for the SOTF element has elapsed			
Description of bits:	**Mod.A: T,F,6,5,4,3,2,1** **Model L: T,1**	**Setting range:**	
tIN_1	00000000	0-1	1
tIN_1 is high if the set time-delay for the IN_1 element (the first stage) has elapsed			
Description of bits:	**Mod.A: T,F,6,5,4,3,2,1** **Model L: T,1**	**Setting range:**	
tIN_2	00000000	0-1	1
tIN_2 is high if the set time-delay for the IN_2 (the second stage) element has elapsed			
Description of bits:	**Mod.A: T,F,6,5,4,3,2,1** **Model L: T,1**	**Setting range:**	
tIN_3	00000000	0-1	1
tIN_3 is high if the set time-delay for the IN_3 element (the third stage) has elapsed			
Description of bits:	**Model A:T,F,6,5,4,3,2,1**	**Setting range:**	
tI<	00000000	0-1	1
tI< is high if the set time-delay for the I< element has elapsed			
Description of bits:	**Model A:T,F,6,5,4,3,2,1**	**Setting range:**	
tI2>	00000000	0-1	1
tI2> is high if the set time-delay for the Is2> element has elapsed			
Description of bits:	**Model A:T,F,6,5,4,3,2,1**	**Setting range:**	
tBrkn Cond.	00000000	0-1	1
tBrknCond. is high if the set time-delay for the Is2/Is1 element has elapsed			
Description of bits:	**Mod.A: T,F,6,5,4,3,2,1** **Model L: T,1**	**Setting range:**	
Thermal Trip	00000000	0-1	1
Thermal Trip is high if the trip thermal stage is greater than the set value			
Description of bits:	**Model A: F,6,5,4,3,2,1** **Model L: 1**	**Setting range:**	
Thermal Alarm	0000000	0-1	1
Thermal Alarm is high if the alarm thermal stage is greater than the set value			
Description of bits:	**Mod.A: T,F,6,5,4,3,2,1** **Model L: T,1**	**Setting range:**	

Menu Text	Default Setting	Setting Range	Step Size
CB Fail	00000000	0-1	1
CB Fail is high if the set time-delay for the CBF protection function is elapsed			
Description of bits:	**Model A:T,F,6,5,4,3,2,1**	**Setting range:**	
tAUX1	00000000	0-1	1
tAUX1 is high if the set time-delay for the AUX1 element has elapsed			
Description of bits:	**Model A:T,F,6,5,4,3,2,1**	**Setting range:**	
tAUX2	00000000	0-1	1
tAUX2 is high if the set time-delay for the AUX2 element has elapsed			
Description of bits:	**Model A:T,F,6,5,4,3,2,1**	**Setting range:**	
tAUX3	00000000	0-1	1
tAUX3 is high if the set time-delay for the AUX3 element has elapsed			
Description of bits:	**Model A:T,F,6,5,4,3,2,1**	**Setting range:**	
tAUX4	00000000	0-1	1
tAUX4 is high if the set time-delay for the AUX4 element has elapsed			
Description of bits:	**Model A:T,F,6,5,4,3,2,1**	**Setting range:**	
Comm. Order 1	00000000	0-1	1
Comm.Order 1 is used for control of outputs via an RS485 command. The pulse duration is set at ***GLOBAL SETTING/COMMUNICATION ORDER/Pulse Time tCOM1***			
Description of bits:	**Model A:T,F,6,5,4,3,2,1**	**Setting range:**	
Comm. Order 2	00000000	0-1	1
Comm.Order 2 is used for control of outputs via an RS485 command (if in ***GLOBAL SETTINGS/COMMUNICATION ORDERS/COM2 order Conf.*** "***0:RS485***" or "***1:RS485+Button_C***" is set) or via pressing "C" clear key on the front panel (if in ***GLOBAL SETTINGS/COMMUNICATION ORDERS/COM2 order Conf.*** "***2: Button_C***" or "***1:RS485+Button_C***" is set) The pulse duration set in ***GLOBAL SETTING/COMMUNICATION ORDER/Pulse Time tCOM2***			
Description of bits:	**Model A: 6,5,4,3,2,1**	**Setting range:**	
[79] in Progress	000000	0-1	1
[79] in Progress indicates that an auto-reclose cycle is running. The signal is present during the complete reclosing cycle from protection initiation to the end of the reclaim time or lockout			
Description of bits:	**Model A:T,F,6,5,4,3,2,1**	**Setting range:**	
[79] F.Trip	00000000	0-1	1

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Menu Text	Default Setting	Setting Range	Step Size
[79] F.Trip (Final Trip) indicates that the auto-recloser has issued a final trip (after the last reclosing shot the line is still faulty) This alarm can be reset using one of these resetting methods: assigned input (***Reset Latchd Sign***), front panel (**C** clear key), reset command (***Reset Latchd Sign)*** via RS485 Even if this output is configured as not latched output, the alarm signal is reset upon the next CB trip or from one of these resetting methods: nput assigned to ***Reset Latchd Sign***,function, front panel **C** clear key), remote LED reset (***Reset Latchd Sign)*** command via RS485 or remote LED and output reset command via RS485. If this successful auto-reclose signal was not reset before the next Autoreclose, ***[79] in Progress*** will reset this signal, when Autoreclose is started again. Note: If in I/O configuration this output is set to be latched, it is necessary to apply reset of output as additional action (if the reset of the successful auto-reclose signal was without reset of latched outputs – for example made via remote LED reset (***Reset Latchd Sign)*** command via RS485 or assigned input to ***Reset Latchd Sign***).			

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Description of bits:	Model A: F 6,5,4,3,2,1	Setting range:	
[79] Lockout	0000000	0-1	1

[79] Lockout indicates that the relay is in a lockout state and that no further reclose attempts will be made:

- the Reclaim time has elapsed but CB is still open
- the Dead time has elapsed but CB remained open after the reclosing shot
- the CB has failed to close
- the protection element not assigned to the auto-reclose function is tripped.
- Close or Trip command is executed in A/R time (when A/R is running)
- a number of A/R rolling demand valid
- A/R conflict
- the CB is faulty - information based on an external Signal, assigned to an input is in high logic state longer than set in ***tCB FLT Ext.Sign (GLOBAL SETTINGS/CIRCUIT BREAKER)***

This alarm can be reset using one of these resetting methods: assigned input (***Reset Latchd Sign***), front panel (**C** clear key), reset command (***Reset Latchd Sign)*** via RS485

Even if this output is configured as not latched output, the alarm signal is reset upon the next CB trip or from one of these resetting methods: nput assigned to ***Reset Latchd Sign***,function, front panel **C** clear key), remote LED reset (***Reset Latchd Sign)*** command via RS485 or remote LED and output reset command via RS485.

The lockout auto-reclose condition can reset by a manual closing after the ***Inhib Time tI***.

Note: If in I/O configuration this output is set to be latched, it is necessary to apply reset of output as additional action (if the reset of the successful auto-reclose signal was without reset of latched outputs – for example made via remote LED reset (***Reset Latchd Sign)*** command via RS485 or assigned input to ***Reset Latchd Sign***).

Description of bits:	Model A: F,6,5,4,3,2,1	Setting range:	
[79] Blocked	0000000	0-1	1

[79] Blocked indicates that the auto-recloser is inhibited (blocked) due to one of the following reasons:

- blocking from the front panel (blocking via Menu)
- the auto-recloser is disabled by setting (disabled)
- a binary input is assigned to the blocking function (blocking via Input)
- remote blocking via RS485 (blocking via RS485)
- ***Time Inhibit tI on Close*** (***GLOBAL SETTINGS/[79] ADVANCED SETTINGS***) is counted (after Close command execution. A/R close command is excluded from this logic)

Information about the reason of blocking is available in menu default window.

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Description of bits:	**Model A: F,6,5,4,3,2,1**	**Setting range:**	
[79] Success.	0000000	0-1	1
[79] Success. Indicates that an auto-reclose cycle has been successfully completed. A successful auto-reclose signal is given after the CB was tripped by a protection function and re-closed whereupon the fault was cleared and the reclaim time expired thus resetting the auto-reclose cycle. Even if this output is configured as not latched output, the successful auto-reclose signal is reset upon the next CB trip or from one of these resetting methods: input assigned to ***Reset Latchd Sign***,function, front panel **C** clear key), remote LED reset (***Reset Latchd Sign)*** command via RS485 or remote LED and output reset command via RS485. If this successful auto-reclose signal was not reset before the next Autoreclose, ***[79] in Progress*** will reset this signal, when Autoreclose is started again. Note: If in I/O configuration this output is set to be latched, it is necessary to apply reset of output as additional action (if the reset of the successful auto-reclose signal was without reset of latched outputs – for example made via remote LED reset (***Reset Latchd Sign)*** command via RS485 or assigned input to ***Reset Latchd Sign***).			
Description of bits:	**Model A: F,6,5,4,3,2,1**	**Setting range:**	
TCS 52 Fail	0000000	0-1	1
TCS 52 Fail : Trip circuit supervision (TCS) failure function signal.			
Description of bits:	**Model A: F,6,5,4,3,2,1**	**Setting range:**	
CB Alarm	0000000	0-1	1
CB Alarm : Circuit Breaker Alarm function signal (***CB Open No.***, ***Sum Amps(n)***, ***TCS 52 Fail***, ***CB Open Time*** and ***CB Close Time, State of CB***)			
Description of bits:	**Model A: 6,5,4,3,2,1**	**Setting range:**	
Trip pulse tP	000000	0-1	1
Any trip is high if ***Protection Trip*** is high when the ***tP*** time-delay elapses (***tP***: trip pulse duration is set at ***GLOBAL SETTINGS/CIRCUIT BREAKER/tP pulse***)			
Description of bits:	**Model A: F 6,5,4,3,2,1**	**Setting range:**	
tCB FLT Ext.Sign	0000000	0-1	1
tCB FLT Ext.Sign is high if the ***tCB FLT ext.*** time-delay has elapsed. The counter is started if the function ***CB FLT Ext.Sign*** assigned to binary input is high. Binary input is used to indicate that there is sufficient energy in the CB operating mechanism to close and trip the CB. The ***tCB FLT ext.*** time-delay is set at ***GLOBAL SETTINGS/CIRCUIT BREAKER/ tCB FLT ext***. The binary input is set at SETTING GROUP x/INPUTS CONFIGURATION Gx/ CB FLT Ext.Sign.			
Description of bits:	**Model A: 6,5,4,3,2,1**	**Setting range:**	
Setting Group 1	000000	0-1	1
Setting Group 1 is active (switched via a binary input, the front panel, RS485 comms).			

2.3 Input Configuration (Model A)

Binary Input settings define which signals are mapped to the P116’s opto-isolated inputs. Matrix configuration allows free mapping of any one function to each input.

<table>
<tr><th>Menu Text</th><th>Default Setting</th><th>Setting Range</th><th>Step Size</th></tr>
<tr><td>Description of bits:</td><td>L: 6,5,4,3,2,1</td><td>Setting range:</td><td></td></tr>
<tr><td>Reverse Inp. Logic</td><td>000000</td><td>0-1</td><td>1</td></tr>
<tr><td colspan="4">Reverse logic provides extra flexibility to the application. Reverse Input Logic means that the high state of a binary input causes the corresponding logic signal to be in low state.
Default Setting: “000000” means that:
L6: “0” – input L6 is without reverse logic. The state of L6 logic input is in line with the state of L6 binary input
L5: “0” – see Input 6
L4: “0” – see Input 6
L3: “0” – see Input 6
L2: “0” – see Input 6
L1: “0” – see Input 6</td></tr>
<tr><td>Description of bits:</td><td>L: 6,5,4,3,2,1</td><td>Setting range:</td><td></td></tr>
<tr><td>Mainten. Mode</td><td>000000</td><td>0-1</td><td>1</td></tr>
<tr><td colspan="4">Maintenance Mode ON/OFF change.
The selection of the maintenance mode is possible via a logic input, using a control command (rear or front port), or from the front panel interface. All reasons of triggering works with OR logic for activation of the maintenance mode.

If the function triggered via binary input is high, P116 is in maintenance mode up to low state of this function (there is no any time termination like it does in maintenance mode activated via menu in Commissioning column).

In menu (Commissioning column) it is possible to activate maintenance mode to different options:

- Yes,outp.trips. This mode allows the user to verify the operation of the protection functions with trip signal on the outputs. It is specific option for activation of this function in menu only

- Yes,outp.block. If this option is selected, all the output contacts and energy outputs are blocked, and no command can be issued to these outputs, even if a protection threshold associated with one of these outputs has been crossed

Maintenance Mode triggered via binary input or remote command (RS485) enable Yes,outp.block. option of maintenance mode. So all outputs (contacts and energy outputs) are blocked (are not energized) if Maintenance Mode function triggered via binary input or remote command (RS485).</td></tr>
<tr><td>Reset Latchd Sign</td><td>000000</td><td>0-1</td><td>1</td></tr>
<tr><td colspan="4">The high state of this logic input resets all latched LEDs, Alarm and Trip Information.</td></tr>
<tr><td>Reset Latchd Out</td><td>000000</td><td>0-1</td><td>1</td></tr>
<tr><td colspan="4">The high state of this logic input resets all latched contact outputs</td></tr>
<tr><td>Block. tI></td><td>000000</td><td>0-1</td><td>1</td></tr>
<tr><td colspan="4">The high state of this logic input enables the blocking logic function of the I> protection element (resets its associated time-delay).</td></tr>
<tr><td>Block. tI>></td><td>000000</td><td>0-1</td><td>1</td></tr>
</table>

Menu Text	Default Setting	Setting Range	Step Size
The high state of this logic input enables the blocking logic function of the I>> protection element (resets its associated time-delay)			
Block. tI>>>	000000	0-1	1
The high state of this logic input enables the blocking logic function of the I>>> protection element (resets its associated time-delay)			
Block. tSOTF	000000	0-1	1
The high state of this logic input enables the blocking logic function of the SOTF element (resets its associated time-delay)			
Block. tIN_1	000000	0-1	1
The high state of this logic input enables the blocking logic function of the IN_1 protection element (resets its associated time-delay)			
Block. tIN_2	000000	0-1	1
The high state of this logic input enables the blocking logic function of the IN_2 protection element (resets its associated time-delay)			
Block. tIN_3	000000	0-1	1
The high state of this logic input enables the blocking logic function of the IN_3 protection element (resets its associated time-delay)			
Block. tI<	000000	0-1	1
The high state of this logic input enables the blocking logic function of the I< protection element (resets its associated time-delay)			
Block. tI2>	000000	0-1	1
The high state of this logic input enables the blocking logic function of the I2> element (resets its associated time-delay)			
Block. tBrkn Cond	000000	0-1	1
The high state of this logic input enables the blocking logic function of the Broken Conductor element (resets its associated time–delay)			
Block. Itherm.	000000	0-1	1
The high state of this logic input sets to zero the value at the thermal equivalent current used in the thermal algorithm. It means that for the low state of the input the thermal state does not increase the thermal value and the cooling time constant is applied. This function can be useful for emergency closing.			
Block. AUX1	000000	0-1	1
The high state of this logic input enables the blocking logic function of the AUX1 protection element (resets its associated time-delay and disables the AUX1 start logic signal)			
Block. AUX2	000000	0-1	1
The high state of this logic input enables the blocking logic function of the AUX2 protection element (resets its associated time-delay and disables the AUX2 start logic signal)			
Block. AUX3	000000	0-1	1
The high state of this logic input enables the blocking logic function of the AUX3 protection element (resets its associated time–delay and disables the AUX3 start logic signal)			
Block. tCB Fail	000000	0-1	1
The high state of this logic input enables the blocking logic function of the CB Fail protection function (resets its associated time–delay)			
Block. [79]	000000	0-1	1

Menu Text	Default Setting	Setting Range	Step Size
The high state of this logic input blocks (disables) the auto-reclose element with lockout if blocking occurs while it is running.			
SEL1 tI>>	000000	0-1	1
The high state of this logic input changes the time-delay of the I>> protection element from tI>> (set in the ***SETTING GROUP x/PROTECTION Gx/Phase O/C [50/51]*** menu column) to the tSEL1 value (***SETTING GROUP x/PROTECTION Gx/LOGIC SELECT. Gx/tSEL1).*** The change is performed without resetting the elapsed time-delay. Typically the ***tSEL1*** value is greater than ***tI>>*** to ensure selectivity of the incomer (P116) when the relay on the outgoing line detects a fault (the setting for ***tI>>*** is the same on the incoming feeder and the outgoing line).			
SEL1 tI>>>	000000	0-1	1
See the description of the SEL1 tI>> function. The action is applied for the I>>> protection element and the tSEL1 time-delay			
SEL1 tIN_2	000000	0-1	1
See the description of the SEL1 tI>> function. The action is applied for the IN_2 protection element and the tSEL1 time-delay			
SEL1 tIN_3	000000	0-1	1
See the description of the SEL1 tI>> function. The action is applied for the IN_3 protection element			
SEL2 tI>>	000000	0-1	1
See the description of the SEL1 tI>> function. The action is applied for the I>>> protection element and the tSEL2 time-delay			
SEL2 tI>>>	000000	0-1	1
See the description of the SEL1 tI>>> function. The action is applied for the I>>> protection element and the tSEL2 time-delay			
SEL2 tIN_2	000000	0-1	1
See the description of the SEL1 tIN_2 function. The action is applied for the IN_2 protection element and the tSEL2 time-delay			
SEL2 tIN_3	000000	0-1	1
See the description of the SEL1 tIN_3 function. The action is applied for the IN_3 protection element and the tSEL2 time-delay			
AUX1	000000	0-1	1
This logic input energizes the AUX1 function			
AUX2	000000	0-1	1
This logic input energizes the AUX2 function			
AUX3	000000	0-1	1
This logic input energizes the AUX3 function			
AUX4	000000	0-1	1
This logic input energizes the AUX4 function			

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<table>
<tr><th>Menu Text</th><th>Default Setting</th><th>Setting Range</th><th>Step Size</th></tr>
<tr><td>AUX5</td><td>000000</td><td>0-1</td><td>1</td></tr>
<tr><td colspan="4">This logic input energizes the AUX5 function.
Note:
1. AUX5 has no timer therefore it is not included in the SETTING GROUP x/PROTECTION Gx/AUX TIMERS submenu.
2. AUX5 cannot be assigned directly to Protection Trip or Alarm functions.
3. AUX5 is used as a simple bridge between an input and the LEDs or an input and the outputs without any signaling (Alarm or Trip).</td></tr>
<tr><td>AUX6</td><td>000000</td><td>0-1</td><td>1</td></tr>
<tr><td colspan="4">This logic input energizes the AUX6 function.
Note:
1. AUX5 has no timer therefore it is not included in the SETTING GROUP x/PROTECTION Gx/AUX TIMERS submenu.
2. AUX5 cannot be assigned directly to Protection Trip or Alarm functions.
3. AUX5 is used as a simple bridge between an input and the LEDs or an input and the outputs without any signaling (Alarm or Trip).</td></tr>
<tr><td>Cold Load PU</td><td>000000</td><td>0-1</td><td>1</td></tr>
<tr><td colspan="4">This function assigns chosen inputs to the cold load pick up logic. The protection elements connected to this logic are viewed and set in the SETTING GROUP x/PROTECTION Gx/COLD LOAD PU submenu.
The Cold Load PU function is used to increase the current threshold (% Level) for a period of time (tCL) after CB closing.</td></tr>
<tr><td>Start tBF</td><td>000000</td><td>0-1</td><td>1</td></tr>
<tr><td colspan="4">This logic input launches the tBF Fail timer (SETTING GROUP x/PROTECTION Gx/CB Fail [50BF]/CB Fail Time tBF submenu)</td></tr>
<tr><td>CB Status 52A</td><td>000000</td><td>0-1</td><td>1</td></tr>
<tr><td colspan="4">This logic input provides the P116 with information about the closed state of the CB. This information is used by the communication system, the auto-recloser and CB diagnostic function.
Note:
1. If inputs are assigned to both: CB Status 52A and CB Status 52B, the P116 uses a two-bit CB status logic.
2. If inputs are assigned to either CB Status 52A or CB Status 52B only, the P116 uses a one-bit CB status logic</td></tr>
</table>

Menu Text	Default Setting	Setting Range	Step Size
CB Status 52B	000000	0-1	1
This logic input provides the P116 with information about the open state of the CB. This information is used by the communication system, the auto-recloser and the CB diagnostic function. Note: see above.			
CB FLT Ext.Sign	000000	0-1	1
After switching the logic input's state from low to high this function initiates the "tCB FLT ext" time-delay and blocks a close command. When this time-delay has elapsed the Alarm signal is issued. The binary Input is used to indicate that there is sufficient energy in the CB operating mechanism to close and trip the CB. The ***tCB FLT ext.*** time-delay is set at ***GLOBAL SETTINGS/CIRCUIT BREAKER/ tCB FLT ext***. The Alarm signal can be additionally assigned to ***output*** contacts using the ***CB FLT Ext.Sign*** output (***SETTING GROUP x/OUTPUTRELAYS CONFIGURATION Gx/ CB FLT Ext.Sign***). Depends on the configuration, this alarm can blocks auto-reclose function (***GLOBAL SETTINGS/[79] ADVANCED SETTINGS/CB FLT Monitor?***, the setting: ***Yes***)			
Setting group 2	000000	0-1	1
The high state of this logic input switches the active setting group to Setting Group 2. Setting Group 1 is active from the low state of Logic Input. Note: If two setting groups are switched via binary input, this input must be assigned to this function in both setting groups: Setting Group 1 and Setting Group 2. If it is not done there will be not changing of setting group via this input.			
Manual Close	000000	0-1	1
Mapping of a control close function to the input. When activated, it is possible to control the output relays assigned to the ***Close CB*** function. This input will trigger the SOTF feature. Note: Manual Close command is blocked if: 1. The front panel LEDs are lit (LED resetting is required) 2. An input is assigned to the ***CB FLT Ext.Sign*** function and the state of this function is high			
Manual Trip	000000	0-1	1
Mapping of a control trip function to the input. When activated, it is possible to control the output relay(s) assigned to the ***Trip CB*** function			
Trip Circ Supervis.	000000	0-1	1
Mapping of a TC Supervision function. The P116 continuously checks the trip circuit's continuity whether the CB status is CB open or CB closed. The function **TC Supervision** (***GLOBAL SETTINGS/CIRCUIT BREAKER/*** submenu) is enabled when the trip outputs (***Trip Command*** and ***Trip CB***) are not activated. When activated, it is possible to control the output relay(s) assigned to the ***CB ALARM*** function. Note: 1. The TC Supervision function has to be activated and the ***tSUP*** time-delay for ALARM signal should be set in the ***GLOBAL SETTINGS/CIRCUIT BREAKER/*** submenu.			
Reset Theta val.	000000	0-1	1
This logic input sets to zero the thermal state of the thermal replica. The zero thermal state value is written instead of the low value of this function.			

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Menu Text	Default Setting	Setting Range	Step Size
Start Distur. R.	000000	0-1	1
This logic input triggers the Disturbance Recorder.			
Local CTRL Mode	000000	0-1	1
Local mode condition (if enabled, any remote command is forbidden, except: ***Remote CTR Mode*** and ***Comm. Order*** command via RS485).			
Time Synchr.	000000	0-1	1
Assigning of a time 40synchronization input (see Application chapter).			

2.4 LED Configuration

LED configuration settings define which signals are mapped to the P116's LEDs. Matrix configuration allows free mapping of any one function to each LED.

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Menu Text	Default Setting	Setting Range	Step Size
Description of bits:	Model A: LED 8,7,6,5,4,3 **Model L: LED 8,7,6,5,4,3**	**Setting range:**	
Latched LEDs	**000000**	0-1	1
Each LED can be configured with or without latching. Default Setting: "000000" means that: LED8: "0" – LED 8 is latched until the LEDs are reset (Binary Input, Front panel, communication system) LED7: "0" – see LED8 LED6: "0" – see LED8 LED5: "0" – see LED8 LED4: "0" – see LED8 LED3: "0" – see LED8			
Protect. Trip	**000000**	0-1	1
This LED is lit if any protection element is configured: "Trip" is high (current-based protection elements and external protection elements: AUX1, AUX2, AUX3, AUX4, CBF re-trip). Default Setting: "000000" means that: LED8: "0" – LED 8 is not assigned to a Protection trip function LED7, LED6, LED5, LED4, LED3: "1" – see LED8			
Alarm	**000000**	0–1	1
This LED is lit if any protection element set to "Alarm" is high (current-based protection elements, Thermal Alarm and external protection elements: AUX1, AUX2, AUX3, AUX4, TC Supervision, CB FLT ext, CB Time Supervision, CB Current Diagnostic, CB Number Diagnostic, [79] Lockout, HW Warning function). Default Setting: "000001" means that: LED8: "0" – LED 8 is not assigned to an Alarm LED7, LED6, LED5, LED4, LED3: "1" – see LED8			
General Start	**000000**	0–1	1
This LED is lit if for any current-based protection element set to ***Trip,*** the current exceeds the set threshold (phase or e/f).			
Start Phase A	**000000**	0–1	1

Menu Text	Default Setting	Setting Range	Step Size
This LED is lit if the phase overcurrent stage (set to trip) in phase A has started (phase A current above the phase current thresholds).			
Start Phase B	**000000**	0–1	1
This LED is lit if the phase overcurrent stage (set to trip) in phase B has started (phase B current above the phase current thresholds).			
Start Phase C	**000000**	0–1	1
This LED is lit if the phase overcurrent stage (set to trip) in phase C has started (phase C current above the phase current thresholds).			
Start I>	**000000**	0–1	1
This LED is lit if the phase current exceeds the I> stage.			
Start I>>	**000000**	0–1	1
This LED is lit if the phase current exceeds the I>> stage.			
Start I>>>	**000000**	0–1	1
This LED is lit if the phase current exceeds the I>>> stage.			
Start SOTF	000000	0–1	1
This LED is lit if the phase current exceeds the SOTF stage.			
Start IN_1	**000000**	0–1	1
This LED is lit if the ground current exceeds the IN_1 stage.			
Start IN_2	**000000**	0–1	1
This LED is lit if the ground current exceeds the IN_2 stage.			
Start IN_3	**000000**	0–1	1
This LED is lit if the unbalance current exceeds the IN_3 stage.			
AUX1	000000	0–1	1
This LED is lit if the input assigned to AUX1 sets this function to its high state.			
AUX3	000000	0–1	1
This LED is lit if the input assigned to AUX3 sets this function to its high state.			
AUX4	000000	0–1	1
This LED is lit if the input assigned to AUX4 sets this function to its high state.			
AUX5	000000	0–1	1
This LED is lit if the input assigned to AUX5 sets this function to its high state.			
AUX6	000000	0–1	1
This LED is lit if the input assigned to AUX6 sets this function to its high state.			
tI>	**000000**	0–1	1
This LED is lit if the set time-delay for the I> element has elapsed.			
tI>>	**000000**	0–1	1
This LED is lit if the set time-delay for the I>> element has elapsed.			
tI>>>	**000000**	0–1	1
This LED is lit if the set time-delay for the I>>> element has elapsed.			
tSOTF	000000	0–1	1

Menu Text	Default Setting	Setting Range	Step Size
This LED is lit if the set time-delay for the SOTF element has elapsed.			
tIN_1	000000	0–1	1
This LED is lit if the set time-delay for the IN_1 element has elapsed.			
tIN_2	000000	0–1	1
This LED is lit if the set time-delay for the IN_2 element has elapsed.			
tIN_3	000000	0–1	1
This LED is lit if the set time-delay for the IN_3 element has elapsed.			
tI<	000000	0–1	1
This LED is lit if the set time-delay for the I< element has elapsed.			
tI2>	000000	0–1	1
This LED is lit if the set time-delay for the I2> element has elapsed.			
tBrkn Cond.	000000	0–1	1
This LED is lit if the set time-delay for the Broken Conductor element has elapsed.			
Thermal Trip	000000	0–1	1
This LED is lit if the set time-delay for the Thermal state is above the Thermal Trip threshold, and after tripping it is above the Thermal Trip threshold multiplied by the Theta Trip/Reset Ratio.			
Thermal Alarm	000000	0–1	1
This LED is lit if the set time-delay for the Thermal state is above the Thermal Alarm threshold.			
CB Fail	000000	0–1	1
This LED is lit if the set time-delay for the CBF protection function has elapsed.			
tAUX1	000000	0–1	1
This LED is lit if the set time-delay for the AUX1 element has elapsed.			
tAUX2	000000	0–1	1
This LED is lit if the set time-delay for the AUX2 element has elapsed.			
tAUX3	000000	0–1	1
This LED is lit if the set time-delay for the AUX3 element has elapsed.			
tAUX4	000000	0–1	1
This LED is lit if the set time-delay for the AUX4 element has elapsed.			
[79] in Progress	000000	0–1	1
This LED is lit if auto-reclosing is in progress. ***[79] in Progress*** indicates that an auto-reclose cycle is running. The signal is present during the complete reclosing cycle from protection initiation to the end of the reclaim time or lockout.			
[79] F.Trip	000000	0–1	1

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Menu Text	Default Setting	Setting Range	Step Size
This LED is lit if the auto-recloser has issued the final trip signal. [***79] Final Trip*** indicates that the auto-recloser has issued a final trip (after the last reclosing shot the line is still faulty). The final trip signal is reset upon the next CB trip or from one of these resetting methods: assigned input (***Reset Latchd Sign***), front panel **C** clear key), remote LED reset (***Reset Latchd Sign)*** command via RS485 or remote LED and output reset command via RS485. If the final trip signal was not reset before the next Autoreclose, ***[79] in Progress*** will reset this signal, when Autoreclose is started again.			
[79] Lockout	000000	0–1	1
This LED is lit if the auto-recloser is locked-out. ***[79] Lockout*** indicates that the relay is in a lockout state and that no further reclose attempts will be made: - the Reclaim time has elapsed but CB is still open - the Dead time has elapsed but CB remained open after the reclosing shot - the CB has failed to close - the protection element not assigned to the auto-reclose function is tripped. - a number of A/R rolling demand valid - A/R conflict - the CB is faulty - information based on an external Signal, assigned to an input is in high logic state longer than set in ***tCB FLT Ext.Sign (GLOBAL SETTINGS/CIRCUIT BREAKER)*** This alarm can be reset using one of these resetting methods: assigned input (***Reset Latchd Sign***), front panel (**C** clear key), reset command (***Reset Latchd Sign)*** via RS485 assigned input (***Reset Latchd Sign***), front panel **C** clear key), remote LED reset (***Reset Latchd Sign)*** command via RS485 or remote LED and output reset command via RS485. The lockout auto-reclose condition can reset by a manual closing after the ***Inhib Time tI***.			
[79] Blocked	000000	0–1	1
This LED is lit if the auto-recloser is blocked (disabled). ***[79] Blocked*** indicates that the auto-recloser is inhibited (blocked) due to one of the following reasons: - blocking from the front panel (blocking via Menu) - the auto-recloser is disabled by setting (disabled) - a binary input is assigned to the blocking function (blocking via Input) - remote blocking via RS485 (blocking via RS485) - Close or Trip command is executed in A/R time (when A/R is running) - the CB is faulty – information based on an external Signal assigned to an input is in high logic state longer than set in ***tCB FLT Ext.Sign (GLOBAL SETTINGS/CIRCUIT BREAKER)*** - ***Time Inhibit tI on Close*** (***GLOBAL SETTINGS/[79] ADVANCED SETTINGS***) is counted (after Close command execution. A/R close command is excluded from this logic) Information about the reason of blocking is available in menu default window.			
[79] Success.	000000	0–1	1

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Menu Text	Default Setting	Setting Range	Step Size
This LED is lit if the auto-recloser closes the CB and that no faults occur during the Reclaim Time (tR). ***[79] Success.*** Indicates that an auto-reclose cycle has been successfully completed. A successful auto-reclose signal is given after the CB was tripped by a protection function and re-closed whereupon the fault was cleared and the reclaim time expired thus resetting the auto-reclose cycle. The successful auto-reclose output is reset upon the next CB trip or from one of these resetting methods: assigned input (***Reset Latchd Sign***), front panel **C** clear key), remote LED reset (***Reset Latchd Sign)*** command via RS485 or remote LED and output reset command via RS485. If this successful auto-reclose signal was not reset before the next Autoreclose, ***[79] in Progress*** will reset this signal, when Autoreclose is started again.			
Local CRTL Mode	000000	0–1	1
This LED is lit if CB control is in Local Mode.			
CB Alarm	000000	0–1	1
This LED is lit if a CB Alarm is detected. **CB Alarm:** Circuit Breaker Alarm function signal (CB Open No., **Sum Amps(n)**, **TCS 52 Fail**, **CB Open Time** and **CB Close Time**)			
Maintenance Mode	000000	0–1	1
This LED is lit if the P116 is in ***Maintenance Mode***. If Maintenance Mode function is used, it is strongly recommended to assign it to LED3 (Alarm) or to any programmable LEDs to see when maintenance mode is active.			
tCB FLT Ext.Sign	000000	0-1,0-1,0-1, 0-1	1
This LED is lit if the CB is not ready for CB control after the set time-delay. The counter is started if the function ***CB FLT Ext.Sign*** assigned to a binary input is high. The binary input is used to indicate that there is sufficient energy in the CB operating mechanism to close and trip the CB. The ***tCB FLT ext.*** time-delay is set at ***GLOBAL SETTINGS/CIRCUIT BREAKER/ tCB FLT ext***. The binary input is set at ***SETTING GROUP x/INPUTS CONFIGURATION Gx/ CB FLT Ext.Sign***.			
Setting Group 1	000000	0–1	1
This LED is lit if the P116 is using the first setting group.			

3. GLOBAL SETTINGS

3.1 LOC

Menu Text	Default Setting	Available Settings
Language	English	English German French Spanish Portugal Russian Turkey Regional
This cell is used to change the language of the menu.		
Default Display	Meas. In	Meas. In Meas.A CB Control (Model A) [79] CTRL (Model A) Control Mode (Model A)
This cell is used to change the default display window: ***0: Measurements*** referred to In ***1: Measurements*** in Amps ***2: CB control*** window for CB control (close and trip command) **3: Auto-reclose** control window for blocking of auto-recloser and readout of auto-reclose status information ***4: Control Mode*** window for changing the CB control mode: Local/Remote and for presenting Control Mode state information		
LEDs Reset	Manual only	Manual only Protect.Start Close command (Model A)
This cell is used to change the resetting method of latched LEDs (LEDs configured to be latched) in the menu. ***0:Manual only*** – Resetting of latched LEDs via manual reset only (***C*** clear key, input, USB,RS485) ***1:Protect.Start*** – Resetting of latched LEDs upon any protection start (set for CB tripping) or via manual reset ***2: Close command* -** Resetting of latched LEDs upon any manual close command (input, HMI, RS485) Note: It is also possible to configure the auto-recloser to reset the LEDs via ***[79] Close*** Command (see: ***GLOBAL SETTINGS/[79] Signaling Reset)***		
Trip Info Reset	Manual only	Manual only Protect.Start Close command (Model A)
This cell is used to change the resetting (jump to default window) method of Trip information on the front panel LCD in the menu. ***0:Manual only*** – Resetting of Trip info via manual reset only (***C*** clear key, input, USB,RS485) ***1:Protect.Start*** – Resetting of Trip info upon any protection start (set for CB tripping) or via manual reset ***2: Close command* -** Resetting of Trip info upon any manual close command (input, HMI, RS485) Note: It is also possible to configure the auto-recloser to reset the LEDs via ***[79] Close*** Command (see: ***GLOBAL SETTINGS/[79] Signaling Reset)***		

ST

<table>
<tr><th>Menu Text</th><th>Default Setting</th><th>Available Settings</th></tr>
<tr><td>Ltchd Outp. Reset
(Model A)</td><td>Manual only</td><td>Manual only
Protect.Start
Close command</td></tr>
<tr><td colspan="3">This cell is used to change the resetting method of latched outputs (outputs configured to be latched).
0:Manual only – Resetting of latched outputs via manual reset only (C clear key, input, USB, RS485)
1:Protect.Start – Resetting of latched outputs upon any protection start (set for CB tripping) or via manual reset
2: Close command - Resetting of latched outputs upon any manual close command (input, HMI, RS485)</td></tr>
<tr><td>Alarm Info
(Model A)</td><td>Self-Reset</td><td>Self-Reset
Manual Reset</td></tr>
<tr><td colspan="3">This cell is used to change the resetting method of Alarm indication windows (ALARM STATUS/)
0: Self-Reset – This option means that if an alarm signal has disappeared no information is available in the ALARM STATUS column
1:Manual Reset – this option means that if an alarm signal has disappeared information is still available in the ALARM STATUS column until it is reset in the ALARM STATUS/ Alarm Reset cell.</td></tr>
<tr><td>Nominal Frequency</td><td>50Hz</td><td>50Hz
60Hz</td></tr>
<tr><td colspan="3">This cell is used to set the nominal frequency of the power system.</td></tr>
<tr><td>Out.WD Hardware Sign
(Model A)</td><td>Opened</td><td>Opened
Closed</td></tr>
<tr><td colspan="3">This cell is used to configure the logic of WD contact:
- Opened: after powering remains open. In case of any P116 internal fault will be closed
- Closed: after powering is closed. In case of any P116 internal fault will be opened</td></tr>
<tr><td>Control Keys Confirm</td><td>No</td><td>No
Yes</td></tr>
<tr><td colspan="3">This cell is used to select the way of close/trip command execution from the front panel (CB Close key/CB Open key).
No: after pressing CB Close key or CB Open key the command is executed instantaneously
Yes: after pressing CB Close key or CB Open key the new window will be appeared to confirm or cancel the control command (Close or Trip). After pressing OK key the control command is executed or after pressing C clear key the control command is cancelled.</td></tr>
</table>

3.2 Setting Group Select (Model A)

Menu Text	Default Setting	Available Settings
Number of Groups	Two Groups	One Group Two Groups
This cell is used to choose the number of setting groups available in the P116. By choosing ***One Group*** all settings related to Group 2 are hidden in the menu.		
Setting Group	Group 1	Group 1 Group 2
This cell is used to change the current setting group.		
T Change Settings G1→G2	0.00 s	0.00 to 200 s, step 0.01 s
This cell is used to set the time-delay changing between the setting Group 1 and Group 2.		
Copy Settings	No Operation	No Operation Copy G1→G2 Copy G2→G1
When: - the ***G1→G2*** command is issued, G1 will be copied to the G2 group, - the ***G2→G1*** command is issued, G2 will be copied to the G1 group.		

3.3 CT Ratio

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
Line CT Primary	1.000 A	1	30k	1
In = 1 A: Sets the phase current transformer input’s primary current rating.				
Line CT Primary	5.000 A	5	30k	1
In = 5 A: Sets the phase current transformer input’s primary current rating.				
Line CT Sec	1.000 A	N/A	N/A	N/A
In = 1 A: Sets the phase current transformer input’s secondary current rating.				
Line CT Sec	5.000 A	N/A	N/A	N/A
In = 5 A: Sets the phase current transformer input’s secondary current rating.				
E/Gnd CT Primary	1.000 A	1	30k	1
Ien = 1 A: Sets the earth fault current transformer input’s primary current rating.				
E/Gnd CT Primary	5.000 A	5	30k	1
Ien = 5 A: Sets the earth fault current transformer input’s primary current rating.				
E/Gnd CT Sec	1.000 A	N/A	N/A	N/A
Ien = 1 A: Sets the earth fault current transformer input’s secondary current rating.				
E/Gnd CT Sec	5.000 A	N/A	N/A	N/A
Ien = 5 A: Sets the earth fault current transformer input’s secondary current rating.				
IN connection	terminals: A7-8	terminals: A7-8 terminals: A9-10		
This cell is used to inform the P116 about the IN connection: with or without powering of the P116. The above information is used by the P116 to create an energy-saving stage for lower currents if Vx is not connected to the B1-B2 terminals. Reduction of energy consumption by the P116 allows it to lower its burden on the primary MV CT. At the start, the P116’s CT powering is above 0.2 In but if the CT’s energy is low, P116 switches the LCD display, the LEDs and RS485 off in the non-settable energy saving stage. Only one output relay remains active: RL1 (RL2-6 are switched off to save energy). Input states, event records, fault records, counters and LEDs’ latches are saved. The value compared with the above energy stage is calculated as a sum of the currents that supply the P116. If the vector sum of the currents is above 0.65 In (for example for A-B fault the vector sum: 0.65 In = Ia: 0.3 In + Ib: 0.3 In + Ic: 0 In + IN: 0 Ien) the LCD display, the LEDs and the RS485 communications are switched on. Depending on the setting for ***IN connection***: the earth current is included in the above sum (***0: terminals A7-A8***) or not (***1: terminals A9-A10***). Note: If the energy threshold is below 0.65 In, RL2, RL3, RL4, RL5, RL6 and WD are not energized either, but if they are set to be latched and the P116 is powered again, latched RL2, RL3, RL4, RL5, RL6 will be energized until they are reset. The same will happen with latched LEDs.				

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3.4 Circuit Breaker

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
tOpen Pulse min	0.5 s	0.1 s	10 s	0.01 s
Defines the duration of the trip pulse used by **Protection Trip (pulse)** and **Trip CB *Order*** outputs.				
tClose Pulse (Model A)	0.5 s	0.1 s	10 s	0.01 s
Defines the duration of the close pulse used by the ***Close CB Order*** output.				
Time Delay for Close Model A)	0 s	0 s	200 s	0.01 s
Defines the time-delay for Manual or Remote CB close commands.				
tP pulse (Model A)	5760 mn (4 days)	1 mn	65000 mn	1 mn
Defines the duration of the trip pulse. This pulse can be used for longer signaling of trips. Note: For instance, if RL4 is assigned to this function it can be used to switch on an auxiliary voltage supply after tripping, for a fixed period (for example four days). Thus ensuring communication and signaling facilities. After the fixed period Auxiliary Voltage can be disconnected from the P116's terminals automatically to save a substation battery.				
tCB FLT Ext.Sign. (Model A)	16 s	1 s	200 s	1 s
A settable time-delay is included for manual closure with this circuit breaker check. If the circuit breaker does not indicate a healthy condition in this time period following a close command, then the relay will lockout and set off an alarm.				

Remote CTRL Mode (Model A)	0: Remote only	Remote only Remote+LOC

This cell is used for **definition** of P116 "*Remote*" mode.

Note: P116 can be in two modes: "*Remote*" or "*Local*".

Meaning of "*Local*" mode is clear. The control is possible locally only. Remote commands via RS485 are rejected by P116 (except ***Comm. Order*** command and ***Remote CTRL Mode*** commands via RS485).

The meaning of "*Remote*" mode can differ depends on the custom of users or application.

There are two possible definition:

- "*Remote*" mode means that remote or local control are possible
- "*Remote*" mode means that remote control is possible only (local control is rejected by P116)

Customization of "*Remote*" mode **definition** is applied by selection of proper setting:

0: Remote only – If P116 is in "*Remote*" mode, it is possible to apply: a close and a trip command via RS485 only.

Note: It is possible to see actual status of "*Local*"/"*Remote*" mode on the default window of P116 (see below)

```
LR Status:Remote
CTRL: Remote
```

In the line "**LR Status**" it is given information that remote control is possible only (see "**Remote**")

In "**CTRL**" line of this default menu window, it is possible to change control mode from "*Remote*" to "*Local*" and opposite.

If above change is executed, "**LR Status**" will be changed from "**Remote**" to "**Local**" and opposite.

1: Remote+LOC – If P116 is in "*Remote*" mode, it is possible to close and trip CB via RS485 or locally via: default window of menu, front panel keys, binary input configured to "*Manual close*" or "*Manual open*" function.

Note: If this option is selected, in "*Remote*" mode of P116, the actual right ("**LR Status**") on the default window of P116 is presented as below:

```
LR Status:L+R
CTRL: Remote
```

In the line "**LR Status**" is shown information that "**L+R**" - both way of control: local and remote are possible.

In "**CTRL**" line of default window of P116 menu, it is possible to change control mode from "*Remote*" to "*Local*" mode and opposite. If the change is executed, "**LR Status**" will be changed from "**R+L**" to "**Local**" and opposite.

Note: The changing to "*Local*" mode can be done via properly configured (set to "**Local Mode**" function) binary input too. Input has greater priority than the selection from the default window.

If the logical status of the binary input is high, "**LR Status**" is always "**Local**".

If the logical status of the binary input is low, "**LR Status**" can by changed from "*Local*" to "*Remote*" mode via using "**CTRL**" line in default window of P116 menu.

52 Unblock SOTF Time (Model A)	1 s	0 s	200 s	0.01 s

A settable pulse time is used to unblock SOTF with starting from a CB close command state up to end of pulse time.

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TC Supervision? (Model A)	No	No Yes Yes-52		
Selection of the trip circuit supervision function. Yes – the monitoring is active all time Yes-52 – the monitoring is active if CB is the close state only. If ***Yes or Yes-52*** is selected, the ***TC Supervision*** menu is displayed (***ALARM*** signaling).				
TC Supervision tSUP (Model A)	0.5 s	0.1 s	10 s	0.01 s
Displays the time-delay setting (tSUP) for TC supervision.				
CB Supervision? (Model A)	No	Yes No		
Selection of the time monitoring function of CB open and close operations. If Yes is selected, the ***CB Open Time*** and ***CB Close Time*** menu are displayed. (***ALARM*** signaling)				
Max.CB Open Time (Model A)	0.5 s	0.1 s	10 s	0.01 s
Displays the Alarm time threshold for a CB open operation.				
Max.CB Close Time (Model A)	0.5 s	0.1 s	10 s	0.01 s
Displays the Alarm time threshold for a CB close operation.				
CB Diagnostic? (Model A)	No	Yes No		
Selection of the CB monitoring function. If ***Yes*** is selected, the ***Max.CB Open No.*** and ***Sum AMPS^n*** menus are displayed. (***ALARM*** signaling).				
Max.CB Open Nb (Model A)	0	0	50000	1
Displays the alarm threshold for the CB open count.				
Max Sum AMPS^n (Model A)	**1 MA^n**	**0 MA^n**	**6553.5MA^n**	**0.1MA^n**
Displays the alarm threshold for the summation of the current (in Amps or square Amps) interrupted by the CB.				
AMPS's n= (Model A)	1	1	2	1
Displays the exponent for the current summation: I or I^2.				

3.5 Inrush Blocking

The 2nd Harmonic Blocking detects high inrush current flows that occur when transformers or machines are connected. The function will then block the following functions:

- ***PHASE O/C [50/51]***
- ***SOTF [50/51] (Model A)***
- ***E/GND FAULT [50/51N]***
- ***UNDERCURRENT [37] (Model A)***
- ***NEGATIVE SEQ. O/C [46] (Model A)***
- ***BROKEN CONDUCTOR (Model A)***
- ***AUX TIMERS (Model A)***

Blocking of a protection function is enabled if the main configuration of protection criteria is set to “Trip-Inrush Bl” (for example: “***SETTING GROUP x/PROTECTION Gx/PHASE O/C [50/51] Gx/I>? Trip-Inrush Bl”*** submenu)

The 2nd Harmonic Blocking function identifies an inrush current by evaluating the ratio of the second harmonic current components to the fundamental wave. If this ratio exceeds the set thresholds, then the inrush stabilization function operates.

The minimum fundamental current value required for operation of the Inrush Blocking function is 0.2 In, and there is no upper limit to disable this feature.

2nd Harmonic Blocking operates across all phases.

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
Inrush Blocking?	0: No	0: No 1: Yes 2: Closing (Model A)		
Setting to Disable or Enable the ***Inrush Blocking*** element. Setting choice ***No***: The crossing of the 2nd Harmonic ratio threshold does not activate the Inrush Blocking logic function. Setting choice ***Yes***: The crossing of the 2nd Harmonic ratio threshold on any phase activates the Inrush Blocking Logic function instantaneously. Setting choice ***Closing***: The crossing of the 2nd Harmonic ratio threshold on any phase activates the Inrush Blocking Logic function after CB closing (Close CB order) when ***Unblock Inrush Time*** elapses.				
2nd Harmonic Ratio	20%	10%	50%	1%
Sets the value for the 2nd harmonic threshold ratio calculated as a percentage of the fundamental component from 10 to 50% (step 0.1%).				
Inrush Reset Time	0.0 s	0.0 s	200 s	0.01 s
Sets the value for the Inrush tReset time. This provides a reset delay of the Inrush Blocking signal (logic state=1) once the 2nd harmonic level falls below the set threshold. Note: Typically the Reset Time should be set to 0 ms, because second harmonic blocking can cause an additional tripping delay. If unwanted tripping can be caused by the inrush phenomena this value can be increased. This setting is available when Inrush Blocking? Is set to ***Yes*** or ***Closing***				
Unblock Inrush Time (Model A)	1 s	0.0 s	200 s	0.01 s
A settable pulse time is used to enable Inrush Blocking from the moment the CB close command via P116 is issued until the end of the pulse time. This setting is available when Inrush Blocking? Is set to ***Closing***.				

3.6 [79] Advanced Settings (Model A)

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
CB FLT Montor.?	No	No Yes		
Allows the use of a dedicated input (***CB FLT Ext.Sign.***) to inform the auto-reclose function of the state of the CB (failed or operational). This signal has to be mapped to a digital input in the Automatic Control inputs submenu ***0: No***: ***CB FLT Montor.*** Function not activated. ***1: Yes***: The CB will be declared faulty and the auto-recloser will switch to locked-out state when the ***tCB FLT ext*** time (***GLOBAL SETTINGS/CIRCUIT BREAKER/*** submenu) has elapsed and ***tCB FLT Ext.Sign.*** remains active.				
Block.via Input?	No	No Yes		
Allows the use of a dedicated input (***Block 79***) to block the auto-reclose function. If you set this item to Yes, in order to render it active you have to map the function ***Block [79]*** (***INPUTS CONFIGURATION*** submenu) to a digital input. With the ***Block 79*** function active, the auto-recloser will switch to locked-out state after a protection trip involved in the sequences matrix of the AR.				
Start Dead t on	CB trips	Protect.Reset CB trips		

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Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
Setting that determines whether the dead time is started when the circuit breaker trips (CB is closed) or when the protection trip resets. Note: If no binary inputs are assigned to CB status the auto-reclose function uses the ***0: Protect.Reset*** option, even if it is set to ***1: CB trips***.				
Rolling Demand?	No	No Yes		
1: Yes: activates the trip activity supervision. When the first trip command is generated, the relay starts a time-delay during which, if the number of current-based trips reaches the programmed maximum trip number, the relay stops the current auto-reclose cycle (final trip).				
Max cycles No. Rol.Demand	10	2	100	1
Sets the programmed maximum [79] reclosing shot number to protect the CB against intermittent faults.				
Time period Rol. Demmand	10mn	1mn	1410 mn	1mn
Sets the time-delay for trip activity supervision.				
Inhibit Time tI on Close	1 s	0 s	600 s	0.01 s
Set the value for the Inhibit Time (tI). The ***Inhib Time tI*** timer is used to block the auto-recloser from being initiated after the CB is manually closed onto a fault. The lockout condition can reset by a manual closing after the ***Inhib Time tI***.				
Signaling Reset	No	No Close via 79		
This cell is used to change the General resetting way of signaling (LEDs and Trip information). ***0: No*** – Closing of the CB by the auto-recloser does not reset LED and electromagnetic flags signaling. ***1: Close via 79*** – Reset of signaling (LEDs, flags, trip info) via an auto-reclose close command.				

3.7 Communication Orders (Model A)

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
Pulse Time tCOM1	1 s	0 s	200 s	0.01 s
Defines the duration of the trip pulse used by the ***Comm.Order 1*** output. Note: ***Comm.Order 1*** is not blocked if P116 is in ***Local Mode***, so can be used for remote trip if Local Mode should block remote tripping command.				
Pulse Time tCOM2	1 s	0 s	200 s	0.01 s
Defines the duration of the trip pulse used by the ***Comm.Order 2*** output				
COM2 Order Conf.	RS485	RS485 RS485+Button_C Button_C		
this configuration allows adding to ***Comm.Order 2***: pressing of the 'C' clear key located on the front panel of P116 Setting option: ***RS485+Button_C*** means that if command tCOM2 (Communication Order 2) via RS485 is executed or 'C' Clear key on the front panel is pressed, the output contact assigned to ***Comm.Order 2*** will be energized via set tCOM2 pulse time.				

3.8 Optional Flag Indicators Configuration (Model A)

Optional Flag Indicator configuration settings define which signal is mapped to the P116 Flags.
Matrix configuration allows free mapping of any one function to each Optional Flag.

Menu Text	Default Setting	Setting Range	Step Size
Description of bits:	Flag: 5,4,3,2	**Setting range:**	
Flag Ind. tI>	0000	0–1	1
This Flag is active if the set time-delay for the I> element has elapsed. After the set time-delay, the Flag is latched until it is reset (Binary Input, Front panel, communication system) Default Setting: “0000” means that: Flag 5: ***0*** – Flag 5 is not assigned to the tI> function Flag 4: ***0*** – see Flag 5 Flag 3: ***0*** – see Flag 5 Flag 2: ***0*** – see Flag 5 Note: Flag 1 is fixed to Protection Trip function (not configurable)			
Flag Ind. tI>>	0000	0–1	1
This Flag is latched if the set time-delay for the I>> element has elapsed			
Flag Ind. tI>>>	0000	0–1	1
This Flag is latched if the set time-delay for the I>>> element has elapsed			
Flag Ind. tSOTF	0000	0–1	1
This Flag is latched if the set time-delay for the SOTF element has elapsed			
Flag Ind. tIN_1	0000	0–1	1
This Flag is latched if the set time-delay for the IN_1 element has elapsed			
Flag Ind. tIN_2	0000	0–1	1
This Flag is latched if the set time-delay for the IN_2 element has elapsed			
Flag Ind. tIN_3	0000	0–1	1
This Flag is latched if the set time-delay for the IN_3 element has elapsed			
Flag Ind. tI<	0000	0–1	1
This Flag is latched if the set time-delay for the I< element has elapsed			
Flag Ind. tI2>	0000	0–1	1
This Flag is latched if the set time-delay for the Is2> element has elapsed			
Flag Ind. tBrkn Cond.	0000	0–1	1
This Flag is latched if the set time-delay for the Broken Conductor element has elapsed			
Flag Ind. Thermal Trip	0000	0–1	1
This Flag is latched if the set time-delay for the Thermal state is above the Thermal Trip threshold, and after tripping it is above the Thermal Trip threshold multiplied by the Theta Trip/Reset Ratio.			
Flag Ind. CB Fail	0000	0–1	1
This Flag is latched if the set time-delay of the CBF protection function has elapsed			
Flag Ind. tAUX1	0000	0–1	1

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Menu Text	Default Setting	Setting Range	Step Size
This Flag is latched if the set time-delay for the AUX1 element has elapsed			
Flag Ind. tAUX2	0000	0–1	1
This Flag is latched if the set time-delay for the AUX2 element has elapsed			
Flag Ind. tAUX3	0000	0–1	1
This Flag is latched if the set time-delay for the AUX3 element has elapsed			
Flag Ind. tAUX4	0000	0–1	1
This Flag is latched if the set time-delay for the AUX4 element has elapsed			
[79] F.Trip	0000	0–1	1
This Flag is latched if the auto-recloser have issued the final trip signal. [***79] Final Trip*** indicates the auto-recloser has issued a final trip (after the last reclosing shot the line is still faulty). The successful auto-reclose output is reset upon the next CB trip or from one of these resetting methods: assigned input (***Reset Latchd Sign***), front panel (**C** clear key), reset command (***Reset Latchd Sign)*** via RS485 or remote LED and output reset command via RS485. If this Flag (***[79] F.Trip***) was not reset before the next Autoreclose, ***[79] in Progress*** will reset this Flag, when Autoreclose is started again.			
[79] Lockout	0000	0–1	1
This Flag is latched if the auto-recloser is locked-out (internally blocked). ***79 Lockout*** alarm indicates that the relay is in a lockout state and that no further reclose attempts will be made: - the Reclaim time has elapsed but CB is still open - the Dead time has elapsed but CB remained open after the reclosing shot - the CB has failed to close - the protection element not assigned to the auto-reclose function is tripped. - a number of A/R rolling demand valid - A/R conflict This alarm can be reset using one of these resetting methods: assigned input (***Reset Latchd Sign***), front panel (**C** clear key), reset command (***Reset Latchd Sign)*** via RS485 or remote LED and output reset command via RS485. The lockout auto-reclose condition can reset by a manual closing after the ***Inhib Time tI***.			
79 Success.	0000	0–1	1
This Flag is latched if the auto-recloser closes the CB and that no faults occur during the Reclaim Time (tR). ***79 Success.*** indicates that an auto-reclose cycle has been successfully completed. A successful auto-reclose signal is given after the CB was tripped by a protection function and re-closed whereupon the fault was cleared and the reclaim time expired thus resetting the auto-reclose cycle. The successful auto-reclose output is reset upon the next CB trip or from one of these resetting methods: assigned input (***Reset Latchd Sign***), front panel **C** clear key), remote LED reset (***Reset Latchd Sign)*** command via RS485 or remote LED and output reset command via RS485. If this Flag (***79 Success.***) was not reset before the next Autoreclose, ***[79] in Progress*** will reset this Flag, when Autoreclose is started again.			

3.9 General Input Configuration (Model A)

<table>
<tr><th rowspan="2">Menu Text</th><th rowspan="2">Default Setting</th><th colspan="2">Setting Range</th><th rowspan="2">Step Size</th></tr>
<tr><th>Min.</th><th>Max.</th></tr>
<tr><td colspan="5">Standard Inputs card (24-250Vac/dc)</td></tr>
<tr><td>Inp.1 Filtering?</td><td>dc/ac ENA</td><td colspan="3">dc/ac ENA
ac
dc</td></tr>
<tr><td colspan="5">This menu is hidden if the P116 is fitted with DC special binary inputs (ordering option).
Allows setting of the type of filtering for the voltage signal connected to binary input L1 (the type of auxiliary voltage):
0: dc/ac ENA – the binary input is energized by AC or DC auxiliary voltage.
1: ac – the binary input is energized by the DC component only. This setting should be applied if DC auxiliary voltage is used.
2: ac – the binary input is energized by the AC component only. This setting should be applied if AC auxiliary voltage is used.
For details refer to Technical Data chapter.</td></tr>
<tr><td>Inp.2 Filtering?</td><td>dc/ac ENA</td><td colspan="3">dc/ac ENA
ac
dc</td></tr>
<tr><td colspan="5">This menu is hidden if the P116 is fitted with DC special binary inputs (ordering option).
Allows setting of the type of filtering for the voltage signal connected to binary input L2 (the type of auxiliary voltage):
See Inp.1 Filtering</td></tr>
<tr><td>Inp.3 Filtering?</td><td>dc/ac ENA</td><td colspan="3">dc/ac ENA
ac
dc</td></tr>
<tr><td colspan="5">This menu is hidden if the P116 is fitted with DC special binary inputs (ordering option).
Allows setting of the type of filtering for the voltage signal connected to binary input L3 (the type of auxiliary voltage):
See Inp.1 Filtering</td></tr>
<tr><td>Inp.4 Filtering?</td><td>dc/ac ENA</td><td colspan="3">dc/ac ENA
ac
dc</td></tr>
<tr><td colspan="5">This menu is hidden if the P116 is fitted with DC special binary inputs (ordering option).
Allows setting of the type of filtering for the voltage signal connected to binary input L4 (the type of auxiliary voltage):
See Inp.1 Filtering</td></tr>
<tr><td>Inp.5 Filtering?</td><td>dc/ac ENA</td><td colspan="3">dc/ac ENA
ac
dc</td></tr>
<tr><td colspan="5">This menu is hidden if the P116 is fitted with DC special binary inputs (ordering option).
Allows setting of the type of filtering for the voltage signal connected to binary input L5 (the type of auxiliary voltage):
See Inp.1 Filtering</td></tr>
</table>

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
Inp.6 Filtering?	dc/ac ENA	dc/ac ENA ac dc		
This menu is hidden if the P116 is fitted with DC special binary inputs (ordering option). Allows setting of the type of filtering for the voltage signal connected to binary input L6 (the type of auxiliary voltage): See ***Inp.1 Filtering***				
DC Input card (110-220Vdc)				
Global nominal V	110Vdc	220Vdc 129Vdc 110Vdc		
This menu is available if the P116 is fitted with DC special binary inputs (ordering option). This menu is hidden if the P116 is fitted with standard ac/dc binary inputs (ordering option). Allows setting of the nominal voltage for all binary inputs: ***0: 220Vdc*** – Nominal voltage for all binary inputs: 220 Vdc ***1: 129Vdc*** – Nominal voltage for all binary inputs: 129 Vdc ***2:110Vdc*** – Nominal voltage for all binary inputs: 110 Vdc For details refer to Technical Data chapter.				

ST

3.10 O/C Advanced

This column includes advanced settings for O/C protection elements: [50/51] O/C, [50N/51N] E/, [46] Negative Sequence, [46BC] Broken Conductor.
If it is not caused by specific application, the settings below can remain as default.

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
I< Stage Broken Conductor (Model A)	0.1In	0.1In	1In	0,01In
This cell sets the blocking threshold for Broken Conductor protection element. If the 3 phase current (AND) is below set current threshold Broken Conductor protection element is blocked (deactivated). Note: Broken Conductor criteria is based on % value, so settable blocking threshold is suitable for situation when the natural asymmetry of small current load can be detected by Broken Conductor element as fault condition. Increasing of this threshold allows to protect against maloperation, when increased value of natural asymmetry can happen in protected power system network.				
IDMT interlock by DMT	No	No Yes 20Is		n/a
No : no function **Yes**: IDMT tripping can be blocked if any DMT stage is started. This settings is common for all stages in ***E/Gnd Fault [50N/51N]***, ***Phase O/C [50/51] Negative Sequence [46] O/C*** columns. The function allows for better time coordination between IDMT and DMT tripping characteristics. If Yes is selected and the current is above DMT current stage, tripping via IDMT characteristic is blocked to allow reach of DMT time delay (trip via DMT stage only). It is important for application when the IDMT time delay for current above DMT current stage is shorter that set DMT time delay. ***20Is:*** In this option there is no blocking of IDMT stage via any DMT protection element, but the IDMT characteristic is cut above 20 times of IDMT current setting value (Is). It means that if the measured current is above 20 x Is, the time delay is the same as calculated according to IDMT formula for point 20xIs. In this way, above 20 times IDMT current setting value, IDMT characteristic becomes DMT characteristic with fixed time delay counted for 20xIs. **This option is useful when P20 relays are installed in the network, because IDMT characteristics in P20 relays (for example P123, etc) have such functionality as standard.** This settings is common for all stages in ***E/Gnd Fault [50N/51N]***, ***Phase O/C [50/51] Negative Sequence [46] O/C*** columns.				

ST

3.11 Communication (Model A)

<table>
<tr><th rowspan="2">Menu Text</th><th rowspan="2">Default Setting</th><th colspan="2">Setting Range</th><th rowspan="2">Step Size</th></tr>
<tr><th>Min.</th><th>Max.</th></tr>
<tr><td>Protocol</td><td>IEC103</td><td colspan="3">Modbus
IEC103</td></tr>
<tr><td colspan="5">This cell sets the type of protocol for RS485 only:
0: Modbus RTU protocol
1:IEC103 protocol
This setting parameter is applied for RS485 port only.
Note: USB port has fixed protocol: Modbus.</td></tr>
<tr><td>Relay Address RS485</td><td>254</td><td>1</td><td>254</td><td>1</td></tr>
<tr><td colspan="5">This cell sets the unique address for the relay so that only one relay is accessed by the master station's software. This address is applied for RS485 port only.
Note: USB port has fixed address: 1.</td></tr>
<tr><td>Baud Rate</td><td>19200 bits/s</td><td colspan="3">4800 bits/s , 9600 bits/s, 19200 bits/s, 38400 bits/s, 5760 bits/s</td></tr>
<tr><td colspan="5">This cell controls the communication speed between relay and master station. It is important that both the relay and the master station have the same speed setting.
This setting parameter is applied for RS485 port only.
Note: USB port has fixed Baud Rate: 115.2 kbits/s.</td></tr>
<tr><td>Parity</td><td>No parity</td><td colspan="3">No parity, Odd parity, Even parity</td></tr>
<tr><td colspan="5">This cell controls the parity format used in the data frames. It is important that both the relay and the master station have the same parity setting.
This setting parameter is applied for RS485 port only.
Note: USB port has fixed Parity: No parity.</td></tr>
<tr><td>Stop bits</td><td>1 stop bit</td><td colspan="3">1 stop bit, 2 stop bits</td></tr>
<tr><td colspan="5">This cell controls the stop bit format used in the data frames. It is important that both the relay and the master station have the same stop bits setting.
This setting parameter is applied for RS485 port only.
Note: USB port has fixed Stop bits: 1 stop bit.</td></tr>
</table>

Note: The above parameters are relevant to the RS485 port only.

The USB port has the non-settable following parameters:
- Protocol: Modbus RTU
- Address: 1
- Baud Rate: 115.2 kbits/s
- Comms. Mode:
  - Data Bit: 8
  - Stop bit: 1
  - Parity: none

3.12 MAX & Average I Configuration

The ***Max & Average I Configuration*** submenu makes it possible to set the parameters associated with this function. (Peak and Average values are displayed in the Measurements menu)

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
Time Window	900 s	0 s	3600 s	1 s
Set the value for the time window during which peak and average values are stored.				

3.13 Disturbance Recorder

The Disturb Record submenu makes it possible to set and read out disturbance records. Up to 6 second's duration but not more than 5 disturbance records can be stored.

Total number of records available in disturbance recorder is:

- One - for set Max Record Time from in range: 3.01s - 6s
- Two – for set Max Record Time from in range: 2.01s - 3s
- Three – for set Max Record Time from in range: 1.51s - 2s
- Four – for set Max Record Time from in range: 1.21s – 1.5s
- Five - for set Max Record Time from in range: 0.10s – 1.2s

The beginning of the record can be adjusted with a selected pre-fault time. It is possible to limit the duration of a record.

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
Pre-Time	0.1 s	0.1 s	6s	0.01 s
Setting for the disturbance record pre-fault time. The pre-fault time sets the beginning of the disturbance record. In this example, the record starts 100 ms before the disturbance. Its length can be limited by setting.				
Post-Time	0.1 s	0.1 s	1 s	0.01 s
Setting for the disturbance record post-fault time. The total disturbance recording time is: pre-fault time + high state of triggering criteria (Start or Trip time)+ post-fault time. The above total recording time is limited by setting.				
Disturbance Rec.Trig.	on Inst.	on Inst. on Trip		
Setting for the trigger criteria: ***0: on Inst***. – the trigger is the disturbance indicated by the starting of a protection element set to trip the CB. If this option is chosen the total recording time is: pre-fault time + duration of protection start + post-fault time, but no longer than the value of ***Max Record Time***. ***1: on Trip***. – the trigger is the disturbance indicated by a protection element trip. If this option is chosen the total recording time is: pre-fault time + duration of protection trip+ post-fault time, but no longer than the value of ***Max Record Time***.				
Max Record Time	3 s	0.1 s	6 s	0.01 s
Setting for the maximum total recording time. If default value is kept (3 s) it means that 2 records will be recorded.				

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4. COMMISSIONING

This column contains menu cells which allow the status of the opto-isolated inputs, output relay contacts to be monitored. Additionally there are cells to test the operation of the output contacts, user-programmable LEDs.

<table>
<tr><th>Menu Text</th><th>Default Setting</th><th>Available Settings</th></tr>
<tr><td>Description of bits:</td><td>L: 6,5,4,3,2,1</td><td></td></tr>
<tr><td>Opto I/P Status
(Model A)</td><td colspan="2">000000</td></tr>
<tr><td colspan="3">This menu cell displays the status of the relay’s opto-isolated inputs as a binary string, a ‘1’ indicating an energized opto-isolated input and a ‘0’ a de-energized one. This menu window shows the presence of voltage on the binary input terminals, it means that applying of the reverse logic has no influence of the presented values</td></tr>
<tr><td>Description of bits:</td><td>Model A: 6,5,4,3,2,1
Model L: 1</td><td></td></tr>
<tr><td>Relay O/P Status</td><td colspan="2">000000</td></tr>
<tr><td colspan="3">This menu cell displays the status of the digital signals used to energize the output relays as a binary string, a ‘1’ indicating an operated state and ‘0’ a non-operated state.
This menu window shows the logical state of the outputs – not physical state on the terminals.
(Logical state of the output means: before Reverse Logic. So Logical state of the output can differ from Physical state - terminals if Reverse Logic for this output is set)</td></tr>
<tr><td>Maintenance Mode</td><td>No</td><td>No
Yes,outp.trips
Yes,outp.block</td></tr>
<tr><td colspan="3">Choose whether you want to activate the MAINTENANCE MODE of the relay.
MAINTENANCE MODE allows to test outputs (contacts and energy outputs) and functional tests.

It is recommended to assign this function to “Alarm” LED (LED3) or any programmable LED to see when the Maintenance Mode is active.

For changing this value Control password have to be entered.
If “No” is selected, all menu cells below are hidden.
If “Yes,outp.trips” or “Yes,outp.block” is set ALARM LED is lit (if it is assigned to Maintenance Mode) and 10 minutes timer is started for returning to “No” option. In this time P16 is in SETTING MODE. Changing of test values and execution of command are allowed.
If “Yes,outp.block” is selected, outputs (relays and energy outputs) are disconnected from the protection and automation functions.
Note: Remote command (via RS485) or Binary input enable “Yes,outp.block” option .
So “Yes,outp.trips” option can be enabled via P116 menu only.</td></tr>
<tr><td>Description of bits:</td><td>Model A: T,F,6,5,4,3,2,1
Model L: T,1</td><td></td></tr>
<tr><td>Test Pattern</td><td colspan="2">00000000</td></tr>
</table>

ST

Menu Text	Default Setting		Available Settings	
This menu cell is used to set outputs for the test. The digit: 1 set in this cell means that this output will be energized after the test command is applied. If the test is applied (***COMMISSIONING/Test outputs* cell**) outputs set in this cell will be energized for the duration of ***Contact Test Time***.				
Contact Test Time	0.1 s	0 s	200 s	0.01 s
Set the time pulse of contact closing during the tests.				
Test outputs	no operation		no operation Apply test	
This menu cell is used to apply a test to the outputs set in the ***Test Pattern*** cell. To apply the output test: Press OK, change a setting option from 0 to 1 (1: Apply test), confirm this action by pressing the OK key. After this, outputs (set in ***Test Pattern*** cell) are energized for the duration of ***Contact Test Time***. Note: If the *Test control* password is not equal to 0 before changing of option (from 0 to 1) at least ***Test control*** password should be entered (as for every other P116 setting).				
Functional Test	I>		I> I>> I>>> SOTF (Model A) IN_1 IN_2 IN_3 I< (Model A) I2> (Model A) Brkn Cond (Model A) Therm Trip CBF	
This menu cell is used to set a protection element for Functional tests.				
Functional Test End (Model A)	CB Trip		CB trip Time	
This menu cell is used to choose the method of ending the test procedure. 0: CB trip – the test is applied until Trip signal 1: Time – the test is ended after the Functional Test Time set value. Note: in model L the test is ended after Functional Test Time only				
Functional Test Time	0.1 s	0.1 s	200 s	0.01 s
Setting for the time pulse of contact closing during Functional tests.				
Functional Test CTRL	no operat.		no operat. Operate	
This menu cell is used to apply test of outputs which were set in ***Functional Test*** pattern cell. To apply output test: Press enter, change a setting option from ***no operat.*** to ***Operate***, confirm this action by pressing OK key. After that outputs (set in ***Functional Test*** pattern cell) are energized via ***Functional Test Time***. Note: if *Test control* password is not equal 0 before changing of option (from ***no operat.*** to ***Operat***) at least ***Test control*** password should be entered (like for every P116 setting).				

5. SETTING CHANGE MODE

This column contains menu cells which allow the settings and configuration to be changed.

Before any change to the settings it is necessary to set a P116's ***Edit Setting Mode*** to ***Without limits*** or ***Protection only***. If changing of parameters is allowed, the LEDs light up one by one until the ***Setting Change status*** cell is in the ***Protected*** state.

In the ***Without limits*** state, it is possible to change all of the settings.

In the ***Protection only*** state, it is only possible to change protection settings (***PROTECTION*** columns)

In the ***Control*** state, it is possible to control the CB in the default window and apply ***MAINTENANCE MODE*** for outputs and functional tests . If the password is set to 0000, no password is necessary to control the CB.

In the ***Protected*** state, settings are password-protected.

Menu Text	Default Setting	Available Settings
Edit Settings?	Enter PSWD	0000 – 9999
This cell is used to switch the P116 to Edit Settings in order to allow changing the settings.		
Setting Change	Protected	Protected/Without limits/Protection only/Test Control
This cell displays the level of rights to change settings.		
Change Password		0000 – 9999
This cell is displayed if the password is entered. To change the password it is necessary to press the OK key and enter the new password. After that it is necessary to press enter to save the new password.		

To access the ***Edit Setting*** Menu window faster, press the left and up keys at the same time.

This action makes the menu jump to the ***Edit Setting*** cell.

Then press the OK key, a password will be requested.

Enter the password (the default factory password is “0000” for every password level)

In the ***Without limits*** or the ***Protection only*** state, all the LEDs will then light up, in rapid sequence. This indicates that the P116 is operating in Edit Mode: the parameters can be changed in this state.

In the ***Control*** state there is no any LED signaling (no lighting up in rapid sequence as above).

After having set all the required parameters, press simultaneously the and keys, then press the OK key once

6. OP PARAMETERS

This column contains menu cells to show some of the P116's parameters.

Menu Text	Default Setting	Available Settings
Description	P116	Read only
This cell is used to show the type of relay.		
Serial Nb	000000	Read only
This cell is used to show the serial number of the relay.		
Reference	SE MiCOM	Read only
This cell is used to show the relay's manufacturer.		
Software Version	1.B.00	Read only
This cell is used to show the software version (firmware)		
Hardware Version	00	Read only
This cell is used to show the hardware version ordered		
Active Set Group (Model A)	Group 1	Read only
This cell is used to show the active setting group		
Date (Model A)	01/01/08	00/00/00 – 99/99/99
This cell is used to set the date of the internal clock		
Time (Model A)	00:00:00	00:00:00 – 23/59/59
This cell is used to set the time of the internal clock Note: 1. A back-up clock capacitor is charged from an auxiliary voltage supply (terminals B1-B2) only. The capacitor's energy allows storage of real time information for up to 2 days. When the back-up capacitor is completely discharged, it takes less than 10 minutes to recharge it completely 2. If the clock has no real time information (the back-up capacitor is recharged) and the current exceeds the minimum current required for operation, the real time is set to 01/01/2008 00:00:00. Therefore events are dated with reference to this start time value.		
Nominal Frequency:	50Hz or 60Hz	Read only
This cell is used to show the nominal frequency setting.		

ST

ST

OP

OPERATION

Date:	**17th November 2013**
Hardware Suffix:	**A**
Software Version:	**1C**
Connection Diagrams:	**10P11602**

OP

CONTENTS

OP

FIGURES

OP

1. HARDWARE OPERATION

P116 have two models: model A and Model L. The I/O difference between two models are shown on external connection diagrams available in INSTALATION Section P116/EN IN.

The P116 model A is supplied from the power system's CTs or/and from the auxiliary voltage supply (terminals: B1-B2). In case of auxiliary voltage loss on the B1-B2 terminals, the P116 requires a minimum current flowing in one of the three phase inputs or the earth fault input (A7-A8 terminals) in order to function. The minimum current required for operation is 20% of the nominal current of the relay (Technical Data Section P116/EN TD)

The P116 model L is supplied from the power system's CTs only. The P116 requires a minimum current flowing in one of the three phase inputs or the earth fault input (A7-A8 terminals) in order to function. The minimum current required for operation is 20% of the nominal current of the relay (Technical Data Section P116/EN TD)

The energy taken from the current and/or from auxiliary voltage supply is used to charge up the integrated capacitors: trip outputs and relay outputs (flag indicator). If any protection function trips, the energy is provided to the C1-C2 (CB coil output) and C3-C4 (flag indicator output available in Model A only) terminals. The output signal is a pulse, the repetition of which is dependent on the trip coil's impedance and on the current level.

If the current in one of the three phases or at the earth fault input (A7-A8 terminals) is above 0.2 In (Ien), the following functions:

- output contact: RL1,
- all inputs (L1 – L6), but they have to be supplied from another auxiliary voltage which can light inputs (Model A only),
- event recording (Model A only),
- fault recording,
- disturbance recording,
- storage of latched LEDs and outputs information,
- storage of counter information
- energy outputs for sensitive tripping coil and external flag indicator (Model A only)

are operational, even if there is no auxiliary voltage on the B1-B2 terminals (model A only).

If the sum of the vector current values ($|\underline{I}_A - \underline{I}_B| + |\underline{I}_C + \underline{I}_N^{1)}|$) that supply the P116 is below 0.65 In (for example the sum for A-B fault:
0.65 In = Ia: 0.325 In + Ib: 0.325 In + Ic: 0.00 In + I_N: 0.00 Ien), the following functions are no longer available in case of auxiliary voltage supply loss (P116 Model L has no powering from auxiliary suppy):

- in model A: the RS485 communication port is switched off (no communication with the system via RS485),
- the LCD display is switched off,
- the LEDs are switched off. If after a switch-on-to-fault operation, the P116 is supplied again (currents above 0.65 In or auxiliary power or USB), the stored LED information will be displayed until it is reset.
- Neither outputs RL2 to RL6 (Model A) nor the WD contact are energized. If after a switch-on-to-fault operation, the P116 is supplied again (currents above 0.65 In or auxiliary power or USB), the stored output relay information (latched outputs) will be active until it is reset.

If the sum of the vector current values ($|\underline{I}_A - \underline{I}_B| + |\underline{I}_C + \underline{I}_N^{1)}|$) that supply the P116 is above 0.65 In all functions are active (full functionality of P116).

[1)] – Powering of P116 from earth input is selectable by using proper terminals (A7-8: with powering or A9-10: without powering) and additionally by configuration in P116 menu

(GLOBAL SETTINGS/CT RATIO/IN connection). Detailed information is given in the Setting chapter (P116/EN ST) and Installation chapter (P116/EN IN).

Depending on the setting for ***GLOBAL SETTINGS/CT RATIO/IN connection*** the earth current is included in the above sum (***0: terminals:A7-8***) or not (***1: terminals A9-10***).

Note:

1. In Model A a back-up clock capacitor is charged from an auxiliary voltage supply (terminals B1-B2) and current inputs. The capacitor's energy allows storage of real time information for up to 2 days. When the back-up capacitor is completely discharged, it takes less than 10 minutes to recharge it completely.

2. In Model A: if the clock has no real time information (the back-up capacitor is recharged) and the current exceeds the minimum current required for operation, the real time is set to 01/01/2008 00:00:00. Therefore events are dated with reference to this start time value.

3. In Model A: if RS485 communications are required, it is recommended to supply P116 from the auxiliary voltage in order to ensure that real time information is used in the event and fault recorders.

4. The FRAM memory (settings, events - Model A, fault records, latched LEDs and outputs information) is a non-volatile memory.

5. The USB port integrates electronic boards only to allow communications with the P116 via the user interface (HMI) or the setting software. Therefore the status of inputs and outputs is not read via the P116 system. The status information available on the menu is set to its default value. Healthy information available on the Healthy LED refers to the electronic part supplied via the USB port.

6. If there are any hardware problems the “Healthy LED” is blinking. If the “Healthy LED” is not lit, this means that no source of supply is available or that P116 is not healthy. For CT powered relays it is not possible to differentiate between the above conditions. Output contacts can also be assigned to the “Healthy” function (Setting Section P116/EN ST).

2. OPERATION OF INDIVIDUAL PROTECTION FUNCTIONS

The following sections detail the individual protection functions.

P116 have two models: model A and Model L. Operation chapter shows maximum software/hardware option. To see which functions are available in which model – refer to INTRODUCTION (P116/EN IT), GETTING STARTED (P116/EN GS) and SETTINGS (P116/EN ST) chapters.

2.1 Overcurrent Protection

The overcurrent protection included in the P116 relays provides three-stage non-directional three-phase overcurrent protection with independent time-delay characteristics. All overcurrent settings apply to all three phases but are independent for each of the three stages.

Each protection stage can be selected to Trip the CB or to issue a signal (Alarm) only.

If an overcurrent protection stage (I***>?***, I***>>?*** or I***>>>?*** menu) is set to ***Trip***, ***Trip-Inrush Bl*** or ***Trip-Latch***, it means that that stage is linked to the ***Protect.Trip*** and ***Prot.Trip pulse*** functions (see LED and Output configuration).

If an overcurrent protection stage (I***>?***, I***>>?*** or I***>>>?*** menu) is set to ***Alarm***, it means that that stage is linked to the ***Alarm*** function (see LED and Output configuration).

If ***Trip-Inrush Bl*** is selected, the overcurrent stage is blocked via the ***Inrush Blocking*** function (refer to Inrush Blocking section).

If ***Trip-Latch*** is selected, the overcurrent stage will remain high after a trip, until it is reset via a binary input, the HMI or a remote RESET command.

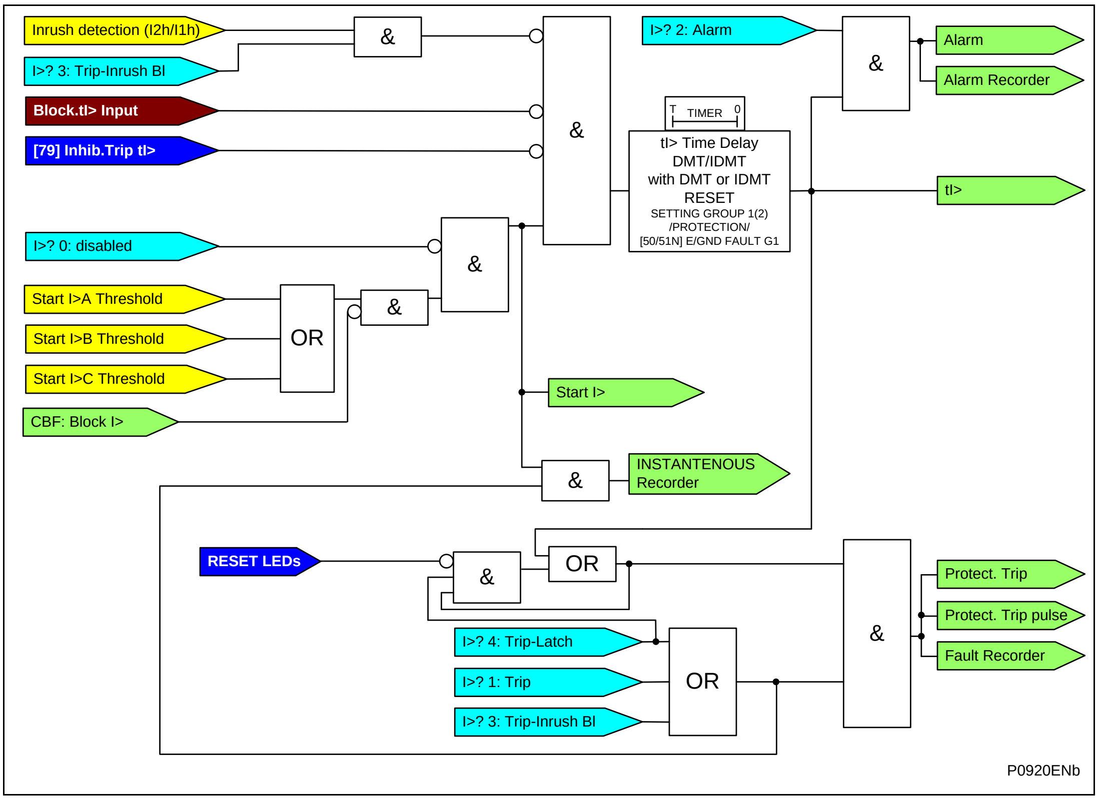


Figure 1: Overcurrent protection logic diagram

2.1.1 Operation Time-Delay

The first (I>) and second (I>>) stages of overcurrent protection have time-delayed characteristics which are selectable between inverse definite minimum time (IDMT) and definite time (DMT). The third (I>>>) stage has a definite time characteristic only.

Various methods are available to achieve correct relay co-ordination on a system; by means of time alone, current alone or a combination of both time and current. Grading by means of current is only possible where there is an appreciable difference in fault level between the two relay locations. Grading by time is used by some utilities but can often lead to excessive fault clearance times at or near source substations where the fault level is highest. For these reasons the most commonly applied characteristic in coordinating overcurrent relays is the IDMT type.

The inverse time-delayed characteristics indicated above comply with the following formulae:

IEC/UK/FR curves: $$t = TMS \cdot \left(\frac{k}{\left(\frac{G}{Gs}\right)^{\alpha} - P} + c\right);$$

OP

IEEE/US curves: $$t = TD \cdot \left(\frac{k}{\left(\frac{G}{Gs}\right)^{\alpha} - P} + c\right);$$

where:

t = Operating time in [s]

k, P, c = Constant

G = Measured current in [A]

TMS = Time multiplier setting for IEC curves

TD = Time dial setting for IEEE curves

Gs = Current threshold setting [A]

α = Constant

Type of Curve according to IEC60255-151 std definition	**Standard**	**k**	**c**	**α**	**P**
IEC Standard Inverse Time (SI)	IEC/A	0.14	0	0.02	1
IEC Very Inverse Time (VI)	IEC/B	13.5	0	1	1
IEC Extremely Inverse Time (EI)	IEC/C	80	0	2	1
IEC Long Time Inverse (LTI)	IEC	120	0	1	1
FR Short Time Inverse (STI)	FR	0.05	0	0.04	1
UK Rectifier (Rect)	UK	45900	0	5.6	1
IEEE Moderately Inverse Time (MI)	IEEE (IEC/D)	0.0515	0.114	0.02	1
IEEE Very Inverse Time (VI)	IEEE (IEC/E)	19.61	0.491	2	1
IEEE Extremely Inverse Time (EI)	IEEE (IEC/F)	28.2	0.1217	2	1
US Time Inverse (CO8)	US	5.95	0.18	2	1
US Short Time Inverse (CO2 P20)	US	0.02394	0.01694	0.02	1
US Short Time Inverse (CO2 P40)	US	0.16758	0.11858	0.02	1

BNP (EDF)	EDF	1000	0.655	2	1
RI		-4.2373	0	-1	1.43644

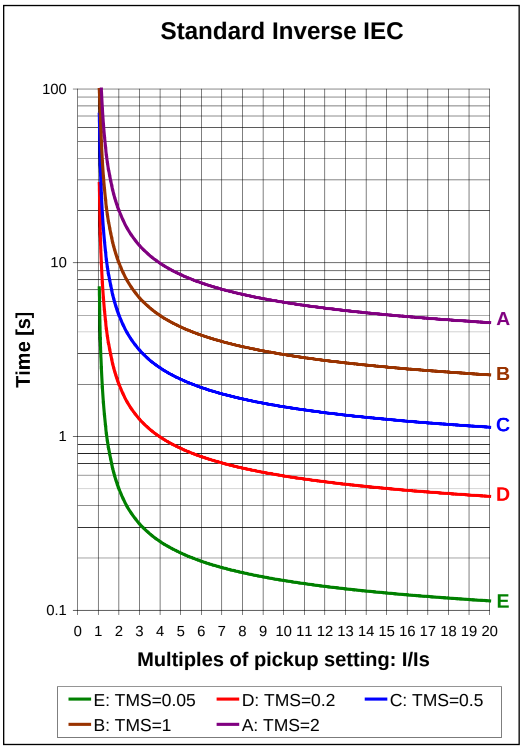
A time multiplier setting TMS is used to adjust the operating time of IEC & UK IDMT curves.

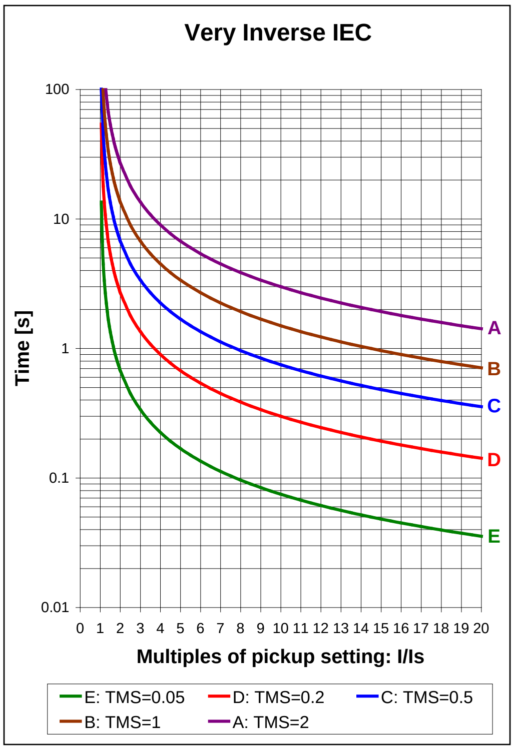
A time multiplier setting TD is used to adjust the operating time of IEEE or US IDMT curves.

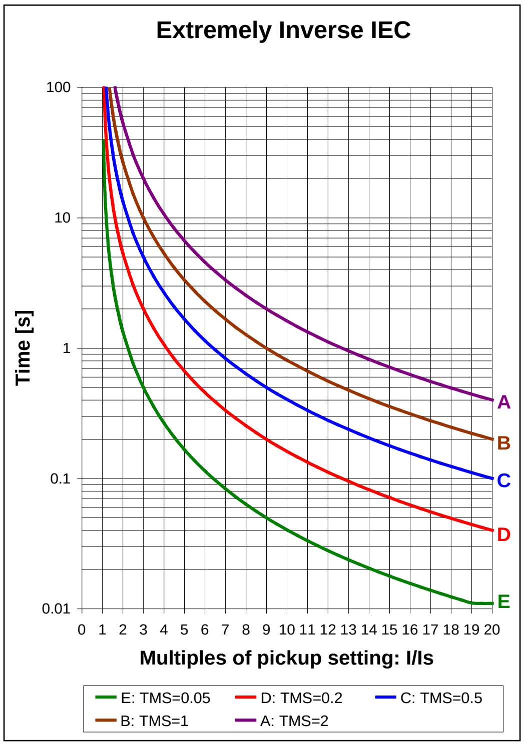
Note:

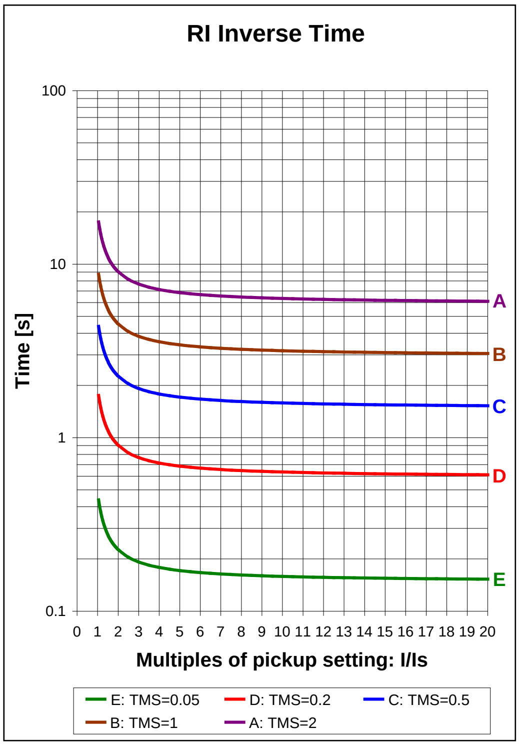
1. For (CO2 P20), TD is defined like in MiCOM P20 series
2. For (CO2 P40), TD is defined like in MiCOM P40 series

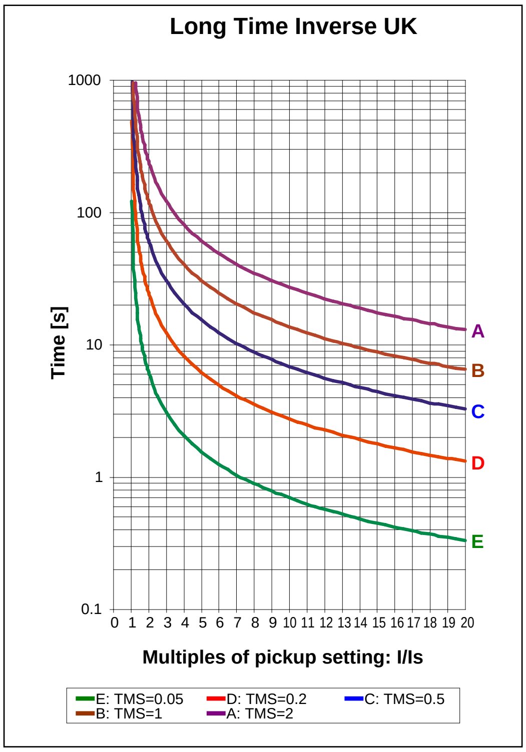
The difference between above two characteristics is in definition of TD setting value only.

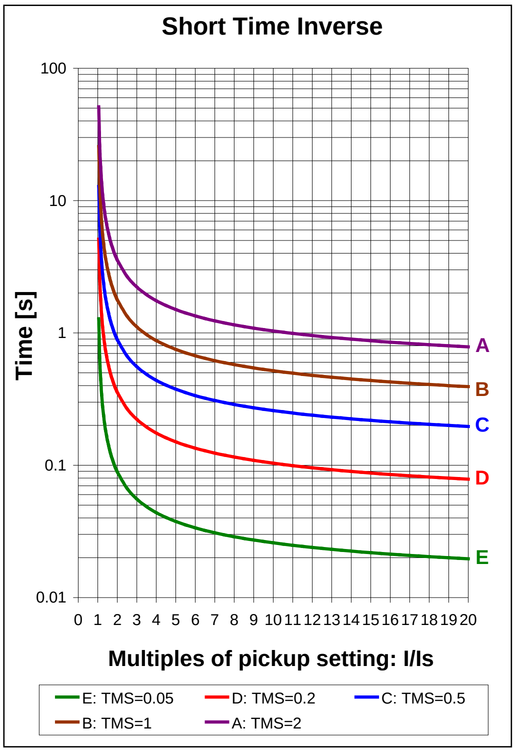


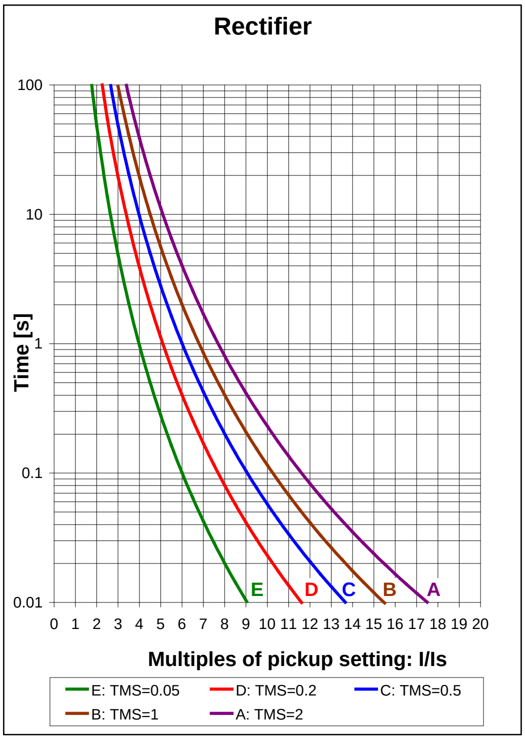


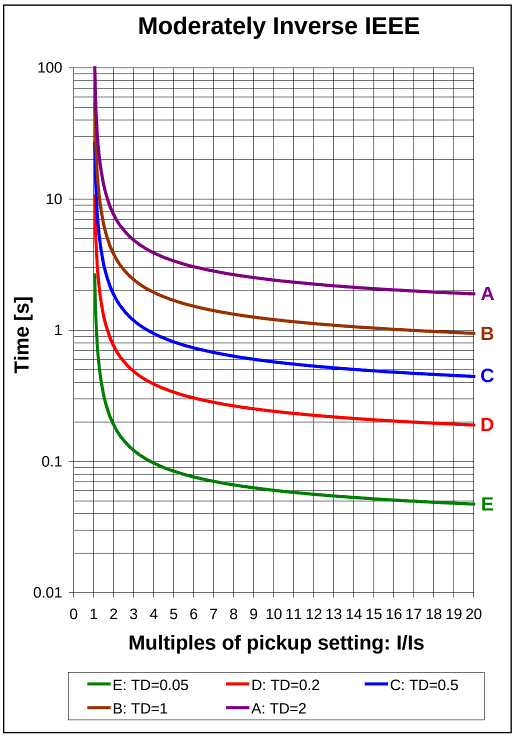

Extremely Inverse IEC
100
10
1
0.1
0.01
Time [s]
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Multiples of pickup setting: I/Is
A
B
C
D
E
E: TMS=0.05
D: TMS=0.2
C: TMS=0.5
B: TMS=1
A: TMS=2

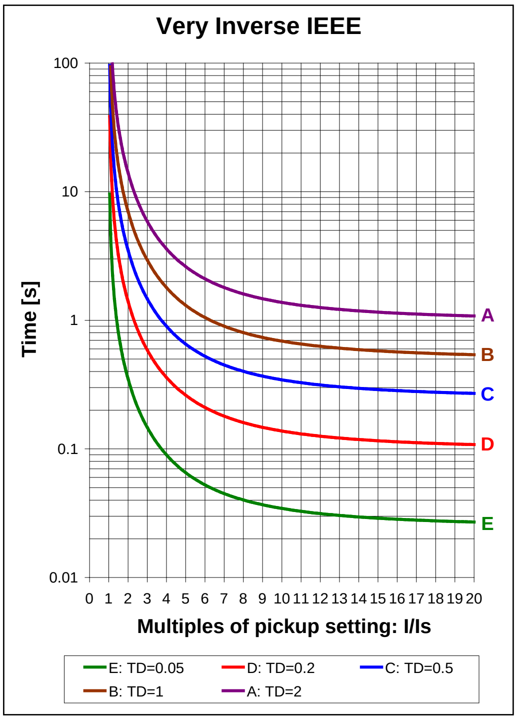

RI Inverse Time
100
10
1
0.1
Time [s]
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Multiples of pickup setting: I/Is
A
B
C
D
E
E: TMS=0.05
D: TMS=0.2
C: TMS=0.5
B: TMS=1
A: TMS=2

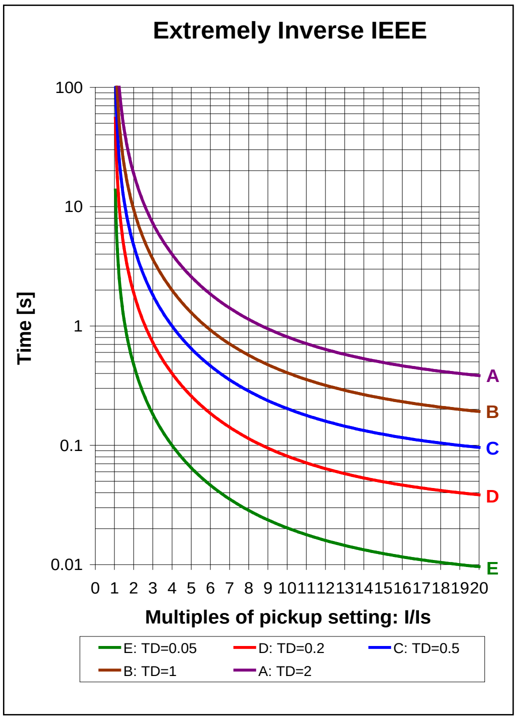

Long Time Inverse UK
1000
100
10
1
0.1
Time [s]
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Multiples of pickup setting: I/Is
A
B
C
D
E
E: TMS=0.05
D: TMS=0.2
C: TMS=0.5
B: TMS=1
A: TMS=2


Short Time Inverse
100
10
1
0.1
0.01
Time [s]
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Multiples of pickup setting: I/Is
A
B
C
D
E
E: TMS=0.05
D: TMS=0.2
C: TMS=0.5
B: TMS=1
A: TMS=2


Rectifier
Time [s]
100
10
1
0.1
0.01
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
E D C B A
Multiples of pickup setting: I/Is
E: TMS=0.05
D: TMS=0.2
C: TMS=0.5
B: TMS=1
A: TMS=2

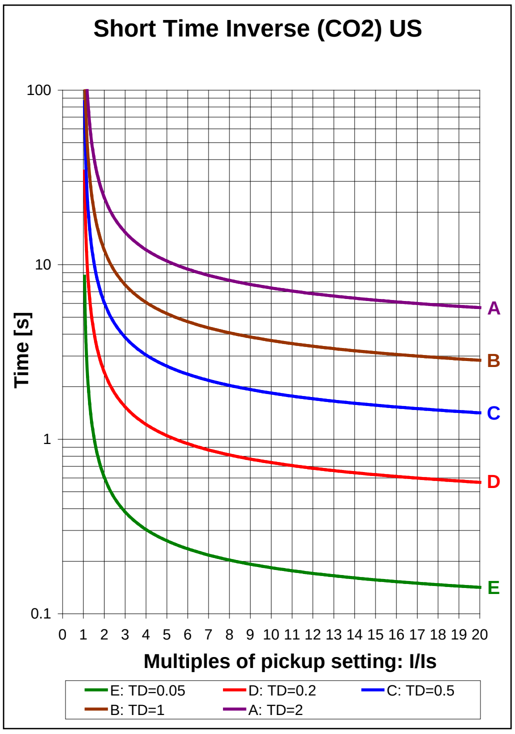

Moderately Inverse IEEE
Time [s]
100
10
1
0.1
0.01
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
A
B
C
D
E
Multiples of pickup setting: I/Is
E: TD=0.05
D: TD=0.2
C: TD=0.5
B: TD=1
A: TD=2

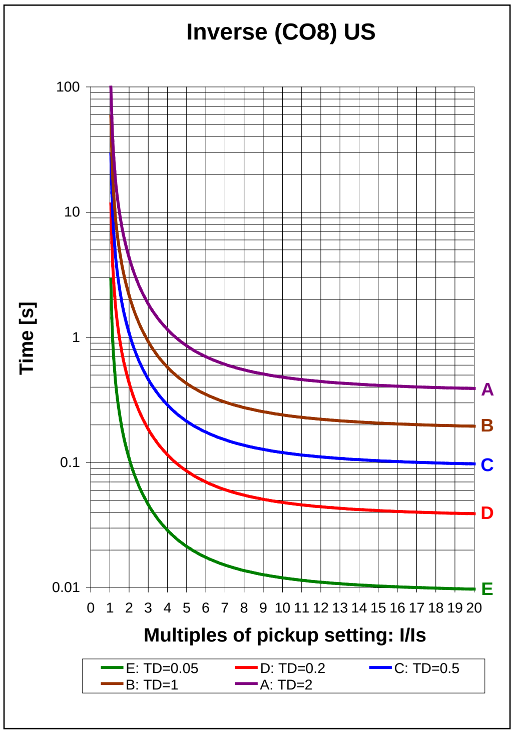

Very Inverse IEEE
Time [s]
100
10
1
0.1
0.01
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
A
B
C
D
E
Multiples of pickup setting: I/Is
E: TD=0.05
D: TD=0.2
C: TD=0.5
B: TD=1
A: TD=2


Extremely Inverse IEEE
Time [s]
100
10
1
0.1
0.01
0 1 2 3 4 5 6 7 8 9 1011121314151617181920
A
B
C
D
E
Multiples of pickup setting: I/Is
E: TD=0.05
D: TD=0.2
C: TD=0.5
B: TD=1
A: TD=2

OP

OP





RXIDG Curves

RXIDG curves can be selected on P116 with medium earth current sensitivity (corresponding to Cortec model number P116xxx2xxxxxxxxxx)

The first earth thresholds can be selected with dedicated RXIDG curves.

The curves available follow the formula:

$t = 5.8 – 1.35 * \ln (1/ (k * Gs/G))$

Where:

t = tripping time

k = coefficient (from 0.3 to 1, by steps of 0.01)

Gs = value of the programmed threshold (Pick-up value)

G = value of measured current

In order to be compliant with the Netmanagement specifications the relay must be used with:

- An earth current range 0.01 Ion to 8 Ion
- A rated current wiring 1A
- A core balanced CT with a ratio 25/1.

2.1.2 Timer Hold Facility

The first two stages of overcurrent protection in the P116 relay are provided with a timer hold facility, which may either be set to zero or to a definite time value. Setting of the timer to zero means that the overcurrent timer for that stage will reset instantaneously once the current falls below 95% of the current setting. Setting of the hold timer to a value other than zero, delays the resetting of the protection element timers for this period. When the reset time of the overcurrent relay is instantaneous, the relay will be repeatedly reset and not be able to trip until the fault becomes permanent. By using the Timer Hold facility the relay will integrate the fault current pulses, thereby reducing fault clearance time.

The timer hold facility can be found for the first and second overcurrent stages as settings ***I> DMT tRESET"*** and "***I>> DMT tRESET***", respectively. Note that this cell is not visible for the IEC/IEEE/US curves if an inverse time reset characteristic has been selected (***SETTING GROUP x/PROTECTION Gx/ PHASE O/C G1(G2)/ I> (I>>) Reset Delay Type 1:IDMT*** setting), as the reset time is then determined by the programmed time dial setting.

Reset IDMT Characteristic

IEEE/US/IEC

The IEEE/US/IEC curves may have an inverse time reset characteristic (***I> (I>>) Reset Delay Type 1: IDMT*** setting) or instantaneous reset ***(I> (I>>) Reset Delay Type 0:DMT*** setting). If IDMT reset is selected (***I> (I>>) Reset Delay Type 1: IDMT*** setting) then the following menu will be available: ***I> (I>>) RTD/RTMS RESET***. The following equation can be used to calculate the inverse reset time for IEEE/US/IEC curves:

IEC and UK and FR: $$reset\ time = RTMS \cdot \frac{tr}{1-(\frac{G}{Gs})^{p}}$$

IEEE and US: $$reset\ time = RTD \cdot \frac{tr}{1-(\frac{G}{Gs})^{p}}$$

where:

RTD = Time dial setting for IEEE/US curves

RTMS = A time multiplier setting for IEC curves

tr = Constant (see table below)

α = Constant (see table below)

M = I/Is

Note: To be in line with IEEE/US/IEC the RTMS (RTD) value should be equal to the TMS (TD) value. The setting for RTMS or RTD is given to adjust the reset characteristic to specific applications. Typically RTMS = TMS and RTD = TD.

Type of Curve	Standard	tr	p
IEC Standard Inverse Time (SI)	IEC/A	8.2	6.45
IEC Very Inverse Time (VI)	IEC/B	50.92	2.4
IEC Extremely Inverse Time (EI)	IEC/C	44.1	3.03
IEC Long Time Inverse (LTI)	IEC	40.62	0.4
FR Short Time Inverse (STI)	FR	0	0
UK Rectifier (Rect)	UK	0	0
IEEE Moderately Inverse Time (MI)	IEEE (IEC/D)	4.850	2

IEEE Very Inverse Time (VI)	IEEE (IEC/E)	21.600	2
IEEE Extremely Inverse Time (EI)	IEEE (IEC/F)	29.100	2
Time Inverse (CO8)	US	5.950	2
Short Time Inverse (CO2_P20)	US	0.323	2
Short Time Inverse (CO2_P40)	US	2.261	2
BNP EDF	BNP EDF	0	2
RXIDG	RXIDG	0	2

Note:

1. For CO2_P20, RTD is defined like in MiCOM P20 series
2. For CO2_P40, RTD is defined like in MiCOM P40 series

The difference between above two characteristics is in definition of TD setting value only.

2.2 SOTF: Switch On To Fault (Model A)

2.2.1 General

In some feeder applications, fast tripping may be required if a fault is still present on the feeder after the reclosure of the circuit breaker (Close on to fault).

In the case of a CB being manually closed, a switch on to an existing fault may occur. This situation is particularly critical because the overcurrent protection element would not clear the fault until the set time-delay has elapsed. It is then desirable to clear the fault as fast as possible.

Enabling and setting the SOTF (Switch On To Fault) function can be done under the ***SETTING GROUP x/PROTECTION Gx/SOTF?*** submenu.

Crossing the SOTF Threshold will initiate the SOTF function. The tSOTF time-delay will then be started.

If the ***SOTF*** element is set to ***Trip***, **Trip-Inrush Bl** or ***Trip-Latch***, it means that it is linked to the ***Protect.Trip*** and ***Prot.Trip pulse*** functions (see LED and Output configuration).

If the ***SOTF*** element is set to ***Alarm***, it means that it is linked to the ***Alarm*** function (see LED and Output configuration).

If **Trip-Inrush Bl** is selected, the SOTF element is blocked via the ***Inrush Blocking*** function (refer to Inrush Blocking section).

If ***Trip-Latch*** is selected, the SOTF element will remain high after a trip, until it is reset via a binary input, the HMI or a remote RESET command.

2.2.2 SOTF Description

The following signals can activate the SOTF function:

- manual closing ordered using the HMI (menu or function Close key)
- command generated by a digital input labelled ***Manual Close***,
- front communication Closing command,
- rear communication Closing command,

The diagram below illustrates this functionality.

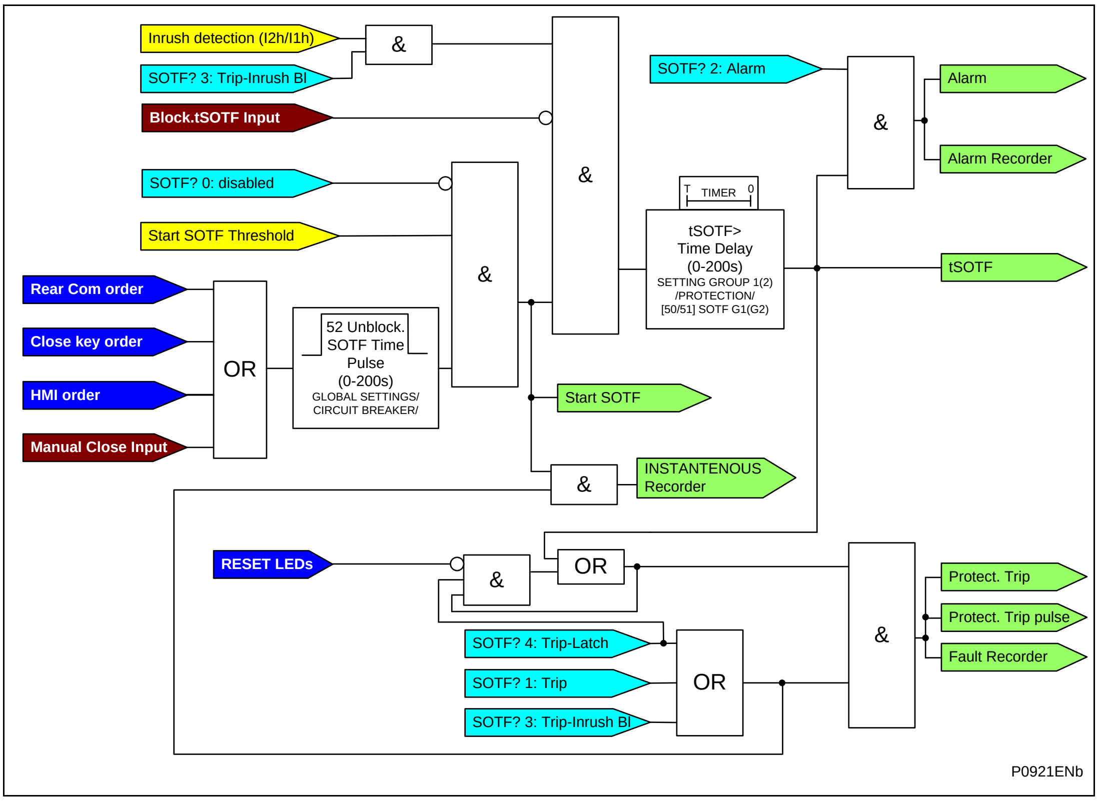


Figure 2: Switch on to fault logic diagram

When at least one of the signals listed above has been detected, a timer starts and lasts until ***52 Unblock.SOTF Time (GLOBAL SETTINGS/CIRCUIT BREAKER*** submenu) elapses.

Once the above timer has elapsed and the SOTF thresholds have been crossed, the ***tSOTF*** settable time-delay starts. This settable time-delay is particularly useful in applications where fault selectivity is required.

This time-delay is also useful in cases where serious transients may be present, where the three poles of the CB do not all close at the same time and in cases where the CB may not close instantaneously.

"tSOTF" can also be considered as a trip time-delay that substitutes itself to the trip time-delay associated with the crossed threshold so that the tripping time is accelerated.

If the SOTF stage is reset before the settable time-delay ***tSOTF*** elapses, the SOTF function is reset.

OP

2.3 Earth Fault Protection

The Earth fault element operates from a measured earth fault current quantity (A7-A8 or A9-A10).

The first earth fault stage has time-delayed characteristics which are selectable between inverse definite minimum time (IDMT) and definite time (DMT). The second stage has a definite time characteristic only.

If an earth fault stage (***IN_1 stage?***, ***IN_2 stage?*** or ***IN_3 stage?*** menu) is set to ***Trip***, **Trip-Inrush BI** or ***Trip-Latch*** it means that that stage is linked to the ***Protect.Trip*** and ***Prot.Trip pulse*** functions (see LED and Output configuration).

If an earth fault stage (***IN_1 stage?***, ***IN_2 stage?*** or ***IN_3 stage?*** menu) is set to ***Alarm***, it means that that stage is linked to the ***Alarm*** function (see LED and Output configuration).

If **Trip-Inrush BI** is selected, the earth fault stage is blocked via the ***Inrush Blocking*** function (refer to Inrush Blocking chapter).

OP

If ***Trip-Latch*** is selected, the earth fault stage will remain after a trip, until it is reset via a binary input, the HMI or a remote RESET command.

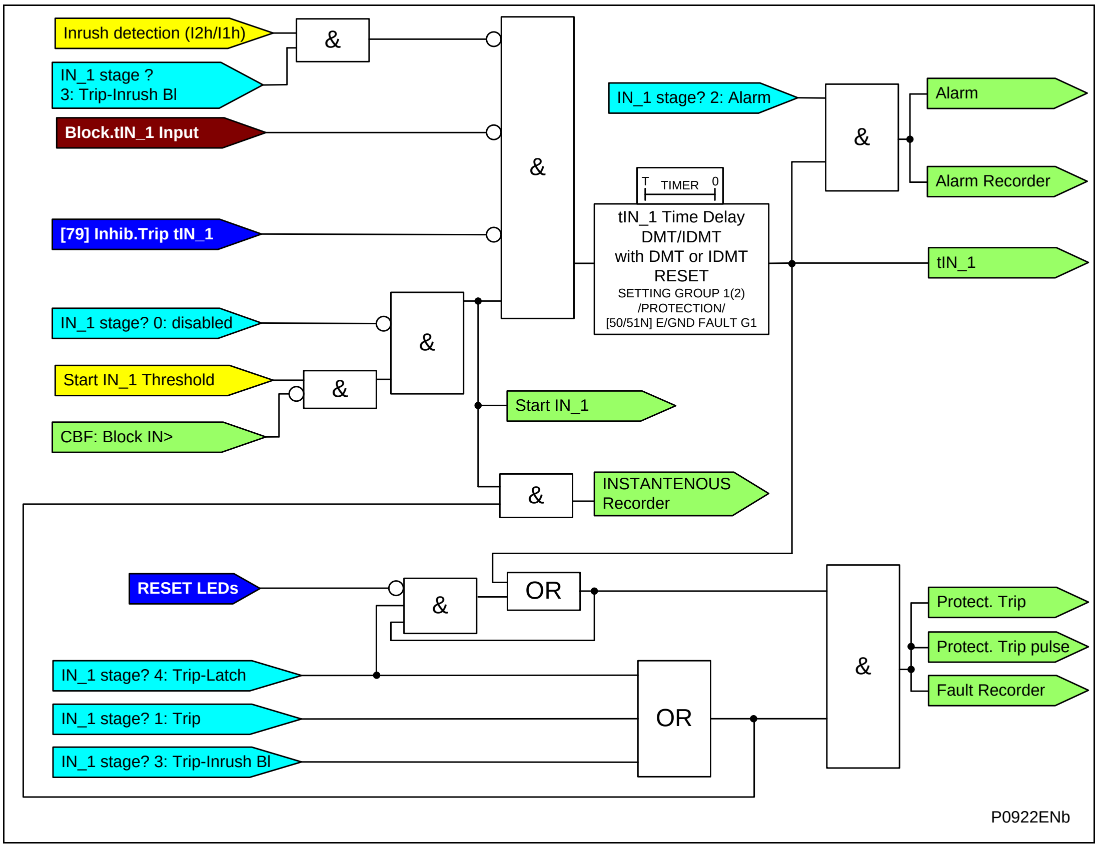


Figure 3: Earth Fault protection logic diagram for IN_1. For IN_2, the logic diagram is the same but without the IDMT characteristics

The types of characteristics are the same as for phase protection elements:

- IEC Standard Inverse Time (SI)
- IEC Very Inverse Time (VI)
- IEC Extremely Inverse Time (EI)
- IEC Long Time Inverse (LTI)
- FR Short Time Inverse (STI)
- UK Rectifier (Rect)

- RI: Electromechanical Inverse
- IEEE Moderately Inverse Time (MI)
- IEEE Very Inverse Time (VI)
- IEEE Extremely Inverse Time (EI)
- US Short Time Inverse; TD setting in line with MiCOM P20 (CO2_P20)
- US Short Time Inverse; TD setting in line with MiCOM P40 (CO2_P40)
- US CO8: Time Inverse
- BNP EDF
- RXIDG

The mathematical formulae and curves for the twelve Inverse Time characteristics available with the P116 are presented in section 2.1 of this chapter .

The IEEE/US/IEC curves may have an inverse time reset characteristic, DMT delayed or instantaneous reset (refer to section 2.1 of this chapter)

Depending on the connection of the e/f CT to the current terminals, the e/f current can supply the P116 (terminals A7 and A8) or not supply the P116 (terminals A9 and A10) (refer to section 8 of the Installation chapter of this manual).

2.4 Undercurrent Protection (Model A)

In motor applications undercurrent thresholds must sometimes be set below the no load current level (for example: pump application).

Undercurrent stage ***I<*** can be set to ***Alarm***, ***Trip***, ***Trip-Inrush BI***, ***Trip-Latch***, ***Alarm inhib 52*** or ***Trip inhib 52***.

If the ***I<*** protection element is set to ***Trip***, ***Trip-Inrush BI***, ***Trip-Latch*** or ***Trip inhib 52***, it means that that element is linked to the ***Protect.Trip*** and ***Prot.Trip pulse*** functions (see LED and Output configuration).

If the ***I<*** protection element is set to ***Alarm***, it means that that element is linked to the ***Alarm*** function (see LED and Output configuration).

If **Trip-Inrush BI** is selected, the undercurrent element is blocked via the ***Inrush Blocking*** function (refer to Inrush Blocking section).

If ***Trip-Latch*** is selected, the undercurrent element will remain high after a trip, until it is reset via a binary input, the HMI or a remote RESET command.

OP

The undercurrent element can be blocked via the CB open status (***CB status 52B*** logic input) if I< is set to ***Alarm inhib 52*** or ***Trip Inhib 52***.

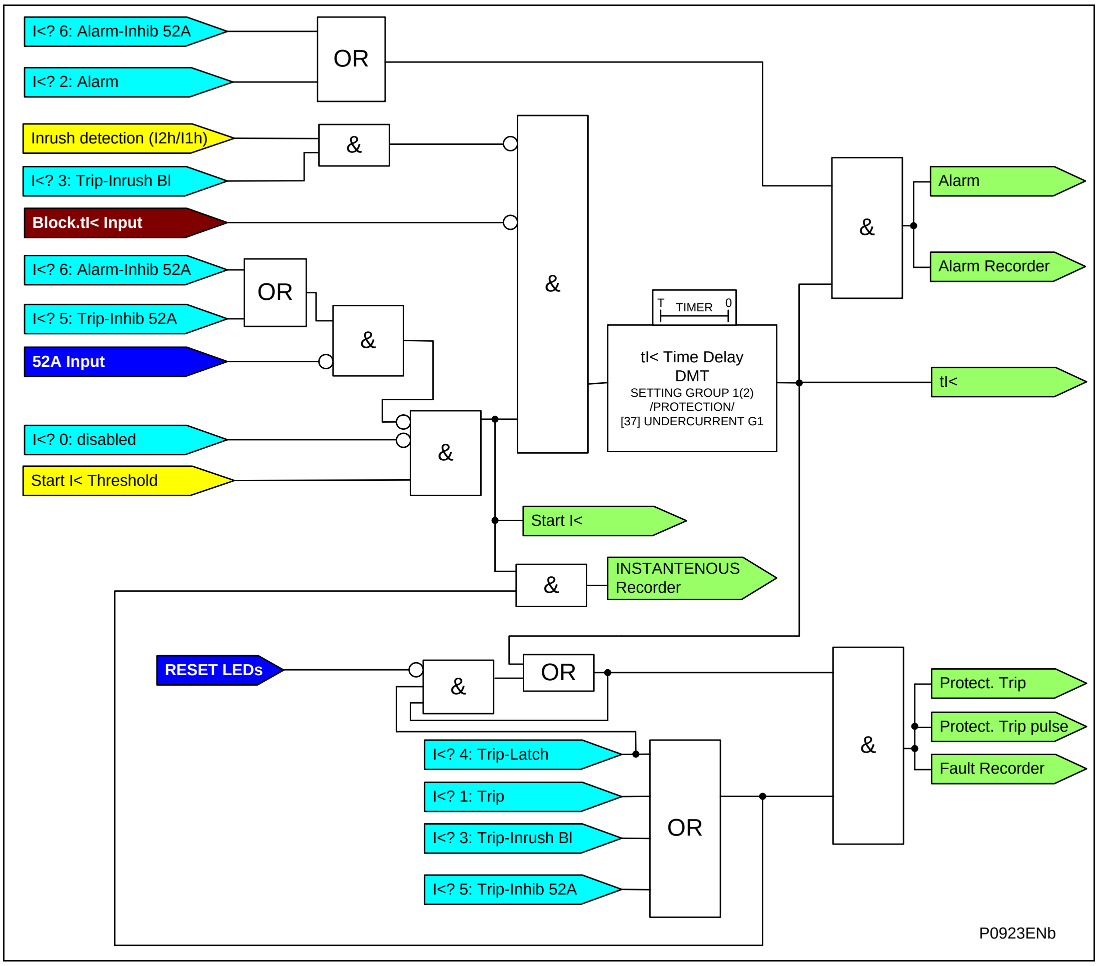


Figure 4: Undercurrent protection logic

2.5 Negative Sequence Overcurrent Protection (Model A)

In traditional phase overcurrent protection schemes, overcurrent thresholds must be set above the maximum load current levels. This limits the sensitivity of the relay. Most protection schemes also use an earth fault element based on residual current, which improves sensitivity for earth faults. However, it can happen that some faults occur and stay undetected by such schemes.

Any unbalanced fault condition will produce negative sequence current. Thus, a negative phase sequence overcurrent element can detect both phase-to-phase and phase-to-earth faults.

The negative phase sequence overcurrent element included in the P116 relays provides one stage non-directional overcurrent protection with independent time-delay characteristics. These characteristics are selectable between inverse definite minimum time (IDMT) and definite time (DT). The inverse time-delayed characteristics support both IEC and IEEE curves. Please refer to section 2.1 for a detailed description.

If the ***I2>*** protection element is set to ***Trip***, **Trip-Inrush BI** or ***Trip-Latch***, it means that that element is linked to the ***Protect.Trip*** and ***Prot.Trip pulse*** functions (see LED and Output configuration).

If the ***I2>*** protection element is set to ***Alarm***, it means that that element is linked to the ***Alarm*** function (see LED and Output configuration).

If **Trip-Inrush BI** is selected, the negative sequence overcurrent element is blocked via the ***Inrush Blocking*** function (refer to Inrush Blocking section).

If ***Trip-Latch*** is selected, the negative sequence overcurrent element will remain high after a trip, until it is reset via a binary input, the HMI or a remote RESET command.

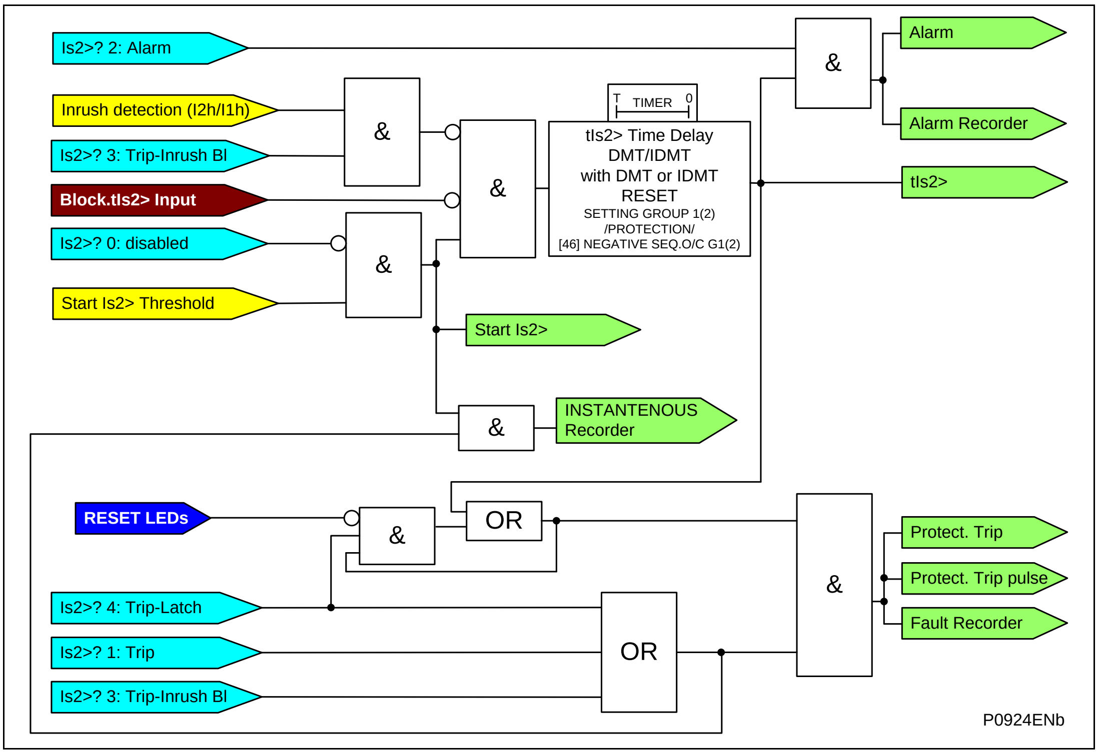


Figure 5: Negative sequence overcurrent protection logic

OP

2.6 Broken Conductor Detection (Model A)

The relay incorporates an element that measures the ratio of negative to positive phase sequence current (I_2/I_1). This will be affected to a lesser extent than the measurement of negative sequence current alone, since the ratio is approximately constant with variations in load current. Hence, a more sensitive setting may be achieved. The logic diagram is as shown below. The ratio of I_2/I_1 is calculated and compared with the ***Ratio I2/I1*** threshold. If it exceeds the threshold then the time-delay ***tBCond*** is initiated. The ***Brkn Cond I< block*** signal is used to disable Broken Conductor function if the max current value from three phases is too low. The ***Brkn Cond I< block*** undercurrent threshold is settable (***GLOBAL SETTINGS/O/C ADVANCED/[46BC] Brkn.Cond I< Block.***). Factory setting value is 0.1 In.

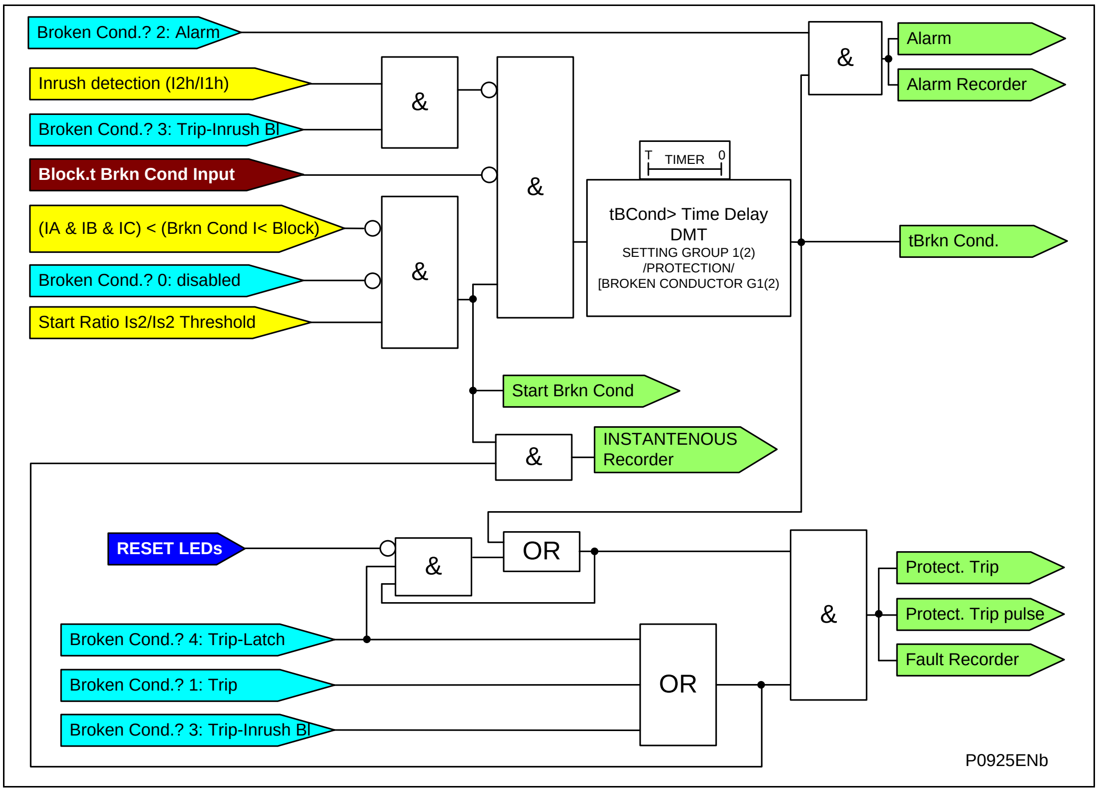


Figure 6: Broken conductor protection logic

The Broken Conductor function can be set to: ***Trip***, **Trip-Inrush BI**, ***Trip-Latch*** or ***Alarm***.

If the ***Broken Conductor*** element is set to ***Trip***, **Trip-Inrush BI** or ***Trip-Latch***, it means that it is linked to the ***Protect.Trip*** and ***Prot.Trip pulse*** functions (see LED and Output configuration).

If the ***Broken Conductor*** element is set to ***Alarm***, it means that it is linked to the ***Alarm*** function (see LED and Output configuration).

If **Trip-Inrush BI** is selected, the I2/I1 threshold is blocked via the ***Inrush Blocking*** function (refer to Inrush Blocking section).

If ***Trip-Latch*** is selected, the Broken Conductor element will remain high after a trip, until it is reset via a binary input, the HMI or a remote RESET command.

2.7 Thermal Overload Protection

The relay incorporates a current-based thermal replica, using r.m.s. load current to model heating and cooling of the protected plant. The element can be set with both alarm and trip stages.

The heat generated within an item of plant, such as a cable or a transformer, is the resistive loss (I^2R x t). Thus, heating is directly proportional to current squared. The thermal time characteristic used in the relay is therefore based on current squared, integrated over time. The relay automatically uses the largest phase current for input to the thermal model.

The equipment is designed to operate continuously at a temperature corresponding to its full load rating, where the generated heat is balanced by heat dissipated through radiation, etc.

Over-temperature conditions therefore occur when currents in excess of the rating are allowed to flow for a period of time. It can be shown that temperatures during heating follow exponential time constants and a similar exponential decrease of temperature occurs during cooling.

This characteristic is used to protect cables, dry type transformers (e.g. type AN), and capacitor banks.

OP

The thermal time characteristic is given by:

$$\mathrm{t\ Trip} = \mathrm{Te\ In}\left(\frac{\left|\mathrm{K}^2 - \theta_p\right|}{\left|K^2 - \theta_{t\,rip}\right|}\right)$$

Where:

t Trip = Tripping time (in seconds)

T_e = Thermal time constant of the equipment to be protected (in seconds)

K = Thermal overload equal to $\dfrac{I_{eq}}{1.05 \cdot I_{therm}}$

I_{eq} = Equivalent current corresponding to the R.M.S. value of the largest phase current

I_P = Steady state pre-loading current before application of the overload

I_{therm} = Setting value. It is full load current rating

θ_P = Steady state pre-loading thermal state before application of the overload

θ_{alarm} = Initial thermal state. If the initial thermal state = 30% then θ =0.3

θ_{trip} = Trip thermal state. If the trip thermal state is set at 100%, then θ trip = 1

The tripping time varies according to the load current carried before application of the overload, i.e. whether the overload was applied from '**hot**" or "**cold**".

The parameter settings are available in the various menus. The calculation of the thermal state is given by the following formula:

$$\Theta_{\tau+1} = \left(\frac{I_{eq}}{1.05 \cdot I_{therm}}\right)^2 \left[1 - e^{\left(\frac{-t}{Te}\right)}\right] + \Theta_\tau e^{\left(\frac{-t}{Te}\right)}$$

θ is calculated every 10 ms.

θ is memorized with time stamp every 500 ms. After recovering of P116 power supply, actual θ is recalculated based on θ memorized value, time stamp and actual time. For recalculation time constant for cooling (Tr) is used.

If all the phase currents are above 0.1 x I_{therm} the value of Tr (time constant for cooling) is used instead of Te (time constant for heating):

$$\Theta_{\tau+1} = \left(\frac{I_{eq}}{1.05 \cdot I_{therm}}\right)^2 \left[1 - e^{\left(\frac{-t}{Tr}\right)}\right] + \Theta_\tau e^{\left(\frac{-t}{Tr}\right)}$$

In a typical application (transformer, cable, ...) Tr should be equal to Te. Different setting values of Te and Tr are only used in motor applications.

Where θ is the thermal state and is θp the pre-fault thermal state.

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

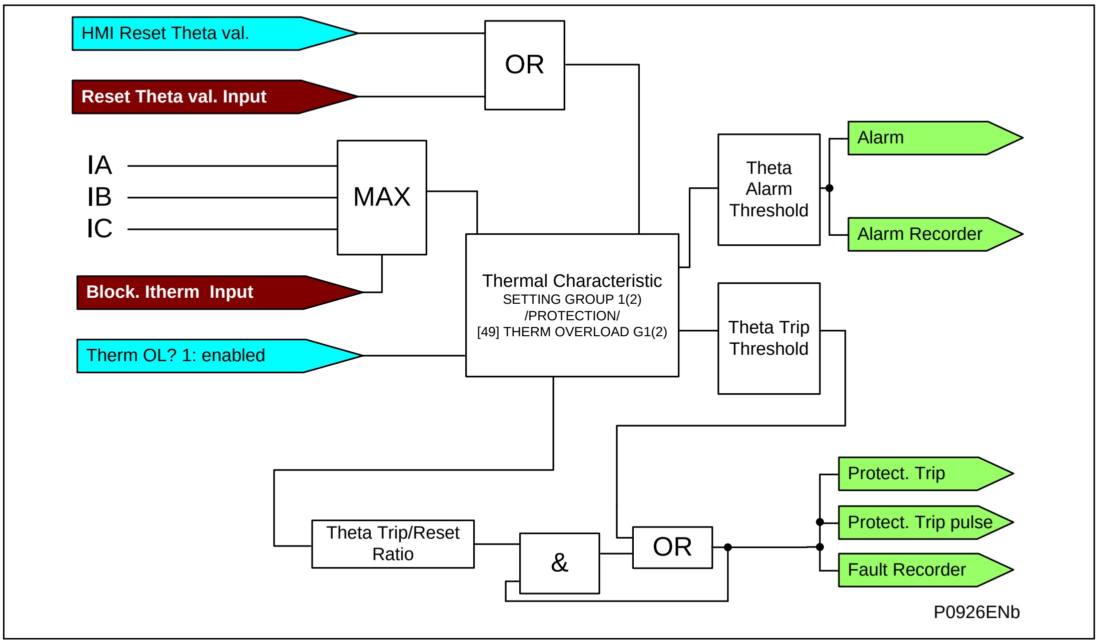


Figure 7: Thermal overload protection logic

The functional block diagram for the thermal overload protection is shown in Figure 7

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

The Thermal Trip signal remains high until the thermal state drops below the thermal reset threshold.

The thermal reset threshold is settable using the ***Theta Trip/Reset Ratio*** value.

The Thermal Reset Ratio is calculated:

Thermal Reset Threshold = ***Theta Trip/Reset Ratio*** x ***Theta Trip***

For ***Theta Trip/Reset Ratio*** = 90% (0.9) and ***Theta Trip***=120%:

Thermal Reset Threshold = 0.9 x 120%=108%

If the Thermal State is above the ***Theta Trip*** threshold and then drops, the Thermal Trip signal will reset when the Thermal State drops below the ***Thermal Reset Threshold*** (see above).

If ***Blocking Ithermal Input*** is in high state, for calculation Thermal Characteristic uses current value 0xIn instead of measured value.

Thermal protection also provides an indication of the thermal state in the ***MEASUREMENTS*** column of the relay. The thermal state can be reset by either an opto-input (if assigned to this function using the programmable scheme logic) or the relay menu.

The reset function in the menu is also found in the ***MEASUREMENTS*** column with the thermal state menu.

2.8 Circuit Breaker Failure Function (CB Fail)

The circuit breaker failure protection function incorporates one timer allowing configuration for the following scenario: upon any protection trip, ***CB Fail Timer tBF*** is started, and normally reset when the circuit breaker opens to isolate the fault. If breaker opening is not detected, ***CB Fail Timer tBF*** times out and closes an output contact assigned to ***tCBF***. This contact is used to backtrip upstream switchgear, generally tripping all infeeds connected to the same busbar section.

The complete breaker fail logic is illustrated in Figure 8.

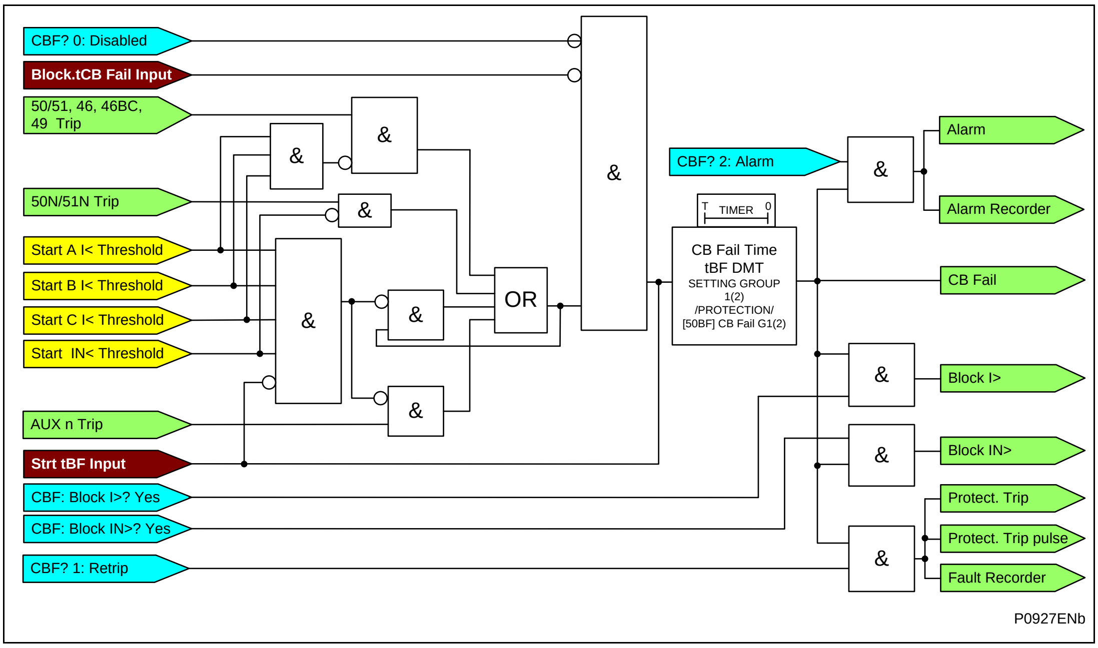


Figure 8: Circuit Breaker Failure protection logic

The CBF element ***CB Fail Timer tBF*** operates for trips triggered by protection elements within the relay or via an external protection device (binary input). The latter is achieved by assigning one of the relay opto-isolated inputs to ***AUX n*** set for tripping or ***Strt tBF*** (depends on the application).

When CBF is triggered by a current-based protection element included in the P116, it is reset by an undercurrent element (***I<Threshold CBF*** or ***IN< Threshold CBF***) only.

When it is triggered via the ***AUX n*** input, CBF is reset by an undercurrent element.

When it is triggered via the ***Strt tBF*** input, CBF is reset by the low state of this input only.

The ***Block I>?*** and ***Block IN>?*** settings are used to cancel starts issued by the overcurrent and earth fault elements, respectively, following a breaker fail time out. The start is cancelled when the cell is set to ***Yes.***

If the ***Retrip*** option is selected for the ***CB Fail*** function, it means that it is linked to the ***Protect.Trip*** and ***Prot.Trip pulse*** functions (see LED and Output configuration).

If ***CB Fail*** is set to ***Alarm***, any outputs and LEDs assigned to the ***Alarm*** or ***tCBF*** function are energized.

If ***CB Fail*** is not set to ***Disabled***, any outputs and LEDs assigned to the ***tCBF*** function are energized.

2.9 Auxiliary Timers (Model A)

Four auxiliary timers, tAux1, tAux2, tAux3 and tAux4, are available and associated with logic inputs Aux1, Aux2, Aux3 and Aux4 (refer to the ***SETTING GROUP x/INPUTS CONFIGURATION*** menu). When these inputs are energized, the associated timers start and, when the set time has elapsed, the associated LEDs (***SETTING GROUP 1(2)/LEDs CONFIGURATION*** menu) are lit or/and the associated output relays close (refer to the ***SETTING GROUP 1(2)/OUTPUT RELAYS CONFIGURATION*** menu). Time-delays can be independently set from 0 ms to 600 s.

Each auxiliary timer can be set independently to:

- ***Alarm:*** Alarm signal
- ***Trip***: Protection Trip signal
- ***Trip-Inrush Bl***: Protection Trip signal with inrush blocking
- ***Trip-Latch:*** Protection Trip signal latched until it is reset via a binary input (***Reset Ltch Sign***), the HMI or a remote reset command
- ***Load Shedding***: The high state of an AUX logic input starts the corresponding tAUX timer at the expiry of which it is associated with the ***Trip CB Order*** and ***tAUX*** outputs (refer to the ***SETTING GROUP 1(2)/OUTPUT RELAYS CONFIGURATION*** menu). Additionally this state (***Load Shedding state***) is stored in memory. The stored value is reset by any protection trip, a close signal or the CB closed status (**CB status 52A** logic input) (refer to chapter P116/EN AP – Application).
- ***AR after LS Hi:*** If the ***Load Shedding*** state is stored, *the high state of the logic input triggers the **tAUX*** timer. When the set value has elapsed the close command is executed ***(Close CB order*** output) (refer to chapter P116/EN AP – Application).
- **AR after LS Lo:** If the ***Load Shedding*** state is stored, *the low state of the logic input triggers the **tAUX*** timer. When the set value has elapsed the close command is executed ***(Close CB order*** output) (refer to chapter P116/EN AP – Application).

In the ***SETTING GROUP x/INPUTS CONFIGURATION*** menu ***AUX5*** and/or ***AUX6*** can be mapped to inputs. These input functions have no timers (instantaneous action). They can be used as bridges between inputs and LEDs or inputs and outputs. It is not possible to link this input function to a ***Trip*** or ***Alarm*** signal.

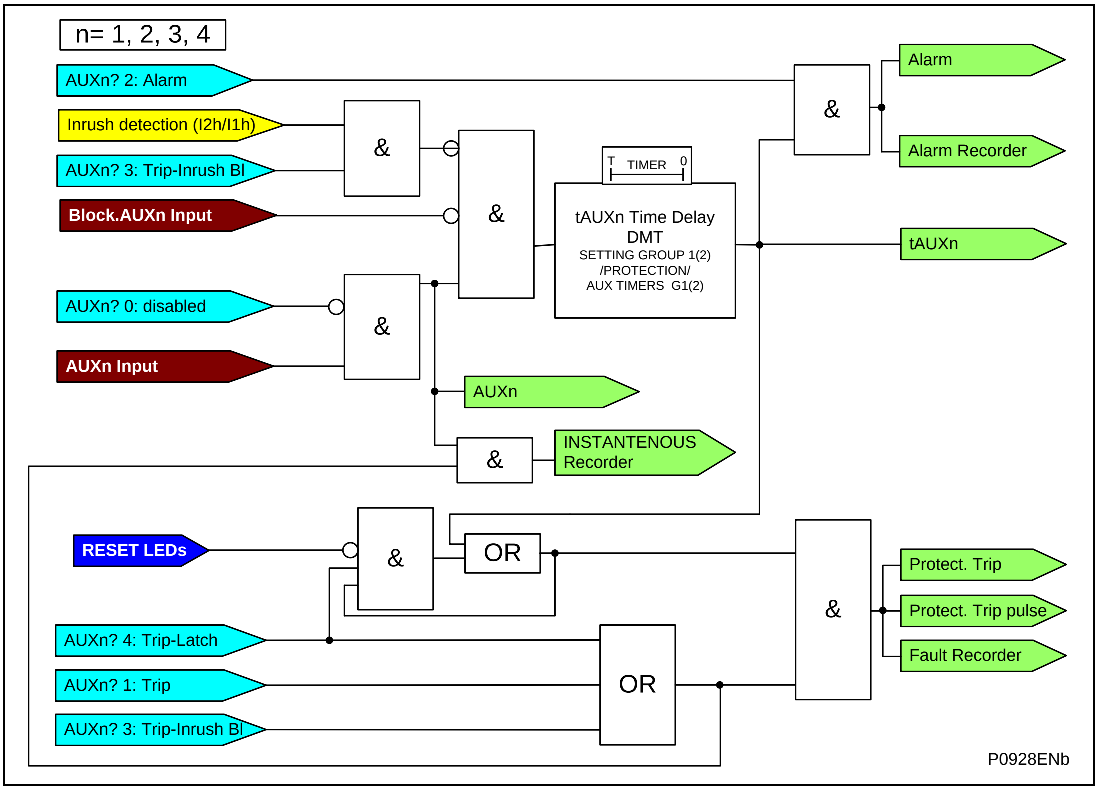


Figure 9: AUX Timer Logic (AUX1-AUX4) (for Alarm, Trip, Trip-Inrush BL, Trip-Latch options)

2.10 Logic Selectivity (Model A)

Section 2.10 describes the use of non-cascade protection schemes that make use of start contacts from downstream relays connected to block operation of upstream relays. In the case of ***Logic Selectivity*** (Sel), the start contacts are used to raise the time-delays of upstream relays, instead of blocking them. This provides an alternative approach to achieving non-cascade types of overcurrent scheme. This may be more familiar to some utilities than the blocked overcurrent arrangement. The ***Logic Selectivity*** function provides the ability to temporarily increase the time-delay settings of the second and third stages of phase overcurrent and measured earth fault protection elements.

Two independent Logic Selectivity functions are available: ***Sel1*** and/or ***Sel2***.

This logic is initiated by energization of the appropriate binary input assigned to Sel1 (Sel2)

To allow time for a start contact to initiate a change of setting, the time settings of the second and third stages should include a nominal delay.

This function acts upon the following protection functions:

- Phase overcurrent (2nd and/or 3rd stages)
- Earth fault (2nd and/or 3rd stages)

The logic diagram for the selective overcurrent function is shown for phase A of the third overcurrent stage. The principle of operation is identical for the 3-phase phase overcurrent element, stages 2 and 3, and the earth fault element, stages 2 and 3. When the selective logic function is enabled, the action of the blocking input is as follows:

1. No block applied
In the event of a fault condition that continuously asserts the start output, the function will assert a trip signal after the normal time-delay tI>>> has elapsed.

2. Logic input block applied
In the event of a fault condition that continuously asserts the start output, the function will assert a trip signal after the selective logic time-delay tSelx has elapsed.

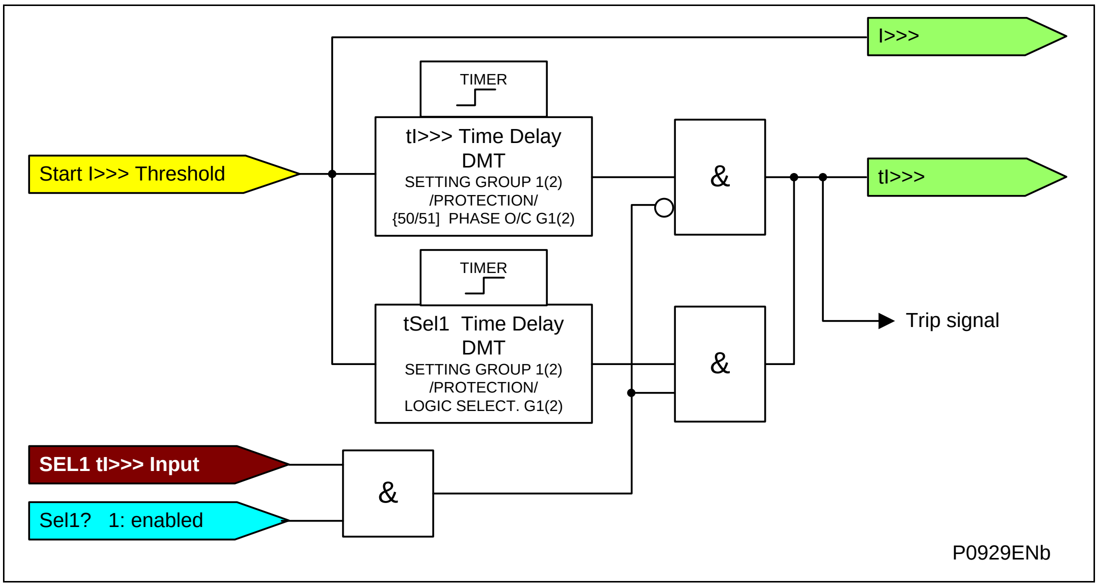


Figure 10: Selective Logic scheme for the I>>> protection element

2.11 Cold Load Pick Up (Model A)

The Cold Load Pick-up feature allows selected settings of MiCOM P116 relays to be changed to react to temporary overload conditions that may occur during cold starts. This condition may happen by switching on large heating loads after a sufficient cooling period, or loads that draw high initial starting currents.

When a feeder is energized, the current levels that flow for a period of time following energizing may differ greatly from the normal load levels. Consequently, overcurrent settings that have been applied to give short circuit protection may not be suitable during this period.

This function acts upon the following protection functions:

- Phase overcurrent (1st, 2nd and 3rd stages)
- Earth fault (1st, 2nd and 3rd stages)
- Broken Conductor I2/I1 element
- Thermal Overload I_{therm} setting
- Negative sequence overcurrent

OP

The Cold Load Pick-up (CLP) logic raises (x Level%) the settings of selected stages for a set duration (tCL). This allows the protection settings to be set closer to the load profile. Cold load pick-up cannot restart until the end of tCL duration. The CLP logic provides stability, without compromising protection performance during starting.

The CLP can be started by a digital logic Input Cold Load PU (***Cold Load PU? 1: Cur+Input*** or ***Cold Load PU? 2: Input***) which can be assigned to 52a CB status or by current stages logic (***Cold Load PU? 1: Cur+Input***). If the Cold Load PU logic has to be triggered by current criteria only, ***Cold Load PU Input*** function must not be configured to any digital input. If this function is configured to selected input, both criteria will work in parallel way. But the current criteria reset will be blocked if the ***Cold Load PU Input*** will be in the high state. So if ***Cold Load PU Input*** is in the high state (CB is closed) even if the current is below 10% In tCL timer will counts pulse time (P116 works on the Cold Load PU values).

Typically Cold Load PU Binary Input is wired to 52A CB status (***Cold Load PU? 2: Input***)

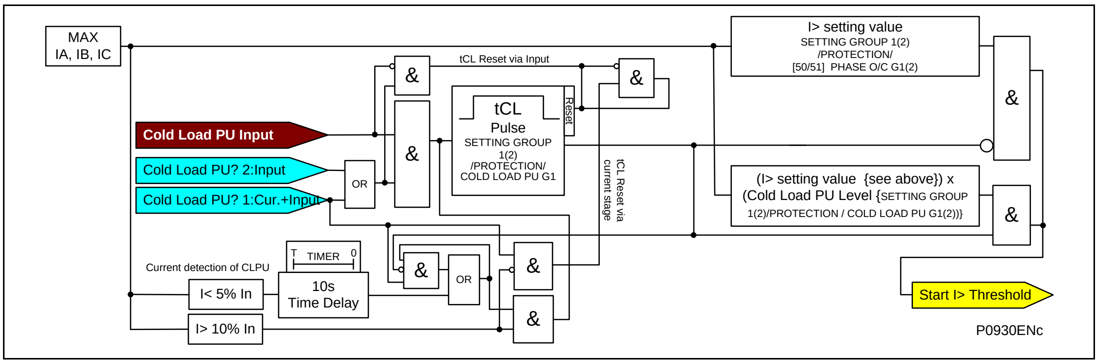


Figure 11: Cold Load Pick Up scheme for the I> protection element

2.12 Auto-reclose (Model A)

2.12.1 Auto-reclose Enabling

Note: If the auxiliary supply is lost during an auto-reclose cycle, the auto-reclose function is totally disabled.

The auto-reclose function is enabled in the ***SETTING GROUP x/PROTECTION Gx/[79] AUTORECLOSE Gx*** menu. The current state of the auto-reclose function is shown in the default Autoreclose cell of the menu:

[79]: Ready CTRL: no operation

The first line informs about the current state of the auto-reclose function. The following can be displayed:

- ***[79] Ready*** – The auto-reclose function is unblocked and ready to operate.
- ***[79] In progress*** – An auto-reclose cycle is in progress.
- ***[79] Tempor.Block***. – The auto-reclose function is temporary blocked after Closing of CB (from RS485, Front Panel or via configured Binary Input) during ***Inhibit Time tI on Close*** (***GLOBAL SETTINGS/[79] ADVANCED SETTINGS/Inhibit Time tI on Close***)
- ***[79]: Lockout*** – The auto-reclose function is internally blocked up to reset signalling (Input assigned to ***Reset Latched Signals***, ***C*** clear key on the front panel, ***Reset Latched Signals*** via RS485, closing of CB command via P116 or ***Unlockout*** command in CTRL line).
- ***[79] Block:CTRL***. – The auto-reclose function is blocked via the communication port or from P116 menu via the Auto-reclose default cell (CTRL line)
- ***[79] Block:Input*** – The auto-reclose function is blocked via a binary input assigned to this effect.
- ***[79] Disabled*** – The auto-reclose function is disabled in the ***SETTING GROUP x/PROTECTION Gx/[79] AUTORECLOSE Gx*** submenu

There are two menu columns in which the Auto-reclose function can be configured:

- ***SETTING GROUP x/PROTECTION Gx/[79] AUTORECLOSE G1(2)*** – separate settings for each setting group,
- ***GLOBAL SETTINGS/ [79] ADVANCED SETTING*** – common settings for all setting groups.

The Auto-reclose function of the MiCOM P116 is available only if the following conditions are verified:

- The auxiliary contact of the CB status, 52a or 52b, must be connected to the relay. Refer to the ***SETTING GROUP x/PROTECTION Gx/INPUT CONFIGURATION*** menu.
- The auto-recloser is ready for operation (not disabled nor blocked). The Autoreclose default cell should display: ***[79]: Ready***.
- The trip output relay must be set to ***Prot.Trip pulse*** (recommended if an output contact is used) or/and ***Protect Trip*** (if an energy trip output is used) and not latched in the protection element's settings (for example ***I>? Trip-Latch***). The trip output must not be latched either.
- The ***Close CB Order*** command must be assigned to the close CB output. The close contact output must not be latched.
- In the ***SETTING GROUP x/PROTECTION Gx/[79] AUTORECLOSE Gx*** menu all settings are properly configured.

In addition to ***[79] AUTORECLOSE Gx*** settings, the user will be able to fully link the auto-reclose function to the protection function using the menus:

- ***SETTING GROUPS x/PROTECTION Gx/[50/51] PHASE O/C G1***,
- ***SETTING GROUPS x/PROTECTION Gx/[50/51N] E/GND FAULT G1,***
- ***SETTING GROUPS x/PROTECTION Gx/AUX TIMERS Gx.***

2.12.2 Logic Inputs

The auto-reclose function has four inputs that can be assigned to the auto-reclose logic. These inputs can be mapped to opto-isolated inputs in the ***SETTING GROUP x/PROTECTION Gx/INPUT CONFIGURATION*** menu. External contacts can then be wired to these inputs and influence the auto-recloser scheme. These four logic inputs are:

- one external ***CB FLT Ext Sign***. – external information that CB is not ready to close (a spring not charged, too low level of CB gas, etc),
- ***AUX 1*** or ***AUX 2*** assigned to trip and [79] shots - the external starting commands,
- ***Block [79]*** – the external blocking command (for example: an external switch).

OP

The following table gives the "SETTING GROUP 1(2)/INPUT CONFIGURATION 1(2)" menu assigned to the auto-reclose logic input.

	***INPUT CONFIGURATION Gx* submenu:**	***AUTORECLOSE Gx submenu* enabled with:**	***[79] ADVANCED SETTING submenu* enabled with:**
External CB Fail	***CB FLT Ext.Sign.***		***CB FLT Monitor.? 1:Yes***
External starting commands	**AUX1** (Note: ***AUX1*** timer should be set to ***Trip***)	***Close Shot ? 4321*** ***tAUX 1111*** ('1' – means enabled)	
External starting commands	**AUX2** (Note: ***AUX2*** timer should be set to ***Trip***)	***Close Shot ? 4321*** ***tAUX2 1111*** ('1' – means enabled)	
External blocking command	***Block [79]***		***Block.via Input? 1: Yes***

2.12.2.1 External CB faulty signal

Most circuit breakers provide one trip-close-trip cycle. A time-delay is necessary for the CB to return to its nominal state (for example, the spring that allows the circuit breaker to close should be fully charged). The state of the CB can be checked using an input assigned to the ***CB FLT Ext.Sign.*** function. If the ***CB FLT Ext.Sign.*** signal is detected during Closing time, the Auto-reclose Close Command is interrupted and blocked and the CB remains open. In this case the Autorecloser will be Lockout by not successful close command monitored by ***Auto-reclose CB Supervision*** logic (it's separate function to ***CB Supervision*** in ***GLOBAL SETTINGS/CIRCUIT BREAKER*** column). If, on completion of the ***tCB FLT ext*** time (***GLOBAL SETTINGS/CIRCUIT BREAKER*** submenu), the **CB FLT ext** (Alarm) indicates a failed state of the CB, a lockout occurs and the CB remains open.

2.12.2.2 External Starting Commands

Two independent and programmable inputs (AUX1 and AUX2) can be used to initiate the auto-reclose function from an external device (such as an existing overcurrent relay). These logic inputs may be used both independently and in parallel with the overcurrent elements.

Note:

1. The input must be assigned to an AUXx function (***SETTING GROUPx/INPUT CONFIGURATION Gx***),
2. AUXx must be set to ***Trip*** (***SETTING GROUP x/PROTECTION Gx/AUX TIMERS Gx/AUXx?***) and time-delay tAUXx must be configured (instantaneous: ***tAUXx*** set to 0 s),
3. The ***tAUXx Close Shot*** cell must be set for every cycle (Close shot).

2.12.2.3 Internal and External Blocking Commands

The auto-recloser can be blocked by an internal or an external control. It can be used when protection is needed without requiring the use of the auto-reclose function.

The external block is executed by the ***Block [79]*** input, Blocking via RS485, [79] default cell in CTRL line, or temporary blocked after a close command made by an operator until ***Time Inhibit tI on Close*** set in ***GLOBAL SETTINGS/ [79] ADVANCED SETTINGS*** column.

The internal block can be executed by a final trip, a number of valid A/R rolling demands or an A/R conflict.

A typical example is on a transformer feeder, where the auto-recloser may be initiated from the feeder protection device but needs to be blocked on the transformer protection side.

2.12.3 Auto-reclose Output Information

The following output signals can be mapped to an LED (see ***SETTING GROUP x /LEDS CONFIGURATION Gx*** menu) or to output relays (see ***SETTING GROUP x/OUTPUT RELAYS CONFIGURATION Gx*** menu) in order to provide information about the status of the auto-reclose cycle:

- Auto-reclose cycle in progress
- Final Trip
- Internal block
- External block
- Auto-reclose successful

The following table gives the ***SETTING GROUP x /LEDS CONFIGURATION Gx*** and the ***SETTING GROUP x/OUTPUT RELAYS CONFIGURATION Gx*** menus used to assign the auto-reclose output signal.

	LEDs menu	Output relays menu
Auto-reclose in progress	***[79] in Progress***	***[79] in Progress***
Final Trip	***[79] Trip Final***	***[79] F.Trip Final***
Internal block	***[79] Lockout***	***[79] Lockout***
External block	***[79] Blocked***	***[79] Blocked***
Auto-reclose successful	***[79] Success.***	***[79] Success.***

2.12.3.1 Auto-reclose in Progress

The “Auto-reclose in progress” signal is present during the complete reclosing cycles from protection initiation to the end of the reclaim time or lockout.

OP

2.12.3.2 Final Trip

The "Final trip" signal indicates that a complete auto-reclose cycle has been performed and that the fault has not been cleared.

After appearance this signal is latched up to reset.

The "Final trip" signal can be reset after a manual closing of the CB after the settable ***Inhibit Time tI on Close*** (***GLOBAL SETTINGS/ [79] ADVANCED SETTING***) time-delay or reset via a Reset Command (input assigned to ***Reset Latchd Sign*** function, RS485 Reset Latched LED/Signalling command , C clear key).

If this successful auto-reclose signal was not reset before the next Autoreclose, [79] in Progress will reset this signal, when Autoreclose is started again.

2.12.4 Auto-reclose Logic Description

The auto-reclose function makes it possible to automatically control the the CB's reclosing cycles (two, three or four shot cycle, settable using the ***Close Shot ?*** parameter – separate for each protection element (***SETTING GROUP x/PROTECTION Gx/[79] AUTORECLOSE G1(2)*** menu).

Dead times for all the shots (reclose attempts) can be independently adjusted.

The number of shots is directly related to the types of fault likely to occur on the system and the voltage level of the system (for instance medium voltage networks).

The Dead Time (tD1, tD2, tD3 and tD4) and the minimum drop-off time start when the CB has tripped (when the 52a input has dropped off – ***Start Dead t on 1: CB trips*** or the protection element has reset - ***Start Dead t on 0: Protect.Reset*** configuration option). The Dead Time is set to initiate the auto-recloser when the circuit breaker is opened.

At the end of the relevant dead time the close command (***Close CB Order***) is executed and the CB supervision timer is started. The length of this timer is equal to: ***tClose Pulse*** (***GLOBAL SETTINGS/CIRCUIT BREAKER***) + 150 ms (***Auto-reclose CB Supervision*** logic). If the CB is not closed after this time-delay, the auto-recloser is locked out (***[79] Lockout***) and the Alarm is issued (***Alarm CB Time Monitor***).

The reclaim time (***Reclaim Time tR***) starts when the CB has closed. If the circuit breaker does not trip again, the auto-reclose function resets at the end of the reclaim time.

If a protection element operates during the reclaim time, the relay either advances to the next shot programmed in the auto-reclose cycle, or it locks out (see ***Inhib.Trip*** function description).

The total number of reclosures is displayed in the ***RECORDS /COUNTERS/ AUTORECLOSE COUNTER*** menu cell.

2.12.5 Auto-reclose Inhibit Trip

Freely settable the inhibit of the trip after closing command issued via the [79], set separately for each protection element:

tI>, tI>>, tI>>>, tIN_1, tIN_2, tIN_3, tAUX1, tAUX2

The trip inhibit is used for following cases:

- e/f protection in neutral-insulated or compensated systems. The [79] can clear a non-permanent fault in the first cycles. If it will be permanent fault, there will be no the final trip up to reset of the protection trip. For 4-cycle [79]: ***Inhibit Trip 1000*** setting. In the first three cycles (***000***) the trip is executed to allow fault clearance, but the last one (1) is with inhibition, so no trip is executed in case of permanent fault).
- application where for example the setting for the I> stage covers more than the protected zone, so that the [79] can clear faults downstream too, but the final trip will be executed by the downstream relay or a fuse, therefore in the upstream relay, tI> should be inhibited – waiting for tI>> trip of the downstream

relay).
Note: for this case ***Fast Trip O/C*** function can be used too (see below).

Inhibit Trip setting:

- ***0***: means that after close via the [79], the protection element trip will be not inhibited (function is disabled).
- ***1***: means that after close via the [79], the protection element trip will be inhibited.

It is recommended to set another protection stage with setting for Alarm only, to inform that this fault was not cleared by autorecloser so it's still present (tripping from this protection element is inhibited). For above case when the auto-reclose is successful, the reset of inhibition is applied after reset of protection stage (current below the stage value). For another case when during inhibition of protection element, another protection element (set to run [79]) makes a trip after going to the next cycle (the next [79] close command is executed) the inhibition is reset and the further action depends on the configuration:

if in the next cycle this protection element is still set with inhibition, the protection element is still inhibited

if in the next cycle this protection element is not set with inhibition, but the fault is still not cleared, this protection element will trip CB (If another protection element moves auto-reclose to the next cycle, the inhibition is removed automatically and [79] logic checks configuration for the next [79] shot).

2.12.6 Auto-reclose Fast Trip

On circuits using time-graded protection, the auto-recloser allows the use of instantaneous (fast) protection (***Fast O/C Trip*** function in ***SETTING GROUP x/PROTECTION Gx/[79] AUTORECLOSE Gx*** menu) to issue a high speed first trip. With fast tripping, the duration of the power arc resulting from an overhead line fault is reduced to a minimum, thus lessening the chance of damage and of the transient fault developing into a permanent fault. To avoid maloperation because of transients, it is possible to assign a short time-delay to the fast trip: ***Fast O/C Trip Delay*** setting (***SETTING GROUP x/PROTECTION Gx/[79] AUTORECLOSE Gx*** menu column) above the typical transient time value. The fast trip can be associated with phase-to-phase faults (***Fast O/C Trip***) and/or earth faults (***Fast E/Gnd Trip***), separately for every shot in the auto-reclose sequence. If in ***Fast O/C Trip*** configuration the setting for chosen trip shot is ' ***0*** ', the trip is executed after the time-delay of the protection element. If it is set to ' ***1*** ', the time-delay set in the ***Fast O/C Trip Delay*** menu cell is applied. In some regions the typical setting of the fast trip for a 2-shot AR is set:

- ***Fast O/C Trip*** (trip shots): ***00011*** (The first and second trips with ***Fast O/C Trip Delay*** to reduce to minimum the resulting power arc; The third – final – trip after the time-delay of the protection element to ensure the grading in the power system – trip selectivity)
- ***Fast E/GND Trip*** (trip shots): 00000 (alls trips re executed after the time-delays of the protection elements).

Fast O/C Trip – refers to all O/C stages in the PHASE O/C menu column: I>, I>>, I>>>.

Fast E/GND Trip – refers to all E/GND stages in the ***PHASE E/GND*** menu column: ***IN_1***, ***IN_2***, ***IN_3***.

Fast O/C (E/GND) Trip Delay is associated with a DMT characteristic even if the protection element is set to an IDMT characteristic. For the fast trip the reset time-delay of the protection element is not applied.

2.12.7 Auto-reclose Inhibit after Manual Closing

The ***Inhibit Time tI on Close*** timer (***GLOBAL SETTINGS/ [79] ADVANCED SETTING)*** can be used to block the auto-reclose cycle being initiated after the CB has been manually closed onto a fault. The auto-recloser is blocked for the duration of ***Inhibit Time tI on Close*** after a manual CB Closure.

2.12.8 Recloser Lockout

If a protection element operates during the reclaim time, following the final reclose attempt, the relay will lockout and the auto-reclose function will be disabled until the lockout condition is reset.

The lockout condition is reset by a manual closing after the ***Inhibit Time tI on Close*** timer elapses.

Additionally the lockout condition is reset by a reset signalling command (via input assigned to ***Reset Latchd Sign*** function, HMI Ⓒ key, Remote LED/Signalling Reset command).

The auto-recloser can also be locked out using a ***CB FLT Ext.Sign.*** input. This information can be issued from the "not charged" or "Low gas pressure" indications of CB springs.

Note that the auto-recloser can also be locked out by:

- The fact that the CB does not open after the tBF delay (CB Fail) elapses,
- An operating time longer than the set thresholds,
- Local or remote manual Close or Open command when the auto-reclose is in progress,
- The Rolling Demand function detects too many auto-reclose shots.
- CB monitoring logic detects abnormal CB position (opened and closed, or not opened and not closed) for longer than set: ***Max CB Close*** or ***Max CB Open*** time.

OP

In the lockout condition the ALARM with the cause: ***ALARM [79] Lockout*** is displayed up to reset of the lockout condition.

2.12.9 Setting Group Change when the auto-reclose is in progress

During the auto-reclose cycle, if the relay receives a command to switch setting groups, it is executed after the end of auto-reclose action (if auto-reclose is not in progress).

2.12.10 Rolling Demand

This specific counter avoids frequent operations of a CB in case of intermittent faults. The numbers of shots can be set from 2 to 100 in the cell ***Max cycles No. Rol.Demand***, settable over a time period (***GLOBAL SETTINGS/ [79] ADVANCED SETTING /Time period Rol.Demand***) from 1 min to 24 hours.

The rolling demand is used when a defined number of successful recloses are performed over a defined time. If it is happened auto-reclose function is Lockout and he ALARM with the cause: ***ALARM [79] Roll.Demand*** is displayed up to reset the lockout condition.

If after ***Alarm [79] Rolling Demand*** signaling, the lockout condition reset is applied, the recorded number of rolling demand shots are cleared.

2.12.11 Signalling Reset after Close via 79

In the ***GLOBAL SETTINGS/ [79] ADVANCED SETTING*** menu it is possible to set the signalling reset after a close command executed by the auto-recloser. If ***Signalling Reset*** is set to **1: Close via 79**, after the auto-recloser's close shot (confirmed by the 52a CB status), signalling (LEDs, display) of the last trip before the close shot is reset:

- Latched LEDs
- Trip information on the P116's front panel
- Electromagnetic Flag Indicators on the Front Panel
- Latched outputs

This function signals the final trip only and clears signalling if the CB remains closed (Auto-reclose is successful). This function is recommended if the P116 is integrated into a SCADA system or if the substation is rarely supervised by maintenance personnel. In this case it is not necessary to clear signalling if the fault has disappeared and the line is healthy.

Note: Reset of signalling and of latched outputs can be done using the General resetting function.

This configuration can be set in the ***GLOBAL SETTINGS/LOC*** submenu:

- LEDs Reset:
  - ***0: Manual only*** (via Inputs, HMI Ⓒ key, Remote Reset command)
  - ***1: Start protect.*** (Start of the protection element set to Trip)
- Ltchd Outp. Reset:
  - ***0: Manual only*** (via Inputs, HMI Ⓒ key, Remote Reset command)
  - ***1: Start protect.*** (Start of the protection element set to Trip)

The ***Manual only*** option prevents a close command from being issued without readout of the cause of trip by maintenance personnel. It reduces the risk to switch on to fault.

The ***Start protect*** option allows signalling of the latest trip only.

OP

2.13 External Trip via a Binary Input

For some applications it is necessary to issue a CB trip via a binary input. Any input assigned to AUXn (n = 1-4) can be used to that effect. The **AUX** function must be set to ***Trip***.

Tripping is executed after a set time-delay: tAUXn (n = 1-4).

Auxiliary voltage connected to such a configured Input energizes output relays assigned to ***Protect.Trip***, ***Prot.Trip pulse*** or ***tAUX*** AUXn (n = 1-4).

The Low Energy Trip Coil output and/or Flag Indicator output are activated if they are assigned to ***Protect.Trip*** or ***tAUX*** AUXn (n = 1-4) (refer to **Figure 9 - AUX timers logic)**

2.14 Blocking Logic Function and Blocked Overcurrent Scheme Logic

Each stage of the phase protection element can be blocked via an appropriately configured binary input. Binary inputs can be assigned to the following functions (***SETTING GROUPx/INPUT CONFIGURATION Gx***):

- Block.tI>
- Block.tI>>
- Block.tI>>>
- Block.tSOTF
- Block.tIN_1
- Block.tIN_2
- Block.tIN_3
- Block.tI<
- Block.tI2>
- Block.tBrkn Cond
- Block.Itherm
- Block.AUX1
- Block.AUX2
- Block.AUX3
- Block.tCB Fail
- Block. [79]

Such a configured input can be used by the blocking logic function or by a protection element disabling function (Auto-reclose, CB Fail or AUX).

The blocking logic function can be applied to radial feeder circuits where there is little or no back feed. For parallel feeders, ring circuits or where there can be a back feed from generators, directional relays should be considered.

The blocking logic function allows the upstream IDMT relay to be blocked by the start output of a downstream relay that has detected the presence of a fault current above its threshold. Thus both upstream and downstream relays can have the same current and time settings, and the blocking feature will automatically provide grading.

If in ***SETTING GROUPS x/PROTECTION Gx/[[50BF] CB Fail*** the function: ***Block I> (IN>)?*** is set to ***0: Yes*** and the Circuit Breaker Fail protection is enabled, the blocking command on the upstream relay will be removed if the downstream circuit breaker fails to trip.

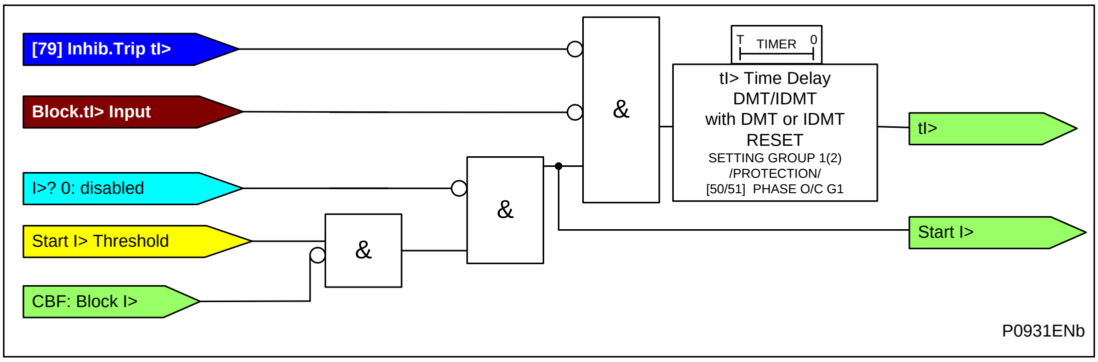


Figure 12: Blocking logic function diagram for the I> protection element

2.15 Inrush Blocking

The Inrush Blocking function measures the ratio of second to fundamental harmonic currents. It can be used as a “blocking logic” of I>, I>>, I>>>, IN_1, IN_2, IN_3, I2 >,SOTF, I<, Broken Cond, CB Fail, and AUXn in cases where the 2nd harmonic ratio is higher than the settable threshold. Indeed, inrush blocking functions will reset the selected protection function starts.

Blocked by the second harmonic ratio of a protection element is set in the main setting cell for that element (for example***: I>? 3: Trip-Inrush Bl***). Each protection element set to ***3: Trip-Inrush Bl*** will be blocked by the Inrush current function.

The minimum duration of an overcurrent threshold inhibition (tReset) can be also set. This value depends on the transformer power transient inrush duration: between 0.1 second (for a 100 kVA transformer) to 1.0 second (for a large unit). It is used to avoid any maloperation during a fixed time period in case of too sensitive a setting.

2.15.1 Operation

For each of the three phases currents (IA, IB, IC), the harmonic restraint function compares the ratio of 2nd harmonic to the fundamental with the set ratio (Harmonic 2 / Fundamental settable from 10 % up to 50 % in steps of 1%).

The minimum fundamental current value required for operation of the Inrush Blocking function is 0.2 In, and there is no upper limit to disable this feature. However, in transformer protection, the high set overcurrent stage shall not be controlled by this Inrush Blocking feature; this enables detection of all high current faults without inrush blocking.

It is possible to set two options for Inrush Current logic in the ***GLOBAL SETTINGS/INRUSH BLOCKING/Inrush Blocking?*** menu:

- ***1: Yes*** – monitoring is permanent. The Inrush Blocking function will block the selected protection stages every time inrush conditions are present on the line (Ratio of 2nd Harmonics measured greater than Inrush H2 set ratio), and will be active at least for the duration of ***Inrush Reset Time***. This timer defines the minimum duration of overcurrent threshold inhibition (0-200 s, settable). This timer starts as soon as operating inrush current threshold picks up:
    - If the inrush condition lasts less than the set value for ***Inrush Reset Time***, the selected overcurrent function will be inhibited for the duration of ***Inrush Reset Time***.
    - If the inrush condition lasts longer than the set value for ***Inrush Reset Time***, the selected overcurrent function will remain inhibited as long as the inrush condition is present.
- ***2: Closing*** (Model A) – monitoring is based on the ***Close CB order*** output. The Inrush Blocking function will block the selected protection stages every time a close command is executed and the Ratio of measured 2nd Harmonics is greater than the set Inrush h2 ratio, and will be active at least for the duration of ***Unblock Inrush Time***.

    Note: Inrush Blocking in P116 relays is not phase-selective. If an inrush condition occurs on any phase, the selected protection stages will be blocked in all 3 phases.

OP

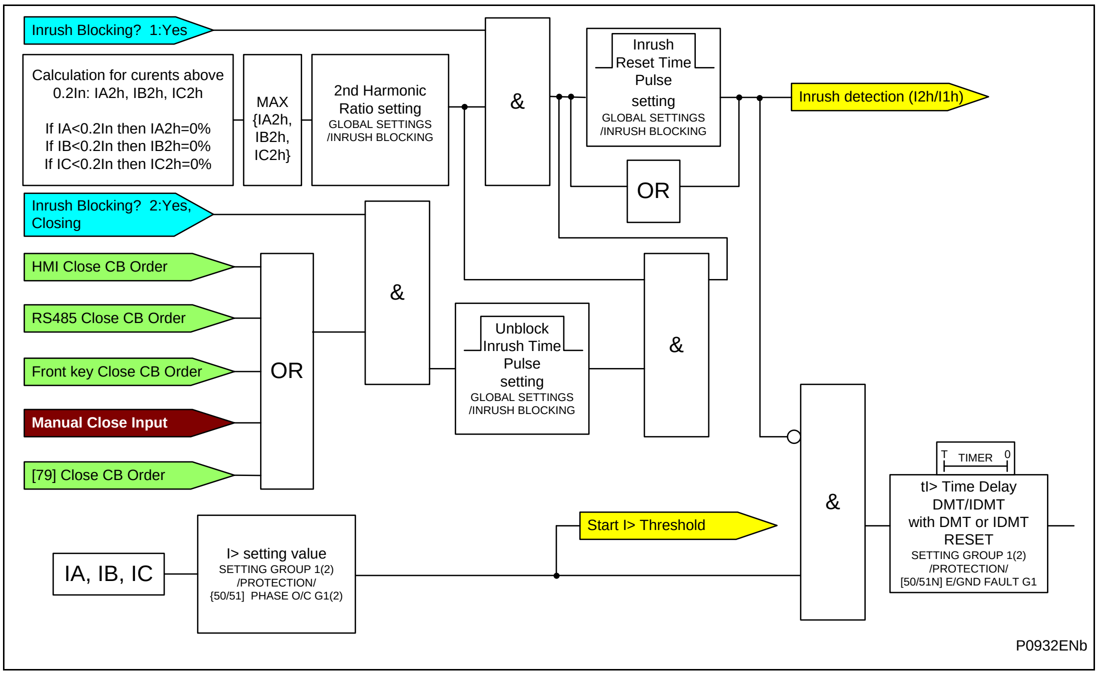


Figure 13: Second harmonic blocking diagram for the I> protection element

OP

3. OPERATION OF NON PROTECTION FUNCTIONS

3.1 Circuit Breaker State Monitoring (Model A)

An operator at a remote location requires a reliable indication of the state of the switchgear. Without an indication that each circuit breaker is either open or closed, the operator has insufficient information to decide on switching operations. The MiCOM P116 relays incorporate circuit breaker state monitoring, giving an indication of the position of the circuit breaker.

This indication is available either on the relay front panel or via the communication network.

The CB positions can be selected at ***SETTING GROUPx/INPUT CONFIGURATION Gx***):

- CB status 52A
- CB status 52B

If two inputs are assigned to both the above inputs, CB status is based on both indications.

If only one function is used, CB status is based on a single-bit information only (the second is derived from the first one).

If CB Supervision function is activated (***GLOBAL SETTINGS/CIRCUIT BREAKER/CB Supervision?: 1:Yes***), CB monitoring logic detects abnormal CB's position (opened and closed, or not opened and not closed) in the monitoring window: the max value from settings: ***Max CB Close Time*** or ***Max CB Open Time*** (***GLOBAL SETTINGS/CIRCUIT BREAKER*** column). CB monitoring logic checks CB position permanently, if an abnormal CB status is detected by the time longer than the monitoring window, the Alarm is issued (***Alarm State of CB***).

The CB's status can be displayed on the P116 front panel using programmable LEDs. To assign an input to the CB status, an AUX function must be used.

For example:

L1 is assigned to CB status 52a and AUX5

L2 is assigned to CB status 52b and AUX6

LED 7 is assigned to AUX5

LED 8 is assigned to AUX6

In the above configuration LED7 indicates the CB closed position and LED8 indicates the CB open position.

If the Control menu cell is selected as the default display, the CB status is indicated on the LCD display:

```
 CB status:Opened
CTRL: no operat.
```

3.2 Circuit Breaker Condition Monitoring (Model A)

Periodic maintenance of circuit breakers is generally based on a fixed time interval, or a fixed number of fault current interruptions.

The relays record the following controls and statistics related to each circuit breaker trip or close operation:

- monitoring time for CB opening (triggered by the ***Trip CB order*** and ***Protect.Trip*** outputs). Operations based on the setting:

    - time-delay setting for tripping (***GLOBAL SETTINGS/CIRCUIT BREAKER/Max CB Open Time***)

    If CB opening time is longer than ***Max CB Open Time*** the Alarm is issued (***Alarm CB Time Monit.***). This function can be activated in the menu: ***GLOBAL SETTINGS/CIRCUIT BREAKER/ CB Supervision? 1: Yes***,

- monitoring time for CB closing (triggered by the ***Close CB order*** output). Operations based on the setting:

    - time-delay setting for closing (***GLOBAL SETTINGS/CIRCUIT BREAKER/Max CB Close Time***)

    If CB closing time is longer than ***Max CB Close Time*** the Alarm is issued (***Alarm CB Time Monit.***). This function can be activated in the menu: ***GLOBAL SETTINGS/CIRCUIT BREAKER/ CB Supervision: 1: Yes***,

- CB open operations counter (triggered by ***Trip CB order:*** HMI, Manual Trip Logic Input, HMI '***Trip***' key, rear communication trip command, USB port trip command)

    - Number of open operations (***RECORDS/COUNTERS/CONTROLCOUNTER/Open No.***)

- CB close operations counter (triggered by ***Close CB order***: HMI, Manual Close Logic Input, HMI 'Close' key, rear communication close command, USB port close command)

    - Number of close operations (***RECORDS/COUNTERS/CONTROL COUNTER/Close No.***)

- protection CB open operations counter (triggered by ***Protect.Trip*** output)

    - Number of CB open operations (***RECORDS/COUNTERS/FAULT COUNTER/Fault Trips No.***)

- CB open operations counter monitoring (triggered by the ***Trip CB order*** and ***Protect.Trip*** output function)

    - setting threshold (***GLOBAL SETTINGS/CIRCUIT BREAKER/MAX CB Open No.***)

    - current value (***RECORDS/COUNTERS/CB MONITORING COUNTER/ CB Open Mon.No.***). This value is editable, so it is possible to change this value or set the value when the relay was replaced by another one,

    This function can be activated in menu: ***GLOBAL SETTINGS/CIRCUIT BREAKER/ CB Diagnostic? 1: Yes***,

- summation of the current interrupted by the CB (triggered by the ***Protect.Trip*** output function):

    - setting threshold (***GLOBAL SETTINGS/CIRCUIT BREAKER/MAX SUM AMPS^n)***

    - current value (***RECORDS/COUNTERS/CB monitoring/CB AMPS Value***). This value is editable, so it is possible to change this value or set the value when the relay was replaced by another one,

    - exponent for the summation (***GLOBAL SETTINGS/CIRCUIT BREAKER/AMPS's n=***), This function can be activated in menu: ***GLOBAL SETTINGS/CIRCUIT BREAKER/ CB Diagnostic: 1: Yes***.

Note: summation of the current interrupted by CB is phase selective, but the max value from three phases is displayed in menu only. If the new value is entered, it is applied for all phases.

CB Alarm output function and ***CB Alarm*** LEDs function signal is generated if ***CB Supervision*** or ***CB Diagnostic*** function detects any problem.

Additionally ***CB Diagnostic*** function triggers TCS 52 Fail output function.

Cause of Alarm	Alarm function	Key setting	Alarm Label	Output	LED
The monitoring time for CB opening	***CB Supervision***	***Max CB Open Time***	***CB Time Monit.***	***CB Alarm***	***CB Alarm***
The monitoring time for CB closing	***CB Supervision***	***Max CB Close Time***	***CB Time Monit.***	***CB Alarm***	***CB Alarm***
The abnormal CB's position for two bits CB's connection (00 or 11)	***CB Supervision***	***Max value:*** ***Max CB Close Time*** ***or*** ***Max CB Open Time***	***State of CB***	***CB Alarm***	***CB Alarm***
CB open operations counter monitoring	***CB Diagnostic***	***MAX CB Open No.***	***CB Nb Diagn.***	***CB Alarm***, ***TCS 52 Fail***	***CB Alarm***
Summation of the current interrupted by the CB	***CB Diagnostic***	***Max Sum AMPS^n***	***CB Curr, Diagn.***	***CB Alarm***, ***TCS 52 Fail***	***CB Alarm***

For the proper collaboration with CB coils, in menu it is possible to set:

- trip pulse time (***GLOBAL SETTINGS/CIRCUIT BREAKER/tOpen pulse***)
- close pulse time (***GLOBAL SETTINGS/CIRCUIT BREAKER/tClose pulse***)

The trip pulse time is used by: ***Protect.Trip pulse*** and ***Trip CB Order*** output functions.

The close pulse time is used by: ***Close CB Order*** output functions.

In cases where the breaker is tripped by an external protection device it is also possible to update the CB condition monitoring. This is achieved by setting one of the ***AUX*** protection element (***Protect.Trip)*** or ***Manual Trip*** logic inputs or via the communications to accept a trigger from an external device.

OP

OP

3.3 Local / Remote Mode (Model A)

The goal of this feature is to make it possible to block commands sent remotely through communication networks (such as setting parameters, control commands, etc.), so as to prevent any accidents or maloperations during maintenance work performed on site.

P116 can be in two modes: “Remote” or “Local”.

Meaning of “Local” mode is clear. The control is possible locally only. Remote commands (via RS485/USB) are rejected by P116 (except remote commands: ***CTRL: Remote*** or ***CTRL: Local, Comms.Order*** commands).

The meaning of “Remote” mode can differ depends on the custom of users or application.

There are two possible definition:

- “*Remote*” mode means that remote or local control are possible
- “*Remote*” mode means that remote control is possible only (local control is rejected by P116)

Customization of “Remote” mode definition is applied by selection of proper setting at ***GLOBAL SETTINGS/CIRCUIT BREAKER/Remote CTRL Mode:***

- ***0: Remote only*** – the first “*Remote*” definition - in “*Remote*” mode, remote control is permitted only. All manual controls (HMI, Close/Trip function keys, Binary Inputs assigned to Manual Close or Trip) are blocked.
- ***1: Remote + LOC -*** the second “*Remote*” definition - remote and local controls are permitted.

“*Local*” mode can be achieved by:

- Control Mode default cell in the menu:

LR Status:L+R
CRL: no operat.

- A digital input labeled: ***Local CTRL Mode***

When the ***Local CTRL Mode*** input is energized, all remote commands are blocked (RS485/USB command: ***CTRL: Remote*** is blocked too). When the ***Local CTRL Mode*** input is de-energized, remote control commands can be issued. In Local mode, only the synchronizing time signal is allowed.

The first line of “Local/Remote” cell allows monitoring of the Local/Remote Mode status:

- ***LR Status: Local*** - Local mode
- ***LR Status: Remote*** – Remote Mode. This description will appear if in ***GLOBAL SETTINGS/CIRCUIT BREAKER/Remote CTRL Mode*** is set to ***0: Remote only***.
- ***Status: L+R*** – both : local and remote control are possible. This description will appear if ***GLOBAL SETTINGS/CIRCUIT BREAKER/Remote CTRL Mode*** is set to ***1: Remote + LOC***.

The second line is used to change Local/Remote Mode in the menu:

- ***CTRL: no operat***. – No operation
- ***CTRL: Local*** – Local Mode command
- ***CTRL: Remote*** – Remote Mode command

To change from ***Remote*** to ***Local*** mode it is necessary to press the OK key, enter Control Password (if it is set), press the OK key twice (confirm password and select changing). Press down or up key to choose ***Local*** confirm by Enter. LR Status indicates: LR Status: Local.

To change from ***Local*** to ***Remote*** mode it is necessary to press the OK key, enter Control Password (if it is set), press the OK key twice (confirm the password and select the change).

Press the ⊽ or ⊼ key to select ***Remote*** then confirm by pressing the **OK** key. LR Status indicates: ***LR Status L+R*** (option ***Remote CTRL Mode 1: Remote + Local***) or ***LR Status Remote*** (option ***Remote CTRL Mode 0: Remote***) .

Note: if the Control Password is set to zero: no asking about password will appear – the Control Password is disabled.

It is possible to map the Local Mode state to an output contact by assigning the output contact to the ***Local CTRL Mode*** output (***SETTING GROUP x/OUTPUT RELAYS CONFIGURATION Gx***.

It is possible to map the Local Mode state to a LED by assigning the LED to the ***Local CTRL Mode*** function (***SETTING GROUP x/LEDs CONFIGURATION Gx***).

Note: If in Local Mode is remote trip is desired, For remote trip ***Comm.Order*** command can be used (refer to output configuration).

3.4 Setting Group Selection (Model A)

MiCOM P116 relays have two protection setting groups called ***PROTECTION G1*** and ***PROTECTION G2***. Only one group is active at any time.

If a group is used in an application it is possible to remove the other group from the menu in order to simplify the setting procedure. If one group only is chosen the relay uses Group 1 even if the other parameters are set to Group 2 (Inputs, Menu, Remote Group Setting).

The selection of the number of groups is done at ***GLOBAL SETTINGS/SETTING GROUP SELECT/ Number of Groups: 1: One Group*** or ***2: Two Groups.***

If ***1: One Group*** is selected, the ***SETTING GROUP 2*** column and the setting group cell are hidden in the menu.

Switching between groups can be done via:

- a selected binary input assigned to the **Setting Group 2** logic input (***SETTING GROUP x/INPUTS CONFIGURATION Gx*** submenu),
- the relay front panel interface (***GLOBAL SETTINGS/SETTING GROUP SELECT/ Setting Group: 1: Group1*** or ***2: Group2***),
- through the communications port (refer to the Mapping Database for detailed information).

Switching between setting groups can be done even while a protection function is active, but it resets all timers, LEDs or flag's on P116 front panel).

The user can check which one of the setting groups is active in the ***OP PARAMETERS*** menu: ***Active Set Group*** cell.

The user can also assign the active group (***Setting Group x*** function) to an output relay (***SETTING GROUP x/OUTPUT RELAYS CONFIGURATION Gx***) or to an LED (***SETTING GROUP x/LEDs CONFIGURATION G1***).

Setting group change via a digital input

It is possible to change the setting group by energizing a digital input (operates on level: logic input is low – setting group 1, logic input is high – setting group 2).

If the setting group switchover is done via a binary input, the change from Group 1 to Group 2 is executed after the set time-delay: ***t Change Setting G1->G2*** (***GLOBAL SETTINGS/SETTING GROUP SELECT***). The switch from Group 2 back to Group 1 is instantaneous.

Warning: If the digital input that has been assigned to the setting group change operates on level (low or high), it is not possible to change the setting group via remote communications.

Switch between Active Groups via a Binary Input

When powering up the relay, the selected group (Group 1 or Group 2) corresponds to the state of the logic input assigned to ***Setting Group 2***. This means:

A – ***Reverse Inp.Logic*** = 0 and ***Setting Group 2*** = 1
(***SETTING GROUP x/INPUTS CONFIGURATION Gx*** submenu),

If the programmed logic input starts being supplied with +V, then after the ***t Change Setting G1->G2*** time-delay the active group will be G2.
If the programmed logic input is not supplied with +V , then the active group will be G1.

B – ***Reverse Inp.Logic*** = 1 and ***Setting Group 2*** = 1
(***SETTING GROUP x/INPUTS CONFIGURATION Gx*** submenu),

If the programmed logic input is supplied with +V, then the active group will be G1.
If the programmed logic input stops being supplied with +V , then after the ***t Change Setting G1->G2*** time-delay the active group will be G2.

Notes:

1. Binary Input configuration is associated with both Setting Groups, so that if in a Setting Group the selected binary input is assigned to ***Setting Group 2***, in the other group it must be set to ***Setting Group 2*** as well, otherwise no switch will occur.
2. If the P116 is powering up (from the currents or the auxiliary voltage) and Group 2 is selected via a binary input, the ***t Change Setting G1->G2*** time-delay is ignored (changing to setting group 2 is instantaneous – without time-delay).
3. The setting group switch is based on the level of the binary input. So as long as Setting Group 2's logic signal is high, the P116 uses Setting Group 2.
4. After changing the setting group all latched LEDs and output contacts are reset.

Switch between Active Groups via the Menu or a Remote Command (RS485, USB)

By using the relay front panel interface it is possible to change the active setting group: ***1: Group1*** or ***2: Group2*** (menu cell: ***GLOBAL SETTINGS/SETTING GROUP SELECT/ Setting Group***).

This menu cell is commonly used for switching groups from the front panel interface and via a remote command (RS485 or USB).

It means that if the ***GLOBAL SETTINGS/SETTING GROUP SELECT/ Setting Group*** menu cell is set to ***1: Group1*** and the remote setting group 2 command is executed, the value of menu cell: ***GLOBAL SETTINGS/SETTING GROUP SELECT/ Setting Group*** will be changed to ***2: Group2*** (Active group: 2).

Setting group 1 will be applied if:

- ***1: Group1*** is set in the ***GLOBAL SETTINGS/SETTING GROUP SELECT/ Setting Group*** menu cell from the relay's front panel interface,
- the remote setting group 1 command is executed. The value of the ***GLOBAL SETTINGS/SETTING GROUP SELECT/ Setting Group*** menu cell will then be changed to ***1: Group1***.

Priority

Warning: If the digital input that has been assigned to the setting group change operates on level (low or high), it is not possible to change the setting group via neither remote communications nor the front panel.

The detailed logic table for setting group selection is shown below:

Binary Input Setting Group 2	**Front Panel and Remote Setting**	**Active Group**
Not configured	G1	G1
Not configured	G2	G2
G1	G1	G1
G1	G2	G1
G2	G1	G2
G2	G2	G2

Note: If a setting group change initiated by a remote command has not been effected due of priority settings, that command is ignored (not recorded in the P116's logic for the future, when priority settings allow changing).

It is possible to assign an Active Group state to an output contact by setting the output contact to the ***Setting Group x*** output (***SETTING GROUP x/OUTPUT RELAYS CONFIGURATION Gx***.

If Active Group signaling is required, some LEDs should be assigned to the ***Setting Group x*** function (***SETTING GROUP x/LEDs CONFIGURATION Gx***).

3.5 Trip Circuit Supervision (Model A)

The trip circuit extends beyond the relay's enclosure and passes through more components, such as fuses, wires, relay contacts, auxiliary switch contacts and so on.

These complications, coupled with the importance of the circuit, have directed attention to its supervision.

The simplest arrangement for trip circuit supervision contains a healthy trip lamp in series with a resistance placed in parallel with the trip output relay contacts of the protection device.

3.5.1 Trip Circuit Supervision Mechanism

The Trip Circuit Supervision function included in the **MiCOM P116** relays is described below:

A logic input is programmed to the ***GLOBAL CONFIGURATION/CIRCUIT BREAKER/TC Supervision*** function. The logic input is associated to the label ***Trip Circ Supervis..*** within the ***SETTING GROUPx/INPUT CONFIGURATION Gx*** menu. Then, this logic input is wired in the trip circuit according to one of the typical application diagrams shown in the following example.

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When the ***TC Supervision*** function is set to ***Yes*** under the ***CIRCUIT BREAKER*** sub-menu, the relay checks continuously on trip circuit continuity whether the CB's status is open or closed.

When the ***TC Supervision*** function is set to ***Yes-52A*** under the ***CIRCUIT BREAKER*** sub-menu, the relay checks continuously on trip circuit continuity in case when the CB's status is closed only.

The ***TC Supervision*** function is enabled when the ***Protect.trip*** or ***Trip CB order*** output is not energized. The ***TC Supervision*** function is not enabled when the ***Protect.trip*** or ***Trip CB*** is energized.

A ***TCS 52 Fail*** and ***CB Alarm*** output function, ***TCS Supervision Alarm*** and ***CB Alarm*** LEDs function signal is generated if the logic input detects no voltage signal during a time longer than the settable timer ***tSUP*** (in ***GLOBAL CONFIGURATION/CIRCUIT BREAKER*** menu). See Chapter P116/EN TD (Technical Data) for the settings.

As this function is disabled when the ***Protect.trip*** or ***Trip CB order*** output is energized, this function is suitable for use with the enabled relay latching logic.

The ***tSUP*** timer can be set according to the following table:

MENU TEXT	SETTING RANGE		STEP SIZE
	MIN	MAX	
TC Supervision ?	Yes	No	
tSUP	100ms	10s	10ms

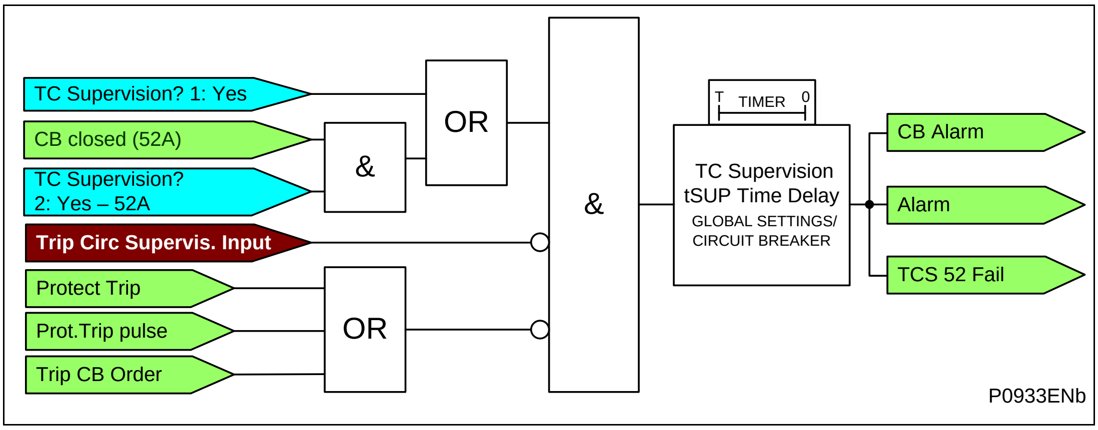

Figure 14: Trip Circuit Supervision Principle

For more details refer to the Application Chapter (P116/EN AP/A11)

3.6 Commissioning

3.6.1 Maintenance Mode

This menu allows the user to check the operation of the protection functions.

It is possible to set following ***Maintenance mode*** options (settings):

- "***No***" - ***Maintenance mode*** is disabled. All window cells below are hidden (***Maintenance mode*** is the latest cell in ***COMMISIONING*** column)

- "***Yes,outp.trips***" - ***Maintenance mode*** is enabled. In this mode all test cells in ***COMMISIONING*** column are shown. During tests outputs are energized.

- "Yes,outp.block" - ***Maintenance mode*** is enabled and all test cells in ***COMMISIONING*** column are shown. In this mode, the high state of output functions are ignored (control of outputs are blocked).

  This option allows the user to check the operation of the protection functions without actually sending any external command (Tripping or signalling).

OP

Depends on the rear protocol selected in menu, transmission of information to SCADA is blocked (Modbus RTU) or sent (IEC 103) with additional information to know that P116 is in Maintenance mode (refer to Communication chapter and EN 60870-5-103 standard).

Changing of setting from "***No***" to "***Yes,….***" from the front panel activate this mode for **10 minutes only**. After this time the option is automatically switched to "***No***".

The selection of the maintenance mode is possible by logic input (the level), control command (rear or front port), or by front panel interface.

The maintenance mode is terminated by:

- Low state of logic input assigned to ***Maintenance mode*** function,

- Control command which deactivate this mode (rear command or setting: "***No,….***") and by turning off the power supply.

Note: Maintenance rear command is available in Modbus protocol only

Maintenance Mode
1: Yes,outp.trips

It is possible to assign the state of ***Maintenance Mode*** to programmable LEDs.

In "***Yes,outp.block***" case, all the output contacts are blocked, and no command can be issued to these contacts, even if a protection threshold associated with one of these output contacts has been crossed. (If a protection threshold is crossed, all associated LEDs will be ON, even the TRIP LED, if protection element is set to ***Trip***).

If the Maintenance Mode is set in menu ("***Yes,outp.trips***" or "***Yes,outp.block***") after 10 minutes this function returns automatically to ***Maintenance mode*** "***No***" (function disabled).

If the input assigned ***to Maintenance Mode*** is logical high, the Maintenance Mode is active (without any time limitation) up to low state of the logical input.

3.6.2 Outputs test

This function is available after activation of ***Maintenance mode***

The commissioning cells allow the user to check the external wiring to the relay's output contacts. To do this, the user has only to set to 1 the desired output contact's corresponding bit, and this will close the contact and allow the continuity of the wiring to be checked.

Test	TF654321
Pattern	00000000

In the cell below, the contact test time can be set:

Contact Test	
Time	001.00s

If the outputs for test are selected and Time for output closing is set, the closing command can be executed in this cell:

Test output
0: no operation

To execute the test, press OK key, press the or key to select ***1: Apply test*** and confirm action by OK. The contact will be closed for the duration of the ***Contact Test Time*** pulse.

3.6.3 Functional test

This function is available after activation of ***Maintenance mode***

The next commissioning cells allow the user to check the functional output configuration of the P116. To do this, the user has only to select which protection element will be triggered, and this will close the contact assigned to this protection element and allow the continuity of the wiring to be checked. If the protection element is disabled there will be no action.

OP

Functional Test
0: I>

In the cell below the end of the functional test can be configured:

Functional Test
End 0: CB trip

The following options are possible:

- ***0: CB trip*** – after triggering the functional test, the test is interrupted after trip command.
- ***1: Time*** – the protection element will be triggered for the duration of the pulse time.

If the ***1: Time*** option is selected it is necessary to set the pulse length:

Contact Test	
Time	001.00s

The next cell is used for functional test execution:

Functional Test
CTRL: no operation

To execute this test, press the OK key, press the or key to select ***1: Operate*** and confirm action by pressing OK. The contact will be closed for the duration of the ***Contact Test Time*** pulse.

NOTE: In ***Maintenance Mode*** P116 works with full functionality (ready to trip in a fault condition, even during functional test). During functional test of selected stage (for example tI>), P116 measures currents so the rest active stages (for example tI>>, tIN>, etc) work on the measured current from the field. Only the tested stage (for example tI>) sees test current: two times greater than tI> current setting value in all phases. After functional test of Thermal replica, the thermal value is set to 0%. After test, in the fault record all recorded current values are based on the currents measured in the field.

If Functional Test will be applied for protection element which is disabled there will be no any action done.

3.7 Circuit Breaker Control (Model A)

The relay includes the following options for control of a single circuit breaker:

- Local tripping and closing, via the relay menu or function keys
- Local tripping and closing, via relay binary inputs
- Remote tripping and closing, using the relay communications

If a local/remote external selector switch is to be used, it is recommended that separate relay output contacts are assigned to remote circuit breaker control and protection trip. This enables the control outputs to be selected via a local/remote selector switch as shown in Figure 14.

Where this feature is not required or is connected to a P116's binary input, the same output contact(s) can be used for both protection (***Protect.Trip*** output) and remote tripping (***Trip CB order*** output).

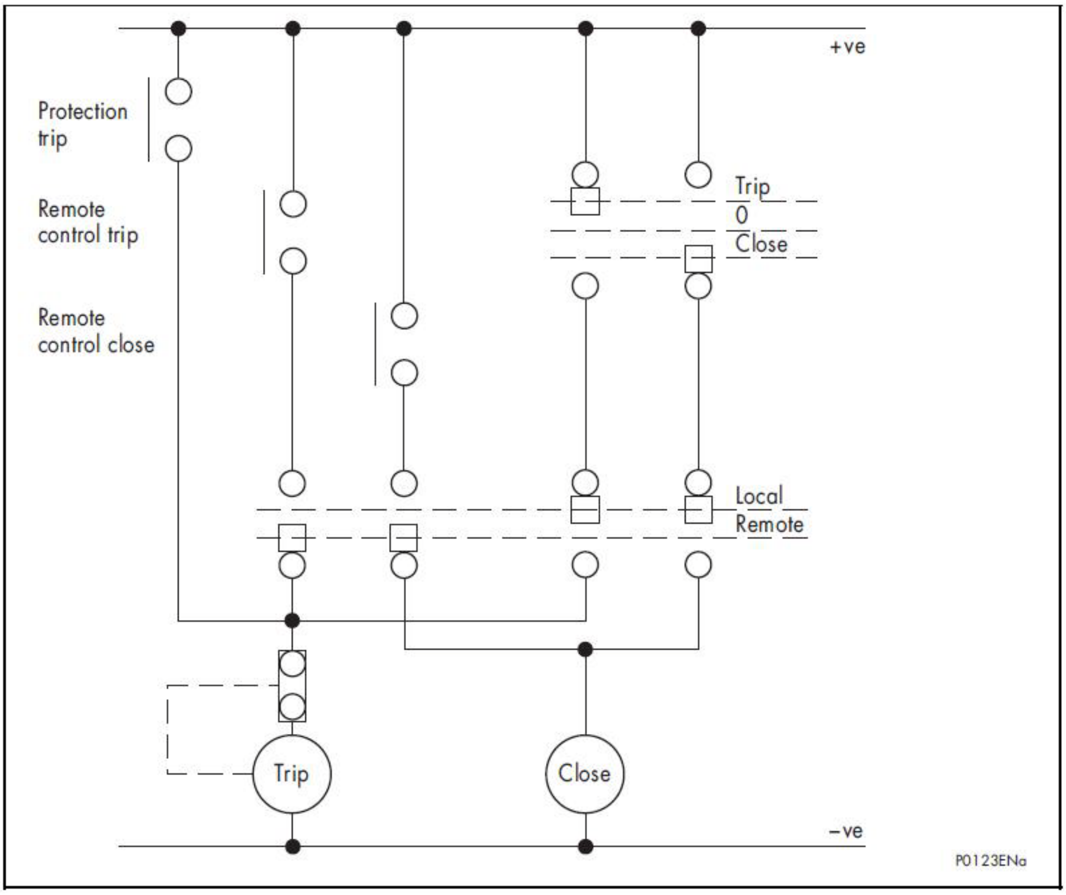

Figure 15: Remote Control of Circuit Breaker

A manual trip will be permitted provided that the circuit breaker is initially closed. Likewise, a close command can only be issued if the CB is initially open. To confirm these states it will be necessary to use the breaker 52A (assigned to ***CB status 52A*** input) and/or 52B (assigned to ***CB status 52B*** input) contacts. Under these circumstances manual CB control will be possible, but the Auto-reclose function will not be available. Additionally, it will be not possible to see the CB status in the Control default cell.

Once a CB Close command is initiated the output contact (***Close CB order)*** can be set to operate following a user-defined time-delay (***Time-delay for Close*** setting in ***GLOBAL SETTINGS/CIRCUIT BREAKER*** menu). This would give personnel time to move safely away from the circuit breaker following the close command. This time-delay will apply to all manual CB Close commands.

The length of the trip or close control pulse can be set via the ***tOPen pulse min*** and ***tClose Pulse*** settings respectively (***GLOBAL SETTINGS/CIRCUIT BREAKER*** menu). These should be set long enough to ensure the breaker has completed its open or close cycle before the pulse has elapsed.

Note: The manual trip and close commands are found in the default Control cell and the Close/Trip keys on the front panel.

If an attempt to close the breaker is being made, and a protection trip signal is generated, the protection trip command overrides the close command.

If ***CB FLT Ext.Sign*** is assigned to a binary input this signal is checked before manual closing of the CB. This function uses the signal received at the relay's binary input to confirm whether the breaker is capable of closing (sufficient circuit breaker energy for example). A user-settable time-delay, ***tCB FLT ext***, is included for manual closure. If, following a close command, the CB does not signal a healthy condition before that timer elapses, then the relay will lockout and issue an alarm.

3.8 General Input Configuration (Model A)

Depending on the P116's hardware version defined in the ***GLOBAL CONFIGURATION/GENERAL INPUT CONFIGURATION*** menu, two types of menu cells are available.

Inputs Hardware Options:

- P116xxxxxxx**1**xxxxxx: Standard Binary Inputs: 24-240 Vac or 24-250 Vdc
- P116xxxxxxx**2**xxxxxx: DC Binary Inputs with settable switching thresholds: 110 Vdc / 129 Vdc / 220 Vdc

3.8.1 Standard Binary Inputs

Standard Binary Inputs are designed to have a high immunity to the disturbances that can appear on the wires connected to the binary inputs:

OP

- the activation current level is high (35 mA over 2 ms) and does not depend on the voltage level. After 2 ms the consumption of current is reduced to 2.3 mA.
- the level of the voltage connected to the binary input must be greater than the minimum acceptable value,
- time filtering is executed. The window and filtering method depend on the type of voltage which will be fed to the input terminals:
    - dc voltage with 5 ms filtering window (at 50 Hz): ***Inp.X Filtering: 2:dc*** (in the ***GLOBAL SETTINGS/GENERAL INPUT CONFIGURATION*** menu). ‘X’ – the number of binary inputs (1-6)
    - ac voltage with 7.5 ms filtering window (at 50 Hz): ***Inp.X Filtering: 1:ac*** (in the ***GLOBAL SETTINGS/GENERAL INPUT CONFIGURATION*** menu). ‘X’ – the number of binary inputs (1-6)
    - ac/dc ENA with 15 ms filtering window (at 50 Hz): ***Inp.X Filtering: 0:dc/ac ENA*** (in the ***GLOBAL SETTINGS/GENERAL INPUT CONFIGURATION*** menu). ‘X’ – the number of binary inputs (1-6)

Figure 12 shows two cases:

- The Logic Input is high because the voltage level is higher than is required (RT level) and the current is greater than about 35 mA. After 2 ms the binary input reduces the current consumption to about 2.3 mA.
- The Logic Input is low because the voltage source connected to the binary input has too high an internal impedance so that the current is lower than 35 mA. The voltage level is OK because it is above the RT level (this value is fixed: refer to chapter P116/EN TD).

Each Input can be configured separately for the ***dc*** or ***ac*** or ***ac/dc ENA*** options.

For example input L1 can be set to ***2: dc*** and input L2 can be set to ***1: ac***.

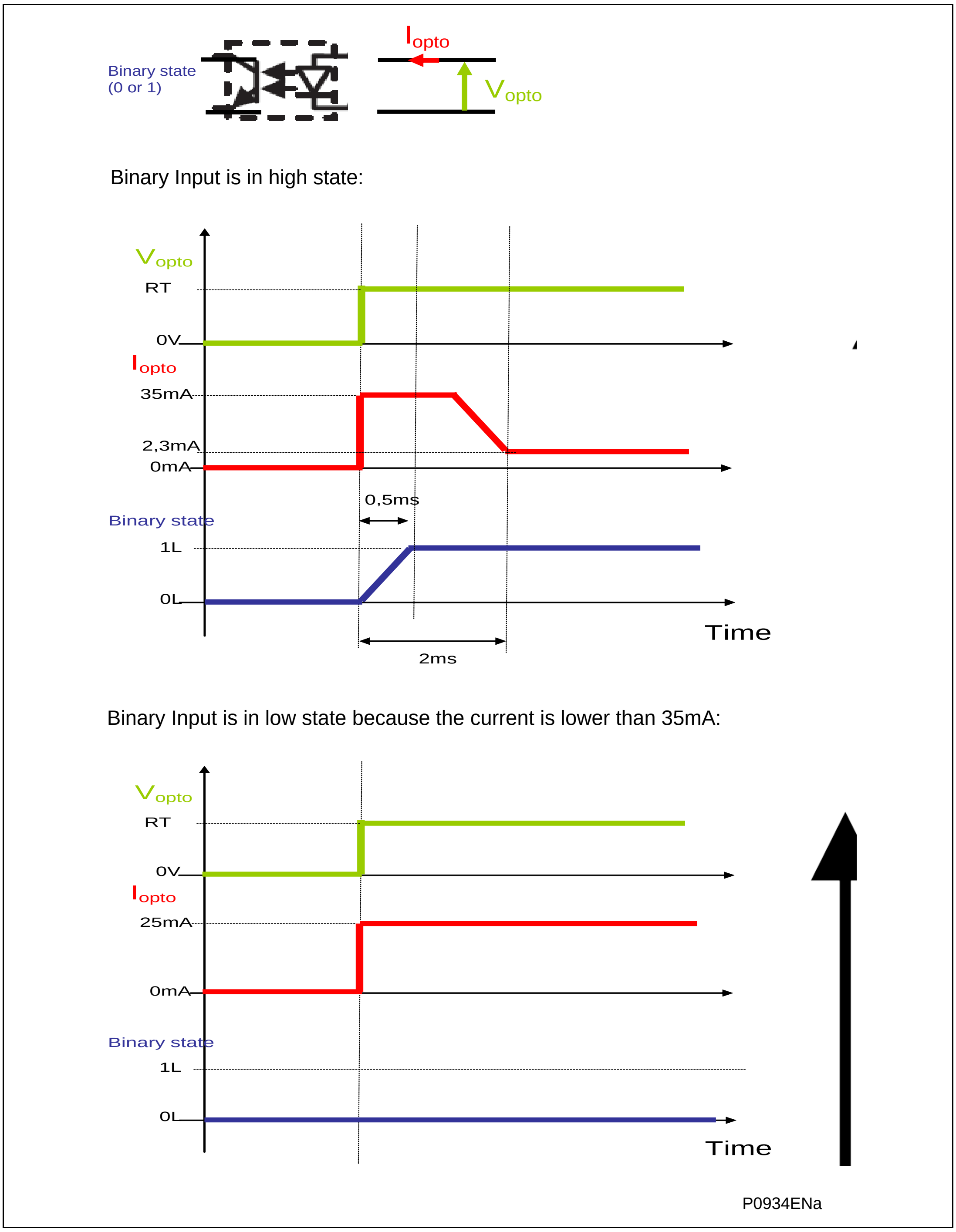

Figure 16: Energizing of binary inputs (P116xxxxxxx1xxxxxx)

3.8.2 DC Binary Inputs

DC Binary inputs can set the nominal dc voltage for inputs. In this way the RT threshold can be set as high as possible (0.7-0.8 x nominal voltage value – refer to chapter P116/EN TD/A11) in order to increase immunity to the disturbances that can appear in the wires connected to the binary inputs. The current consumption is about 3.5 mA at nominal voltage value. The filtering time is 5 ms only.

In the ***GLOBAL SETTINGS/GENERAL INPUT CONFIGURATIO***N menu it is possible to select the following nominal (rated) voltages:

- 110 Vdc
- 129 Vdc
- 220 Vdc

The maximum permissible voltage connected to these inputs does not depend on the selected nominal voltage and is equal to 264 Vdc.

3.9 Real Time Clock Synchronization via Opto-Inputs (Model A)

In modern protective schemes it is often desirable to synchronize the relay's real time clock so that events from different relays can be placed in chronological order. This can be done using the communication interface connected to the substation control system or via a binary input. Any of the available binary inputs on the P116 relay can be selected for synchronization. Pulsing this input will result in the real time clock snapping to the nearest minute. The recommended pulse duration is 20 ms to be repeated no more than once per minute. An example of the time synchronization function is shown.

Time of "Sync. Pulse"	Corrected Time
19:47:00.000 to 19:47:29.999	19:47:00.000
19:47:30.000 to 19:47:59.999	19:48:00.000

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

The input is configured in the ***SETTING GROUPx/INPUT CONFIGURATION Gx*** menu. The input must be assigned to the ***Time Synchr.*** input.

3.10 Resetting of Latched LEDs and Outputs

How latched LEDs and outputs are reset is determined by the inputs assigned to the resetting of latched LED. Outputs can be reset via external inputs, by pressing the C clear key on the P116's front panel if the LCD shows the default display or via the communication port.

The resetting configuration can be entered in the ***GLOBAL SETTINGS/LOC*** menu:

- LEDs Reset:
  - ***0: Manual only*** (via Inputs, HMI C key, Remote Reset command)
  - ***1: Start protect.*** (Start of a protection element set to Trip)
- Ltchd Outp. Reset:
  - ***0: Manual only*** (via Inputs, HMI C key, Remote Reset command)
  - ***1: Start protect.*** (Start of a protection element set to Trip)

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The ***Manual only*** option prevents a close command from being issued without readout of the cause of trip by maintenance personnel. It reduces the risk to switch on to fault.

The ***Start protect*** option allows to signal the latest trip only: Start of any protection element set to trip the CB, reset all latched LEDs and show the default display.

3.11 Records

3.11.1 Fault Recorder

Each time any of the set thresholds are crossed, an instantaneous record is created and displayed in the ***RECORDS/INSTANTANEOUS RECORD*** menu. Information on the last five starts is available, with the duration of the signal.

The following information is displayed in the ***RECORDS/INSTANTANEOUS RECORD*** menu: number of starts, time, date, origin (crossing of a current threshold or start of a protection element's time-delay), current values, duration of the instantaneous signal, and whether or not the crossing of the threshold lead to a trip.

Each time any of the set protection elements trips (***Protect.Trip*** output), a fault record is created and stored in memory. The fault record tags up to 20 faults and stores them in a non-volatile (FRAM) memory. This allows the operator to identify and analyze system failures. When the available memory space is exhausted, the new fault automatically overwrites the oldest fault.

The user can view the latest fault record in the ***RECORD/FAULT RECORDS*** menu, where he or she can choose to display up to 20 stored records. These records are the fault flags, the fault measurements, etc. Also note that the time stamp displayed in the fault record itself will be more accurate than the corresponding time stamp given in the event record. This is due to the fact that events are logged some time after the actual fault is recorded.

The user can view event records either via the front panel interface, via the USB port, or remotely, via the rear EIA(RS)485 port.

3.11.2 Alarm Recorder (Model A)

Each time any of the set protection element issues an ALARM signal (***Alarm*** output), an Alarm record is created and stored in memory. The fault record tags up to 5 faults and stores them in a non-volatile (FRAM) memory. This allows the operator to identify and analyze system failures. When the available memory space is exhausted, the new alarm automatically overwrites the oldest alarm.

The user can view the latest Alarm record in the ***RECORD/ALARM RECORDS*** menu, where he or she can choose to display up to 5 stored records. These records are the alarm flags, the alarm measurements, etc. Also note that the time stamp displayed in the Alarm record itself will be more accurate than the corresponding time stamp given in the event record..

3.11.3 Instantaneous Recorder (Model A)

Each time any of set thresholds are crossed, an instantaneous record is created and displayed in the ***RECORDS/INSTANTANEOUS RECORD*** menu. The last five starting records are available, with the duration of the signal.

The following information is displayed in the ***RECORDS/INSTANTANEOUS RECORD*** menu: number of starts, time, date, origin (crossing of a current threshold or start of a protection element's time-delay), current values.

NOTE: Instantaneous Records is active if P116 is powered from the auxiliary voltage Vx.

3.12 Disturbance Recorder

The integral disturbance recorder has a memory space specifically dedicated to the storage of disturbance records. Up to 6 seconds of disturbance recording can be stored. When the available memory space is exhausted, the new record automatically overwrites the oldest record.

Disturbance recorder are triggered by protection element set to ***Trip*** or via binary input assigned to ***Start Distur. R.*** input function.

The recorder stores actual samples that are taken at a rate of 16 samples per cycle.

Each disturbance record consists of analogue and digital channels. (Note that the relevant CT ratios for the analogue channels are also extracted to enable scaling to primary quantities).

The disturbance recorder is set in the ***GLOBAL SETTINGS/DISTURBANCE RECORDER*** menu.

The total disturbance recording time is 6 s but not more than 5 records are available.

Total number of records available in disturbance recorder is:

- One - for set Max Record Time from in range: 3.01s - 6s
- Two – for set Max Record Time from in range: 2.01s - 3s
- Three – for set Max Record Time from in range: 1.51s - 2s
- Four – for set Max Record Time from in range: 1.21s – 1.5s
- Five - for set Max Record Time from in range: 0.10s – 1.2s

Triggering of disturbance recording depends on the ***Disturb.Rec.Trig.*** configuration:

- ***0: on Inst.*** – Start of a protection element set to ***Trip***,
- ***1: on Trip*** – Trip by a protection element followed by the ***Protect.Trip*** output.

If the ***0: on Inst***. option is selected the record consists of: Pre-fault time + duration of the "any Start" signal presence + Post-fault time.

If the ***1: on Trip*** option is selected the record consists of: Pre-fault time + duration of the Trip signal presence (***Protect.Trip*** function active) + Post-fault time.

The pre-fault time can be set in the cell: ***GLOBAL SETTINGS/DISTURBANCE RECORDER/Pre-Time***. If the pre-fault time is set to 100 ms, recording starts 100 ms before the disturbance.

The post-fault time can be set in the cell: ***GLOBAL SETTINGS/DISTURBANCE RECORDER/Post Trip Time***. If the post trip time is set to 100 ms, recording stops 100 ms after the trip signal.

3.13 Event Records (Model A)

The relay records and time-tags up to 200 events and stores them in a non-volatile (Fram) memory. This allows the system operator to analyze the sequence of events that has occurred within the relay after a particular power system condition, or switching sequence, etc. When the available space is exhausted, the new fault automatically overwrites the oldest fault.

The real time clock within the relay time-tags each event, with a resolution of 1 ms.

The user can view the event records either locally via the USB port, or remotely, via the rear EIA(RS)485 port.

3.14 Demand values

The relay produces fixed and peak demand values, using the reset demand menu cell it is possible to reset these quantities via the user interface or the remote communications.

Information about actual values is available in the ***RECORDS/MAX & AVERAGE I*** submenu.

3.14.1 Fixed Demand Values

The fixed demand value is the average value of a quantity over a specified interval (***Time Window)***. Values are produced for each phase current (A, B, C). The fixed demand values displayed by the relay are those for the previous interval, the values are updated at the end of the settable demand period: ***Time Window*** cell (***GLOBAL SETTINGS/MAX&AVERAGE I CONFIGURATION/***)

NOTE: Fixed Demand Values is active if P116 is powered from the auxiliary voltage Vx.

Time Window setting: from 1 mn to 24 hours

The 3 phase Peak demand values are displayed in the ***RECORDS/MAX & AVERAGE I*** menu:

- Average IA
- Average IB
- Average IC

The calculation is reset either via the front panel interface in the ***RECORDS/MAX & AVERAGE I/ MAX&Aver.Reset*** cell, under Control password (Note: Control password can be deactivated if it is set to 0):

Max&Aver.Reset CTRL: No operation

Resetting can be applied by:

- pressing the OK key,

- enter the Control Password,

- confirm the password by pressing the OK key,

- pressing or key then selecting: ***Reset***

- confirming the command by pressing **OK.**

Note: In case of loss of power supply the fixed demand values are not stored.
Any modification of the **Time Window** setting resets the calculation.

3.14.2 Peak Demand Values

Peak demand values are produced for each phase current quantity. These display the maximum value of the measured quantity since the last reset of the demand values.

The principle of calculation of the Peak value demand for the IA, IB and IC phase currents is as follows:

For every ***Time Window***, a new average value is compared with the previous value calculated for the previous ***Time Window***. If this new value is greater than the previously stored value, then this new value is stored instead of the old one.
To the contrary, if this new value is lower than the previously stored value, then the old value is kept.
This way the average peak value will be refreshed with each ***Time Window***.

There is no dedicated setting for this calculation. The setting for the ***Time Window*** is shared with that for the ***Fixed Demand*** value.

The 3 phase Peak demand values are displayed in the ***RECORDS/MAX & AVERAGE I*** menu:

MAX IA
MAX IB
MAX IC

The calculation can be reset – see Fixed demand value.

Note: In case of loss of power supply, Peak average values are stored. Any modification of the ***Time Window*** setting resets the calculation.

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APPLICATION NOTES

Date:	**17th November 2013**
Hardware Suffix:	**A**
Software Version:	**1C**
Connection Diagrams:	**10P11602**

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FIGURES

1. INTRODUCTION

1.1 Protection of Underground and Overhead Lines

The secure and reliable transmission and distribution of power within a network is heavily dependent upon the integrity of underground cables and overhead lines, which link the various sections of the network together. Therefore the associated protection system must also provide both secure and reliable operation.

The most common fault conditions on underground cables and overhead lines are short circuit faults. These faults may occur between the phase conductors but will most often involve one or more phase conductors being short-circuited to the earth.

Faults caused by short circuits require the fastest clearance times but these should still allow for suitable co-ordination with other downstream protection devices.

Fault sensitivity is an issue common to all voltage levels. For transmission systems, tower-footing resistance can be high. Also, high resistance faults might be prevalent where lines pass over sandy or rocky terrain. Fast and discriminative fault clearance is required in these conditions.

The effect of fault resistance is more pronounced on lower voltage systems, resulting in potentially lower fault currents, which in turn increases the difficulty in the detection of high resistance faults. In addition, many distribution systems use earthing arrangements designed to limit the passage of earth fault current.

Earthing methods as such as resistance, Petersen coil or neutral-insulation make the detection of earth faults arduous. Special protection equipment is often used to overcome these problems.

Nowadays, the supply continuity of power distribution is of paramount importance.

On overhead lines, most faults are transient or semi-permanent in nature.

In order to increase system availability, multi-shot auto-reclose cycles are commonly used in conjunction with instantaneous tripping elements. For permanent faults it is essential that only the faulted section of the system is isolated. High-speed, discriminative fault clearance is therefore a fundamental requirement of any protection scheme on a distribution system.

Power transformers are installed at all voltage levels and have their own specific requirements with regard to protection. In order to limit the damage incurred by a transformer under fault conditions, fast clearance of phase to phase and phase to earth faults on the windings is a primary requirement.

Damage to electrical plant equipment such as transformers, cables and lines may also be incurred by excessive loading conditions, which lead directly to overheating of the equipment and subsequent damage to insulation. To protect against such fault conditions, protective devices must also provide thermal protection.

Uncleared faults, arising either from the failure of the associated protection system or of the switchgear itself, must also be considered. The protection devices concerned should be fitted with logic dealing with breaker failure and the upstream relays must be able to provide adequate back-up protection for such fault conditions.

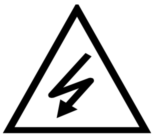
Other situations may arise on overhead lines, such as broken phase conductors. Traditionally, series faults have been difficult to detect.

With today's numerical technology, it is now possible to design elements that are responsive to such unbalanced system conditions and to subsequently issue alarm and trip signals.

On large networks, time co-ordination of the overcurrent and earth fault protection relays can often lead to problematic grading situations or, as is often the case, excessive fault clearance times. Such problems can be overcome by relays operating in blocked overcurrent schemes.

Due to its dual powering featuer, the P116 can be used as back-up protection of HV/MV transformers.

Before carrying out any work on the equipment, the user should be familiar with the contents of the Safety Guide, SFTY/4L M/E11 or later issue, or the safety and technical data section of the technical manual and also the ratings on the equipment rating label.



For safety reasons, no work must be carried out on the P116 until all power sources to the unit have been disconnected.

2. APPLICATION OF INDIVIDUAL PROTECTION FUNCTIONS

P116 have two models: model A and Model L.
Application section shows maximum software/hardware option. To see which functions are available in which model – refer to INTRODUCTION (P116/EN IT), GETTING STARTED (P116/EN GS) and SETTINGS (P116/EN ST) chapters.

The following sections detail individual protection functions in addition to where and how they may be applied. Each section provides some worked examples on how the settings are applied to the relay.

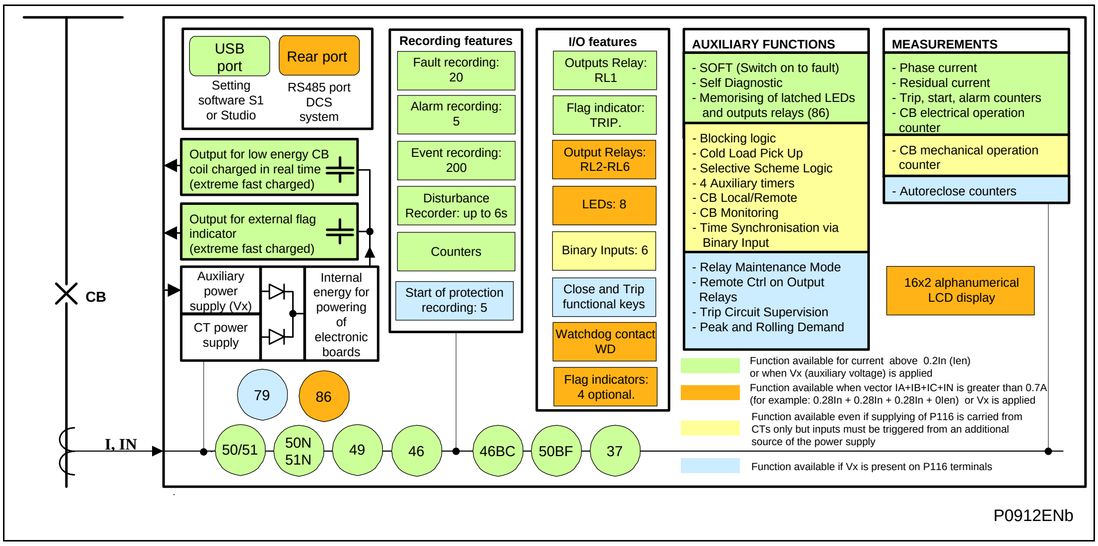


Figure 1: Model A - P116 single-line functional diagram (all options included)

2.1 Earth and Phase Overcurrent Functions

MiCOM P116 relays provide definite and independent time-delayed overcurrent protection.

Each phase current and earth current input is associated with three stages.

The first and second timer stages can be set to definite time-delay or inverse time-delay using the IEC, IEEE, CO, RXIDG, BPN, RI and RECT curves. Their parameters are shown in the Technical Data chapter of this Technical Guide.

The third stages can be set as definite time-delay only.

Similarly, the earth fault elements has three different stages, that also can be set independently of the settings chosen for the phases.

The instantaneous stages are labeled “I>” for the first stage, “I>>” and “I>>>” for the second and third instantaneous stages respectively (“IN_1”, “IN_2” and “IN_3” for earth fault elements).

The time-delayed stages are labeled “tI>” for the first stage, “tI>>” and “tI>>>” for the second and third time-delayed stages respectively (“tIN_1”, “tIN_2” and “tIN_3” for the time-delayed earth fault stages).

The protection elements trip when the following conditions are realized:

- A phase current exceeds the set overcurrent threshold
- The relevant time-delay has elapsed
- The blocking logic (if used) is not activated.

The following diagrams show the functionality for each stage.

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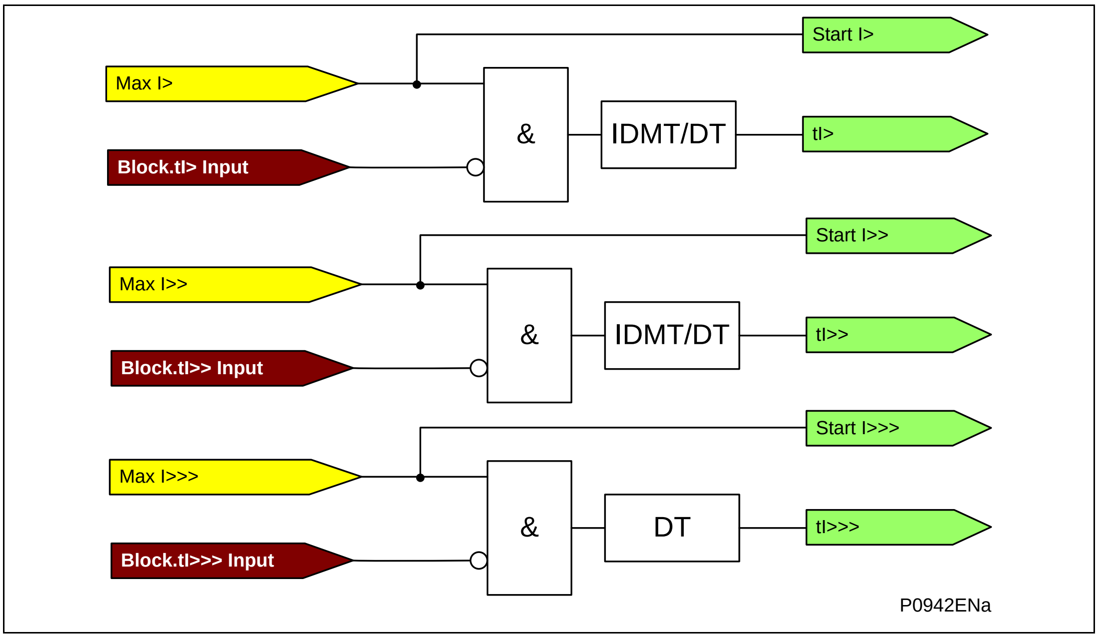

Figure 2: Logic diagram for the phase stages I>, I>> and I>>>

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With: Max I> = [IA>] OR [IB>] OR [IC>]

Max I>> = [IA>>] OR [IB>>] OR [IC>>]

Max I>>> = [IA>>>] OR [IB>>>] OR [IC>>>]

The logic associated with the earth fault stage is identical to the logic described above. The stages I> & tI>, I>> & tI>> and I>>> & tI>>> are respectively replaced by the stages IN_1 & tIN_1, IN_2 & tIN_2, IN_3 & tIN_3.

Thanks to the "Blocking Logic" function, it is possible to freeze the timer as long as the "Block Logic" signal is active.

As soon as the blocking “Block Logic" signal drops, if the overcurrent value is still over the set threshold, the time-delay resumes using the value prior to the activation of the blocking function as its new initial value. This allows faster clearance of the fault after resetting of the “Block Logic" signal.

2.1.1 Instantaneous function

As soon as a phase (or earth) timer stage starts running, the instantaneous output associated with that stage is activated. This output indicates that the protection element has detected a phase (or earth) fault and that the corresponding time-delay has started. This time-delay can be blocked via the associated "Block Logic" logic input. If this blocking input is activated by an output contact of a downstream relay, the logic that will lead to the trip command is then blocked only if the relay that is the closest to the fault can see and therefore eliminate the fault. This principle is known as «Blocking logic» or «Blocking». It is described in more detail in this document.

2.1.2 DMT timer stages

The three phase (earth) overcurrent stages can be assigned definite time-delays. The time to operate is equal to the set time-delay plus the time for the output contact to operate (typically about 30 ms, 20 ms for a current exceeding or equal to twice the threshold) and the time required to detect the overcurrent condition (maximum 20 ms at 50 Hz).

For DMT stages, a definite-time "tReset" reset timer is associated with the first phase o/c stage, and with the first and second earth fault stages.

2.1.3 IDMT timer stages

The first and the second phase (I>, I>>) and e/f (IN_1) overcurrent stages can be selected with an inverse maximum time (IDMT) characteristic.

The time-delay in relay operation is calculated with a mathematical formula that depends on the relay current and TMS (IEC and UK) or TD (IEEE and US) values.

There are twelve inverse time characteristics available:

- SI: Standard Inverse Time Characteristic (IEC/A)
- VI: Very Inverse Time Characteristic (IEC/B)
- EI: Extremely Inverse Time Characteristic (EC/C)
- LTI: Long Time Inverse Characteristic (IEC)
- STI: Short Time Inverse Characteristic (FR)
- RC: Rectifier Characteristic (UK)
- MI: Medium Inverse Time Characteristic (IEEE, IEC/D)
- VI: Very Inverse Time Characteristic (IEEE, IEC/E)
- EI: Extremely Inverse Time Characteristic (IEEE, IEC/F)
- CO2 P20: Short Time Inverse Characteristic (US)
- CO2 P40: Short Time Inverse Characteristic (US)
- CO8: Inverse Characteristic (US)
- RI: Electromechanical Inverse Characteristic
- BNP Time Charactristic (EDF)
- RXIDG Time Charactristic

The mathematical formulae and curves for the twelve Inverse Time characteristics available with the P116 are presented in chapter OP (“Operation”).

In menu of P116 it is possible to select if the curve has no limitation for greater current value, is blocked via DMT stages or is cut (the same time delay as for 20 x Is point for current above 20 x Is, where Is - current setting). Setting parameter: ***GLOBAL SETTINGS/ O/C ADVANCED*** / ***IDMT interlock by DMT***. Above setting is common for all IDMT stages.

2.1.4 Reset timer

The first two phase overcurrent stages [I>/tI>, I>>/tI>>] and the first earth fault stage ([IN_1/tIN_2] have a reset timer.

The value that is set for this reset timer corresponds to the minimum time during which the current value needs to be lower than 95% of the phase (or earth) threshold before the corresponding phase (or earth) time-delay is reset.

Note: This rule does not apply when the protection element is triggered. When the protection element is triggered, the time-delay tI> (or tIN>) is immediately reset.

DMT stages have DMT reset timers only.

IDMT characteristics can be associated with either a DMT or an IDMT reset timer. This selection is made in the menu:

- phase current: ***SETTING GROUP x/PROTECTION Gx /[50/51] PHASE OC Gx /Reset Delay Type***: ***0:DMT or 1: IDMT***
- earth current: ***SETTING GROUP x/PROTECTION Gx /50/51N] E/GND FAULT Gx/Reset Delay Type***: ***0:DMT or 1: IDMT***

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DMT Reset Timer

Type of timer associated with the first & second phase (50/51 only) stages	DMT Reset Timer
DMT (see note below)	0 ms to 600 s
IDMT	0 ms to 600 s

For the first phase and earth overcurrent stages, the MiCOM P116 has a timer hold facility, ***DMT tReset***, which can be set to a definite time value or to an inverse time characteristic. This may be useful in some applications, for example when grading with upstream electromechanical overcurrent relays which have inherent reset time-delays.

This timer hold facility is used to reduce fault clearance times and is also useful in situations where intermittent faults may be experienced. This can for example be the case on a plastic-insulated cable. In that case, the fault energy may cause the cable insulation to melt and reseal, thereby extinguishing the fault. This process repeats itself a couple of times giving a succession of fault current pulses, each of increasing duration with reducing intervals between the pulses, until the fault becomes permanent.

When the reset time of the overcurrent relay is instantaneous the relay will be repeatedly reset and unable to trip until the fault becomes permanent. By using the Timer Hold facility, the relay will integrate the fault current pulses, thereby reducing fault clearance time.

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The MiCOM P116's reset timer ***DMT tReset*** can be found in the following menu cells:

- ***SETTING GROUP x/PROTECTION Gx /[50/51] PHASE OC Gx /DMT tReset*** for the phase.
- ***SETTING GROUP x/PROTECTION Gx /[50/51N] E/GND FAULT Gx /DMT tReset*** for the earth.

IDMT Reset Timer (IDMT Reset Characteristic)

This feature may be useful in certain applications, for example when grading with upstream electromechanical overcurrent relays, which have inherent reset time-delays. Setting the hold timer to a value other than zero, delays the resetting of the protection element timers for this period, thus allowing the element to behave similarly to an electromechanical relay.

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

When the reset time of the overcurrent relay is instantaneous, the relay will be repeatedly reset and unable to trip until the fault becomes permanent. By using the Timer Hold facility for IDMT characteristics the relay will integrate the fault current pulses, thereby reducing fault clearance time.

For IDMT it is possible to set the timer hold facility based on the following formulae:

IEC: $t = RTMS \times \left(\dfrac{tr}{1 - \left(\dfrac{G}{Gs}\right)^{p}} \right)$

IEEE and US: $t = RTD \times \left(\dfrac{tr}{1 - \left(\dfrac{G}{Gs}\right)^{p}} \right)$

where:

t Reset time

tr, p Constant (see table)

G Value of the measured current

Gs Value of the programmed threshold (pick-up value)

RTMS Reset time multiplier setting between 0.02 and 1.5.

RTD Reset time multiplier setting between 0.02 and 100.

Type of curve	Standard	tr	p
US Short time inverse	C02_P40	2.261	2
US Short time inverse	C02_P20	0.323	2
Long time inverse	C08	5.950	2
IEEE Moderately inverse (MI)	IEEE	4.850	2
IEEE Very inverse (VI)	ANSI/IEEE	21.600	2
IEEE Extremely Inverse (EI)	ANSI/IEEE	29.100	2
IEC Standard Inverse Time (SI)	IEC/A	8.2	6.45
IEC Very Inverse Time (VI)	IEC/B	50.92	2.4
IEC Extremely Inverse Time (EI)	IEC/C	44.1	3.03
IEC Long Time Inverse (LTI)	IEC	40.62	0.4
FR Short Time Inverse (STI)	FR	0	2
UK Rectifier (Rect)	UK	0	2
BNP EDF	BNP EDF	0	2
RXIDG	RXIDG	0	2
RI	RI	0	2

Table 1: The value of “tr” for IDMT characteristics

Notes: 1. According to the IEEE and US standards, RTD should be equal to TD. By separately setting the values for RTD and TD it is possible to adapt the reset time to a specific application.
2. Typically for IEC characteristic RTMS can be set equal to TMS.

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2.1.5 Time-graded protection

Inverse definite minimum time relays are time graded in such a way that the relay closer to the fault operates faster than the upstream relays. This is referred to as relay co-ordination because if the relay nearest to the fault does not operate, the next relay will trip in a slightly longer time. The time grading steps are typically 400 ms, the operation times becoming progressively longer with each stage.

When difficulty is experienced in arranging the required time grading steps, the use of a blocked overcurrent scheme should be considered (described in § 2.14 of the Operation chapter, P116/EN OP).

Note**:** The dynamic measurement range is typically 600 times the minimum setting.

2.1.6 Earth fault protection

Earth fault (E/F) current is measured on the e/f input.

Depending on the connection of the terminals, the e/f input can power the P116 hardware (terminals A7 and A8) or not power the P116 hardware (terminals A9 and A10).

Three stages are available: IN_1, IN_2 and IN_3. The first stage has IDMT or DT characteristics. The types of characteristics are the same as for I> (refer to section 2.1.3).

If the e/f CT is connected to terminals A7 and A8 and auxiliary voltage supply is not connected to terminals B1-B2, the current on the e/f input must be greater than 0.2 Ien in order to power the P116 hardware.

2.1.7 Setting guidelines

When applying the overcurrent protection provided in the P116 relays, standard principles should be applied in calculating the necessary current and time settings for co-ordination The Network Protection and Automation Guide (NPAG) textbook offers further assistance. The example detailed below shows a typical setting calculation and describes how the settings are applied to the relay.

Assume the following parameters for a relay feeding an LV switchboard:

CT Ratio	=	500 A/1 A
Full load current of circuit	=	440 A
Slowest downstream protection	=	100 A Fuse

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The current setting employed on the P116 relay must account for both the maximum load current and the reset ratio of the relay itself:

I> must be greater than: (440 A/0.95)/500 A = 0.9263 In

I> must be greater than: 0.9263 In

For setting range 0.2-4 In step is 0.01 In, so the closest I> set value = 0.93 In.

A suitable time-delay characteristic can now be chosen. When coordinating with downstream fuses, the applied relay characteristic should be closely matched to the fuse characteristic. Therefore, assuming IDMT co-ordination is to be used, an IEC Extremely Inverse (EI) time characteristic would normally be chosen.

Finally, a suitable time multiplier setting (TMS) must be calculated and entered. .

MV/LV transformer application

Example:

Transformer:

Snom = 1000 kVA

Unom = 6 kV

CT ratio: 100 A/1 A

$$I_{nom} = \frac{S_{nom}}{\sqrt{3} \cdot U_{nom}} = \frac{1000kVA}{\sqrt{3} \cdot 6kV} = 96A$$

Where:

I_{nom} - nominal current of the transformer

S_{nom} - nominal power of the transformer

U_{nom} - nominal phase-phase voltage

Short circuit I>>

Primary value setting: 1.5kA

I>> current stage: $I_{>>} = 1500A/100A = 15[In]$

$I_{>>}\_set\_value$: 15In

Where:

$I_{>>}\_set\_value$: setting value of the short-circuit overcurrent stage

Overcurrent I>

Overcurrent stage I> should be set above the normal load current

If the primary setting value of I> is equal to 172 A, the set value is calculated as follows:

$$I_{>} = 172A/100A = 1.72 \cdot In$$

Calculation of the required E/F settings

The setting value of E/F overcurrent protection should be greater (with safety margin) than the charging currents flowing in the protected line to prevent an earth fault in other parts of the system tripping the relay. The value of the safety coefficient depends on the application and accuracy of obtained earth fault current value (typically: 1.5 to 2.5).

2.2 Transformer Magnetizing Inrush (Inrush Blocking)

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The inrush blocking function ensures protection stability during transformer energizing based on the presence of harmonic 2.

Either I>>/IN_2 or I>>>/IN_3 can be used as high-set instantaneous elements. Their design is such that they do not respond to the DC transient component of the fault current. The principle of operation allows the current settings to be set down to 35% of the prospective peak inrush current that will be absorbed by a transformer when it is energized. As a first approximation, the peak inrush current is given by the converse of the per unit series reactance of the transformer.

As an alternative, inrush blocking can be applied. This is discussed in the next section.

In applications where the sensitivity of overcurrent thresholds need to be set below the prospective peak inrush current, the inrush blocking function can be used to block the overcurrent, earth fault and negative sequence overcurrent stages. During transformer inrush conditions, the second harmonic component of the inrush current may be as high as 70%. In practice, the second harmonic level may not be the same for all phases during an inrush and therefore the relay will issue an Inrush Blocking signal for any phase above the set threshold. A setting of 15% to 20% for the Inrush harmonic 2 ratio can be applied in most cases. Care must be taken that it is not set too high, as inrush blocking may not operate for low levels of second harmonic current which may result in the O/C element tripping during transformer energization. Similarly if it is set too low, inrush blocking may prevent tripping for some internal transformer faults with significant second harmonic current

2.2.1 Overview

The Inrush Blocking function measures the ratio of second to fundamental harmonic currents. It can be used as “blocking logic” for I>, I>>, I>>>, SOTF, IN_1, IN_2, IN_3, I2>, I<, Broken Conduct, in cases where the harmonic 2 ratio is higher than the set threshold. Indeed, inrush blocking functions will reset selected protection starts.

Two options are available (***GLOBAL SETTINGS/INRUSH BLOCKING*** menu):

- ***1: Yes***
- ***2: Closing***

If ***1: Yes*** is selected, the minimum duration of the overcurrent stage inhibition (***T Inrush Reset***) can be also set. This value depends on the transformer power transient inrush duration: between 0.1 second (for a 100 kVA transformer) to 1.0 second (for a larger unit).

It is used to avoid any maloperation during a fixed time period in case of too sensitive a setting. For example, this option is recommended for incoming feeders where the inrush current is caused by a transformer connected to an outgoing line. However, using the second harmonic can increase the tripping time in case of a fault, especially with DC component included. This option can also be used if the CB contacts are not assigned to any P116 inputs (no information about CB closing).

If ***2: Closing*** is selected, the protection element block is active after the CB closes until ***Unblock Inrush Time*** elapses (this can be also set in the ***GLOBAL SETTINGS/INRUSH BLOCKING*** menu column). If ***1: Closing*** is selected, the minimum duration of the overcurrent stage inhibition (***T Inrush Reset***) can be also set (see above: ***1: Yes***). This option can increase protection reliability, because inrush blocking is limited to cases where inrush current can appear (closing of CB). Therefore it can be used on outgoing lines with transformers. Note that for incoming feeders the inrush current can be also present when CB is closed and an outgoing line with a transformer is closing. In such a case the CB status of the incoming feeder is not changed but Inrush current can trip protection element. The ***2: Closing*** option is not recommended for such an application.

2.2.2 Operation

For each of the three phases currents (IA, IB, IC), the harmonic restraint function compares the ratio of harmonic 2 to the fundamental with the set ratio (Harmonic 2 / Fundamental settable from 10 % to 50 % in steps of 1%).

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The minimum fundamental current value required for operation of the Inrush Blocking function is 0.2 In, and there is no upper limit to disable this feature. However, in transformer protection, this Inrush Blocking feature shall not control the high set overcurrent stage; this enables detection of all high current faults without inrush blocking.

Inrush blocking configuration offers two options:

- ***1: Yes -*** The Inrush Blocking function will block the selected protection stages every time inrush conditions occur on the line (Ratio of measured 2nd Harmonics > Inrush H2 set ratio), and will remain active at least for the duration of ***T Inrush Reset***. The tReset timer defines the minimum duration of overcurrent protection inhibition (0-200 s, settable). This timer starts as soon as an inrush current threshold picks up:
    - If the inrush condition lasts less than the set value for ***T Inrush Reset***., the selected overcurrent function will remain inhibited for the duration of tReset.
    - If the inrush condition lasts longer than the set value for ***T Inrush Reset***., the selected overcurrent function will remain inhibited as long as the inrush condition is present.
- ***2: Closing -*** The Inrush Blocking function will block the selected protection stages every time the CB closes (P116 closing command) until ***Unblock Inrush Time*** has elapsed and as long as the inrush conditions are present on the line (Ratio of measured 2nd Harmonics > Inrush H2 set ratio). If ***1: Closing*** is selected, the minimum duration of the overcurrent stage inhibition (***T Inrush Reset***) can be also set (see above: ***1: Yes***).

The operating Inrush current (2^{nd} Harmonic Ratio) is settable from 10% to 50% of the fundamental current.

Under inrush conditions, the following selectable protection stages can be blocked: I>, I>>, I>>>, SOTF, IN_1, IN_2, IN_3, Is2>, I<, Broken Conduct, if they are set to ***3: Trip-Inrush Bl***.

Note: Inrush Blocking in P116 relays is not phase-selective. If an inrush condition occurs on any phase, the selected protection stages will be blocked in all 3 phases.

2.2.3 Principle (example for the I> protection element only)

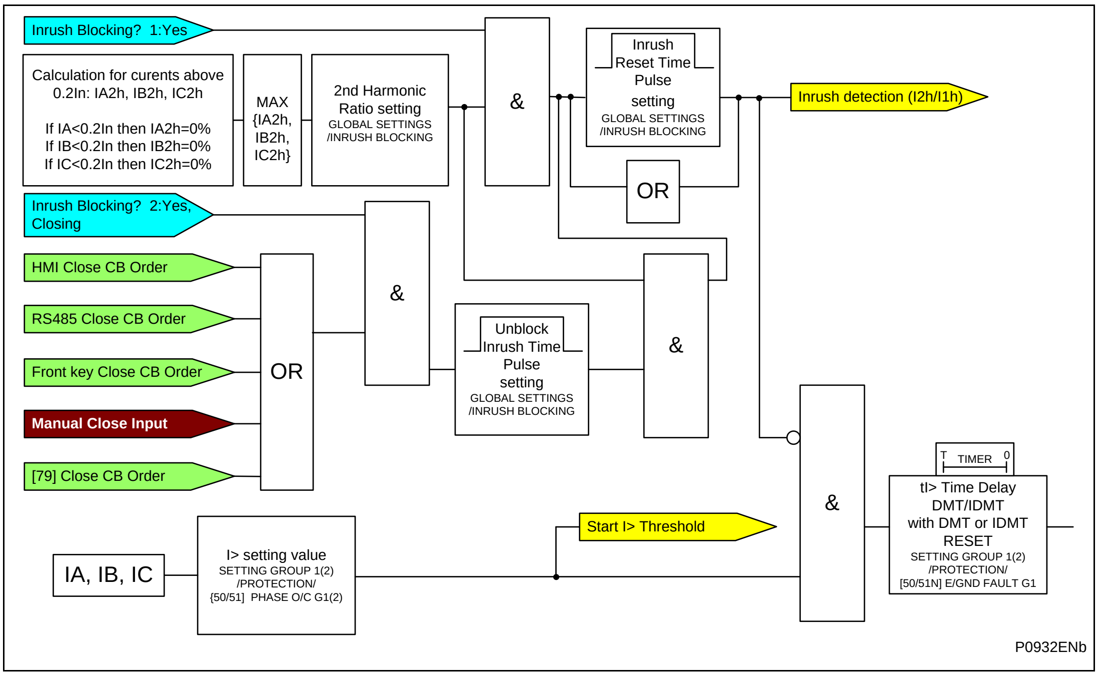

Figure 3: Inrush Blocking Logic

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2.3 Busbar Protection on Radial Systems

The use of non-directional overcurrent relays to protect a busbar is based on the following hypotheses:

- The network is a radial system,
- The incoming and outgoing feeders are clearly defined, the incoming feeders always being considered as suppliers of energy and outgoing feeders as loads.

Under these circumstances, the busbar is effectively protected using the interlocking principle (Figure 4).

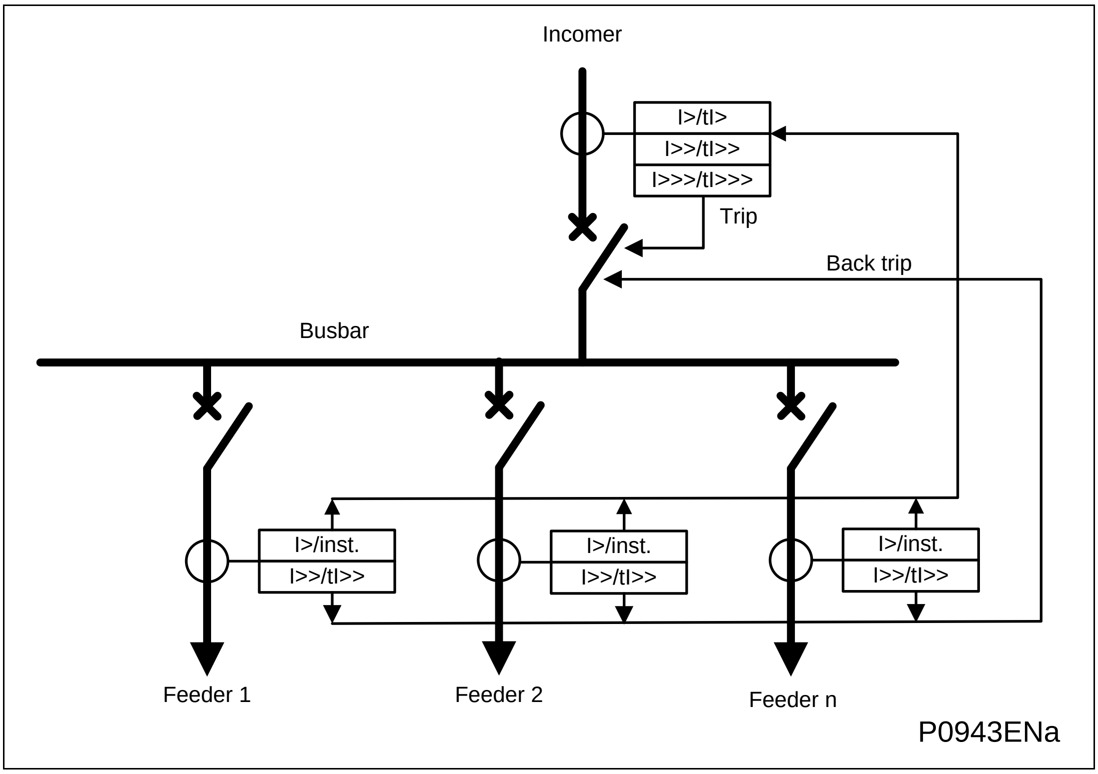

Figure 4: Blocked Overcurrent for Busbar Protection

The instantaneous overcurrent signals of the protection relays on the feeders are grouped together and wired to the "Blocking logic" logic input of the relay protecting the incoming feeder. The blocking function is programmed to inhibit either the first or first two stages. The third I>>> stage will operate at a high value (> 10 In) with a short time-delay (< 60 ms).

If a fault appears on the system, the relay protecting the associated feeder will immediately (in less than 30 ms) send a blocking command to the relay protecting the incoming feeder. After the fault has been cleared (by opening the circuit breaker), the blocking command is withdrawn and the relay protecting the incoming feeder is unblocked. As the fault current is no longer present, the timer is reset.

If a fault appears on the busbar, the fault current exceeds by far the value of the third threshold (I>>>). As this third stage is not blocked by the blocking logic of the relays protecting the incoming feeders, the trip command is sent in less than 60 ms and the busbar is isolated.

2.4 Blocking Logic Function (Blocked Overcurrent Protection)

This type of protection can be applied to radial feeder circuits where there is little or no back feed. For parallel feeders, ring circuits or where there can be a back feed from generators, directional relays should be considered.

The blocking logic function allows the upstream IDMT relay to be blocked by the start output of a downstream relay that has detected the presence of a fault current above its threshold. Thus both upstream and downstream relays can have the same current and time settings, and the blocking feature will automatically provide grading. If the CB failure protection is active, the blocking command on the upstream relay will be removed if the down-stream circuit breaker fails to trip.

Thus for a fault downstream from relay C, the start output from relay C will prevent relay B from operating and the start output of relay B will prevent relay A from operating. Therefore all 3 relays could have the same timer and current settings and grading would be obtained by the blocking signal received from a relay closer to the fault. This gives a constant, close time grading, but there will be no back-up protection in the event of pilot wires being short-circuited.

In practice it is recommended to set the upstream relay to a value that is 10% higher than the downstream relay setting. This ensures that the downstream relay successfully blocks the upstream relay when required.

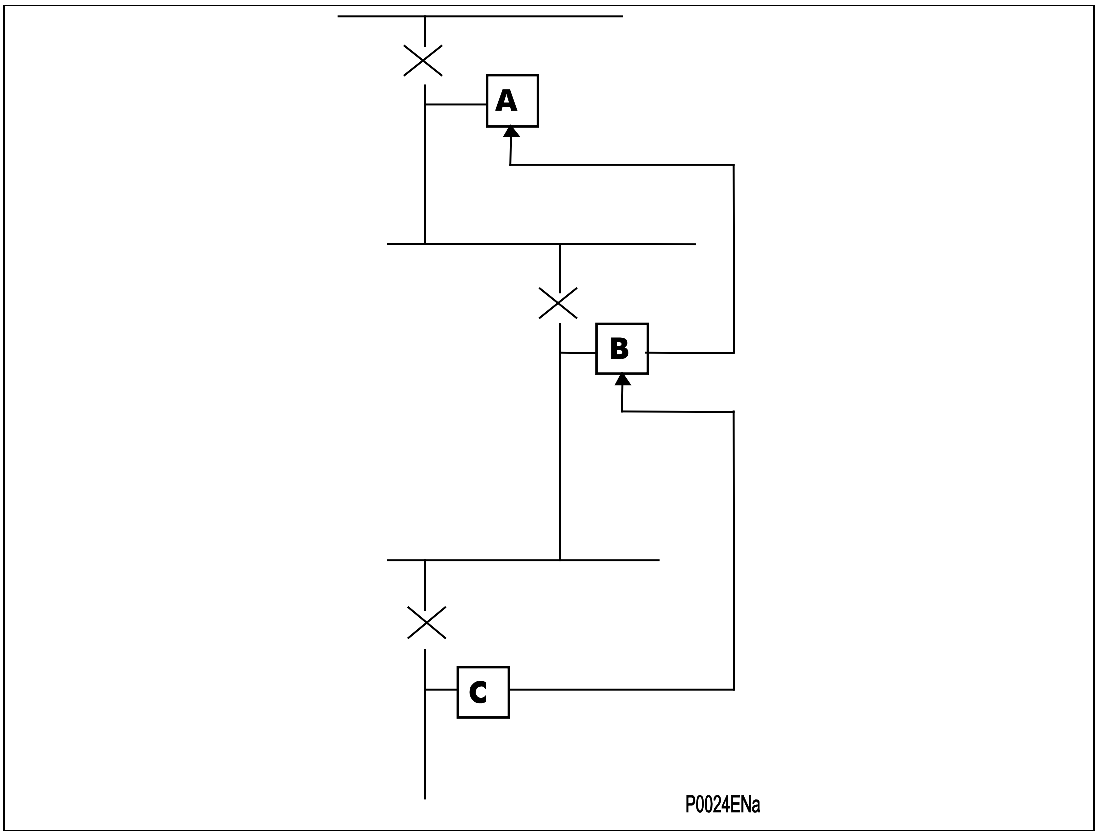

Figure 5: Blocking Logic

The "Blocking Logic" functions are assigned in the ***SETTING GROUP x/ INPUT CONFIGURATION Gx/*** menu. Every protection element can be assigned a blocking function: ***Block.tI>***, ***Block.tI>>***, ***Block.tI>>>***, ***Block.tSOTF***, ***Block.tIN>***, ***Block.tIN_2***, ***Block.tIN_3***, ***Block.tI<***, ***Block.tI2>***, **Block.tBrkn Cond**, ***Block.Itherm***, ***Block.AUX1***, **Block.AUX2**, ***Block.AUX3***, ***Block.tCB Fail***, ***Block.[79]***.

MiCOM P116 relays have separate blocking functions, which can be used to block every protection element, for example: Earth fault and phase overcurrent stages.

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2.5 Protection of Silicon Rectifiers

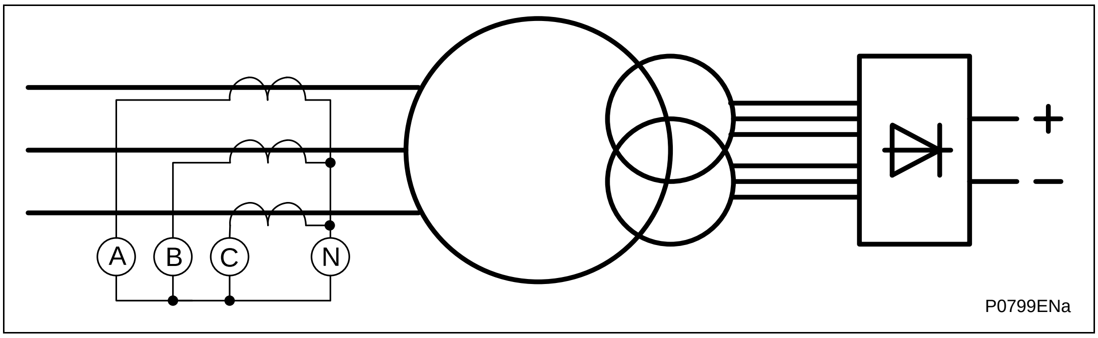

Figure 6: Protection of silicon rectifiers

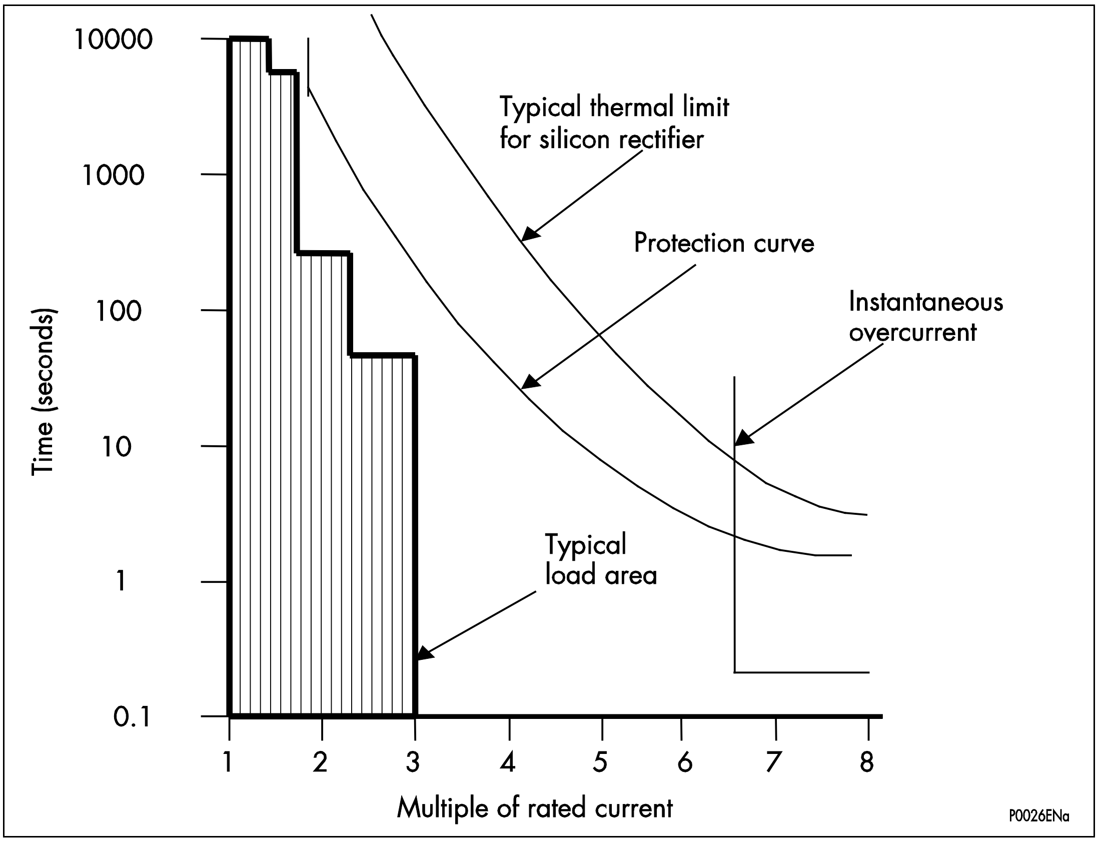

Figure 7: Matching curve to load and thermal limit of rectifier

The rectifier protection feature is based upon the inverse time/current characteristic as used in the MCTD01 (Silicon Rectifier Protection Relay) and the above diagrams show a typical application.

Rectifier protection differs from the more traditional overcurrent applications in that many rectifiers can withstand relatively long overload periods without damage, typically 150% for 2 hours and 300% for 1 min.

The threshold I> should typically be set to 110% of the maximum allowable continuous load of the rectifier. The relay issues start indications when the setting of I> has been exceeded, but this is of no consequence, as this function is not used in this application. The rectifier curve should be selected as it allows for relatively long overloads even with I> set to 110%.

Typical settings for the TMS factor are:

Light industrial service TMS = 0.02

Medium duty service TMS = 0.1

Heavy duty traction TMS = 0.8

The high set threshold is typically set to 8 times the rated current as this ensures that HV AC protection will discriminate with faults covered by LV protection. However, it has been known for the high set threshold to be set to 4 or 5 times the rated current where there is more confidence in the AC protection device. Use of the thermal element to provide protection between 70% and 160% of the rated current could enhance protection. It is also common practice to provide restricted earth fault protection for the transformer feeding the rectifier.

2.6 Back-up Scheme using "Selective Transfer Tripping"

In this application, the relay protecting the incoming feeder can trip the circuit breaker of the faulty feeder via the watchdog contact of the relay protecting the faulty feeder.

Figure 8 illustrates this example:

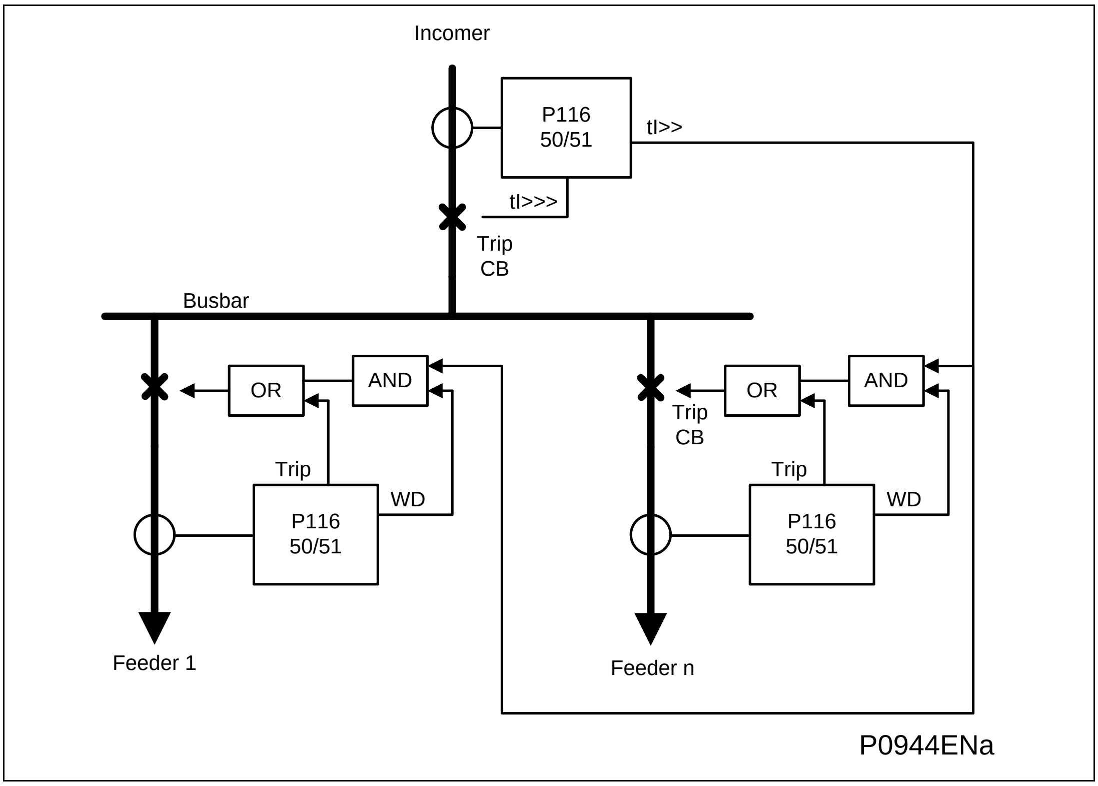

Figure 8: Example of a back-up scheme using "selective transfer tripping"

Thus, a fault occurring on a feeder can be cleared by tripping the circuit breaker of the faulty feeder even if the relay protecting this feeder has failed to operate. Without this function, the fault would normally be cleared by the opening of the circuit breaker of the incoming feeder. This would lead to total disconnection of the affected busbar.

The relay protecting the incoming feeder has two time-delayed outputs available (among others):

- 3rd stage: tI>>> time-delay, at 60 ms (active stage for the high phase current faults).
- 2nd stage: tI>> time-delay, selectively longer than the third stage, i.e. 360 ms.

The output contact associated with the 2nd stage is wired in series with the watchdog contact of the downstream relays, so that it can activate the trip coil of the circuit breakers of the feeders. Regarding the output contact associated with the 2nd and 3rd stages, this contact is directly wired to the trip coil of the incoming feeder's circuit breaker.

<u>Case n°1 → all relays operate normally:</u>

In this case, the watchdog contacts of all the relays are open.

Thus, for a phase fault on the busbar, stage tI>> or tI>>> of the P116 located on the incoming feeder will clear the fault.

For a phase fault on one of the feeder, the stages tI>> and tI>>> of the relay located on the incoming feeder being selectively set to higher values than the ones set for the phase o/c stages of downstream relays, the fault shall be cleared selectively by the relay of the faulty feeder (selectivity between the relay of the incoming feeder and relays of the outgoing feeders is ensured thanks to intervals of selectivity correctly chosen, or thanks to a suitable blocking scheme).

Case n°2 → the relay supervising one of the feeders is faulty:

In this case, the watchdog contact of that relay is closed.

Thus, for a phase fault on the busbar, stages tI>> and tI>>> activate their associated output contacts. However, stage tI>> will clear the fault as its threshold has been set to a lower value than that of stage tI>>>.

For a phase fault on one of the 'healthy' feeders, stages tI>> and tI>>> of the relay located on the incoming feeder being selectively set to higher threshold values than the ones set for the phase o/c stages of the downstream relays, the fault shall be cleared selectively by the relay of the faulty feeder (selectivity between the relay of the incoming feeder and relays of the outgoing feeders is ensured thanks to intervals of selectivity correctly chosen or to a suitable blocking scheme).

For a phase fault on the feeder of the failed relay, the stage tI>> of the relay located on the incoming feeder operates via the watchdog contact of the faulty relay on the trip coil of the circuit breaker of the faulty feeder. This stage being selectively set to a value lower than the stage tI>>> (which operates directly on the coil of the incoming feeder circuit breaker), the fault is therefore selectively cleared.

2.7 Remote Stand-By Protection Scheme

MiCOM P116 relays can be used as back-up for HV distance protection devices (Figure 9). Depending on the type of selectivity required, the P116's 51/51N element needs to be time-delayed either as definite time or as inverse time. The time-delay tI>/tIN> is set to a value that is compatible with stages Z2 or Z3 (2nd and 3rd distance protection zones).

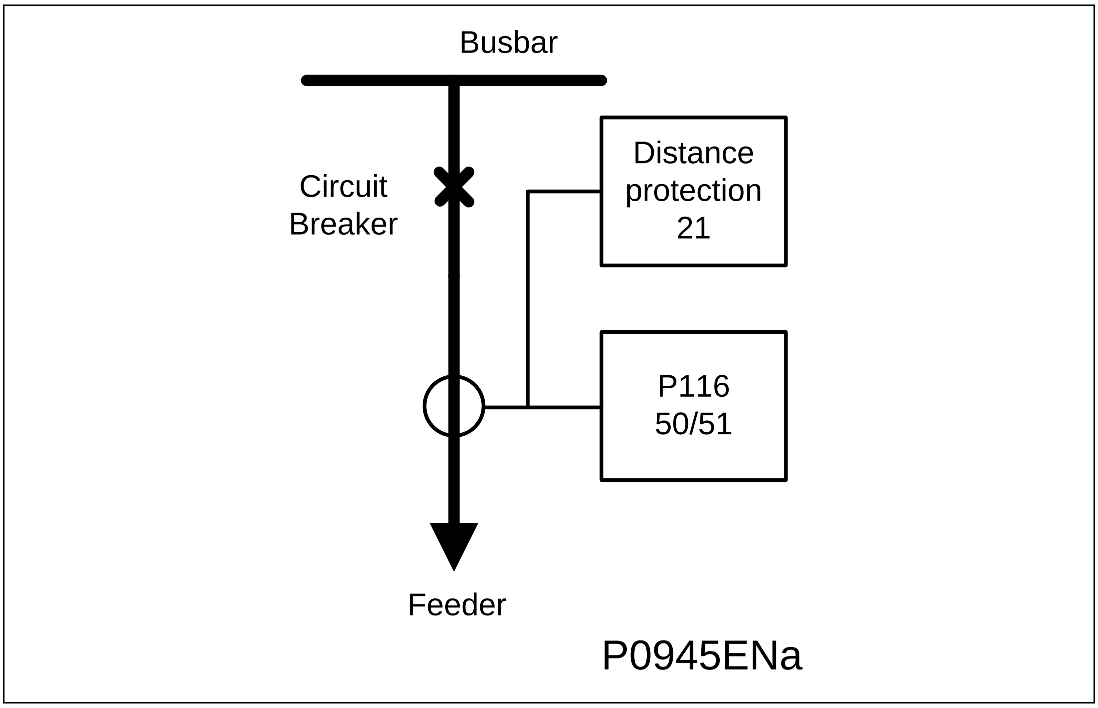

Figure 9: MiCOM P116 relay used as back-up for a distance protection device

The Watchdog contact of the distance protection (on a numerical protection unit) can be wired to a MiCOM P116 relay to optimize the trip time.

2.8 1 ½ Breaker Scheme

For HV/EHV substations with 1½ circuit breaker arrangements (Figure 10), the zone between the two circuit breakers and the switch section must be protected with a standard ANSI 50 protection device.

The tripping time is an essential criterion to be considered when choosing this protection device. MiCOM P116 relays are perfectly suited for this application. The time-delay of the first stage (tI>) is set to a low value (typically 100 ms above the circuit breaker failure time). This will allow the relay to be blocked by the close contact of the associated switch.

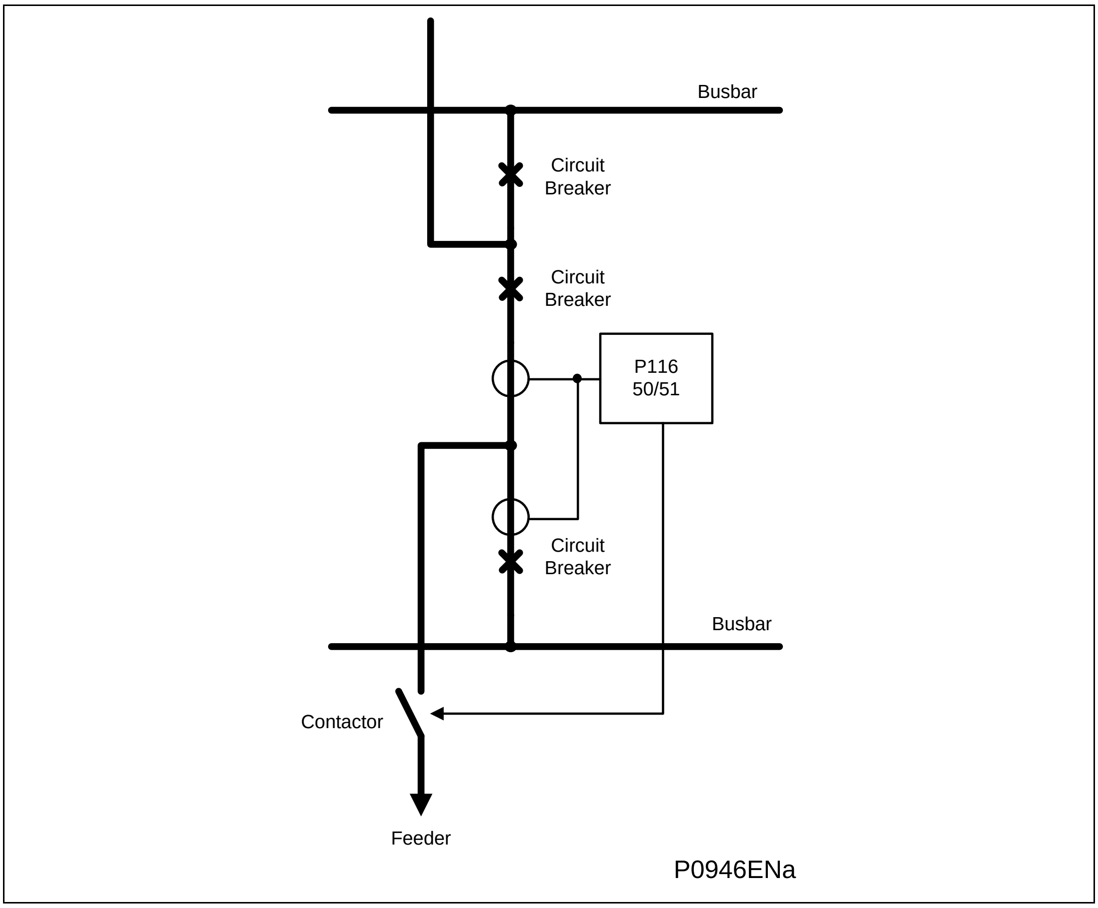

Figure 10: 1 ½ Breaker Scheme

2.9 Thermal Overload Protection

Thermal overload protection can be applied to prevent damages to the equipment of the electrical plant when operating at temperatures that are above the values designed for maximum withstand. A prolonged overloading causes excessive heating, which may result in premature deterioration of the insulation, or in extreme cases, insulation failure.

MiCOM P116 relays incorporate a current-based thermal replica, using load current to reproduce the heating and cooling of the equipment to be protected. The thermal overload protection element can be set with both alarm and trip stages.

Heating within any plant equipment, such as cables or transformers, is of resistive type ($I^2R \times t$). Thus, the quantity of heat generated is directly proportional to the current squared (I^2). The thermal time characteristic used in the relay is based on current squared, integrated over time.

MiCOM P116 relays automatically use the highest phase current as input information for the thermal model.

The equipment is designed to operate continuously at a temperature corresponding to its full load rating, where the generated heat is balanced by the heat dissipated through radiation etc. Over-temperature conditions therefore occur when currents in excess of the rating are allowed to flow for a certain period of time. It can be shown that temperatures during heating follow exponential time constants and a similar exponential decrease of temperature occurs during cooling.

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In order to apply this protection element, the thermal time constant (Te) of the plant equipment to be protected is therefore required.

A thermal time constant for cooling (Tr) is available for motor protection applications.

The following sections will show that different plant items possess different thermal characteristics, due to the nature of their construction.

2.9.1 Time Constant Characteristic

This characteristic is used to protect cables, dry type transformers (e.g. type AN), and capacitor banks.

The thermal time characteristic is given by:

$$\boxed{e^{\left(\frac{-t}{\tau}\right)} = \frac{\left(I^2 - (k \times I_{FLC})^2\right)}{\left(I^2 - I_p^2\right)}}$$

Where:

t	=	Tripping time, following application of the overload current, I
τ	=	Heating and cooling time constant of the protected plant equipment
I	=	Largest phase current
I_{FLC}	=	Full load current rating (relay setting ‘Thermal Trip’: Itherm)
k	=	1.05 constant, allows continuous operation up to < 1.05 I_{FLC}
I_P	=	Steady state pre-loading current before application of the overload

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

Mathematical formula applicable to MiCOM Relays:

The calculation of the tripping time is given by:

$$t_{trip} = \text{Te In}\left(\frac{\left|K^2-\theta\right|}{\left|K^2-\theta trip\right|}\right)$$

Where:

t_{trip} = Tripping time (in seconds)

Te = Thermal time constant of the protected element (in seconds)

K = Thermal overload equal to $I_{eq}/(k*I\theta >)$

I_{eq} = Equivalent current corresponding to the R.M.S. value of the largest phase current.

$I\theta >$ = Full load current rating given by the national standard or by the supplier.

k = Constant associated with the thermal state formula (1.05).

θ = Initial thermal state. If the initial thermal state = 30% then $\theta = 0.3$

θ_{trip} = Trip thermal state. If the trip thermal state is set at 100%, then θ trip = 1

The settings of these parameters are available in the menus:

PROTECTION G1/ [49] Therm OL

PROTECTION G2/ [49] Therm OL

The calculation of the thermal state is given by the following formula:

$$\Theta_{\tau+1} = \left(\frac{I_{eq}}{k \times I\Theta >}\right)^2 \left[1 - e^{\left(\frac{-t}{T_e}\right)}\right] + \Theta_\tau e^{\left(\frac{-t}{T_e}\right)}$$

θ being calculated every 20ms.

2.9.2 Setting Guidelines

The current setting is calculated as:

Thermal Trip (θ_{trip}) = permissible continuous loading of the plant equipment / CT ratio. Typical time constant values are given in the following tables. The ‘Time Constant’ parameter is given in minutes.

Paper-insulated lead sheathed cables or polyethylene insulated cables are placed above the ground or in conduits. The table shows τ in minutes, for different cable rated voltages and conductor cross-sections (CSA):

CSA mm²	**6 - 11 kV**	**22 kV**	**33 kV**	**66 kV**
25 - 50	10	15	40	-
70 - 120	15	25	40	60
150	25	40	40	60
185	25	40	60	60
240	40	40	60	60
300	40	60	60	90
	Time constant τ (minutes)			

Other plant items:

	Time constant Te (minutes)	**Limits**
Dry-type transformers	40 60 - 90	Rating < 400 kVA Rating 400 - 800 kVA
Air-core reactors	40	
Capacitor banks	10	
Overhead lines	10	Cross section ≥ 100 mm^2 Cu or 150mm^2 Al
Busbars	60	

An alarm can be raised when reaching a thermal state corresponding to a percentage of the trip threshold. A typical setting might be ‘Thermal Trip’ = 70% of thermal capacity.

2.10 Cold Load Pick-Up (Model A)

The Cold Load Pick-up feature allows selected settings of MiCOM P116 relays to be changed to react to temporary overload conditions that may occur during cold starts. This condition may happen by switching on large heating loads after a sufficient cooling period, or loads that draw high initial starting currents.

When a feeder is energized, the current levels that flow for a period of time following energizing may differ greatly from the normal load levels. Consequently, overcurrent settings that have been applied to give short circuit protection may not be suitable during this period.

The Cold Load Pick-up (CLPU) logic raises the settings of selected stages for a set duration (tCL). This allows the protection settings to be set closer to the load profile. Cold load pick-up cannot restart until the end of tCL duration. The CLPU logic provides stability, without compromising protection performance during starting.

The CLP can be started by a digital logic Input Cold Load PU (***Cold Load PU? 1: Cur+Input*** or ***Cold Load PU? 2: Input***) which can be assigned to 52a CB status or by current stages logic (***Cold Load PU? 1: Cur+Input***). If the Cold Load PU logic has to be triggered by current criteria only, ***Cold Load PU Input*** function must not be configured to any digital input. If this function is configured to selected input, both criteria will work in parallel way. But the current criteria reset will be blocked if the ***Cold Load PU Input*** will be in the high state. So if ***Cold Load PU Input*** is in the high state (CB is closed) even if the current is below 10% In tCL timer will counts pulse time (P116 works on the Cold Load PU values).

The following diagram shows the logic start for CLPU:

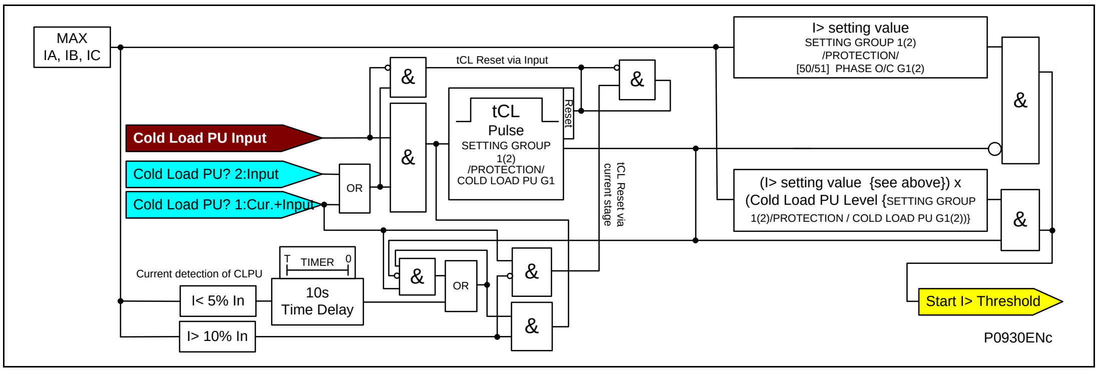

Figure 11: Cold Load Pick-Up Logic

2.10.1 Example of Application for Earth Fault Protection Applied to Transformers

Where an earth fault relay is residually connected on the primary side of a delta-star transformer, no time-delay is required for co-ordination purposes, due to the presence of the delta winding. However, a nominal time-delay or stabilizing resistor is recommended, to ensure transient stability during transformer energizing.

The CLPU logic may be used in a similar manner to that previously described for the motor application.

This method will not provide stability in the event of asymmetric CT saturation (as a result of an unbalanced fault condition). In this case, use a stabilizing resistor.

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2.11 Switch On To Fault / Trip On Reclose Protection (Model A)

2.11.1 General

In some feeder applications, fast tripping may be required if a fault is still present on the feeder after the reclosure of the circuit breaker (Close on to fault).

Some faults may not be cleared after a reclose due to the fact that the conditions that led to the fault have not been removed from the feeder after a reclosing cycle or a manual trip, or due to earthing clamps left on after a maintenance visit. In these cases, it may be desirable to clear the fault more quickly, rather than wait for the DMT or IDMT trip time-delay associated with the involved protection to elapse.

In the case of a CB being manually closed, a switch on to an existing fault may occur. This situation is particularly critical because the overcurrent protection element would not clear the fault until the set time-delay has elapsed. It is then desirable to clear the fault as fast as possible.

Enabling and setting the SOTF (Switch On To Fault) function can be done under the ***SETTING GROUP x/PROTECTION Gx/SOTF*** submenu.

Crossing of SOTF threshold will initiate the SOTF function.

2.11.2 SOTF description

The following signals can activate the SOTF function:

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- closing by Input ***(Manual Close Input)***,
- manual closing controlled by the HMI, (***Close key order***),
- front panel communication control (***HMI order***),
- rear communication control (***Rear Com order***),

The diagram below illustrates this functionality.

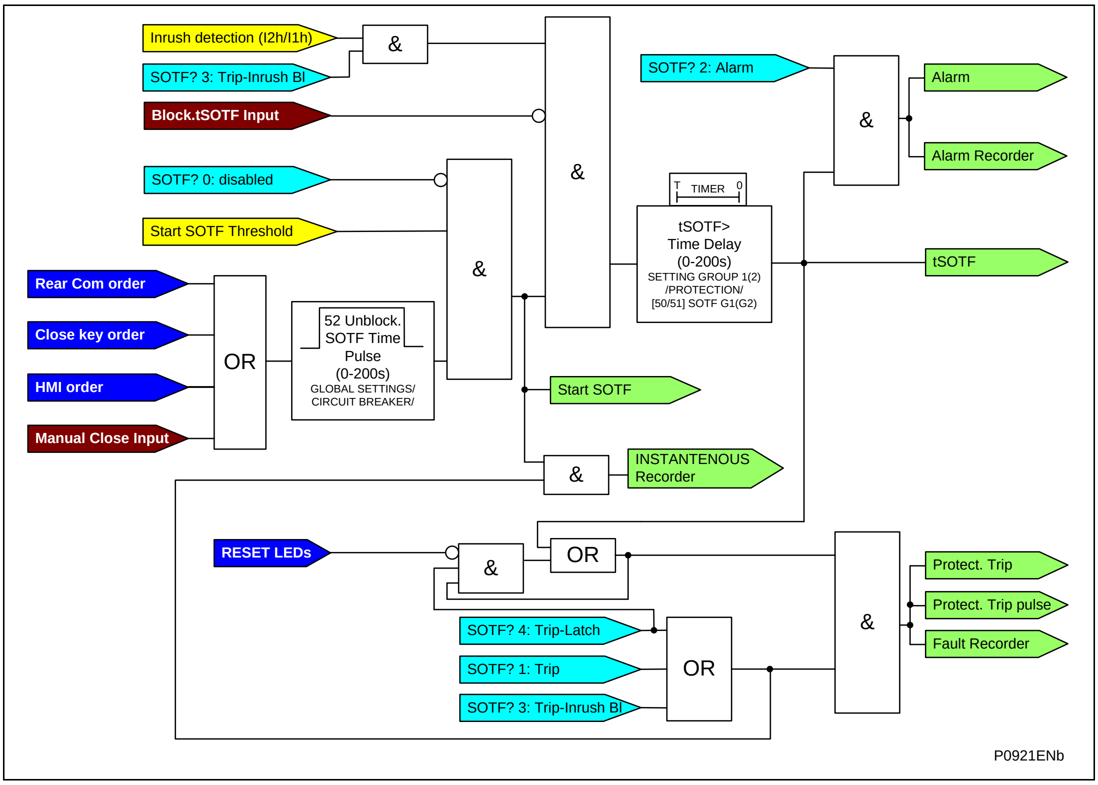

Figure 12: SOTF Logic Diagram

When at least one of the selected signals has been detected, a ***52 Ublock.SOTF Time*** (***GLOBAL SETTINGS/ CIRCUIT BREAKER/ 52 Unblock.SOTF Time*** submenu) timer starts to activates SOTF protection element.

Once this timer (***52 Ublock.SOTF Time***) is active and SOTF thresholds have been crossed, the ***tSOTF*** settable time-delay starts. This settable time-delay is particularly useful in applications where fault selectivity in stages two or three is required.

This time-delay (***tSOTF***) is also useful in cases where serious transients may be present, where the three poles of the CB do not all close at the same time and in cases where the CB may not close instantaneously.

tSOTF can also be considered as a trip time-delay that substitutes itself to the trip time-delay associated with the crossed threshold so that the tripping time is accelerated.

If a trip due to switch on to fault occurs during the reclaim time of the ARC, the trip will be final and the ARC will be locked.

If the SOTF stage is reset before the settable time-delay ***tSOTF*** elapses, the SOTF function is reset.

2.12 LOCAL / REMOTE MODE (Model A)

2.12.1 General

The goal of this feature is to make it possible to block commands sent remotely through communication networks (such as setting parameters, control commands, etc.), so as to prevent any accidents or maloperation during maintenance work performed on site.

A digital input labeled “***Local CTRL mode***” is assigned to this feature. In Local mode, only the synchronizing time signal, ***Remote CTRL mode*** and ***Comm. Oder*** are allowed.

The local mode can also be set in default CTRL mode cell. The Local/Remote mode state is displayed in this cell.

2.12.2 Setting

Meaning of “*Local*” mode is clear: the control is possible locally only so remote commands (via RS485) are rejected by P116.

The meaning of “*Remote*” mode can differ depends on the custom of users or application.

There are two possible definition:

- “*Remote*” mode means that remote or local control are possible
- “*Remote*” mode means that remote control is possible only (local control is rejected by P116)

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Customization of “*Remote*” mode **definition** is applied by selection of proper setting in the ***GLOBAL SETTINGS/CIRCUIT BREAKER/ Remote CTRL Mode*** cell:

- ***0: Remote only*** – Local control via an input or/and the HMI or/and the Close/Trip key are blocked.
- ***1: Remote + LOC*** – Local and Remote control are permitted.

Note: The auto-recloser is not blocked via the Local/Remote Mode.

When the “Local” input is energized, all remote commands are blocked. When the “Local” input is de-energized, remote control commands are accepted.

If local/remote switching has to be done outside of the P116, the output configuration can be as follows (Figure 13):

- the protection trip is assigned to the ***Prot.Trip pulse*** output,
- the remote close command is assigned to the ***Close CB Order*** output,
- the remote trip command is assigned to the ***Trip CB Order*** output.

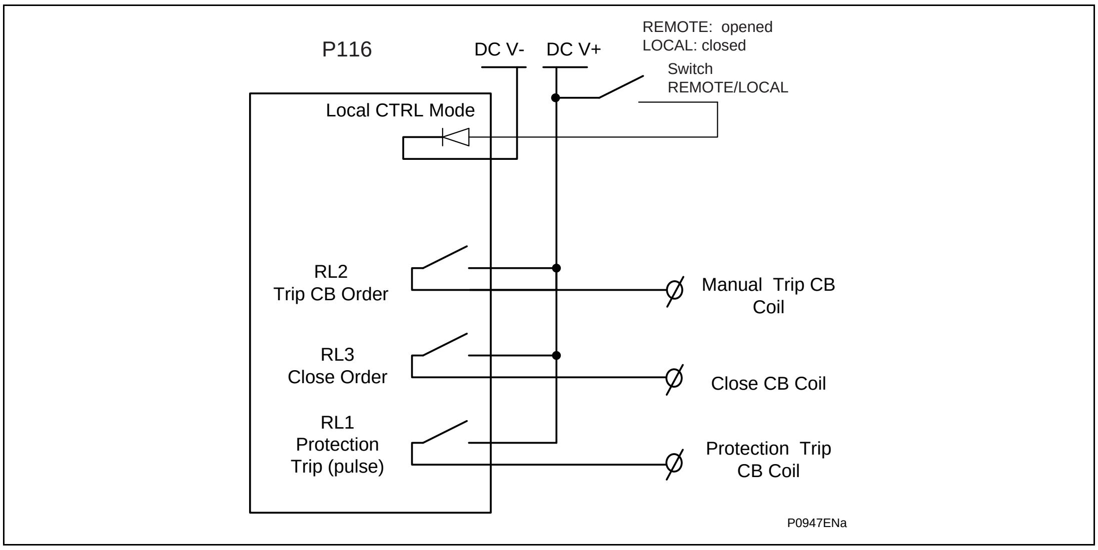

Figure 13: Example of Local/Remote Application

If separate output contacts for remote and local commands are required because external Local/Remote switching is used, commands sent remotely should be assigned to:

- ***Comm.Order1*** for a remote trip command,
- ***Comm.Order2*** for a remote close command,

The protection trip is assigned to the ***Prot.Trip pulse*** output.

The Local Trip (HMI, Input, Trip key) is assigned to the ***Trip CB Order*** output.

The Local Close (HMI, Input, Trip key) and the Auto-reclose function are assigned to the ***Close CB Order*** output.

Example for the above application:

In the following scheme (Figure 14), the user may assign the different signals to different relays: “TRIP” signal may be assigned to the trip relay (***Prot.Trip pulse*** and ***Trip CB Order)***, the ***Comm.Order1*** (remote trip) signal to the auxiliary relay number 2, the ***Close CB Order*** signal to the auxiliary relay number 3 and the ***Comm.Order2*** (remote close) to the auxiliary relay number 4.

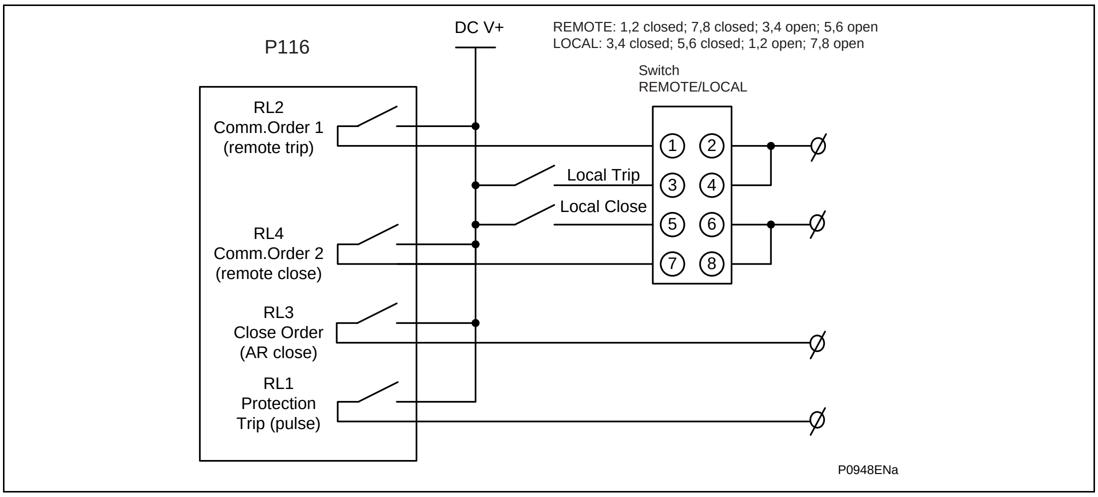

Figure 14: Example of Local/Remote Application

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2.13 Selective scheme logic (Model A)

The following figure describes the use of non-cascade protection schemes using the start contacts from downstream relays to block operation of upstream relays.

In the case of Selective Overcurrent Logic (SOL), the start contacts are used to increase the time-delays of upstream relays, instead of blocking them. This provides an alternative approach to achieving a non-cascade type of overcurrent scheme. It may be more familiar to some utilities than the blocked overcurrent arrangement.

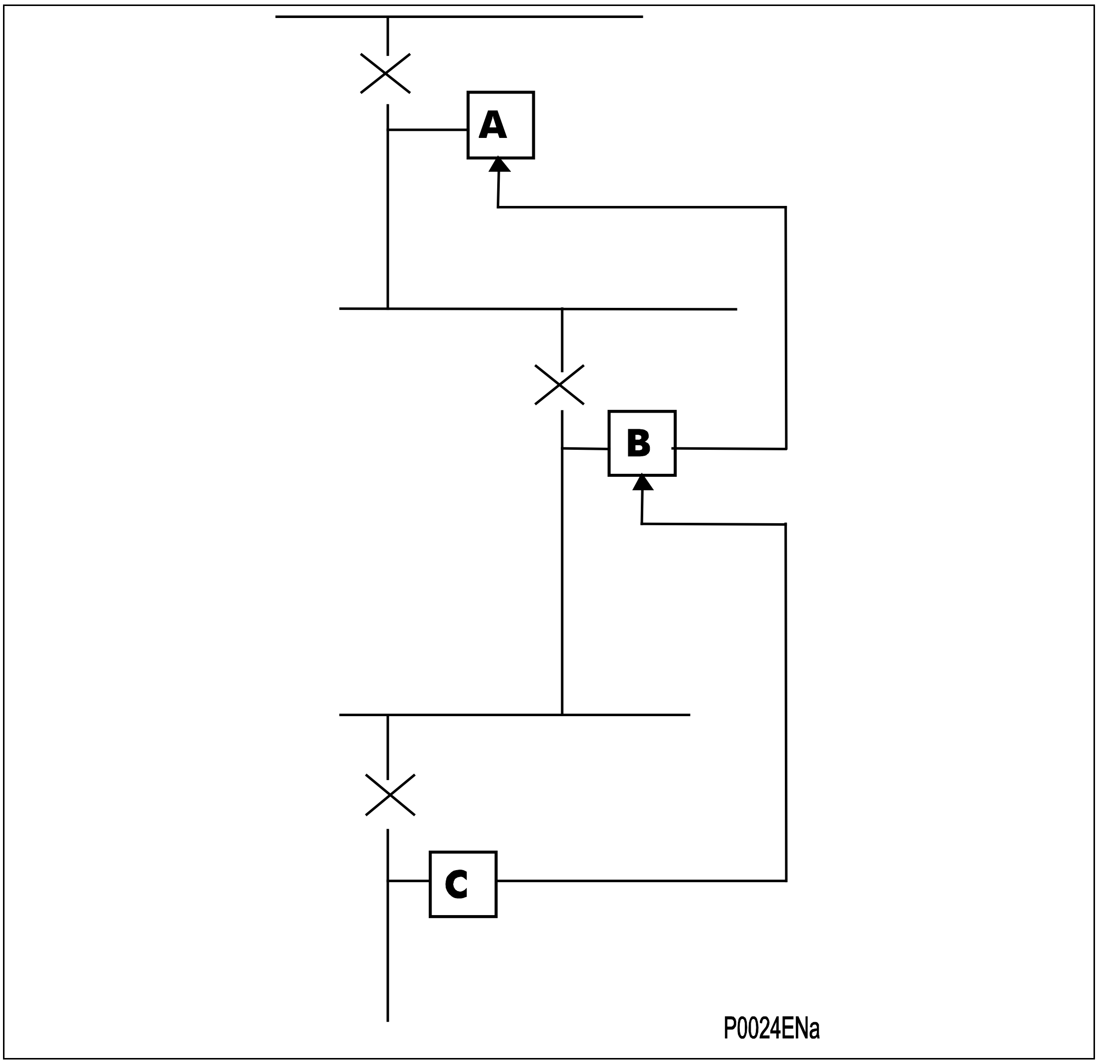

Figure 15: TYPICAL SCHEME LOGIC

The SOL function temporarily increases the time-delay settings of the second and third stages of phase overcurrent, derived and measured earth fault and sensitive earth fault protection elements. This logic is initiated by energizing the appropriate logic input (***SEL1*** or ***SEL2***) as selected in ***SETTING GROUP x/INPUTS CONFIGURATION Gx*** menu.

To allow time for a start contact to initiate a change of setting, the time settings of the second and third stages should include a nominal delay. Guidelines for minimum time settings are identical to those given for blocked overcurrent schemes.

The tSel1 and tSel2 timers can be independently set from 0 to 200 s (***SETTING GROUP x/PROTECTION Gx/LOGIC SELECT. Gx*** menu).

2.14 Auxiliary timers (Model A)

Four auxiliary timers tAux1, tAux2, tAux3, tAux4 are available and associated with Aux1, Aux2, Aux3, Aux4 logic inputs (refer to ***SETTING GROUP x/INPUTS CONFIGURATION Gx*** menu). When these inputs are energized, the associated timers start and, when the set time has elapsed, the associated output relays close (refer to ***SETTING GROUP x/OUTPUT RELAYS CONFIGURATION Gx*** menu). Time-delays can be independently set from 0 ms to 600 s (***SETTING GROUP x/PROTECTION Gx/AUX TIMERS Gx*** menu).

AUX function can be configured to:

- Trip CB (***Protect.Trip***, ***Prot.Trip pulse***, Disturbance and Fault Recorder, **TRIP** LED and FLAG)
- Alarm signal (***Alarm***, ***Alarm*** LED),
- Trip CB with Inrush blocking (***Protect.Trip***, ***Prot.Trip pulse***, Disturbance and Fault Recorder, **TRIP** LED and FLAG)
- Trip CB with latching up to signaling reset (***Protect.Trip***, ***Prot.Trip pulse***, Disturbance and Fault Recorder, **TRIP** LED and FLAG)
- Load Shedding triggered via AUX input (***Trip CB Order),*** tAUX is time-delay for trip,
- Auto-reclose after Load Shedding triggered via AUX input (high level); tAUX is time-delay for close ***(Close CB Order)***,
- Auto-reclose after Load Shedding triggered via AUX input (low level); tAUX is time-delay for close ***(Close CB Order)***,

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For more details about: Trip CB, Alarm signal, Trip with Inrush blocking, Trip CB with latching refer to the Operation Chapter (P116/EN OP)

AUX and ***tAUX*** signal can be assigned to LEDs or outputs.

AUX1, ***AUX2*** and ***AUX3*** can be blocked via binary input assigned to the ***Block.AUXn*** output.

Binary Inputs can be configured to AUX5 and AUX6. These AUX functions have no timers and can be used as logic bridge between inputs and: LEDs and/or outputs.

An example of Load Shedding and Auto-reclose after Load Shedding logic is shown: Figure 16.

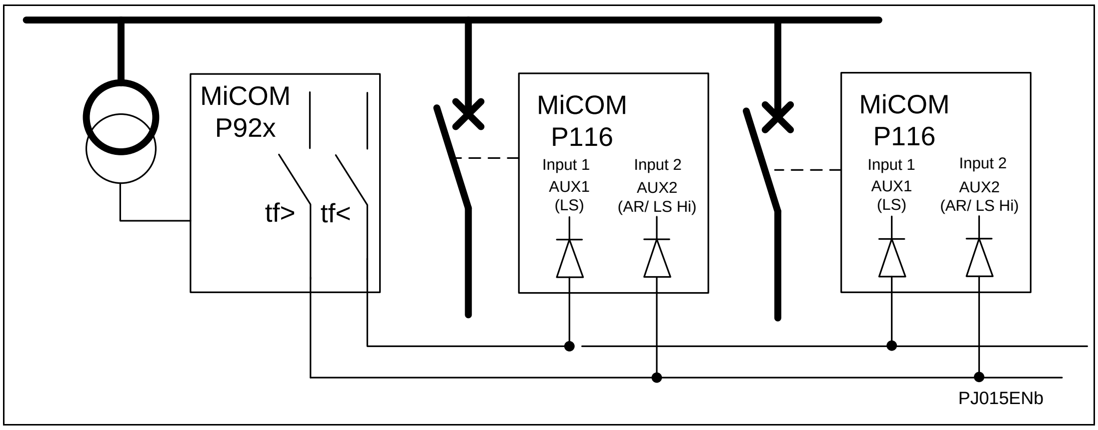

Figure 16: An example: Load Shedding and Auto-reclose after Load Shedding logic. Separate inputs for: LS (AUX1) and AR after LS (AUX2)

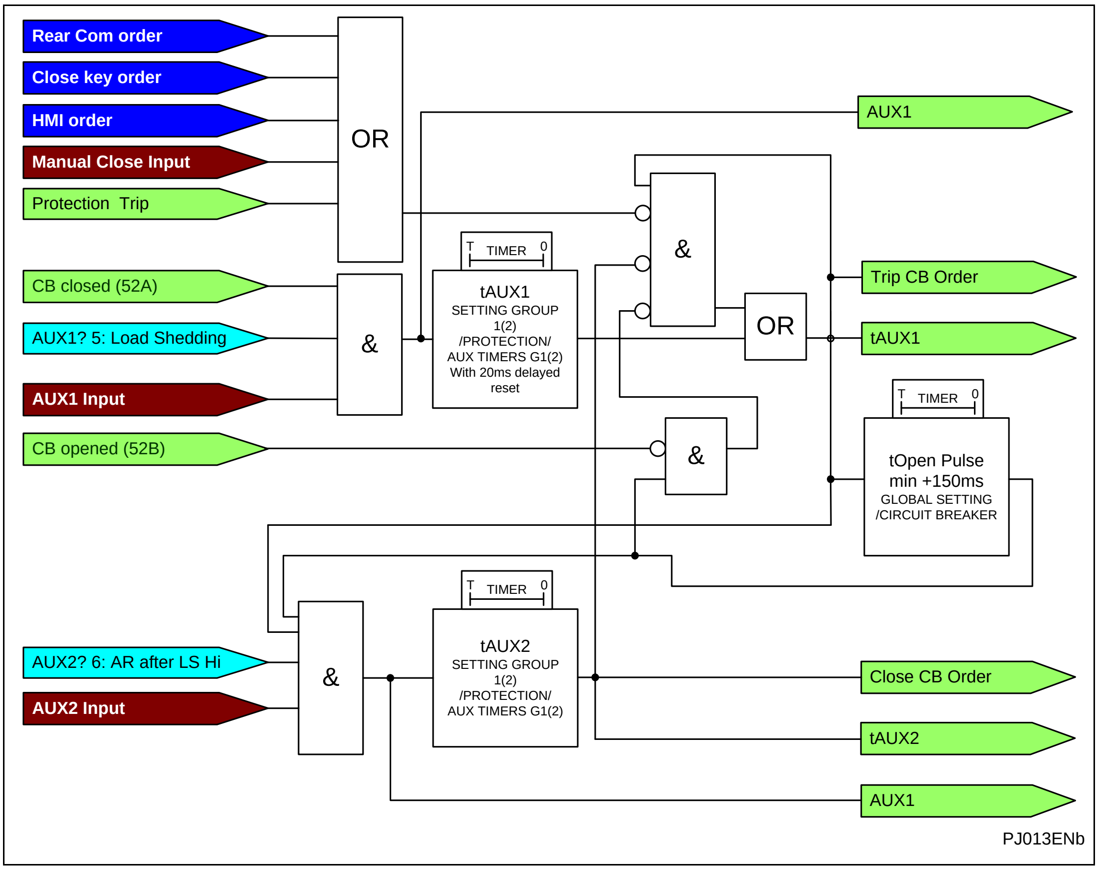

Figure 17: Load Shedding and Auto-reclose after Load Shedding logic. Separate inputs for: LS (AUX1) and auto-reclose after LS (AUX2) (for example: Input 1 configured to AUX1, Input 2 to AUX2) – see Figure 16

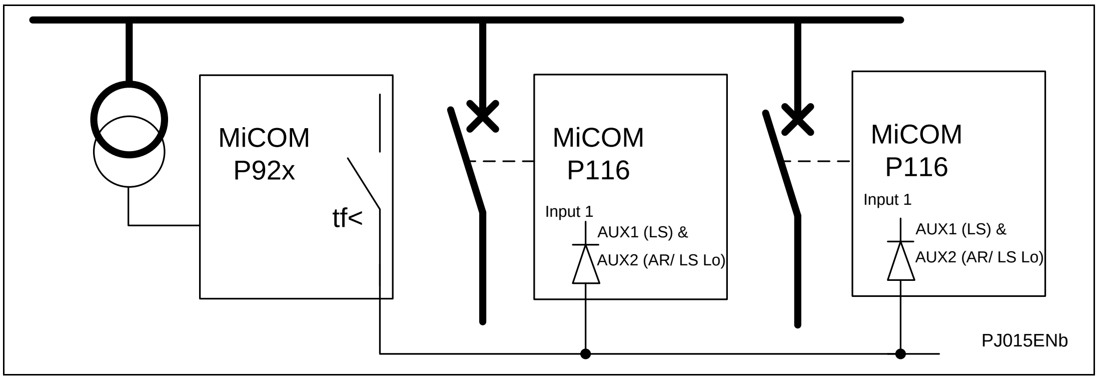

Figure 18: An example: Load Shedding and Auto-reclose after Load Shedding logic. Separate inputs for: LS (AUX1) and auto-reclose after LS (AUX2)

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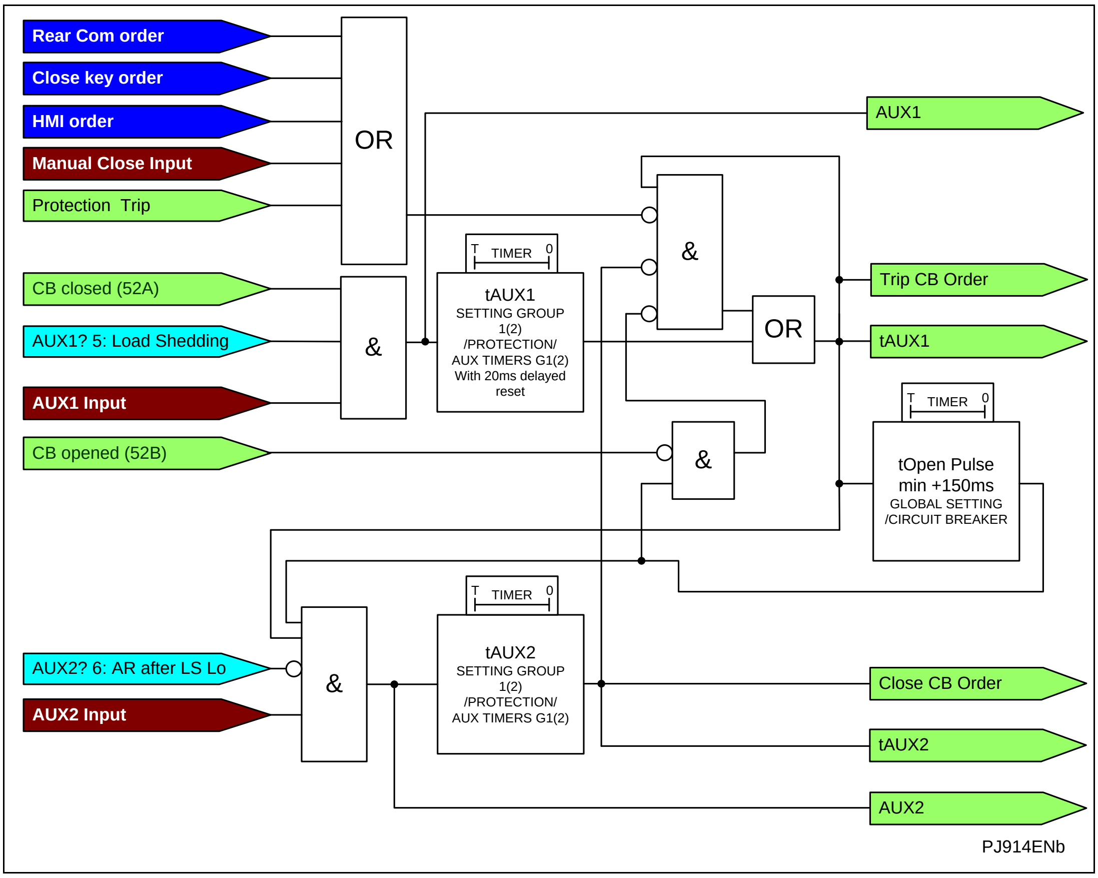

Figure 19: Load Shedding and Auto-reclose after Load Shedding logic. The same input for: LS (AUX1) and AR after LS (AUX2) (for example: Input 1 configured to AUX1 and AUX2) - see Figure 18

2.15 Setting Group Selection (Model A)

MiCOM P116 relays have two protection setting groups called PROTECTION G1 and PROTECTION G2. Only a one group is active at any time.

If a group is used in an application it is possible to remove the other group from the menu in order to simplify the setting procedure. If one group only is chosen the relay uses Group 1 even if the other parameters are set to Group 2 (Inputs, Menu, Remote Group Setting).

The selection of the number of groups is done at ***GLOBAL SETTINGS/SETTING GROUP SELECT/ Number of Groups: 1: One Group*** or ***2: Two Groups.***

If ***1: One Group*** is selected, the ***SETTING GROUP 2*** column and the setting group cell are hidden in menu.

Switching between the groups can be done via:

- a selected binary input assigned to the **Setting Group 2** logic input (***SETTING GROUP x/INPUTS CONFIGURATION Gx*** submenu),
- the relay front panel interface (***GLOBAL SETTINGS/SETTING GROUP SELECT/ Setting Group: 1: Group1*** or ***2: Group2***),
- through the communications port (refer to Mapping Database for detailed information).

Switching between setting groups can be done even while a protection function is active (no timers are resetting).

The user can check which one of the setting groups is active looking in the ***OP PARAMETERS*** menu: ***Active Set Group*** cell.

The user can also assign the active group (***Setting Group x*** function) to an output relay (***SETTING GROUP x/OUTPUT RELAYS CONFIGURATION Gx***) or to an LED (***SETTING GROUP x/LEDs CONFIGURATION G1***).

Setting group change via a digital input

It is possible to change the setting group by energizing a digital input (on level).

If the setting group switchover is done via a binary input, the change from Group 1 to Group 2 is executed after the set time-delay: ***t Change Setting G1->G2*** (***GLOBAL SETTINGS/SETTING GROUP SELECT***). The switch from Group 2 back to Group 1 is instantaneous.

Switch between Active Groups via a Binary Input

When powering up the relay, the selected group (Group 1 or Group 2) corresponds to the state of the logic input assigned to ***Setting Group 2***. This means:

A – ***Reverse Inp.Logic*** = 0 and ***Setting Group 2*** = 1
(***SETTING GROUP x/INPUTS CONFIGURATION Gx*** submenu),

If the programmed logic input starts being supplied with +V, then after the ***t Change Setting G1->G2*** time-delay the active group will be G2.
If the programmed logic input is not supplied with +V, then the active group will be G1.

B – ***Reverse Inp.Logic*** = 1 and ***Setting Group 2*** = 1
(***SETTING GROUP x/INPUTS CONFIGURATION Gx*** submenu),

If the programmed logic input is supplied with +V, then the active group will be G1.
If the programmed logic input stops being supplied with +V, then after the ***t Change Setting G1->G2*** time-delay the active group will be G2.

Notes: 1. Binary Input configuration is associated with both Setting Groups, so that if in a Setting Group the selected binary input is assigned to ***Setting Group 2***, in the other group it must be set to ***Setting Group 2*** as well, otherwise no switch will occur.

2. If the P116 is powering up (from the currents or the auxiliary voltage) and Group 2 is selected via a binary input, the ***t Change Setting G1->G2*** time-delay is ignored (changing to setting group 2 is instantaneous – without time-delay).

3. The setting group switch is based on the level of the binary input. So as long as Setting Group 2's logic signal is high, the P116 uses Setting Group 2.

Switch between Active Groups via the Menu or a Remote Command (RS485, USB)

By using the relay front panel interface it is possible to change the active setting group: ***1: Group1*** or ***2: Group2*** (menu cell: ***GLOBAL SETTINGS/SETTING GROUP SELECT/ Setting Group***).

Above menu cell is common for changing from panel interface and via remote command (RS485 or USB).

It means that if the ***GLOBAL SETTINGS/SETTING GROUP SELECT/ Setting Group*** menu cell is set to ***1: Group1*** and the remote setting group 2 command is executed, the value of menu cell: ***GLOBAL SETTINGS/SETTING GROUP SELECT/ Setting Group*** will be changed to ***2: Group2*** value (Active group: 2).

Setting group 1 will be applied if:

- ***1: Group1*** is set in the ***GLOBAL SETTINGS/SETTING GROUP SELECT/ Setting Group*** menu cell from the relay's front panel interface,

  or

- the remote setting group 1 command is executed. The value of the ***GLOBAL SETTINGS/SETTING GROUP SELECT/ Setting Group*** menu cell will then be changed to ***1: Group1***.

WARNING: If the digital input has been assigned to the setting group change, it is not possible to change the setting group via remote communications. If changing via Menu or RS485 is required ensure that no input is assigned to ***Setting Group 2***.

Priority

The detailed logic table for setting group selection is shown below:

Binary Input ***Setting Group 2***	Front Panel and Remote Setting	Active Group
Not configured	G1	G1
Not configured	G2	G2
G1	G1	G1
G1	G2	G1
G2	G1	G2
G2	G2	G2

Note: If a setting group change initiated by a remote command has not been effected due of priority settings, that command is ignored (not recorded in the P116's logic for the future, when priority settings allow changing).

It is possible to assign an Active Group state to an output contact by setting the output contact to the ***Setting Group x*** output (***SETTING GROUP x/OUTPUT RELAYS CONFIGURATION Gx***.

If Active Group signaling is required, some LEDs should be assigned to the ***Setting Group x*** function (***SETTING GROUP x/LEDs CONFIGURATION Gx***).

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2.16 Maintenance Mode

This menu allows the user to check the operation of the protection functions.

It is possible to set following ***Maintenance mode*** options (settings):

- "***No***" - ***Maintenance mode*** is disabled. All window cells below are hidden (***Maintenance mode*** is the latest cell in ***COMMISIONING*** column)
- "***Yes,outp.trips***" - ***Maintenance mode*** is enabled. In this mode all test cells in ***COMMISIONING*** column are shown. During tests outputs are energized.
- "***Yes,outp.block***" - ***Maintenance mode*** is enabled and all test cells in ***COMMISIONING*** column are shown. In this mode, the high state of output functions are ignored (control of outputs are blocked).

  This option allows the user to check the operation of the protection functions without actually sending any external command (Tripping or signalling).

Depends on the rear protocol selected in menu, transmission of information to SCADA is blocked (Modbus RTU) or sent (IEC 103) with additional information to know that P116 is in Maintenance mode (refer to Communication chapter and EN 60870-5-103 standard).

Changing of setting from "***No***" to "***Yes,….***" from the front panel activate this mode for 5 minutes only. After this time the option is automatically switched to "***No***".

The selection of the maintenance mode is possible by logic input (the level), control command (rear or front port), or by front panel interface. The maintenance mode is terminated by:

- Low state of logic input assigned to ***Maintenance mode*** function,
- Control command which activate this mode (rear command or setting: "***Yes,….***") and by turning off the power supply.

Note: Maintenance rear command is available in Modbus protocol only

When this menu is activated (set to: "***Yes,outp.trips***" or "***Yes,outp.block***"), the Alarm led is lit. Additionally it is possible to configure Maintenance Mode to programmable LED.

In "***Yes,outp.block***" case, all the output contacts are blocked, and no command can be issued to these contacts, even if a protection threshold associated with one of these output contacts has been crossed. (If a protection threshold is crossed, all associated LEDs will be ON, even the TRIP LED, if protection element is set to ***Trip***).

2.17 Negative Sequence Overcurrent Protection (Model A)

In traditional phase overcurrent protection schemes, overcurrent thresholds must be set above the maximum load current levels. This limits sensitivity of the relay. Most protection schemes also use an earth fault element based on residual current, which improves sensitivity for earth faults. However, it can happen that some faults occur and stay undetected by such schemes.

Any unbalanced fault condition will produce negative sequence current. Thus, a negative phase sequence overcurrent element can detect both phase-to-phase and phase-to-earth faults.

This section describes how negative phase sequence overcurrent protection may be applied in conjunction with standard overcurrent and earth fault protection in order to solve some application problems.

- Negative phase sequence overcurrent protection is more sensitive to resistive phase-to-phase faults than phase overcurrent elements, which may not operate.
- In some applications, an earth fault relay may not be able to detect a residual current because of the configuration of the network. For example, an earth fault relay connected on the delta side of a delta-star transformer is unable to detect earth faults on the star side. However, negative sequence current will be present on both sides of the transformer in any fault condition, independently of the transformer configuration. Therefore, negative phase sequence overcurrent element may be used to provide time-delayed back-up protection for any uncleared asymmetrical faults.
- Where fuses are used to protect motors on rotating machines, a blown fuse produces a large amount of negative sequence current. This is a dangerous condition for the machine because negative phase sequence current generates overheating. Then, a negative phase sequence overcurrent element may be used to back-up motor protection relays.
- It may also be required to trigger an alarm to announce the presence of negative phase sequence currents in the system. Operators are then prompted to investigate the cause of the unbalance.

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The negative phase sequence overcurrent elements have a current pick up setting, I2>, and can be time-delayed using configurable timer tI2>.

I2> stages can be set under the ***SETTING GROUP x/PROTECTION G1 (2)/[46] NEGATIVE SEQ. O/C*** menu column.

The current pick-up stage I2> must be set to a value that is higher than the normal negative phase sequence current because of the normal unbalance conditions on the network. This can be done practically during the commissioning, using the ***MEASUREMENTS*** menu of the relay to display the negative phase sequence current value. Then, this value has to be increased by 20%.

Where negative phase sequence element is used to clear particular cases of uncleared asymmetric faults, the stage setting have to be calculated based on a fault analysis of that particular system, due to the complexities involved. However, to ensure that the protection element will operate, the current pick-up value has to be set to approximately 20% below the lowest calculated negative phase sequence fault current for a specific remote fault.

It is essential to set correctly the time-delay associated with this function. It should also be noted that this element is used primarily as a back-up protection to other protective devices or to provide an alarm. Therefore, this function is usually set with a long time-delay.

Care must be made to ensure that the time-delay is set above the operating time of any other protection device (at minimum fault level) present on the system and that may react to unbalanced faults, such as:

- Phase overcurrent elements
- Earth fault elements
- Broken conductor elements

- Negative phase sequence influenced thermal protection elements

The tI2> time-delay associated with the I2> stage can be set under the menu ***SETTING GROUP x/PROTECTION G1 (2)/[46] NEGATIVE SEQ. O/C***.

2.18 Broken Conductor Detection (Model A)

Most of the faults that affect a power system occur between one phase and the earth or between two phases and the earth. These faults are shunt faults and are caused by lightning discharges and other overvoltages generating flashovers. They may also arise from birds on overhead lines or mechanical damage on underground cables, etc.

Such faults lead the current to increase appreciably and therefore they can easily be detected in most applications. Open circuit faults are a different type of faults that can happen in electrical networks. These faults can be caused by broken conductors, blown fuses or maloperation of a pole of a circuit-breaker.

Series faults will not lead to an increase in phase current and therefore they cannot easily be detected by common overcurrent relays. However, this type of fault produces an unbalance that creates negative phase sequence current, which can be detected.

The use of negative phase sequence overcurrent is then recommended to detect such faulty conditions. However, on lightly loaded lines, the value of the negative sequence current caused by a faulty condition may be very close to, or even inferior, to the full load steady state unbalance generated by CT errors, load unbalances, etc. As a consequence, a negative sequence protection element would not work for low level of loads.

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As a solution, the MiCOM P116 have a protection element that measures the ratio between the negative and the positive phase sequence current (I2/I1). By using this ratio rather than only the measured I2, the relay will be able to detect a fault condition independently of the load level on the power system, since the ratio remains approximately constant whatever the variations in load current. It is then possible to have a more sensitive setting.

Note: The Broken Conductor function is inhibited if the value of the current flowing in each of the three phases is below ***Brkn Cond I< block*** undercurrent threshold (factory setting: 10% of the nominal current).

<u>Setting Guidelines</u>

On single point earthed power systems, there is a low zero sequence current flow and the ratio Is2/Is1 that flows is close to 100%. On power systems with multiple earthing, (assuming that the impedances in each sequence system are equals), the ratio I2/I1 will be equal to 50%.

It is possible to calculate the ratio I2/I1 corresponding to various system impedances, according to the following equations:

$$I_{1F} = \frac{E_g(Z_2+Z_0)}{Z_1Z_2+Z_1Z_0+Z_2Z_0}$$

$$I_{2F} = \frac{-E_gZ_0}{Z_1Z_2+Z_1Z_0+Z_2Z_0}$$

Where:

E_g = Power System Voltage
Z_0 = Zero sequence impedance
Z_1 = Positive sequence impedance
Z_2 = Negative sequence impedance

Therefore:

$$\frac{I_{2F}}{I_{1F}} = \frac{Z_0}{Z_0+Z_2}$$

As a consequence, for an open circuit in a particular part of the system, I2/I1 can be determined from the ratio between the zero sequence and the negative sequence impedance. It must be noted however that this ratio may vary depending on the location of the fault. It is therefore desirable to apply a setting that is as sensitive as possible. Practically, the levels of standing negative phase sequence current present on the system guide the choice of this minimum setting. A system study or the use of the relay's measurement data during commissioning are two ways to determine this minimum setting. If the latter method is chosen, it is important to record measurements during maximum load conditions, to ensure that all single-phase loads are taken into account.

A time-delay (tBCond) is necessary to ensure co-ordination with other protective devices.

2.18.1 Setting Example

The following information comes from a the relay commissioning report;

I_{FLC} = 500 A

I2= 50 A

Then:

I2/I1 = 50/500 = 0.1

To include some margin and tolerate load variations, it is typical to set this value 200% above this result: Therefore, RATIO I2/I1 = 20%

Set tBCond to 60 s to allow short circuits to be cleared by time-delayed protection elements.

2.19 Description and Setting Guide of the Auto-Reclose Function (Model A)

2.19.1 Introduction

An analysis of faults on overhead line network has shown that:

- 80-90% of faults are transient in nature,
- the remaining 10-20% of faults are either non-permanent (arcing faults) or permanent.

A transient fault is a self-clearing 'non-damage' fault. This type of fault can be isolated and cleared by the immediate tripping of one or more circuit breakers, and does not reappear when the line is re-energized. The most common causes of transient faults are lightning, insulator flashover, clashing conductors and debris blown by the wind.

The initial trip might not clear a non-permanent or permanent fault, and the use of the reclosing sequence could be necessary in order to clear it. A small tree branch falling on the line could cause a non-permanent fault. Permanent faults could be caused by broken conductors, transformer faults, cable faults or machine faults, which must be located and repaired before the supply can be restored.

Most of the time, if the faulty line is immediately opened, and the fault arc is allowed sufficient time to de-ionize, reclosing the circuit breakers will result in the line being successfully re-energized. Auto-reclosing schemes are used to automatically reclose a switching device once a time-delay started after the CB has opened has elapsed.

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On HV/MV distribution networks, the Auto-reclose function is used mainly for radial feeders where system stability problems do not generally arise. Using the auto-recloser minimizes outage time and reduces operating costs.

Automatic reclosing allows a substation to operate unattended: the number of visits to manually reclose a circuit breaker is substantially reduced. This feature constitutes therefore an important advantage for substations supervised remotely.

On circuits using time-graded protection, the auto-recloser allows the use of instantaneous (fast) protection (***Fast O/C Trip*** function in ***SETTING GROUP x/PROTECTION Gx/[79] AUTORECLOSE Gx*** menu) to issue a high speed first trip. With fast tripping, the duration of the power arc resulting from an overhead line fault is reduced to a minimum, thus lessening the chance of damage and of the transient fault developing into a permanent fault. To avoid maloperation because of transients, it is possible to assign a short time-delay to the fast trip: **Fast O/C Trip Delay** setting (***SETTING GROUP x/PROTECTION Gx/[79] AUTORECLOSE Gx*** menu column) above the typical transient time value. The fast trip can be associated with phase-to-phase faults (***Fast O/C Trip)*** and/or earth faults (***Fast E/Gnd Trip***), separately for every shot in the auto-reclose sequence. If in ***Fast O/C Trip*** configuration the setting for chosen trip shot is ***' 0 '***, the trip is executed after the time-delay of the protection element. If it is set to ***' 1 '***, the time-delay set in the **Fast O/C Trip Delay** menu cell is applied. In some regions the typical setting of the fast trip for a 2-shot AR is set:

- ***Fast O/C Trip*** (trip shots): 00011 (The first and second trips with **Fast O/C Trip Delay** to reduce to minimum the resulting power arc; The third – final – trip after the time-delay of the protection element to ensure the grading in the power system – trip selectivity)
- ***Fast E/GND Trip*** (trip shots): 00000 (alls trips re executed after the time-delays of the protection elements).

Fast O/C Trip – refers to all O/C stages in the ***PHASE O/C*** menu column: ***I>, I>>, I>>>.***

Fast E/GND Trip – refers to all E/GND stages in the ***PHASE E/GND*** menu column: ***IN_1, IN_2, IN_3***.

Fast O/C (E/GND) Trip Delay is associated with a DMT characteristic even if the protection element is set to an IDMT characteristic. For the fast trip the reset time-delay of the protection element is not applied.

Using a short time-delay prevents the blowing of fuses and reduces circuit breaker maintenance by eliminating pre-arc heating when clearing transient faults.

The figure below shows an example of 4 auto-reclose cycles (maximum numbers of allowed cycles) until the final trip (tD1, tD2, tD3, tD4 = dead times 1, 2, 3 and 4, tR = Reclaim time).

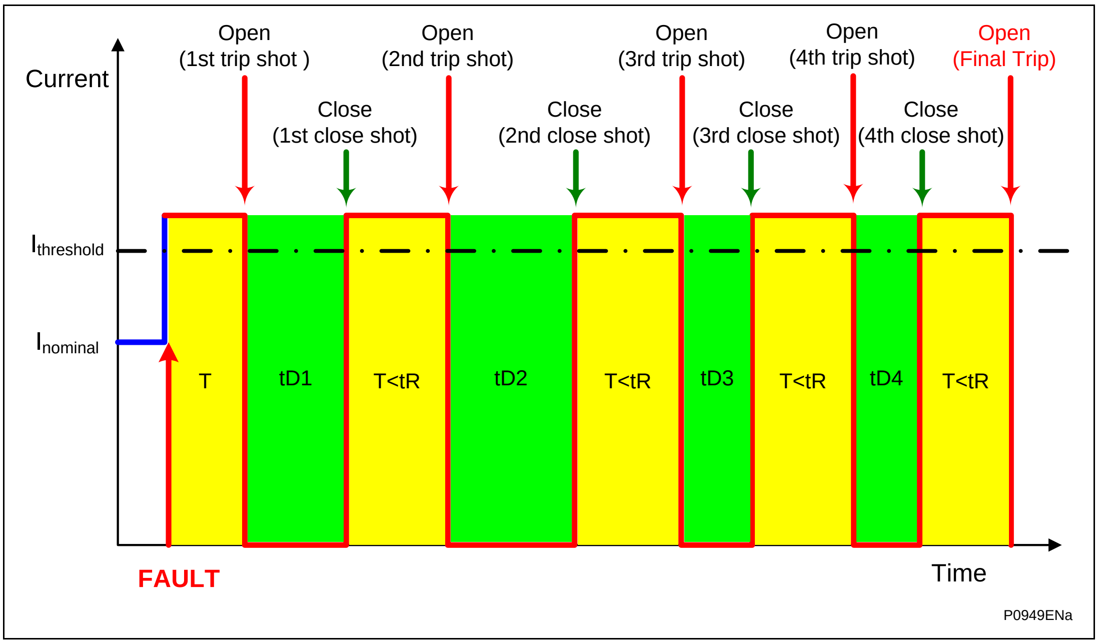

Figure 20: Typical Auto-Reclose Sequence

When short time-delay protection is used with auto-reclosing, the scheme can be arranged to block the instantaneous element after the first trip. Therefore, if the fault persists after re-closing, time-graded protection will issue discriminative tripping with fuses or other protection devices, resulting in the isolation of the faulted section. However, for certain applications, where the majority of the faults are likely to be transient, it is not uncommon to allow more than one instantaneous trip before instantaneous protection stops being applied or the time-delay for fast trip is set.

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

Any decision to apply the Auto-reclose function would be influenced by all known data about the frequency of transient faults (for instance feeders which consist partly of overhead lines and partly of underground cables). When a significant proportion of the faults are permanent, the advantages of auto-reclosing are small, particularly since re-closing on to a faulty cable is likely to compound the damage.

The auto-reclose function has four inputs that can be assigned to the auto-reclosing logic. These inputs can be mapped to opto-isolated inputs in the ***SETTING GROUP x/PROTECTION Gx/INPUT CONFIGURATION*** menu. External contacts can then be wired to these inputs and influence the auto-recloser scheme. These four logic inputs are:

- one external CB Faulty signaling,
- two external starting commands,
- one external blocking command.

The following table gives the “AUTOMAT.CTRL/Inputs” menu assigned to the auto-reclose logic input.

	***INPUT CONFIGURATION Gx* submenu:**	***AUTO-RECLOSE Gx* submenu enabled with:**	***[79] ADVANCED SETTING* submenu enabled with:**
External CB faulty signaling	***CB FLT Ext.Sign.***		***CB FLT Monitor.? 1:Yes***
External starting commands	**AUX1** (Note: ***AUX1*** timer should be set to ***Trip***)	***Close Shot ? 4321*** ***tAUX1 1111*** (‘1’ – means that closing is enabled)	
External starting commands	**AUX2** (Note: ***AUX2*** timer should be set to ***Trip***)	***Close Shot ? 4321*** ***tAUX2 1111*** (‘1’ – means that closing is enabled)	
External blocking command	***Block 79***		***Block.via Input? 1: Yes***

2.19.1.1 External CB Fail signaling

Most of circuit breakers provide one trip-close-trip cycle. A time-delay is necessary for the CT to return to its nominal state (for example, the spring that allows the circuit breaker to close should be fully charged). The state of the CB can be checked using an input assigned to the ***CB FLT Ext.Sign.*** function. If, on completion of the **tCB FLT ext** time (***GLOBAL SETTINGS/CIRCUIT BREAKER*** submenu), the **CB FLT ext** (Alarm) indicates a failed state of the CB, a lockout occurs and the CB remains open.

2.19.1.2 External Starting Commands

Two independent and programmable inputs (AUX1 and AUX2) can be used to initiate the auto-reclose function from an external device (such as an existing overcurrent relay). These logic inputs may be used both independently and in parallel with the overcurrent elements.

Notes:

1. The input must be assigned to an AUXx function (***SETTING GROUPx/INPUT CONFIGURATION Gx***),
2. AUXx must be set to ***Trip*** (***SETTING GROUP x/PROTECTION Gx/AUX TIMERS Gx/AUXx?***) and time-delay tAUXx must be configured (instantaneous: ***tAUXx*** set to 0 s),
3. The ***tAUXx Close Shot*** cell must be set for every cycle (Close shot).

2.19.1.3 Internal and External Blocking Commands

The auto-recloser can be blocked by an internal or an external control. It can be used when a protection is needed without requiring the use of the auto-recloser function.

The external block is the ***Block [79]*** input.

The internal block can be a final trip, a number of [79] rolling demand valid or an [79] conflict.

A typical example is on a transformer feeder, where the Auto-reclose may be initiated from the feeder protection but need to be blocked from the transformer protection side.

2.19.2 Auto-reclose Output Information

The following output signals can be mapped to an LED (see ***SETTING GROUP x /LEDS CONFIGURATION Gx*** menu) or to output relays (see ***SETTING GROUP x/OUTPUT RELAYS CONFIGURATION Gx*** menu) in order to provide information about the status of the auto-reclose cycle:

- Auto-reclose cycle in progress
- Final Trip
- Internal block
- External block
- Auto-reclose successful

The following table gives the ***SETTING GROUP x /LEDS CONFIGURATION Gx*** and the ***SETTING GROUP x/OUTPUT RELAYS CONFIGURATION Gx*** menus used to assign the auto-reclose output signal.

	LEDs menu	Output relays menu
Auto-reclose in progress	***79 in Progress***	***79 in Progress***
Final Trip	***79 Trip Final***	***79 Trip Final***
Internal block	***79 Lockout***	***79 Lockout***
External block	***79 Blocked***	***79 Blocked***
Auto-reclose successful	***79 Success.***	***79 Success.***

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2.19.2.1 Auto-reclose in progress

The “Auto-reclose in progress” signal is present during the complete reclosing cycles from protection initiation to the end of the reclaim time or lockout.

2.19.2.2 Final trip

The "Final trip" signal indicates that a complete auto-reclose cycle has been performed and that the fault has been cleared.

The "Final trip" signal can be reset after a manual closing of the CB after the settable ***Inhibit Time tI on Close*** (***GLOBAL SETTINGS/ [79] ADVANCED SETTING***) time-delay or reset via a Reset Command

2.19.3 Auto-reclose Logic Description

The auto-reclose function makes it possible to automatically control the CB's reclosing cycles (two, three or four shot cycle, settable using the ***Close Shot ?*** parameter – separate for each O/C and E/GND protection element (***SETTING GROUP x/PROTECTION Gx/[79] AUTO-RECLOSE Gx*** menu).

Dead times for all the shots (reclose attempts) can be independently adjusted.

The number of shots is directly related to the type of faults likely to occur on the system and the voltage level of the system (for instance medium voltage networks).

The Dead Time (tD1, tD2, tD3 and tD4) and the minimum drop-off time start when the CB has tripped (when the 52a input has dropped off – ***Start Dead t on 1: CB trips*** or the protection element has reset – ***Start Dead t on 0: Protect.Reset*** configuration option). The Dead Time is set to initiate the auto-recloser when the circuit breaker is opened.

At the end of the relevant dead time the close command (***Close CB Order***) is executed and the CB supervision timer is started. The length of this timer is equal to: ***tClose Pulse*** (***GLOBAL SETTINGS/CIRCUIT BREAKER***) + 150 ms. If the CB is not closed after this time-delay, the auto-recloser is locked out and Alarm is issued (***Alarm CB Time Monitor***).

The reclaim time (***Reclaim Time tR***) starts when the CB has closed. If the circuit breaker does not trip again, the Auto-reclose function resets at the end of the reclaim time.

If a protection element operates during the reclaim time, the relay either advances to the next shot programmed in the auto-reclose cycle, or it locks out (see ***Inhib.Trip*** function description).

The total number of reclosures is displayed in the ***RECORDS/ COUNTERS/ AUTORECLOSE COUNTER*** menu cell.

2.19.4 Auto-reclose ***Inhibit Trip***

The trip inhibit is used for following cases:

- e/f protection in neutral-insulated or compensated systems. The A/R can clear a non-permanent fault in the first cycles. If it will be permanent fault, there will be no the final trip up to reset of the protection trip.
- application where for example the setting for the I> stage covers more than the protected zone, so that the [79] can clear faults downstream too, but the final trip will be executed by the downstream relay or a fuse, therefore in the upstream relay, tI> should be inhibited – waiting for tI>> trip of the downstream relay).
  Note: for this case ***Fast Trip O/C*** function can be used too (see below).

It is recommended to set another protection stage with setting for Alarm only, to inform that this fault was not cleared by autorecloser so it’s still present (tripping from this protection element is inhibited). For above case when the auto-reclose is successful, the reset of inhibition is applied after reset of protection stage (current below the stage value).
For another case when during inhibition of protection element, another protection element (set to run [79]) makes a trip after going to the next cycle (the next A/R close command is executed) the inhibition is reset and the further action depends on the configuration:

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- if in the next cycle this protection element is still set with inhibition, the protection element is still inhibited
- if in the next cycle this protection element is not set with inhibition, but the fault is still not cleared, this protection element will trip CB (If another protection element moves auto-reclose to the next cycle, the inhibition is removed automatically and [79]logic checks configuration for the next [79] shot).

2.19.5 Auto-reclose Inhibit after Manual Closing

The ***Inhibit Time tI on Close*** timer (***GLOBAL SETTINGS/ [79] ADVANCED SETTING)*** can be used to block the auto-reclose cycle being initiated after the CB has been manually closed onto a fault. The Auto-reclose is blocked for the duration of ***Inhibit Time tI on Close*** after a manual CB Closure (The blocking indication: ***[79] blocked***, the reason of blocking: ***[79] Tempor.Block***).

2.19.6 Recloser lockout

If a protection element operates during the reclaim time, following the final reclose attempt, the relay will lockout and the auto-reclose function will be disabled until the lockout condition is reset.

The lockout condition can be reset by a manual closure after the ***Inhibit Time tI on Close*** timer elapses.

The auto-recloser can also be locked out using a ***CB FLT Ext.Sign.*** input. This information can be issued from the "not charged" or "Low gas pressure" indications of CB springs.

Note that the auto-recloser can also be locked out by:

- The fact that the CB does not open after the tBF delay (CB Fail) elapses,
- An operating time longer than the set thresholds,
- Local or remote manual Close or Open command when the auto-reclose is in progress,
- The Rolling Demand function detects too many auto-reclose shots.

In the lockout condition the ALARM with the cause: ***ALARM [79] Lockout*** is displayed up to reset of the lockout condition.

2.19.7 CB monitoring logic detects abnormal CB position (opened and closed, or not opened and not closed) for longer than set: ***Max CB Close*** or ***Max CB Open*** time.

2.19.8 Setting Group Change

During the auto-reclose cycle, if the relay receives a command to switch setting groups, it is executed immediately upon the end of the current A/R cycle.

2.19.9 Rolling demand

This specific counter avoids frequent operations of a CB in case of intermittent faults. The number of shots can be set from 2 to 100 in the cell ***Max cycles Nb Rol.Demand***, settable over a time period (***GLOBAL SETTINGS/ [79] ADVANCED SETTING /Time period Rol.Demand***) from 1 min to 24 hours.

The rolling demand is used when a defined number of successful recloses are performed over a defined time. If it is happened auto-reclose function is Lockout and he ALARM with the cause: ***ALARM [79] Roll.Demand*** is displayed up to reset the lockout condition.

If after ***Alarm [79] Rolling Demand*** signaling, the lockout condition reset is applied, the recorded number of rolling demand shots are cleared

2.19.10 Signaling Reset after Close via 79

In the ***GLOBAL SETTINGS/ [79] ADVANCED SETTING*** menu it is possible to set the signaling reset after a close command executed by the auto-recloser. If ***Signaling Reset*** is set to **1: Close via 79**, after the auto-recloser's close shot (confirmed by the 52a CB status), signaling (LEDs, display) of the last trip before the close shot is reset:

- Latched LEDs
- Trip information on the P116's front panel
- Electromagnetic Flag Indicators on the Front Panel
- Latched outputs

This function signals the final trip only and clears signaling if the CB remains closed (Auto-reclose is successful). This function is recommended if the P116 is integrated into a SCADA system or if the substation is rarely supervised by maintenance personnel. In this case it is not necessary to clear signaling if the fault has disappeared and the line is healthy.

Note: Reset of signaling and of latched outputs can be done using the General resetting function.

This configuration can be set in the ***GLOBAL SETTINGS/LOC*** submenu:

- LEDs Reset:
  - ***0: Manual only*** (via Inputs, HMI C key, Remote Reset command)
  - ***1: Start protect.*** (Start of the protection element set to Trip)
- Ltchd Outp. Reset:
  - ***0: Manual only*** (via Inputs, HMI C key, Remote Reset command)
  - ***1: Start protect.*** (Start of the protection element set to Trip)

The ***Manual only*** option prevents a close command from being issued without readout of the cause of trip by maintenance personnel. It reduces the risk to switch on to fault.

The ***Start protect*** option allows signaling of the latest trip only.

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2.19.11 Setting Guidelines

2.19.11.1 Number Of Shots

There is no perfect rule to define the number of shots for a particular application.

In medium voltage systems it is common to use two or three auto-reclose shots, and, for specific applications, four shots. Using four shots, the final dead time can be set to a time long enough to allow thunderstorms to end before the final reclosure. This scheme prevents unnecessary lockout caused by consecutive transient faults.

Typically, the first trip, and sometimes the second, are caused by the instantaneous protection element. Since 80% of faults are transient, further trips will be time-delayed, and all will have increasing dead times so as to clear non-permanent faults.

In order to determine the required number of shots, the first factor is the ability for the circuit breaker to perform several trip-close operations in a short time and the effect of these operations on the maintenance period.

If a moderate percentage of non-permanent faults are present in a system, two or more shots are justified. If fused 'tees' are used and the fault level is low, the timer of the fuses may not discriminate with the main IDMT relay: several shots are useful. This would not warm up the fuse to such an extent that it would eventually blow before the main protection element operated.

2.19.11.2 Dead Time Setting

Load, circuit breaker, fault de-ionizing time and protection reset are taken into consideration when setting the dead time.

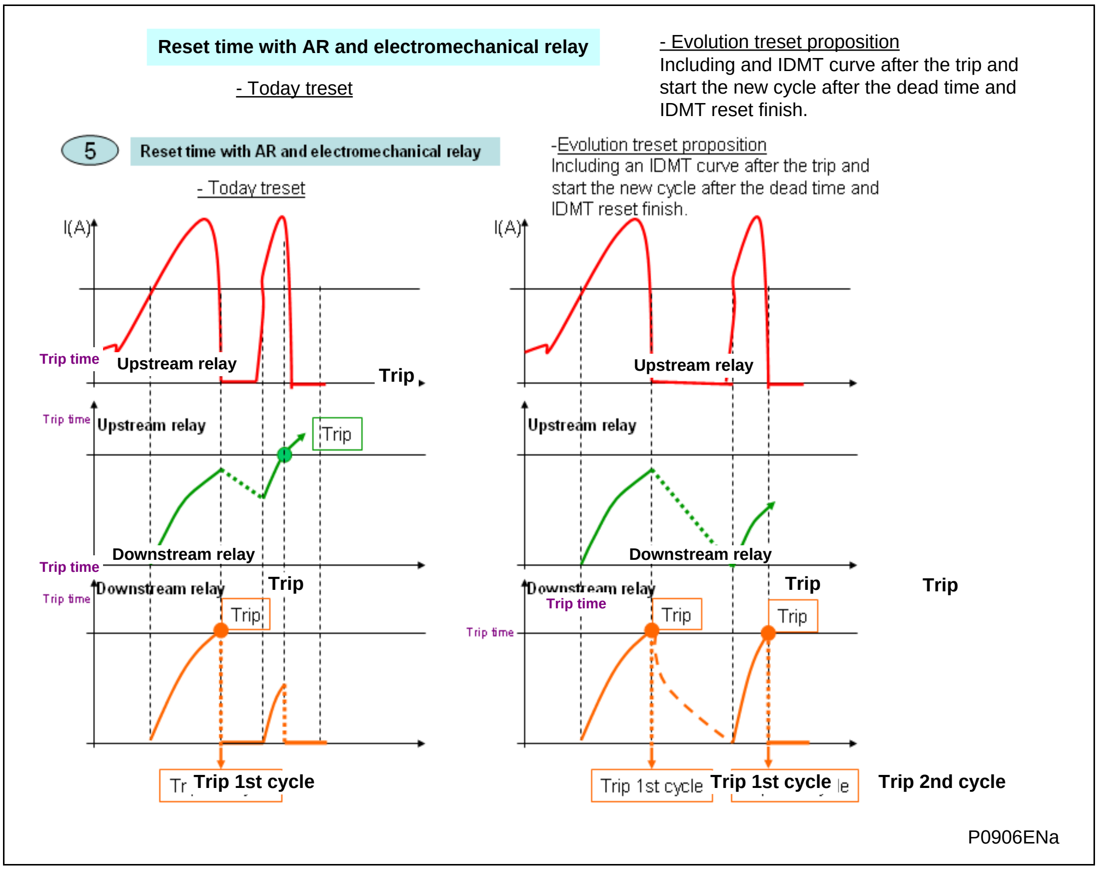
2.19.11.3 Minimum Drop-Off Time Setting

If an electromagnetic relay is used (working on the principle of disc in the electromagnetic field due to eddy current generated in the disc), an additional dead time (Min Drop-off Time), depending of the trip cause, is settable.

This function includes the choice to select an IDMT curve on the relay's reset time, setting the drop-off time on phase and neutral auto-reclose cycles.

This drop-off time blocks the next cycle if the current one has not elapsed.

A new cycle can start if both the dead time and tReset have elapsed.



Note: This function is currently used with an IDMT curve.
If dead time > drop-off time, the relay will close the CB at the end of the dead time.
If dead time < drop-off time, the relay will close the CB at the end of the drop-off time.

2.19.11.3.1 Load

It is very difficult to optimize the dead time due to the great diversity of loads on a system. However, it is possible to study each type of load separately and thereby be able to define a typical dead time.

The most common types of loads are synchronous or induction motors and lighting circuits.

Synchronous motors tolerate only extremely short interruptions of supply without loss of synchronism. In practice, the dead time should be sufficient to allow the motor no-volt device to operate. Typically, a minimum dead time of 0.2-0.3 second is recommended.

Induction motors, on the other hand, can withstand supply interruptions, up to a maximum of 0.5 second and re-accelerate successfully. In general dead times of 3-10 seconds are normally satisfactory, but there may be special cases for which additional time is required to allow the reset of manual controls and safety devices.

Loss of supply of lighting circuits, such as street lighting, can lead to important safety problems (car circulation). Regarding domestic customers, the main consideration is linked to the inconvenience caused.

The number of minutes lost per year to customers will be reduced on feeders using the auto-recloser and will also be affected by the dead time settings used.

2.19.11.3.2 Circuit Breaker

For high speed reclosing, the minimum dead time of the power system depends on the minimum time-delay imposed by the circuit breaker during a trip and reclose operation.

Since a circuit breaker is a mechanical device, it has an inherent contact separation time. This operating time for a modern circuit breaker is usually within the 50-100 ms range, but could be longer with older designs.

After a trip, the mechanism needs some time to reset before applying a close pulse. This reset time varies depending on the circuit breaker, but lasts typically 0.1 second.

Once the circuit breaker has reset, the breaker can start to close. The period of time between the energization of the closing mechanism and the making of the contacts is called closing time. Because of the time constant of a solenoid closing mechanism and the inertia of the plunger, a solenoid closing mechanism may take 0.3 s. A spring-operated breaker, on the other hand, can close in less than 0.2 second.

Where high speed reclosing is required, for the majority of medium voltage applications, the circuit breaker mechanism dictates itself the minimum dead time. However, the fault de-ionizing time may also have to be considered.

High speed reclosing may be required to maintain stability on a network that has two or more power sources. For high speed reclosing, the system disturbance time should be minimized using fast protection, <50 ms, such as distance or feeder differential protection and fast circuit breakers < 100 ms. Fast fault clearance can reduce the time for the fault arc to de-ionize.

To ensure stability between two sources, a dead time of less than 300 ms is typically required. Considering only the CB, this minimum time corresponds to the reset time of the mechanism plus the CB closing time. Thus, a solenoid mechanism is not adapted for high speed reclosing due to the fact that the closing time is generally too long.

2.19.11.3.3 Fault De-ionizing Time

For high speed reclosing, the time to de-ionize faults may be the most important factor when considering the dead time. This is the time required for the ionized air to disperse around the fault location so that the insulation level of the air is restored. This time may be around the following value:

De-ionizing time = (10.5 + ((system voltage in kV)/34.5)) / frequency

For 66 kV = 0.25 s (50 Hz)

For 132 kV = 0.29 s (50 Hz)

2.19.11.3.4 Protection Reset

It is essential that the protection device fully resets during the dead time, so that correct time discrimination is maintained after reclosing on to a fault. For high speed reclosing, instantaneous protection reset is required.

Typical 11/33 kV dead time settings in the UK are as follow:

1st dead time = 5 - 10 seconds

2nd dead time = 30 seconds

3rd dead time = 60 - 100 seconds

4th dead time (uncommon in the UK, however used in South Africa) = 60 - 100 seconds

2.19.11.4 Reclaim Time Setting

The following factors influence the choice of the reclaim time:

- Supply continuity - Large reclaim times can result in unnecessary lockout for transient faults.
- Fault incidence/Past experience - Small reclaim times may be required where there is a high incidence of lightning strikes to prevent unnecessary lockout for transient faults.
- Charging time of the spring or resetting of electromagnetical induction disk relay - For high speed reclosing, the reclaim time may be set longer than the spring charging time to ensure that there is sufficient energy in the circuit breaker to perform a trip-close-trip cycle. For delayed reclosing, this setting is of no need as the dead time can be extended by an extra CB healthy check window time if there is insufficient energy in the CB. If there is insufficient energy after the check window time the relay will lockout.
- Switchgear Maintenance - Excessive operation resulting from short reclaim times can mean shorter maintenance periods. A minimum reclaim time of 5 s may be needed to give sufficient time to the CB to recover after a trip and close before it can perform another trip-close-trip cycle.

The reclaim time must be long enough to allow any time-delayed protection leading the auto-recloser to operate. Failure to do so can cause the auto-recloser to reset too soon and the reactivation of the instantaneous protection.

If that were the case, a permanent fault would look like a sequence of transient faults caused by repeated auto-recloses. Applying protection against excessive fault frequency lockout is an additional precaution that can solve this problem.

It is possible to obtain short reclaim times to reduce the number of CB lockouts by blocking the reclaim time from the protection start signals. If short reclaim times are to be used, then the switchgear rating may dictate the minimum reclaim time.

Sensitive earth fault protection is used to detect high resistance earth faults. The time-delay of such protections is usually a long time-delay, typically about 10-15 s. If auto-reclosing is caused by SEF protection, this timer must be taken into account when deciding the value of the reclaim time, if the reclaim time is not blocked by an SEF protection start signal. Sensitive earth faults, caused by a broken overhead conductor in contact with dry ground or a wood fence are rarely transient faults and may be dangerous to people.

It is therefore common practice to block the auto-recloser using the sensitive earth fault protection element and to lockout the circuit breaker.

Where motor-wound spring closed circuit breakers are used, the reclaim time must be at least as long as the spring winding time for high speed reclosing to ensure that the breaker can perform a trip-close-trip cycle.

A typical 11/33 kV reclaim time is 3-10 seconds, this prevents unnecessary lockout during thunderstorms. However, times up to 60-180 seconds may be used.

2.19.11.5 Auto-reclose Setting Guideline

2.19.11.5.1 General Setting

SETTING CONDITION FOR THE A/R FUNCTIONALITY

SETTING GROUP x/PROTECTION Gx / [79] AUTO-RECLOSE Gx		
Autoreclose?	***1: Enabled***	Enabling the Auto-reclose function
Dead Time tDx, where x – number of cycle after a trip during A/R	See 2.22.2	The time-delay between CB opening via the trip command and reclose command via the A/R. These values must be set according to the application.
Reclaim Time tR	See 2.22.4	The time between CB closure via the reclose command and reset of the Auto-reclose function (ready to the next fault from the first cycle). This value must be set according to application.
Fast O/C Trip for every trip when the A/R is activated.	54321 00000	' 0 ' - means that the overcurrent trip before the A/R reclosing shot will occur according to the time-delay set in the protection element submenu (Fast Trip function is not applied) ' 1 ' - means that the overcurrent trip before the reclosing shot will occur according to the DMT time-delay and ***Fast E/Gnd Trip Delay*** – not according to the time-delay set in the protection element submenu (Fast Trip function is applied). The default value is ***00000***.
Fast O/C Trip Delay	0s	Time-delay for Fast Trip function. The time-delay set to avoid transients impacting on selectivity. The fast tripping reduces de-ionization time. The default value is 0 s.
Fast E/Gnd Trip for every trip when the A/R is activated.	54321 00000	' 0 ' - means that the e/f trip before the A/R reclosing shot will occur according to the time-delay set in the protection element submenu (Fast Trip function is not applied) ' 1 ' - means that the e/f trip before the reclosing shot will occur according to DMT time-delay and ***Fast E/Gnd Trip Delay*** – not according to the time-delay set in the protection element submenu (***Fast Trip*** function is applied). The default value is ***00000***.
Fast E/Gnd Trip Delay	0s	Time-delay for ***Fast Trip*** function. The time-delay is set to avoid transients impacting on selectivity. Fast tripping reduces de-ionization time. The default value is 0 s.

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<table>
<tr><th colspan="3">SETTING GROUP x/PROTECTION Gx / [79] AUTO-RECLOSE Gx</th></tr>
<tr><td>Close Shot ?
Freely settable the number of Auto-reclose cycles (closing shots), set separately for each protection element:
tI>, tI>>, tI>>>, tIN_1, tIN_2, tIN_3, tAUX1, tAUX2</td><td>4321
0111</td><td>Max number cycle: 4 cycles.
' 0 ' - means that after a trip issued by a protection element, the A/R will be blocked – no reclose command will be executed.
' 1 ' - means that after a trip issued by a protection element the A/R will close CB (closing shot will be executed).
If the protection element is set: 1111 – it means that 4 cycles are set. If 0011 – it means that 2 cycles are set.
The default value is 00000. This value must be set according to the application.</td></tr>
<tr><td>Inhibit Trip
Freely settable the inhibit of the trip after closing command issued via the A/R, set separately for each protection element:
tI>, tI>>, tI>>>, tIN_1, tIN_2, tIN_3, tAUX1, tAUX2</td><td>4321
0000</td><td>Freely settable the inhibit of the trip after closing command issued via the A/R, set separately for each protection element:
tI>, tI>>, tI>>>, tIN_1, tIN_2, tIN_3, tAUX1, tAUX2
Inhibit Trip setting:
- 0: means that after close via the A/R, the protection element trip will be not inhibited (function is disabled).
- 1: means that after close via the A/R, the protection element trip will be inhibited.
An example:
For 4-cycle [79]: Inhibit Trip 1000 setting. In the first three cycles (000) the trip is executed to allow fault clearance, but the last one (1) is with inhibition, so no trip is executed in case of permanent fault).
(see P116 Operation chapter)
The default value is: 0000</td></tr>
</table>

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GLOBAL SETTINGS / [79] ADVANCED SETTINGS		
CB FLT Monitor. ?	***No*** or ***Yes***	Disable or enable: CB faulty monitoring via binary input. See 2.19.1.1, 2.20, 2.21 Typically the auto-recloser uses this function. Default value is ***Yes.***
Block.via Input?	***No*** or ***Yes***	Disable or enable: blocking of the Auto-reclose function via a binary input. See section 2.19.6. Typically the auto-recloser uses this function. Default value is ***Yes***.
Start Dead t on	Protection reset or CB trips	Definition of Dead time start: - ***Protect.Reset***: no protection elements are energized. - ***CB trips***: the CB is open (information from inputs) Typically auto-reclosing occurs based on CB status. The default value is ***CB trips***.
Rolling Demand?	***No*** or ***Yes***	Enable of Rolling Demand function. This function protects the CB against mechanical wear in case of intermittent faults (for example a fault caused by a tree branch).
Max cycles No.	***100***	Number of accepted cycles in settable time period. If the number in the sliding window is greater than the set value for ***Max cycles Nb*** the auto-recloser is blocked. If ***Rolling Demand? = Yes,*** these values must be set according to the application. See section 2.19.8.
Time period Rol.Demand	***0010 mn***	Sliding window period ***Max cycles No.*** calculation.
Inhibit Time tI on Close	***1.00 s***	Inhibit of auto-reclosing time after manual closure of the CB (via a binary input, the front panel, RS485 or USB port). The default value: 1s. If 0 s is applied, inhibition of A/R on closing is disabled. See section 2.19.5.
Signaling Reset	***No*** or ***Close via 79***	This function resets the latched LEDs and outputs via the auto-reclose Close command. If ***Close via 79*** is selected, in case of a successful A/R there will be no signaling (reset not needed). Only the last fault will be displayed. See section 2.19.9.

SETTING GROUP x/INPUTS CONFIGURATION Gx		
CB status	***CB status 52A***	*At least a one* of the digital inputs have

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SETTING GROUP x/INPUTS CONFIGURATION Gx		
Input or inputs assigned to CB state (contact position)	or/and ***CB status 52B*** Inputs: 654321 000000	to be assigned to the CB's contact position. - ***CB status 52A:*** This input must correspond to the CB state: HIGH for CB close, LOW for CB open. - ***CB status 52B:*** This input must correspond to the CB state: LOW for CB close, HIGH for CB open. If a one input is used the CB status is based on a one-bit monitoring. If two inputs are used, the CB status is based on two-bit monitoring. By default no inputs are assigned to CB contact position. These values must be set according to the application.
CB FLT Ext.Sign. CB failure external signaling mapped to an input.	Inputs: 654321 000000	See section 2.19.1. By default no inputs are assigned to CB failure monitoring. This value can be set according to application.
Block.79 Blocking of the auto-recloser via a binary input.	Inputs: 654321 000000	See section 2.19.1.3. By default no inputs are assigned to blocking of the auto-reclose function. This value can be set according to the application.

SETTING GROUP x/ OUTPUT RELAYS CONFIGURATION Gx		
Prot.Trip pulse CB Open via protection elements and the auto-reclose function.	Outputs: 654321 000000	Output relays 1 to 6. An output relay must be assigned to this function to CB trip.
Close CB order CB Close by the A/R or a manual close command.	Outputs: 654321 000000	Output relays 1 to 6. An output relay must be assigned to this function to CB close.
[79] in Progress Auto-reclose in progress (running)	Outputs: 654321 000000	An output relay can be assigned to this function.
[79] F.Trip Auto-recloser lockout after final trip.	Outputs: TF654321 00000000	An output relay can be assigned to this function.
[79] Lockout Auto-recloser lockout.	Outputs: F654321 0000000	An output relay can be assigned to this function.
[79] Blocked Auto-recloser blocked or disabled	Outputs: F654321 0000000	An output relay can be assigned to this function.
[79] Success. The Reclaim Time is elapsed and no trip has occurred.	Outputs: F654321 0000000	An output relay can be assigned to this function.

2.19.11.5.2 Trip and reclose (normal operation)

The auto-recloser starts only if a trip command (***Prot.Trip pulse*** output) has been issued.

The red Trip LED will illuminate whenever the auto-recloser starts. It can however be reset by a close command (***Signalling Reset*** setting).

PROTECTION Gx / [79] AUTORECLOSE		
"Autoreclose"	Yes	
Cycles tI>, tI>>, tI>>>, tIN_1, tIN_2, tIN_3	1234 0111	Maximum number of shots: Max. 4 shots for each protection element selected separately.

SETTING GROUP x/ OUTPUT RELAYS CONFIGURATION Gx		
Trip and Close Commands	At least one trip and close command	Overcurrent and/or earth fault overcurrent trip stages (One is enough).

2.20 Circuit Breaker State Monitoring (Model A)

An operator at a remote location requires a reliable indication of the state of the switchgear. Without an indication that each circuit breaker is either open or closed, the operator has insufficient information to decide on switching operations. The MiCOM P116 relays incorporate a circuit breaker state monitoring feature, giving an indication of the position of the circuit breaker.

This indication is available either on the relay's front panel or via the communication network.

The positions of the CB contacts can be selected under the ***SETTING GROUP x/INPUTS CONFIGURATION Gx*** and ***SETTING GROUP x/LEDs CONFIGURATION Gx*** menus using **AUX5** (in parallel with **CB Status 52A**) and **AUX6** (in parallel with **CB Status 52B**).

AUX5 (CB closed) and AUX6 (CB opened) must be assigned to LEDs in ***SETTING GROUP x/LEDs CONFIGURATION Gx*** menu.

Furthermore, the MiCOM P116 relays can inform the operator that the CB has not opened following a remote trip command (refer to section “CB FAIL protection”).

2.21 Circuit Breaker Condition Monitoring (Model A)

Periodic maintenance of circuit breakers is generally based on a fixed time interval, or a fixed number of fault current interruptions.

The relays record the following controls and statistics related to each circuit breaker trip operation:

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- time-delay setting,
- monitoring time for CB open and close operations,
- CB open count,
- summation of the current interrupted by the CB,
- exponent for the summation,
- tripping and closing pulse time

2.22 Circuit Breaker Condition Monitoring Features (Model A)

For each circuit breaker trip operation the relay records statistics as shown in the following table taken from the relay menu. The **RECORDS/COUNTERS/CB Monitoring** menu cells shown are counter values only.

The circuit breaker condition monitoring counter increases when it receives:

- a protection trip command (***Prot.Trip pulse***),
- an HMI (or MiCOM S1) opening command (**Trip CB Order**),
- a rear com opening command (**Trip CB Order**),
- a digital input opening command (**Trip CB Order**).

In cases where the breaker is tripped by an external protection device it is also possible to update the CB condition monitoring. This is achieved by assigning one of the logic inputs or via the communication to accept a trigger from an external device.

2.23 Setting guidelines

2.23.1 Setting the ΣI^n Threshold

Where overhead lines are prone to frequent faults and are protected by oil circuit breakers (OCB's), oil changes account for a large proportion of the life cycle cost of the switchgear. Generally, oil changes are performed at a fixed interval of circuit breaker fault operations. However, this may result in premature maintenance where fault currents tend to be low, and hence oil degradation is slower than expected.

The ΣI^n counter monitors the cumulative severity of the duty placed on the interrupter allowing a more accurate assessment of the circuit breaker condition.

For OCB's, the dielectric withstand of the oil generally decreases as a function of ΣI^2t. This is where 'I' is the fault current broken, and 't' is the arcing time within the interrupter tank (not the interrupting time). As the arcing time cannot be determined accurately, the relay would normally be set to monitor the sum of the broken current squared, by setting ***n*** = 2.

For other types of circuit breaker, especially those operating on higher voltage systems, practical evidence suggests that the value of ***n*** = 2 may be inappropriate. In such applications ***n*'** may be set to 1.

An alarm in this instance may be indicative of the need for gas/vacuum interrupter HV pressure testing, for example.

It is imperative that any maintenance program must be fully compliant with the switchgear manufacturer's instructions.

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2.23.2 Setting the Number of Operations Threshold

Every operation of a circuit breaker results in some degree of wear for its components. Thus, routine maintenance, such as oiling of mechanisms, may be based upon the number of operations. Suitable setting of the maintenance threshold will allow an alarm to be raised, indicating when preventative maintenance is due.

Should maintenance not be carried out, the relay can be set to lockout the auto-reclose function upon reaching a number of operations. This prevents further reclosure when the circuit breaker has not been maintained to the standard required by the switchgear manufacturer's maintenance instructions.

Certain circuit breakers, such as oil circuit breakers (OCB's) can only perform a certain number of fault interruptions before requiring maintenance attention. This is because each fault interruption causes carbonizing of the oil, degrading its dielectric properties.

2.23.3 Setting the Operating Time Threshold

Slow CB operation is also indicative of the need for mechanism maintenance. Therefore, an alarm is provided and is settable in the range of 100 ms to 5 s. This time is set in relation to the specified interrupting time of the circuit breaker.

2.24 Undercurrent Protection Function (Model A)

MiCOM P116 relays include two undercurrent elements.

One is dedicated to CB fail detection (see CB Fail protection section).

The other can be used to provide additional protective functions to prevent damage/further damage to the power system. This function allows typical applications such as loss of load.

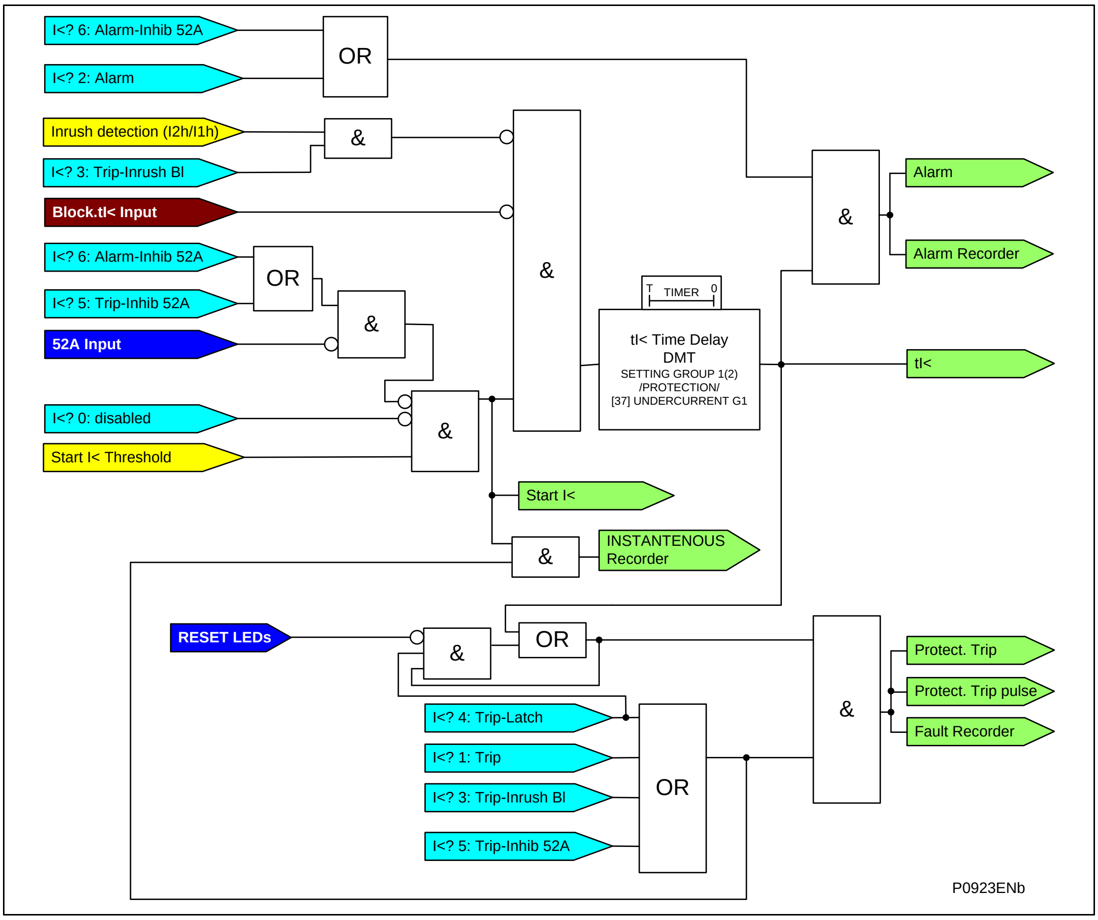

Figure 21: Undercurrent Protection Logic

Undercurrent stage ***I<*** can be set to ***Alarm***, ***Trip***, ***Trip-Inrush BI***, ***Trip-Latch***, ***Alarm inhib 52*** or ***Trip inhib 52***.

For the ***Alarm***, ***Trip***, ***Trip-Inrush BI***, ***Trip-Latch*** and ***Trip inhib 52*** settings the outputs and LEDs are energized if they are set to ***Protect.Trip***, ***Prot.Trip pulse*** or ***tI<***.

If ***I<*** is set to ***Alarm***: the outputs and LEDs are energized if they are set to ***Alarm*** or ***tI<***.

If **Trip-Inrush BI** is selected the overcurrent stage is blocked by the ***Inrush Blocking*** function (refer to Inrush Blocking section).

If ***Trip-Latch*** is selected, after a trip the overcurrent stage remains high until it is reset via a binary input, the HMI or by a remote RESET command.

The undercurrent stage can be blocked by the CB open status (***CB status 52B*** logic input) if I< is set to ***Alarm inhib 52*** or ***Trip inhib 52***.

See the ***AUTOMAT. CTRL/Output Relays/ tI<*** menu for the mapping of tI< to an auxiliary output relay RL2 to RL8 (to RL6 for P122).

The I< threshold can be set in the ***SETTING GROUP x/PROTECTION Gx/ UNDERCURRENT [37]/ I<*** menu, from 10% to 200% of the rated current In.

The tI< time-delay can be set in the ***SETTING GROUP x/PROTECTION Gx/ UNDERCURRENT [37]/tI<*** menu from 0 to 200 s.

2.25 Circuit Breaker Failure Protection: CB Fail

When a fault is detected, one or more main protection elements will issue a trip command to the associated circuit breaker(s). To isolate the fault, and prevent (further) damage to the power system it is essential that the circuit breaker operates correctly.

A fault that is not cleared quickly enough threatens the stability of the system. It is therefore common practice to install circuit breaker failure protection devices/elements that check that the circuit breaker has opened within a reasonable period of time. If the fault current has not been eliminated after the set time-delay, breaker failure protection (CB Fail) will send a signal.

The CB Fail protection element can be used to back-trip upstream circuit breakers to ensure that the fault is correctly isolated. The CB Fail protection element can also clear all blocking commands associated with logic selectivity.

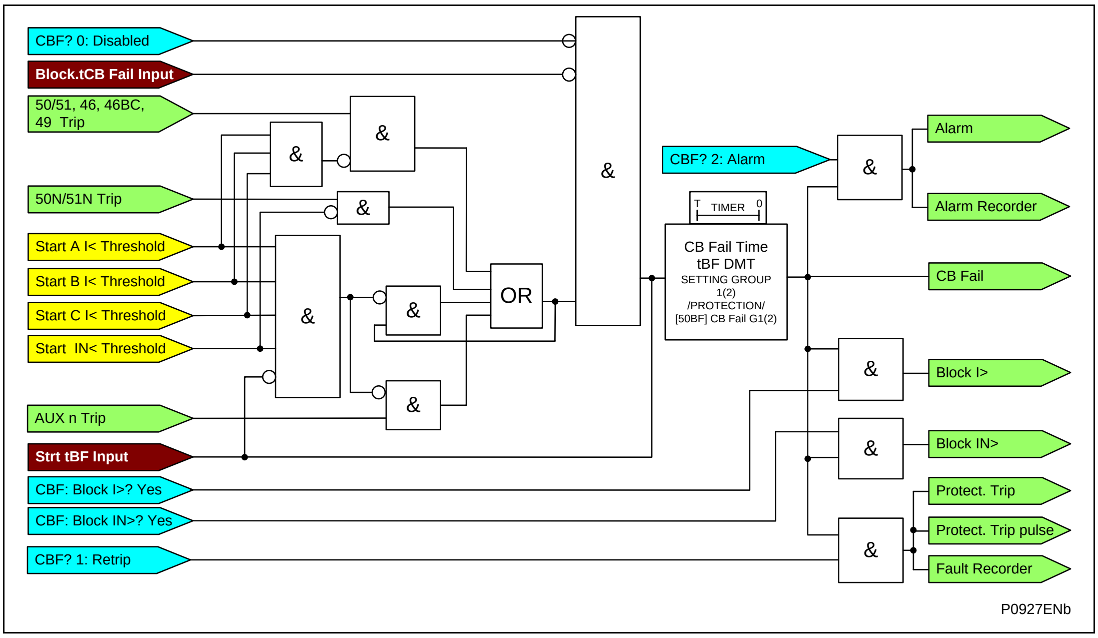

Figure 22: CB Fail Principle

The ***tBF*** timer is initiated when a trip command is issued by a protection element. Note that the trip command can be issued either by a protection element, or by a logic input assigned to an AUX counter. Then the relay monitors the current signal of each phase and compares each phase current signal with the bandzone made by the undercurrent I< threshold. This value can be set under the ***SETTING GROUP x/PROTECTION Gx / [50BF] CB FAIL Gx*** menu.

The selection in the relay menu is grouped as follows:

MENU TEXT	SETTING RANGE		STEP SIZE
	MIN	MAX	
CB Fail ?	Disabled, Retrip, Alarm,		
tBF	0.01 s	10 s	10 ms
I< Threshold CBF	0.1 In	2 In	0.01 In
IN< Threshold CBF (hardware option: 0.002-1 Ien)	0.01 In	1 In	0.01 In
IN< Threshold CBF (hardware option: 0.01-8 Ien)	0.05In	1 In	0.01 In
IN< Threshold CBF	0.1 In	1 In	0.01 In

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(hardware option: 0.002-1 Ien)			
Block I>?	No, Yes		
Block IN>?	No, Yes		

One of these options:

- ***Retrip***: a retrip signal is issued concurrently with the ***tCBF*** output (***Protect.Trip*** and ***Prot.Trip pulse*** output). The TRIP LED and FLAG are activated,
- ***Alarm***: typical setting. In case of CB Failure, an alarm is issued concurrently with the ***tCBF*** output. The ***Alarm*** LED is lit,

must be set in order to enable CB Fail protection.

2.25.1 Typical settings

2.25.1.1 Breaker Fail Timer Settings

The typical timer settings to use are as follows:

CB fail reset mechanism	tBF time-delay	Typical delay for 2 cycle circuit breaker
Initiating element reset	CB interrupting time + element reset time (max.) + error in tBF timer + safety margin	50 + 50 + 10 + 50 = 160 ms
CB open	CB auxiliary contacts opening/ closing time (max.) + error in tBF timer + safety margin	50 + 10 + 50 = 110 ms
Undercurrent elements	CB interrupting time + undercurrent element (max.) + safety margin operating time	50 + 25 + 50 = 125 ms

Note that all the CB Fail resetting methods involve the operation of the undercurrent element. Where element reset or CB open resetting is used the undercurrent time setting should still be used if this proves to be the worst case.

The examples above consider direct tripping of a circuit breaker. Note that where auxiliary tripping relays are used, an additional 10-15ms must be added to allow for trip relay operation.

2.25.1.2 Breaker Fail Undercurrent Settings

The phase undercurrent threshold (I<) must be set below the load current, to ensure that I< operation indicates that the circuit breaker pole is open. A typical setting for overhead lines or cable circuits is 20% In, with 5% In common for generator circuit breaker CBF.

The standard earth fault undercurrent element must be set to less than the trip setting, typically as follows:

IN< = (IN> trip) / 2

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2.26 Trip Circuit Supervision (Model A)

The trip circuit extends beyond the relay enclosure and passes through more components, such as fuse, wires, relay contacts, auxiliary switch contact and so on.

These complications, coupled with the importance of the circuit, have directed attention to its supervision.

The simplest arrangement for trip circuit supervision contains a healthy trip lamp in series with a resistance placed in parallel with a trip output relay contacts of the protection device.

2.26.1 Trip Circuit Supervision Mechanism

The Trip Circuit Supervision function included in the MiCOM P116 relays is described below:

A logic input is assigned to the **GLOBAL SETTINGS/CIRCUIT BREAKER/TC Supervision?** function. This logic input is labeled **Trip Circ Supervis.** in the ***SETTING GROUP x/INPUTS CONFIGURATION Gx*** menu. This logic input is then wired to the trip circuit according to one of the typical application scheme examples shown below.

When the TC Supervision function is set to "Yes" under the **TC Supervision?** sub-menu, the relay checks continuously the trip circuit continuity whether the CB status is CB opened or CB closed.

When the ***TC Supervision*** function is set to ***Yes-52A*** under the ***CIRCUIT BREAKER*** sub-menu, the relay checks continuously on trip circuit continuity in case when the CB's status is closed only.

The **TC Supervision** function is enabled when the ***Prot.Trip pulse*** and ***Trip CB order*** outputs are not energized. The **TC Supervision** function is not enabled when the ***Prot.Trip pulse*** and ***Trip CB order*** output are energized.

An ***Alarm***: **TC Supervision** (trip circuit failure) signal is generated if the logic input detects no voltage signal for a time longer than the settable timer ***tSUP***. See Chapter P116/EN OP (Operation) and Chapter P116/EN TD (Technical Data) for the settings.

As this function is disabled when the ***Prot.Trip pulse*** and ***Trip CB order*** outputs are energized, it is suitable for use with the output latching logic disabled.

The tSUP timer can be set according to the following table:

MENU TEXT	SETTING RANGE		STEP SIZE
	MIN	MAX	
TC Supervision ?	No or Yes or Yes-52A		
tSUP	100 ms	10 s	10 ms

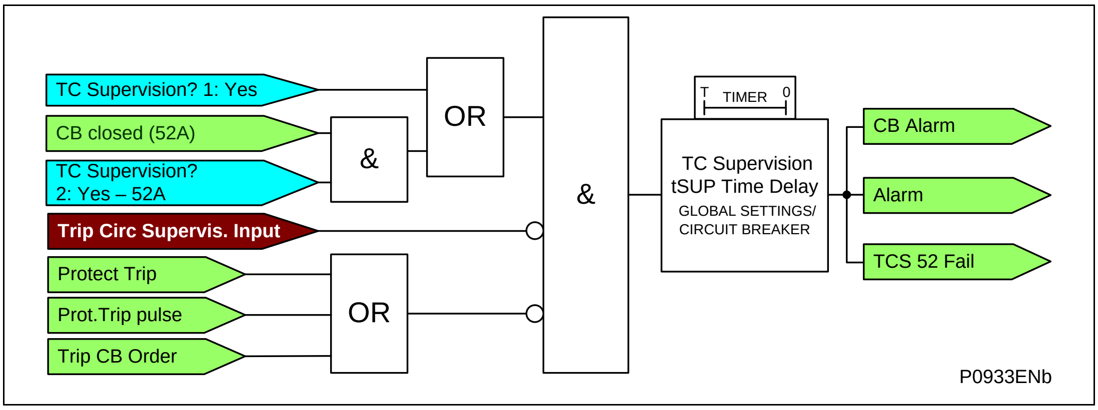

Figure 23: Trip Circuit Supervision Principle

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Three examples of application are given below.

Note: It is considered that the CB is fitted out with its own safety device.

Example 1

In this example only the 52a auxiliary contact is available, the MiCOM relay monitors the trip coil whatever the CB status is (CB open or CB closed).

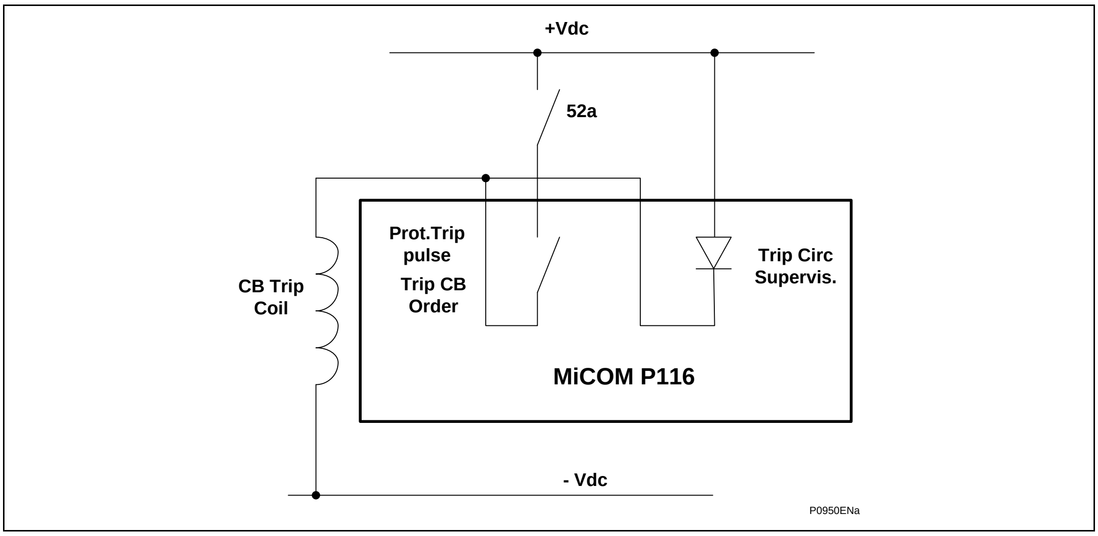

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Figure 24: Trip Coil Monitoring

Example 2

In this example both 52a and 52b auxiliary contacts are available; the MiCOM P116 relay monitors the complete trip circuit when the CB is closed and a part of the trip circuit when the CB is open.

In this case it is necessary to insert a resistor R1 in series with 52b, if either the output trip is latched or if it stays accidently closed, or if a long time trip pulse is programmed.

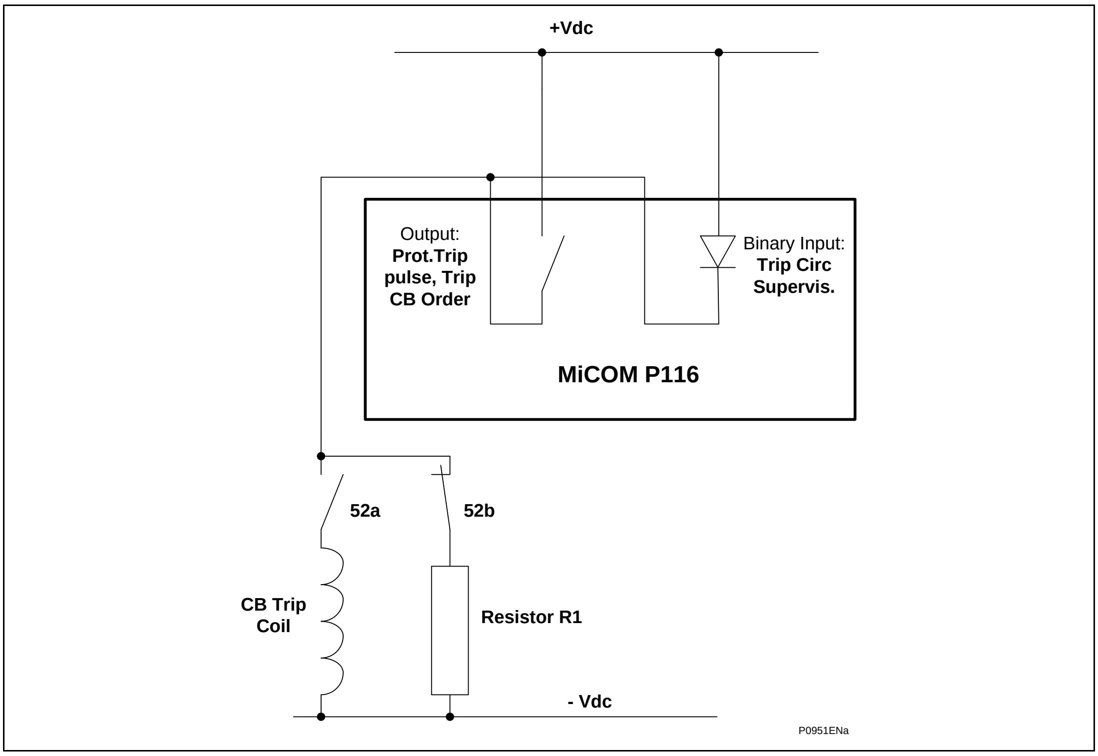

Figure 25: Example 2: Trip Coil and Auxiliary Contact Monitoring

Example 3

In this example both 52a and 52b auxiliary contacts are available, the MiCOM P116 relay monitors the complete trip circuit whatever the CB status (CB open or CB closed).

In this case it is necessary to insert a R1, if either the output trip is latched, or if it stays accidently closed, or if a long time trip pulse is programmed.

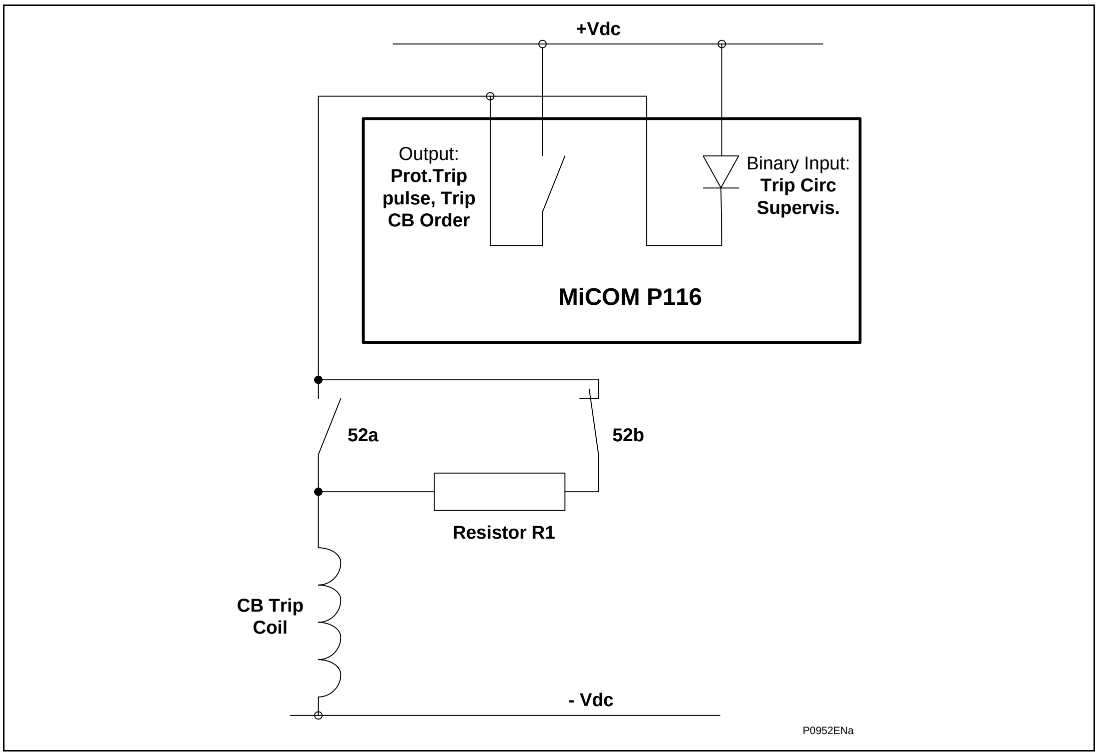

Figure 26: Example 3: Trip Coil and Auxiliary Contact Monitoring Whatever the Position of the CB contacts

External Resistor R1 Calculation

The calculation of the R1 resistor value will take into account the fact that a minimum current is flowing through the logic input. This minimum current value is a function of the relay auxiliary voltage range (U_{aux}).

1 - Case of example 2:

The R1 resistor maximum value (in Ohm) is defined by the following formula:

$$R1 < \frac{0.8 \times U_{aux} - U_{min}}{I_{min}} \ \Omega$$

Where:

U_{aux} = auxiliary voltage value (in this case a DC voltage; range is given on label under the top hinged cover. See table below).
U_{min} = internal minimum voltage value needed for the opto logic input to operate.
I_{min} = minimum current value needed for the opto logic input to operate.

Relay auxiliary voltage range (U_{aux})	
24-60 Vdc (ordering code P116xxxxxx**4**xxxxxxx)	48-250 Vdc/ac (ordering code P116xxxxxx5xxxxxxx)
R1 < (0.8 x U_{aux} – 19.2)/0.035	R1 < (0.8 x U_{aux} – 19.2)/0.035

The R1 resistor withstand value (in Watt) is defined below:

$$P_{R1} > 2 \times \frac{(1.2 \times U_{aux})^2}{R1} \text{ Watts}$$

2 - Case of example 3:

The R1 resistor maximum value (in Ohm) is defined by the following formula:

$$R1 < \frac{0.8 \times U_{aux} - U_{min}}{I_{min}} - R_{coil} \quad \Omega$$

Where:

U_{aux} = auxiliary voltage value (in this case a DC voltage; its range is given on the label under the top hinged cover. See table below.)
U_{min} = internal minimum voltage value needed for the opto-input to operate.
I_{min} = minimum current value needed for the opto-input to operate.
R_{coil} = trip coil resistance value.

Relay auxiliary voltage range (U_{aux})	
24-60 Vdc (ordering code P116xxxxxx**4**xxxxxxx)	48-250 Vdc/ac (ordering code P116xxxxxx5xxxxxxx)
R1 < (0.8 x U_{aux} – 19.2)/0.035 – R_{coil}	R1 < (0.8 x U_{aux} – 19.2)/0.035 – R_{coil}

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The R1 resistor withstand value (in Watt) is defined below:

$$P_{R1} > 2 \times \frac{(1{,}2 \times U_a)^2}{(R1 + R_{Coil})} [W]$$

Notes: – The presence of auxiliary relays, such as an anti-pumping system for instance, in the trip circuit must be taken into account for the R1 resistance values specification.
– We consider that the maximum variation of the auxiliary voltage value is ±20%.

Example 4

In this example both 52a and 52b auxiliary contacts are available, the MiCOM P116 relay monitors the complete trip circuit whatever the CB status (CB open or CB closed).

This application need to assign two Binary Inputs to one ***Trip Circuit Supervision*** input logic function.

In this case it is necessary to insert a RL1, if either the output trip is latched, or if it stays accidently closed, or if a long time trip pulse is programmed.

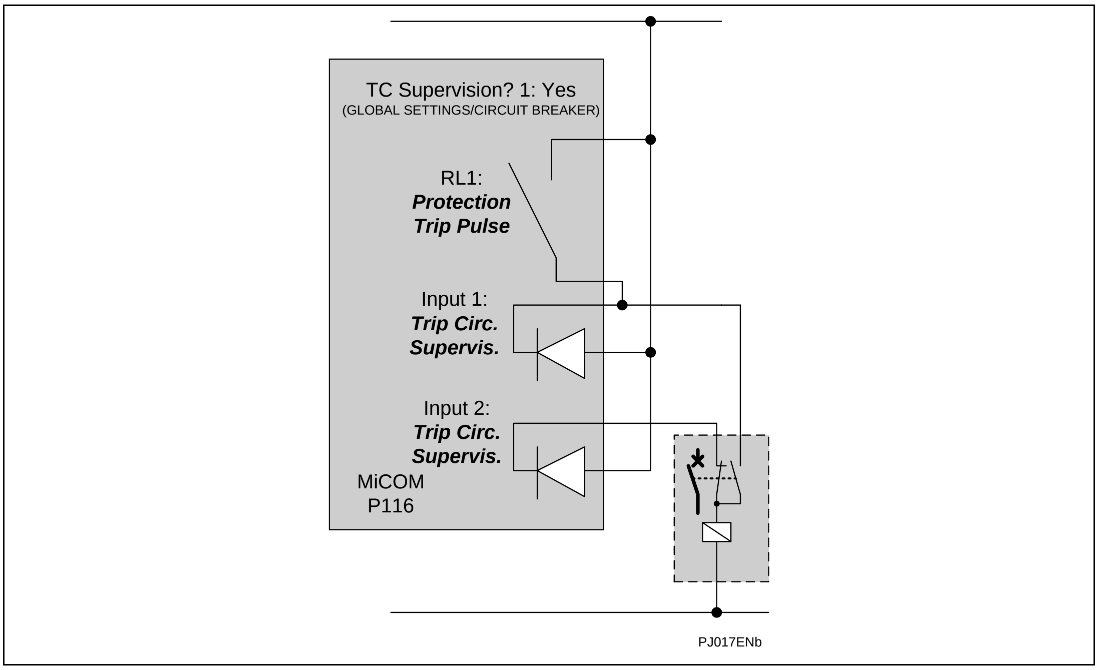

Figure 27: Example 4: Trip Coil and Auxiliary Contact Monitoring by using two Binary Inputs

Example 5

In this example 52a auxiliary contacts is available, the MiCOM P116 relay monitors the complete trip circuit if the CB status is closed.

This application need to assign one Binary Input to ***Trip Circuit Supervision*** input logic function.

In this case it is necessary to insert a RL1, if either the output trip is latched, or if it stays accidently closed, or if a long time trip pulse is programmed.

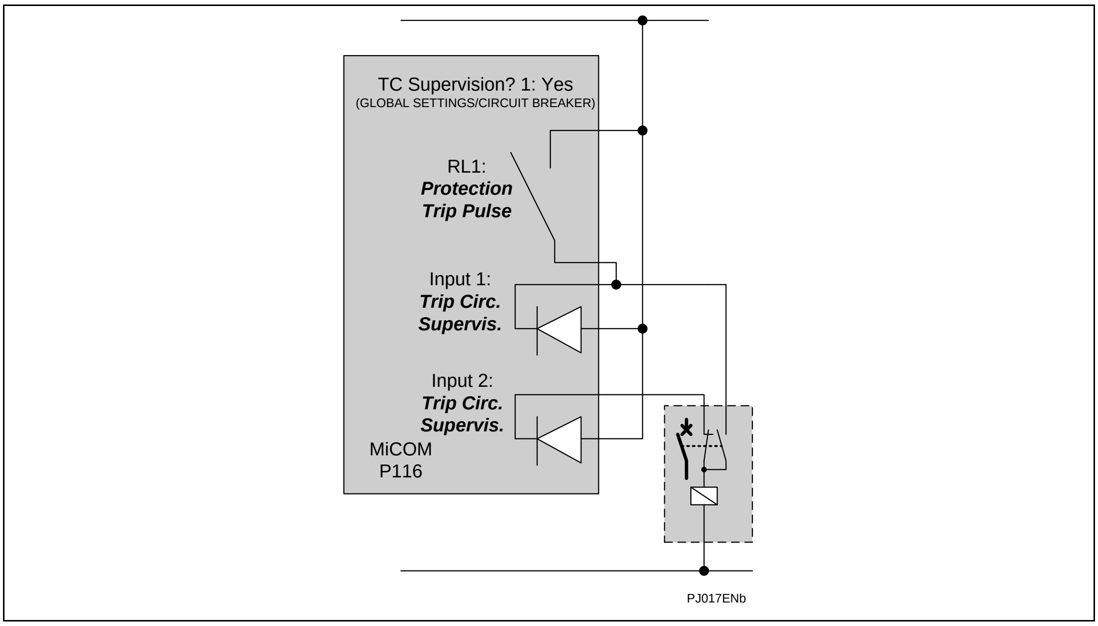

Figure 28: Example 4: Trip Coil and Auxiliary Contact Monitoring by using two Binary Inputs

2.27 Real time clock synchronization via opto-inputs (Model A)

In modern protection schemes it is often desirable to synchronize the relay's real time clock so that events from various relays can be placed in chronological order. This can be done using the communication interface connected to the substation control system or via a binary input. Any of the available binary inputs on the P116 relay can be selected for synchronization. Pulsing this input will result in the real time clock snapping to the nearest minute. The recommended pulse duration is 20 ms to be repeated no more than once per minute. An example of the time synchronization function is shown.

Time of "Sync. Pulse"	Corrected Time
19:47:00.000 to 19:47:29.999	19:47:00.000
19:47:30.000 to 19:47:59.999	19:48:00.000

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

The input is configured in the ***SETTING GROUPx/INPUT CONFIGURATION Gx*** menu. The input must be assigned to ***Time Synchr.***

2.28 Event Records (Model A)

The relay records and time-tags up to 200 events and stores them in a non-volatile (Fram) memory. This allows the system operator to analyze the sequence of events that has occurred within the relay after a particular power system condition, or switching sequence, etc. When the available space is exhausted, the new fault automatically overwrites the oldest fault.

The real time clock within the relay time-tags each event, with a resolution of 1 ms.

The user can view the event records either locally via the USB port, or remotely, via the rear EIA(RS)485 port.

2.29 Fault Records

Each time any of the set thresholds are crossed, an instantaneous record is created and displayed in the ***RECORDS/INSTANTANEOUS RECORD*** menu. Information on the last five starts is available, with the duration of the signal.

The following information is displayed in the ***RECORDS/INSTANTANEOUS RECORD*** menu: number of starts, time, date, origin (crossing of a current threshold or start of a protection element's time-delay), current values.

Each time any of the set protection elements trips (***Protect.Trip*** output), a fault record is created and stored in memory. The fault record tags up to 20 faults and stores them in a non-volatile (Fram) memory. This allows the operator to identify and analyze system failures. When the available memory space is exhausted, the new fault automatically overwrites the oldest fault.

The user can view the latest fault record in the ***RECORD/FAULT RECORDS*** menu, where he or she can choose to display up to 20 stored records. These records are the fault flags, the fault measurements, etc. Also note that the time stamp displayed in the fault record itself will be more accurate than the corresponding time stamp given in the event record. This is due to the fact that events are logged some time after the actual fault is recorded.

The user can view event records either via the front panel interface, via the USB port, or remotely, via the rear EIA (RS) 485 port.

2.30 Instantaneous Recorder (Model A)

Each time any of set thresholds are crossed, an instantaneous record is created and displayed in the ***RECORDS/INSTANTANEOUS RECORD*** menu. The last five starting records are available, with the duration of the signal.

The following information is displayed in the ***RECORDS/INSTANTANEOUS RECORD*** menu: number of starts, time, date, origin (crossing of a current threshold or start of a protection element's time-delay), current values.

Instantaneous Recorder is memorized if P116 is powered from auxiliary voltage (Vx).

2.31 Alarm Recorder (Model A)

Each time any of the programmed protection element makes ALARM signal (***Alarm*** output), an Alarm record is created and stored in memory. The fault record tags up to 5 faults and stores them in a non-volatile (Fram) memory. This allows the system operator to identify and analyze network failures. When the available memory space is exhausted, the new fault automatically overwrites the oldest Alarm.

The user can view actual Alarm record under the ***RECORD/ALARM RECORDS*** menu, where he can select to display up to 5 stored records. These records are Alarm flags, Alarm measurements, etc. Also note that the time stamp displayed in the Alarm record itself will be more accurate than the corresponding time stamp given in the event record.

2.32 Disturbance Recorder

The integral disturbance recorder has a memory space specifically dedicated to the storage of disturbance records. Up to 6 seconds of disturbance recording can be stored. When the available memory space is exhausted, the new record automatically overwrites the oldest record.

The recorder stores actual samples that are taken at a rate of 16 samples per cycle.

Each disturbance record consists of analogue and digital channels. (Note that the relevant CT ratios for the analogue channels are also extracted to enable scaling to primary quantities).

The disturbance recorder is set in the ***GLOBAL SETTINGS/DISTURBANCE RECORDER*** menu.

The total disturbance recording time is 6 s.

Total number of records available in disturbance recorder is:

- One - for set Max Record Time from in range: 3.01s - 6s
- Two – for set Max Record Time from in range: 2.01s - 3s
- Three – for set Max Record Time from in range: 1.51s - 2s
- Four – for set Max Record Time from in range: 1.21s – 1.5s
- Five - for set Max Record Time from in range: 0.10s – 1.2s

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Triggering of disturbance recording depends on the ***Disturb.Rec.Trig.*** configuration:

- ***0: on Inst.*** – Start of a protection element set to ***Trip***,
- ***1: on Trip*** – Trip by a protection element followed by the ***Protect.Trip*** output.

If the ***0: on Inst***. option is selected the record consists of: Pre-fault time + duration of the "any Start" signal presence + Post-fault time.

If the ***1: on Trip*** option is selected the record consists of: Pre-fault time + duration of the Trip signal presence (***Protect.Trip*** function active) + Post-fault time.

The pre-fault time can be set in the cell: ***GLOBAL SETTINGS/DISTURBANCE RECORDER/Pre-Time***. If the pre-fault time is set to 100 ms, recording starts 100 ms before the disturbance.

The post trip time can be set in the cell: ***GLOBAL SETTINGS/DISTURBANCE RECORDER/Post Trip Time***. If the post-fault time is set to 100 ms, recording stops 100 ms after the disturbance.

2.33 Demand values

The relay produces fixed and peak demand values, using the reset demand menu cell it is possible to reset these quantities via the user interface or the remote communications.

Information about actual values is available in the ***RECORDS/MAX & AVERAGE I*** submenu.

2.33.1 Fixed demand values

The fixed demand value is the average value of a quantity over a specified interval (***Time Window)***. Values are produced for each phase current (A, B, C). The fixed demand values displayed by the relay are those for the previous interval, the values are updated at the end of the settable demand period: ***Time Window*** cell (***GLOBAL SETTINGS/MAX&AVERAGE I CONFIGURATION/***)

Time Window setting: from 1 mn to 24 hour

The 3 phase Peak demand values are displayed in the ***RECORDS/MAX & AVERAGE I*** menu:

- Average IA

- Average IB
- Average IC

The calculation is reset either via the front panel interface in the ***RECORDS/MAX & AVERAGE I/ MAX&Aver.Reset*** cell under Control password (Note: Control password can be deactivated if it is set to 0):

```
Max&Aver.Reset
CTRL:No operation
```

Resetting can be applied by:

- pressing the OK key,

- entering the Control Password,

- confirming the password by pressing the OK key,

- pressing or key then selecting: ***1.Reset***

- confirming the command by pressing OK.

Note: In case of loss of power supply the fixed demand values are not stored.
Any modification of the **Time Window** setting resets the calculation.

2.33.2 Peak Demand Values

Peak demand values are produced for each phase current quantity. These display the maximum value of the measured quantity since the last reset of the demand values.

The principle of calculation of the Peak value demand for the IA, IB and IC phase currents is as follows:

For every ***Time Window***, a new average value is compared with the previous value calculated for the previous ***Time Window***. If this new value is greater than the previously stored value, then this new value is stored instead of the old one.
To the contrary, if this new value is lower than the previously stored value, then the old value is kept.
This way the average peak value will be refreshed with each ***Time Window***.

There is no dedicated setting for this calculation. The setting for the ***Time Window*** is shared with that for the ***Fixed Demand*** value.

The 3 phase Peak demand values are displayed in the ***RECORDS/MAX & AVERAGE I*** menu:

MAX IA
MAX IB
MAX IC

The calculation can be reset – see Fixed demand value.

Note: In case of loss of power supply, Peak average values are stored. Any modification of the ***Time Window*** setting resets the calculation.

2.34 External trip (Model A)

A Binary Input can be configured to CB trip by using the AUX1 or AUX2 or AUX3 or AUX4 functions.

The AUX1 – AUX4 functions have a timer so a trip can be time-delayed.

tAUX1 – tAUX4 can be mapped to:

- RL1,
- RL2,
- RL3,
- RL4,
- RL5,
- RL6,
- Trip (protection trip)
- Alarm signal
- Programmable LEDs

If it is configured to Trip (protection trip), tAUX1 - tAUX2 will illuminate the “Trip” LED.

2.35 Minimum Tripping Time

The minimum tripping time when the relay switches on to a fault is subject to the fault current level.

TYPICAL OPERATION TIME **(protection time-delay set to 0 ms and the current value is greater than two times of the setting value)** The P116 is supplied from Vx or the current is above 0.2 In (Ien).		
Operation time:	All types of faults	≤ 40ms
TYPICAL OPERATION TIME **(protection time-delay set to 0 ms and the current value is greater than two times of the setting value)** The pre-fault current is below 0.2 In (Ien) in all phases and that there is no Vx on the B1 – B2 terminals. The case: CB switch on to fault without auxiliary voltage supply. Typically: ≤ 65ms. Detailed calculation below:		
Operation time calculation:	$\frac{K}{\left\|\overrightarrow{I_A}-\overrightarrow{I_B}\right\|+\left\|\overrightarrow{I_C}+\overrightarrow{I_N}\right\|-S}+C\ [ms]$, **but not less than 50 ms**	
The trip coil and the flag indicator energy outputs are disabled.	$K=7;\ S=0.1;\ C=60;$	
The flag indicator energy output is enabled. The trip coil energy output is disabled.	$K=18;\ S=0.15;\ C=45;$	
The trip coil and the flag indicator energy outputs are enabled.	$K=55;\ S=0.14;\ C=25;$	

Example:

The trip coil and the flag indicator are enabled in the ***SETTING GROUP 1 (2) / OUTPUT RELAYS CONFIGURATION G1 (G2)*** menu.

Three-phase fault with current value of 0.5 In:

$$\overrightarrow{I_A} = 0.5e^{j0\deg}\ In\,;\ \overrightarrow{I_B} = 0.5e^{-j120\deg}\ In\,;\ \overrightarrow{I_C} = 0.5e^{j120\deg}\ In\,;\ \overrightarrow{I_N} = 0.0e^{j0\deg}\ Ien$$

Calculation:

$$\left|\overrightarrow{I_A} - \overrightarrow{I_B}\right| = \sqrt{\left(0.5\cdot\cos(0\deg) - 0.5\cos(-120\deg)\right)^2 + \left(0.5\cdot\sin(0\deg) - 0.5\sin(-120\deg)\right)^2} = 0.866In$$

$$\left|\overrightarrow{I_C} + \overrightarrow{I_N}\right| = \sqrt{\left(0.5\cdot\cos(120\deg) + 0\cos(0\deg)\right)^2 + \left(0.5\cdot\sin(120\deg) + 0\sin(0\deg)\right)^2} = 0.5In$$

Operation time:

$$\frac{55}{\left|\overrightarrow{I_A} - \overrightarrow{I_B}\right| + \left|\overrightarrow{I_C} + \overrightarrow{I_N}\right| - 0.14} + 25\ ms = \frac{55}{0.866 + 0.5 - 0.14} + 25\ ms = 70ms$$

Operation time = 70 ms

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3. CT REQUIREMENTS

For the conventional case of a resistive load, the voltage at the secondary winding of the transformer is proportional to the primary current, therefore the error remains constant.

In the case of a MiCOM P116 self-powered protection relay, this no longer applies, since the voltage at the input of the protection circuit is in a non-proportional ratio to the input current.

The best solution to check whether the MiCOM P116 relay is adapted to a given CT is to have available the magnetization curve and the internal resistance of the CT in question.

To guarantee good accuracy at low current levels, the magnetizing current of the CT must be low. In other words, the input voltage of the relay must be sufficiently low compared with the knee-point voltage Vk of the CT.

The following sections show the ac burden of the P116 MiCOM relay and, taking into account the magnetizing curve of a CT, it is then possible to determine the accuracy of the system as a whole for the entire current range: P116 + associated CT.

3.1 Recapitulation of the Current Transformer's Characteristics

3.1.1 Characterization of a Current Transformer

The characteristics of a protection relay CT are based on:

- Its rated output burden expressed in VA, its relevant accuracy class (5P or 10P) and the rated **accuracy limit current** (5 In, 10 In, 15 In, 20 In). The **accuracy limit factor (K)** is the ratio between the precision limit current and the nominal current rating.
- Naturally, the transformation ratio of the CT is to be added to this. This ratio is the ratio of the primary current to the secondary current **I1/I2**. The secondary current rating is generally 1 A or 5 A.
- Other characteristics such as the insulating voltage or the thermal behavior are also taken into account.

Standard BS 3938 proposes a specification identical to that of IEC 185 for class P transformers. The CT is characterized in accordance with a second class known as X class (Cx) which, in addition to the calculated ratio, requires a knee-point voltage **Vk** and an internal resistance **Rct**.

The following quantities are associated with the magnetization curve of a CT:

- The knee-point voltage **Vk**, which is determined by the point on the curve V=f (Im) beyond which an increase of 10% in the voltage V results in a 50% increase of the magnetizing current.
- The voltage related to the accuracy limit of the CT.

\- For a 5PK CT (accuracy class 5P, accuracy limit factor K):

At the saturation voltage **Vs1** we will have a 5% accuracy on the current K * In.

\- For a 10PK TC (accuracy class 10P, accuracy limit factor K):

At the saturation voltage **Vs2** we will have a 10% accuracy on the current K * In

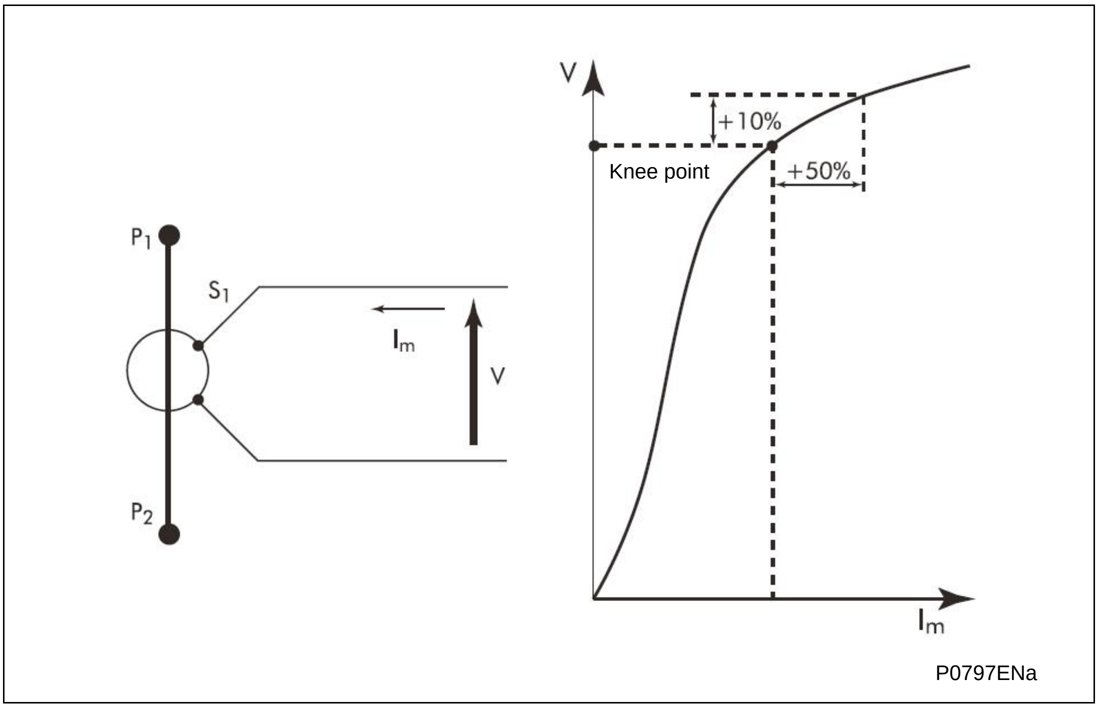

Figure 29: Definition of the Magnetizing Curve's Knee-Point

With the materials generally used to manufacture current transformers, we have:

Vk corresponds to 1.4 tesla

Vs1 corresponds to 1.6 tesla

Vs2 corresponds to 1.9 tesla

3.1.2 Equivalent diagram of a current transformer

The equivalent diagram of a CT is indicated below:

- CT ratio: n2/n1
- L_m: magnetization self-induction coil of the CT
- I_m: magnetizing current
- I_1: primary current
- I_2: secondary current = I_1 * n2 /n1
- I_s: secondary current passing through the load resistance Rp.: $\overrightarrow{I_S} = \overrightarrow{I_2} - \overrightarrow{I_m}$
- Rct: secondary winding resistance of the CT (ohms)

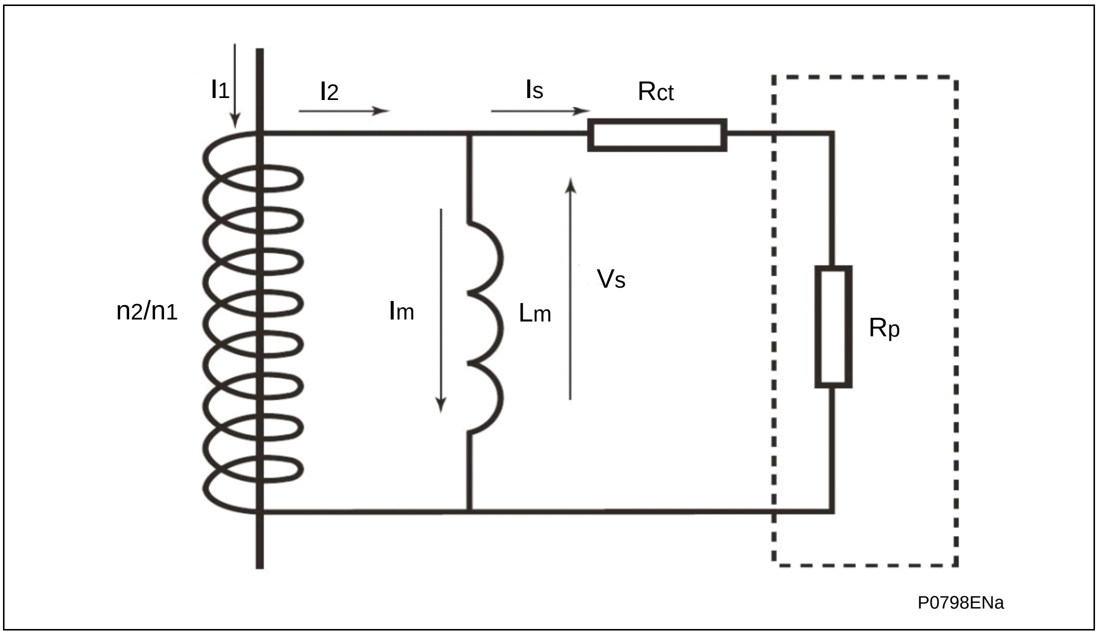

Figure 30: Equivalent diagram of a current transformer

AP

The magnetizing current Im of the transformer depends on the voltage generated at the secondary windings of the transformer.

It is this current that introduces an error signal into the measurement. If the CT were perfect, the magnetizing current would be null.

3.1.3 How to calculate the rated burden, in VA, of a CT based on its characteristic quantities (Vk, Rct)

The saturation voltage is derived using the following formula: Vs = (Rct + Rp) Is

The nominal load impedance of the CT is Rp = Pn /In^2

We have Vs = (Rct + Pn /In^2) Is

Hence: Pn = (Vs/Is - Rct) In^2

• For a transformer with in a **5P** accuracy class: Vs1/Vk = 1.6/1.4

Thus: Vs1 = 1.6/1.4 * Vk, at Is1 equals K * In

Hence: Pn = [(1.6/1.4 * Vk)/(K * In) - Rct] * In^2

• For a transformer with a 10P accuracy class: Vs2/Vk = 1.9/1.4

thus Vs2 = 1.9/1.4 * Vk, at Is2 equals K * In

Hence: Pn = [(1.9/1.4 * Vk)/(K * In) - Rct] * In^2

3.1.4 Definition equivalence for common CTs

Since the only constants of a CT are its magnetizing curve, its Rct resistance and its transformation ratio, it is possible to replace a transformer which Pn1 power in VA is of the 5PK1 type with a transformer which Pn2 power in VA is of the 5PK2 type.

Given that the values of Vs1 and Rct are known:

$Vs1 = (Rct + Pn1/In^2)*K1 * In = (Rct + Pn2/In^2)*K2 * In$

$Pi = Rct * In^2$ (ohmic loss of CT)

$(Pi + Pn1) * K1 = (Pi + Pn2) * K2$

Hence $\mathbf{K2 = [(Rct * In^2 + Pn1)/(Rct * In^2 + Pn2)] * K1}$

3.1.5 How to calculate the knee-point voltage Vk of a CT defined in class **P**

• For a transformer with accuracy class of **5P**: $Vs1/Vk = 1.6/1.4$

$Pn = [(1.6/1.4 * Vk)/(K * In) - Rct] * In^2$

Hence $\mathbf{Vk = 1.4/1.6 (Pn/In^2 + Rct) K * In}$

• For a transformer with a precision class **10P**: $Vs2/Vk = 1.9/1.4$

$Pn = [(1.9/1.4 * Vk)/K * In - Rct] * In^2$

Hence $\mathbf{Vk = 1.4/1.9 (Pn/In^2 + Rct) K * In}$**.**

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3.2 Consumption of MiCOM P116 Relays

The MiCOM P116's self- and dual-powered hardware versions (with identical ac burden at their current inputs) have a minimum self-supply starting current of 0.2 In. This minimum level of current is needed on at least one phase in order to enable the MiCOM relay to be correctly self-powered and thus ensure the full capability of its protection functions:

CAUTION: THE FOLLOWING ARE THERMAL CHARACTERISTICS

• 3 In continuous rating

• 40 In during 100 s

• 100 In during 1 s

The P116's current input resistance depends on the value of the current. Table 2 shows the resistance for a single current input per P116: In = 1 A / 5 A, and common connection for a single current input per P116 + current transformer WA-25. if e/f input supplies P116, it is necessary to take into account a double value of the resistance (I + IN), as shown in Table 2.

Current I	Input resistance (Rp) in tripping condition									
	Single current input I (IN)								WA25+I+IN	
	CT powering only (no Vx auxiliary supply)				With auxiliary supply (Vx)				CT only	
	In (Ien) = 1 A		In (Ien) = 5 A		In (Ien) = 1 A		In (Ien) = 5 A		In (Ien) = 1 A	
	Rp	Vp	Rp	Vp	Rp	Vp	Rp	Vp	Rp	Vp
In (Ien)	Ω	V	Ω	V	Ω	V	Ω	V	Ω	V
0.04	n/a	n/a	n/a	n/a	71.656	2.87	4.687	0.94	n/a	n/a
0.06	n/a	n/a	n/a	n/a	77.306	4.64	3.994	1.20	n/a	n/a
0.08	n/a	n/a	n/a	n/a	61.648	4.93	2.436	0.98	n/a	n/a
0.10	n/a	n/a	n/a	n/a	34.815	3.48	1.820	0.91	n/a	n/a
0.12	n/a	n/a	n/a	n/a	24.108	2.89	1.347	0.81	n/a	n/a
0.14	n/a	n/a	n/a	n/a	13.452	1.88	0.990	0.69	n/a	n/a
0.16	n/a	n/a	n/a	n/a	12.150	1.94	1.026	0.82	n/a	n/a
0.18	n/a	n/a	n/a	n/a	8.937	1.61	0.346	0.31	n/a	n/a
0.20	31.063	6.21	1.219	1.22	7.373	1.47	0.313	0.31	61.063	12.21
0.22	27.683	6.09	1.074	1.18	6.376	1.40	0.247	0.27	46.415	10.21
0.24	24.395	5.85	0.938	1.13	4.552	1.09	0.177	0.21	40.182	9.64
0.30	21.82	6.55	0.646	1.00	3.172	0.95	0.118	0.18	25.933	7.78
0.40	12.274	4.91	0.351	0.70	1.508	0.60	0.074	0.15	21.056	8.42
0.50	7.629	3.81	0.225	0.56	0.949	0.47	0.047	0.12	13.710	6.86
0.60	5.320	3.19	0.250	0.75	0.902	0.54	0.036	0.11	10.199	6.12
0.70	5.833	4.08	0.186	0.65	0.679	0.48	0.033	0.12	8.092	5.66
0.80	4.44	3.55	0.148	0.59	0.595	0.48	0.029	0.12	6.744	5.40
0.90	3.564	3.21	0.123	0.55	0.513	0.46	0.028	0.13	5.763	5.19
1.00	2.898	2.90	0.099	0.49	0.450	0.45	0.026	0.13	5.108	5.11
1.20	1.852	2.22	0.074	0.44	0.366	0.44	0.021	0.13	4.150	4.98
1.40	1.415	1.98	0.062	0.44	0.321	0.45	0.021	0.15	3.777	5.29
1.60	1.123	1.80	0.045	0.36	0.305	0.49	0.020	0.16	3.479	5.57
1.80	0.940	1.69	0.040	0.36	0.273	0.49	0.018	0.16	3.234	5.82
2.00	0.791	1.58	0.035	0.35	0.261	0.52	0.018	0.18	3.074	6.15
3.00	0.475	1.43	0.024	0.36	0.240	0.72	0.018	0.28	2.658	7.98
4.00	0.328	1.31	0.019	0.38	0.235	0.94	0.017	0.34	2.539	10.16
5.00	0.317	1.58	0.019	0.47	0.238	1.19	0.016	0.41	2.496	12.48
10.0	0.250	2.50	0.016	0.81	0.235	2.35	0.015	0.75	2.432	24.32
15.0	0.240	3.60	0.016	1.20	0.235	3.53	0.015	1.11	2.402	36.04
20.0	0.235	4.70	0.016	1.57	0.234	4.67	0.015	1.45	2.427	48.54
25.0	0.238	5.94	0.016	1.96	0.237	5.94	0.015	1.82	2.448	61.21
30.0	0.241	7.23	0.016	2.36	0.240	7.19	0.015	2.19	2.447	73.41

Table 2: P116 Current Input Resistance

3.3 Calculation of Required CT for Protection Relays

It is not possible to recommend any CT without detailed information. The decision needs to be based on calculation.

The following parameters have to be considered:

- Type of CT (nominal power, nominal current and current ratio, internal resistance, nominal accuracy limit factor, class and construction),
- Resistance of wiring (length, cross section, specific resistance of material),
- Resistance of P116 current inputs (as per table 2 in section 3.2).

Depend on the regional laws and the best practice two ways of calculation is possible:

- The first method gives the minimum CT requirement to be sure that the o/c relay trips
- The second method assures that CTs will be not saturated at all conditions (DC component should be taken into account in fault prospective current). This method is recommended for full functionality (measurement, recording in full range, etc) of the relay.

Note: Assuming that the CT does not supply any circuits other than the MiCOM P116 and the distance between P116 and CTs is short, the folowing CTs types are recommended as minimum:

- 5VA 10P20 for 1A secondary rating
- 10VA 10P20 for 5A secondary rating

The first method:

Protection type	Knee-point voltage
Non-directional DT/IDMT overcurrent and earth fault protection	
Time-delayed phase overcurrent	$V_k \geq \frac{I_{fp}}{2}(R_{ct} + R_l + R_{rel\,p})$
Time-delayed earth fault overcurrent	$V_k \geq \frac{I_{fn}}{2}(R_{ct} + 2 \cdot R_l + R_{rel\,p} + R_{rel\,n})$
Non-directional instantenous overcurrent and earth fault protection	
Instantenous phase overcurrent	$V_k \geq I_{sp} \cdot (R_{ct} + R_l + R_{rel\,p})$
Instantenous earth fault overcurrent	$V_k \geq \frac{I_{fn}}{2}(R_{ct} + 2 \cdot R_l + R_{rel\,p} + R_{rel\,n})$

Where:

V_k : Required CT knee-point voltage [V]

I_{fp} : Maximum prospective secondary phase current [A]

I_{psc} : Maximum prospective primary phase current [A]

I_{fn} : Maximum prospective secondary earth fault current [A]

$I_{psc\,N}$: Maximum prospective primary earth fault current [A]

I_{sp} : Stage 2 and 3 setting [A]

R_{ct} : Secondary CT winding resistance [Ω]

R_l : Resistance of single lead from the relay to current transformer [Ω]

$R_{rel\ p}$: Resistance of P116 phase current input at 30In [Ω]

$R_{rel\ n}$: Resistance of P116 neutral current input at 30In [Ω]

R_{bn} : rated (nominal) CT burden resistance

R_b : real CT burden resistance (for example: wires of circuit between CT and the relay and resistance of all contacts in circuits, etc)

K_n : CT ratio

I_{pn} : rated (nominal) primary phase CT current

$I_{pn\ N}$: rated (nominal) primary CT e/f current

I_{sn} : rated (nominal) secondary CT current

$I_{sn\ N}$: rated (nominal) secondary CT e/f current

S_n : rated (nominal) CT power

P_{bn} : rated (nominal) CT burden (typically the burden of CT has efective character so $P_{bn} = S_n$)

n_n : rated (nominal) CT accuracy limit factor (for example for 5P20: $n_n = 20$)

V_{sal} : rated (nominal) CT knee-point voltage [V]

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For more details refer to B&CT_EN_AP_D11.pdf ("Burdens & Current Transformer Requirements of MiCOM Relays, Application Notes.")

The second method:

Two critical cases have to be checked for different types of faults:

- the set current threshold value at which the relay has to operate.
- the highest possible short-circuit current, which depends on the maximum short-circuit power on the busbar of the substation (maximum current).

The following equation is used for dimensioning a current transformer:

$$V_{sal} = n_n \cdot I_{sn} \cdot \left(R_{ct} + R_{bn}\right) \geq \frac{I_{psc}}{K_n} \cdot \left(R_{ct} + R_b\right)$$

The current transformer can be dimensioned for the minimum required secondary accuracy limiting voltage acc. to IEC 60044-1, 2.3.4:

$$V_{sal} \geq \frac{I_{psc}}{K_n} \cdot \left(R_{ct} + R_b\right)$$

$$\geq \frac{I_{psc}}{I_{pn}} \cdot I_{sn} \cdot \left(R_{ct} + R_b\right)$$

$$\boxed{V_{sal} \geq K_{ssc} \cdot I_{sn} \cdot \left(R_{ct} + R_b\right)}$$

Alternatively, the current transformer can also be dimensioned for the minimum required rated accuracy limit factor acc. to IEC 60044-1, 2.3.3:

$$n_n \geq \frac{I_{psc}/K_n}{I_{sn}} \cdot \frac{\left(R_{ct} + R_b\right)}{\left(R_{ct} + R_{bn}\right)}$$

$$\geq \frac{I_{psc}}{I_{pn}} \cdot \frac{\left(R_{ct} + R_b\right)}{\left(R_{ct} + R_{bn}\right)}$$

$$\boxed{n_n \geq K_{ssc} \cdot \frac{(R_{ct} + R_b)}{(R_{ct} + R_{bn})} = K_{ssc} \cdot \frac{(P_{ct} + P_b)}{(P_{ct} + P_{bn})}}$$

The actual secondary connected burden R_b is given as follow:

$(in\ P116: R_{rel\ p} = R_{rel\ n} = R_{rel})$

- For phase-to-ground faults: $R_b = 2 \cdot R_l + 2 \cdot R_{rel}$
- For phase-to-phase faults: $R_b = R_l + R_{rel}$

The relay's burden R_{rel} is per table 2 (see section 3.2).
The lead resistance R_l is to be calculated from wire length, cross section and specific resistance.

The relation between secondary accuracy limiting voltage acc. to IEC 60044-1, 2.3.4 and rated (nominal) accuracy limit factor acc. to IEC 60044-1, 2.3.3 is given as follows:

$$V_{sal} = n_n \cdot \left(\frac{P_{bn}}{I_{sn}} + I_{sn} \cdot R_{ct} \right)$$

Sample calculation

The following application data are given:

CT ratio: 100 A /1 A (I_{pn} =100A; I_{sn} = I_n (P116) = 1A)

P116 e/f input is connected to star point of phase CTs (no dedicated CT for e/f)

So e/f CT ratio: 100 A /1 A ($I_{pn} = I_{pn\ N}$ =100A; $I_{sn\ N}$ = I_{sn} = I_n (P116) = I_{en} (P116) =1A)

CT nominal power (producer data value): S_n=2.5 VA

Nominal (rated) CT burden: $R_{bn} = \frac{S_n}{I_{sn}{}^2} = \frac{2.5VA}{(1A)^2} = 2.5\Omega$

CT internal burden R_{ct} = 0.5 Ω (producer data value or measured for CT secondary wire)

Lead resistance (wires between CTs and P116): R_l = 0.01774 Ω (2 m one way, 2.5 mm^2 Cu)

Calculation	Calculation condition	Current used for calculation (fault calculation or setting values)		R_{rel} (R_p – refer Table 2)
		Symbol	Value	
Required accuracy limit factor	Max prospective short circuit value for 3-phase fault	I_{psc}	100 I_{pn} (10 kA)	0.240Ω @ 30I_n; I_n=1A
	Max prospective earth fault value for phase-ground fault	$I_{psc\ N}$	20 I_{pn} (2 kA)	0.234Ω @ 20I_{en}; I_{en}=1A
Checking of CT accuracy because of the real burden	The first o/c stage	I>	1 I_n	2.898Ω @ 1I_n; I_n=1A
	The second o/c stage	I>>	10 I_n	0.250Ω @ 10I_n; I_n=1A
	The first e/f stage	(IN>)	0.2 I_{en}	31.061Ω @ 0.2I_{en}; I_{en}=1A

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Checking of CT accuracy because of the real burden at setting point value

Phase-earth fault at the first stage current,

where $(K_{ssc}) = (IN > value)$ and $R_b = 2 \cdot (R_l + R_{rel})$: :

$$n_n \geq K_{ssc} \cdot \frac{R_{ct} + R_b}{R_{ct} + R_{bn}} = 0.2 \cdot \frac{0.5 + 2 \cdot (0.01774 \cdot 31.063)}{0.5 + 2.5} = 4.18$$

Phase-phase fault at the first stage current,

where $(K_{ssc}) = (I > value)$ and $R_b = R_l + R_{rel}$:

$$n_n \geq K_{ssc} \cdot \frac{R_{ct} + R_b}{R_{ct} + R_{bn}} = 1.0 \cdot \frac{0.5 + (0.01774 \cdot 2.898)}{0.5 + 2.5} = 1.14$$

Phase-phase fault at the second stage current,

where $(K_{ssc}) = (I >> value)$ and $R_b = R_l + R_{rel}$:

$$n_n \geq K_{ssc} \cdot \frac{R_{ct} + R_b}{R_{ct} + R_{bn}} = 10.0 \cdot \frac{0.5 + (0.01774 \cdot 0.250)}{0.5 + 2.5} = 2.56$$

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Checking of accuracy limit factor point for max current:

Phase-earth fault, maximum current,

where $(K_{ssc}) = (\frac{I_{pscN}}{I_{pnN}})$ and $R_b = 2 \cdot (R_l + R_{rel})$:

$$n_n \geq K_{ssc} \cdot \frac{R_{ct} + R_b}{R_{ct} + R_{bn}} = 20 \cdot \frac{0.5 + 2 \cdot (0.01774 \cdot 0.234)}{0.5 + 2.5} = 6.69$$

3 phase fault, maximum current,

where $(K_{ssc}) = (I_{psc} / I_{n\,primary})$ and $R_b = R_l + R_{rel}$:

$$n_n \geq K_{ssc} \cdot \frac{R_{ct} + R_b}{R_{ct} + R_{bn}} = 100 \frac{0.5 + (0.01774 \cdot 0.240)}{0.5 + 2.5} = 25.258$$

Summary of calculation:

The maximum value (for all above cases) of required accuracy limit factor is for three phase fault with maximum current.

Overall, a minimum rated accuracy limit factor of 25.258 is required. A typical (standard) value thus would be n_n = 30.

A typical (standard) value thus would be 2.5 VA (2.5 VA P30);

If a CT with n_n = 20 is to be used, it is necessary to increase the nominal power of the CT based on the following formula:

$$n_{n1} \cdot S_{n1} = n_{n2} \cdot S_{n2}$$

Where:

S_{n1} - nominal power of assumed CT for the first approach of calculation: 2.5VA

n_{n1} - minimum required accuracy limit factor for the first approach of calculation: 25.258.

n_{n2} - assumed accuracy limit factor for required CT: n_n = 20.

S_{n2} - nominal power of required CT for assumed accuracy limit factor: ?

$$\boxed{S_{n2} = S_{n1} \cdot \frac{(n_{n1})}{(n_{n2})} = 2.5VA \cdot \frac{(25.258)}{(20)} = 3.16VA}$$

A typical (standard) value thus would be 5 VA (5 VA P20);

The new CT requirement calculation based on 5 VA P20 CT can be repeated again for double check.

4. POSSIBLE CONNECTIONS OF CTs AT THE P116's INPUT

Connection diagrams are given in the Installation chapter (P116/EN IN) of this manual.

4.1 Connection to 3 Phase CTs + Core Balance CT

4.1.1 Core balance CT connected to the Earth Current Measurement Input (terminals A9 – A10)

This application can be used in systems with a small value of e/f current (isolated neutral or with Petersen coil). To ensure that the P116 is powered during earth fault conditions, the auxiliary voltage supply should be connected to terminals B1 and B2 (Vx). Typically phase-to-phase AC voltage from substation auxiliary transformer or VT is applied. For the above types of system, the phase-to-phase voltage does not disappear during earth faults. For phase-to-phase faults the P116 is supplied from the CTs only.

Refer to Application chapter: P116/EN AP, Figure 3.

Advantage:
In this case, a typical core balance CT can be used.

The earth fault current value has no influence on the CB tripping.

Drawback:
Additional Vx powering from an ac voltage source is required to trip in case of an e/f.

4.1.2 Connection to 2 Phase CTs + Core Balance CT

Refer to Application chapter: P116/EN AP, Figure 4.

Advantage:
Only 2 CTs are used, resulting in saving one phase CT. The third phase is reformed by the wiring.

Drawback:
The phase and earth CTs must be suitably over-dimensioned. The core balance CT must be connected to the supply input of the earth current input (terminals A7 – A8).

We assume that the system is balanced. This solution can be applied in specific applications only, because of the cost of over-dimensioned core balance CTs is significant and there is technical difficulty to turn more than one wire in a core balance CT. It is recommended to use dual powering application with powering from phase-phase AC voltage (for example from the busbar) so that the P116 is powered from the auxiliary voltage (B1 – B2 terminals) in case of e/f with small current value (too small to supply the P116 from the earth fault current).

4.2 Earth Current Input Connected to the Summation of the 3 Phase CTs

Refer to Application chapter: P116 EN AP, Figure 2.

Advantage:
In this case, the earth current is detected by summing the 3 phase currents, the use of a core balance CT is therefore not required. The summing operation is performed at terminals A9 – A10 of the earth current input.

It is not necessary to supply the relay via the earth current input. However, an additional supply (shown Figure 3) via the earth fault current will provide more energy to the P116. Therefore the CT starts supplying the P116 when the current drops below 0.2 Ien (refer to the Technical Data chapter, P116/EN TD)

Drawback:
Less sensitivity than the core balance CT connection.

5. AUXILIARY SUPPLY FUSE RATING (Model A)

In the Safety section of this manual, the maximum allowable fuse rating of 16 A is quoted. To allow time grading with upstream fuses, a lower fuse link current rating is often preferable. Use of standard ratings of between 6 A and 16 A is recommended. Low voltage fuse links, rated at 250 V minimum and compliant with IEC 60269-2 general application type gG, with high rupturing capacity are acceptable. This gives equivalent characteristics to HRC "red spot" fuses type NIT/TIA often specified historically.

The table below recommends advisory limits on relays connected per fused spur. This applies to the MiCOM P116**,** as these have inrush current limitation on switch-on, to conserve the fuse-link.

Maximum Number of MiCOM P116 Relays Recommended Per Fuse				
Battery Nominal Voltage	6 A	10 A Fuse	15 or 16 A Fuse	Fuse Rating > 16 A
24 to 60 Vac/dc	2	4	6	Not permitted
60 to 240 Vac/ 60 to 250 Vdc	6	10	16	Not permitted

Alternatively, miniature circuit breakers (MCB) may be used to protect the auxiliary supply circuits.

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MEASUREMENTS AND RECORDING

MR

Date:	**17th November 2013**
Hardware Suffix:	**A**
Software Version:	**1C**
Connection Diagrams:	**10P11602**

CONTENTS

MR

1. MEASUREMENTS AND RECORDING

1.1 Introduction

The P116 is equipped with integral fault recording facilities suitable for analysis of complex system disturbances. Fault records can be read out by setting software MiCOM S1 via the USB port accessible on the P116 front panel. The USB port offers a communications facility to the P116.

Communications can be established via the USB port even if the P116 is supplied neither by the CT nor by the auxiliary voltage.

Access to the USB port is protected by means of a plastic cover.

1.2 Event records (Model A)

The relay records and time tags up to 200 events and stores them in non-volatile FRAM memory. This enables the system operator to establish the sequence of events that occurred within the relay following a particular power system condition, switching sequence etc. When the available space is exhausted, the oldest event is automatically overwritten by the most recent.

The real time clock within the relay provides the time tag for each event, to a resolution of 1 ms.

The event records are available for remote viewing, via the communications ports RS485 or USB.

For extraction from a remote source via communications ports, refer to the SCADA Communications section (P116/EN CT), where the procedure is fully explained.

Types of event

An event may be a change of state of a control input or output relay, a trip condition, etc. The following sections show the various items that constitute an event:

Change of state of binary inputs

If one or more of the binary inputs has changed state since the last time that the protection algorithm ran, the new status is logged as an event. The information is available if the event is extracted and viewed via a PC.

Change of state of one or more output relay contacts

If one or more of the output relay contacts have changed state since the last time that the protection algorithm ran, then the new status is logged as an event. The information is available if the event is extracted and viewed via PC.

Relay alarm conditions

Any alarm conditions generated by the relays will also be logged as individual events. The following table shows examples of some of the alarm conditions and how they appear in the event list:

Alarm Condition	Event Text	Event Value
Auxiliary Supply Fail	Vx Fail ON/OFF	Bit position 0 in 32 bit field
CT Supply Fail	CT Supply Fail ON/OFF	Bit position 1 in 32 bit field

The above table shows the abbreviated description that is given to the various alarm conditions and also a corresponding value between 0 and 31. This value is appended to each alarm. It is used by the event extraction software, such as MiCOM S1, to identify the alarm. Either ON or OFF is shown after the description to signify whether the particular condition is operational or has reset.

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Protection element trips

Any operation of protection elements (a trip condition) will be logged as an event record, consisting of a text string indicating the operated element and an event value. Again, this value is intended for use by the event extraction software, such as MiCOM S1.

1.3 Fault records

Each fault record is generated with time stamp.

The following data is recorded for any relevant elements that operated during a fault, and can be viewed in each of the last 20 fault records:

(i) Event Text (the reason for a trip):

Phase Overcurrent:

- I> trip
- I>> trip
- I>>> trip
- SOTF trip (Model A)
- IN_1 trip
- IN_2 trip
- IN_3 trip
- I< trip (Model A)
- I2> trip (Model A)
- Brkn Cond trip (Model A)
- CB Fail trip
- AUX1 trip (Model A)
- AUX2 trip (Model A)
- AUX3 trip (Model A)
- AUX4 trip (Model A)
- Therm OL (Model A)

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(ii) Active setting Group (Model A)

(iii) Fault Time an Fault Date (Model A)

(iv) Fault Orgin: type of fault (for example: phase A-B, A-B-C, etc)

(v) Event Value:

Per phase record of the current value during the fault: Iφ and measured IN

Fault records are stored in non-volatile memory (FRAM memory). This type of memory does not require any maintenance (no battery inside the P116). Fault records are stored without any time limitation even if the P116 is not supplied from any power source.

1.4 Alarm records (Model A)

Each alarm record is generated with time stamp.

The following data is recorded for any relevant elements that operated during an alarm, and can be viewed in each of the last 5 alarm records:

(i) Event Text (the reason for a protection alarm):

Phase Overcurrent:
- tI> Alarm
- tI>> Alarm
- tI>>> Alarm
- tSOTF Alarm
- tIN_1 Alarm
- tIN_2 Alarm
- tIN_3 Alarm
- tI< Alarm
- tI2> Alarm
- tBrkn Cond Alarm
- tCB Fail Alarm
- tAUX1 Alarm
- tAUX2 Alarm
- tAUX3 Alarm
- tAUX4 Alarm
- tTherm OL Alarm

(ii) Active setting Group

(iii) Alarm Time an Alarm Date

(iv) Alarm Orgin: type of alarm (for example: phase A-B, A-B-C, etc)

(v) Event Value:

Per phase record of the current value during the alarm: $I\varphi$ and measured IN

Alarm records are stored in non-volatile memory (FRAM memory). This type of memory does not require any maintenance (no battery inside the P116). Alarm records are stored without any time limitation even if the P116 is not supplied from any power source.

1.5 Instantaneous records (Model A)

Each instantaneous record is generated with time stamp if P116 is supplied from auxiliary voltage Vx.

The following data is recorded for any relevant current elements with the crossed threshold, and can be viewed in each of the last 5 instantaneous records:

(i) Event Text (the reason for a current protection start):

Phase Overcurrent:

I>
I>>
I>>>
SOTF
IN_1
IN_2
IN_3

(ii) Active setting Group

(iii) Alarm Time an Alarm Date

(iv) Alarm Orgin: type of alarm (for example: phase A-B, A-B-C, etc)

(v) Event Value:

Per phase record of the current value during the alarm: $I\varphi$ and measured IN

Instantaneous records are recorded in case of powering from an auxiliary voltage (not recorded if P116 is powered from CTs only) and stored in non-volatile memory (FRAM memory). This type of memory does not require any maintenance (no battery inside the P116). Instantaneous records are stored without any time limitation even if the P116 is not supplied from any power source.

1.6 Alarm status

Alarm status presents the current Alarm signals.

The Alarm signals information can be with latching or without latching, depends on the setting value ***GLOBAL SETTINGS/LOC/***

- Alarms Info 0:Self-reset – only current Alarm status is displayed,

- Alarms Info 1:Latching – Alarm information is latched up to reset in cell: ALARM STATUS/Reset Press ENTER cell.

The following Alarm is viewed:

tI> Alarm	Alarm by the first phase overcurrent stage	
tI>> Alarm	Alarm by the second phase overcurrent stage	
tI>>> Alarm	Alarm by the third phase overcurrent stage	
tSOTF Alarm	Alarm by SOTF element	Model A
tIN_1 Alarm	Alarm by the first earth fault overcurrent stage	
tIN_2 Alarm	Alarm by the second earth fault overcurrent stage	
tIN_3 Alarm	Alarm by the third earth fault overcurrent stage	
tI< Alarm	Alarm by the undercurrent element	Model A
tI2> Alarm	Alarm by the negative sequence overcurrent element	Model A
tBrkn Cond Alarm	Alarm by Broken Conductor protection	Model A
CB Fail Alarm	Circuit Breaker Failure protection time-delay elapsed	
tAUX1 Alarm	tAUX1 time-delay elapsed	Model A
tAUX2 Alarm	tAUX2 time-delay elapsed	Model A
tAUX3 Alarm	tAUX3 time-delay elapsed	Model A
tAUX4 Alarm	tAUX4 time-delay elapsed	Model A
Thermal Overload Alarm	Thermal Alarm stage crossed by actual Thermal State value	
tCB FLTY Ext.Sign. Alarm	An input mapped to this function detects CB problems that may influence control possibilities (for example spring problem, insufficient pressure, etc.)	Model A
Inrush Bl. Alarm.	Inrush Blocking (the second harmonic level crossing threshold	
TC Supervision Alarm.	Trip Circuit Supervision detects a problem	Model A
CB Time Monit. Alarm.	The monitoring time for CB opening/closing	Model A
CB Curr.Diagn. Alarm.	Summation of the current interrupted by the CB	Model A
CB Nb Diagn. Alarm.	CB open operations counter monitoring	Model A
[79] Lockout Alarm	Auto-recloser lockout condition	Model A
Hardw.Warning Alarm	Any hardware problem detected	
State of CB Alarm	The abnormal CB's position for two bits CB's connection (00 or 11)	Model A
[79] Roll.Demand Alarm	The number of Autoreclose cycles in the defined (set) time window is greater than set value	Model A

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1.7 Measurements

The relay produces a variety of directly measured power system quantities:

IA, IB, IC	-	R.M.S. values
I1, I2, I2/I1	-	calculated fundamental harmonic ratio (Model A)
IN	-	measured fundamental harmonic only (E/F analogue input)
Thermal	-	thermal state based on RMS value from the max phase current
IA 2nd harmonic	-	second harmonic in phase A
IB 2nd harmonic	-	second harmonic in phase B
IC 2nd harmonic	-	second harmonic in phase C

1.8 Demand values

The relay produces fixed and peak demand values. Using the reset demand menu cell it is possible to reset these quantities via the user interface or the remote communications.

The information about actual values is available in the ***RECORDS/MAX & AVERAGE I*** submenu.

Demands values are recorded in case of powering from an auxiliary voltage (not recorded if P116 is powered from CTs only) and stored in non-volatile memory (FRAM memory). This type of memory does not require any maintenance (no battery inside the P116). Instantaneous records are stored without any time limitation even if the P116 is not supplied from any power source.

1.8.1 Fixed Demand Values

The fixed demand value is the average value of a quantity over the specified interval (***Time Window)***. Values are produced for each phase current (A, B, C). The fixed demand values displayed by the relay are those for the previous interval, the values are updated at the end of the settable demand period: ***Time Window*** cell (***GLOBAL SETTINGS/MAX&AVERAGE I CONFIGURATION/***)

Time Window setting: from 1 mn to 24 hours

The three phase Peak value demand are displayed in the ***RECORDS/MAX & AVERAGE I*** menu:

- Average IA
- Average IB
- Average IC

1.8.2 Peak Demand Values

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Peak demand values are produced for each phase current quantities. These display the maximum value of the measured quantity since the last reset of the demand values.

The calculation principle for the Peak value demand of IA, IB and IC currents is the following:

For each ***Time Window***, a new average value is compared with the value calculated for the previous ***Time Window***. If this new value is greater than the previously stored value, then this new value is stored instead of the previous one.
On the other hand, if this new value is lower than the previously stored value, then the previous value is stored.
This way the average peak value will be refreshed for each ***Time Window.***

There is no dedicated setting for this calculation. The setting of ***Time Window*** is common with that of the ***Fixed Demand*** value.

The three phase Peak demand values are displayed in the ***RECORDS/MAX & AVERAGE I*** menu:

MAX IA
MAX IB
MAX IC

1.9 Counters

The P116's counters are available in the ***RECORDS/COUNTERS*** menu:

- ***CONTROL COUNTER (*** Model A):
  - ***No. Trips*** – Number of manual trip commands (inputs, menu default Control Window, trip key, remote control via RS485 or USB)
  - ***No. Close -*** Number of manual close commands (inputs, menu default Control Window, trip key, remote control via RS485 or USB)

  Counters can be reset in the ***CONTROL COUNTER*** column.
- ***FAULT COUNTER***:
  - ***No. Fault Trips –*** Number of trip commands from protection elements (current-based protection element trip, AUX trips and Auto-recloser trips)
  - ***No. Fault Starts*** – Number of timer starts by protection elements set to trip (current-based protection element and AUX)
  - ***No. Alarms*** - Number of Alarm signals from protection elements set to Alarm or functions mapped to an Alarm signal,
  - ***No. HW Warnings*** – Number of hardware problems detected by the self-monitoring function.

  Counters can be reset in the ***FAULT COUNTER*** column.
- ***AUTORECLOSE COUNTER*** (Model A):
  - ***No. Total [79] action –*** Total number of Auto-recloser starts
  - ***No. Trips&Lockout*** – Total number of final trips or lockouts
  - ***No. Successful –*** Total number of successful auto-reclosures (the reclaim time has elapsed without tripping)
  - ***Cycle 1 Reclose –*** Number of first shots (the counter is incremented with each first close shot, even if the following trip occurs during the reclaim time)
  - ***Cycle 2 Reclose –*** Number of second shots (the counter is incremented with each second close shot, even if the following trip occurs during the reclaim time)
  - ***Cycle 3 Reclose –*** Number of third shots (the counter is incremented with each third close shot, even if the following trip occurs during the reclaim time)
  - ***Cycle 4 Reclose –*** Number of fourth shots (the counter is incremented with each fourth close shot, even if the following trip occurs during the reclaim time)

Counters can be reset in the ***AUTORECLOSE COUNTER*** column.

Note: For a 4-shot auto-reclose sequence (TCTCTC, the next TCTC, the next TCTCTCTCT and the next TCT (lockout)) the counters shows:

Total [79] action:	4
Total Trips&Lockout:	1
Total Successful:	2
Cycle 1 Reclose:	4
Cycle 2 Reclose:	3
Cycle 3 Reclose:	2
Cycle 4 Reclose:	1

- ***CB MONITORING COUNTER*** (Model A):
  - ***CB Close Mon.*** – total number of close commands (auto-recloser included)
  - ***CB Open Mon. –*** total number of open commands (Manual and Fault trips)
  - ***CB AMPS Value*** – cumulative value of current broken by the CB for fault clearance trips.

1.10 Disturbance Recorder

The integral disturbance recorder has an area of memory specifically set aside for record storage. The number of records that may be stored by the relay is dependent upon the selected recording duration:

- One - for set Max Record Time from in range: 3.01s - 6s
- Two – for set Max Record Time from in range: 2.01s - 3s
- Three – for set Max Record Time from in range: 1.51s - 2s
- Four – for set Max Record Time from in range: 1.21s – 1.5s
- Five - for set Max Record Time from in range: 0.10s – 1.2s

The recorder stores actual samples that are taken at a rate of 16 samples per cycle. Each disturbance record consists of eight analog data channels and thirty-two digital data channels. The relevant CT and VT ratios for the analog channels are also extracted to enable scaling to primary quantities.

Note: If a CT ratio is set to less than a unit, the relay will choose a scaling factor of zero for the appropriate channel.

The "**DISTURBANCE RECORDER**" menu column is shown in the following table:

<table>
<tr><th rowspan="2">Menu Text</th><th rowspan="2">Default Setting</th><th colspan="2">Setting Range</th><th rowspan="2">Step Size</th></tr>
<tr><th>Min.</th><th>Max.</th></tr>
<tr><td>Pre-Time</td><td>0.1 s</td><td>0.1 s</td><td>6 s</td><td>0.01 s</td></tr>
<tr><td colspan="5">Setting for the disturbance record pre-fault time. The pre-fault time adjusts the beginning of the disturbance record: In this example, the record starts 100ms before the disturbance. Its length can be limited by setting.</td></tr>
<tr><td>Post-Fault Time</td><td>0.1 s</td><td>0.1 s</td><td>1 s</td><td>0.01 s</td></tr>
<tr><td colspan="5">Setting for the disturbance record post-fault time. The total disturbance recording time is: pre-fault time + high state of triggering criteria (Start or Trip time)+ post-fault time.
The above total recording time is limited by setting.</td></tr>
<tr><td>Disturbance Rec.Trig.</td><td>0: on Inst.</td><td colspan="3">0: on Inst.
1: on Trip</td></tr>
<tr><td colspan="5">Setting for the trigger criteria:
0: on Inst. – the trigger is the disturbance indicated by the starting of a protection element set to trip the CB. If this option is chosen the total recording time is: pre-fault time + duration of protection start + post-fault time, but no longer than the value of Max Record Time.
1: on Trip. – the trigger is the disturbance indicated by the protection element trip. If this option is chosen the total recording time is: pre-fault time + duration of protection trip+ post-fault time, but no longer than the value of Max Record Time.</td></tr>
<tr><td>Max Record Time</td><td>1.5 s</td><td>0.1 s</td><td>6 s</td><td>0.01 s</td></tr>
<tr><td colspan="5">Setting for the maximum total recording time. If default value is kept (3 s) it means that 2 records will be recorded.</td></tr>
</table>

It is not possible to display the disturbance records locally on the LCD; they must be extracted using suitable software such as MiCOM S1 or MiCOM S1 Studio.

1.11 Measurement Settings

The following settings under the measurements heading can be used to configure the relay measurement function.

1.11.1 CT Ratio

GLOBAL SETTINGS/CT RATIO menu

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
Line CT Primary	1.000 A	1	30k	1
In = 1 A: Sets the phase current transformer input's primary current rating.				
Line CT Primary	5.000 A	5	30k	1
In = 5 A: Sets the phase current transformer input's primary current rating.				
Line CT Sec	1.000 A	N/A	N/A	N/A
In = 1 A: Sets the phase current transformer input's secondary current rating.				
Line CT Sec	5.000 A	N/A	N/A	N/A
In = 5 A: Sets the phase current transformer input's secondary current rating.				
E/Gnd CT Primary	1.000 A	1	30k	1
Ien = 1 A: Sets the earth fault current transformer input's primary current rating.				
E/Gnd CT Primary	5.000 A	5	30k	1
Ien = 5 A: Sets the earth fault current transformer input's primary current rating.				
E/Gnd CT Sec	1.000 A	N/A	N/A	N/A
Ien = 1 A: Sets the earth fault current transformer input's secondary current rating.				
E/Gnd CT Sec	5.000A	N/A	N/A	N/A
Ien = 5 A: Sets the earth fault current transformer input's secondary current rating.				
IN connection	0:terminals:A7-A8	0: terminals:A7-A8 1: terminals: A9-A10		
This cell is used to inform the P116 about the IN connection: with or without powering of the P116.				

1.11.2 Default Measuring Window

Default window is after connection of power supply to P116 or after resetting of signaling.

GLOBAL SETTINGS/LOC menu

Menu Text	Default Setting	Available Settings
Default Display	0:Meas. In	0:Meas. In 1: Meas.A 2: Control CB (Model A): 3: [79] CTRL (Model A): 4:Control Mode (Model A):

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Menu Text	Default Setting	Available Settings
This cell is used to change the default display window 0: Measurements referred to In 1: Measurements in Amps 2: Control CB window for control of CB (close and trip command) 3: Auto-reclose control window for blocking of the auto-recloser and readout of auto-reclose status information 4: Control Mode window for changing of the CB control mode: Local/Remote and for presenting Control Mode state information		

1.11.3 Max and Average Currents

The ***Max & Average I Configuration*** submenu makes it possible to set parameters associated with this function. (Peak and Average values displayed in the Measurements menu)

GLOBAL SETTINGS/MAX&AVERAGE I CONFIGURATION menu

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
Time Window	900 s	0 s	3600 s	1 s
Setting for the length of the time window during which peak and average values are stored.				

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COMMISSIONING

CM

Date:	**17th November 2013**
Hardware Suffix:	**A**
Software Version:	**1C**
Connection Diagrams:	**10P11602**

CONTENTS

INTRODUCTION

The MiCOM P116 feeder protection relays are fully numerical in design, implementing all protection and non-protection functions in software. The relays employ a high degree of self-monitoring. The commissioning tests do not need to be as extensive as with non-numeric electronic or electro-mechanical relays.

In the commissioning of numeric relays, it is only necessary to verify that the hardware is functioning correctly and that the application-specific software settings have been applied to the relay. It is considered unnecessary to test every function of the relay if the settings have been verified by one of the following methods:

- Extracting the settings applied to the relay using appropriate setting software (preferred method)
- Via the operator interface

Unless previously agreed to the contrary, the customer will be responsible for determining the application-specific settings applied to the relay and for testing of any scheme logic applied by external wiring.

Blank commissioning test and setting records are provided at the end of this chapter for completion as required.

BEFORE CARRYING OUT ANY WORK ON THE EQUIPMENT, THE USER SHOULD BE FAMILIAR WITH THE CONTENTS OF THE SAFETY GUIDE SFTY/4L M/E11 OR LATER ISSUE, OR THE SAFETY AND TECHNICAL DATA SECTION OF THE TECHNICAL MANUAL AND ALSO THE RATINGS ON THE EQUIPMENT RATING LABEL.

For safety reasons, no work must be carried out on the P116 until all power sources to the unit have been disconnected.

1. SETTING FAMILIARIZATION

When commissioning a MiCOM P116 relay for the first time, sufficient time should be allowed to enable the user to become familiar with the method by which the settings are applied.

The Getting Started chapter (P116/EN GS) contains a detailed description of the P116 relay.

Via the front panel all the settings can be changed (refer to Settings chapter P116 /EN ST of this manual), LEDs and alarms reset, and fault and event records cleared. However, menu cells with access levels higher than the default level will require the appropriate password to be entered, before changes can be made.

Alternatively, if a portable PC is available together with suitable setting software (such as MiCOM S1 or S1 Studio), the menu can be viewed a page at a time to display a full column of data and text. This PC software also allows settings to be entered more easily, saved to a file on disk for future reference or printed to produce a setting record. Refer to the PC software user manual for details (refer to Getting Started P116 /EN GS). If the software is being used for the first time, allow sufficient time to become familiar with its operation.

2. EQUIPMENT REQUIRED FOR COMMISSIONING

2.1 Minimum equipment required

Multifunctional dynamic current injection test set.

Multimeter with suitable ac current range.

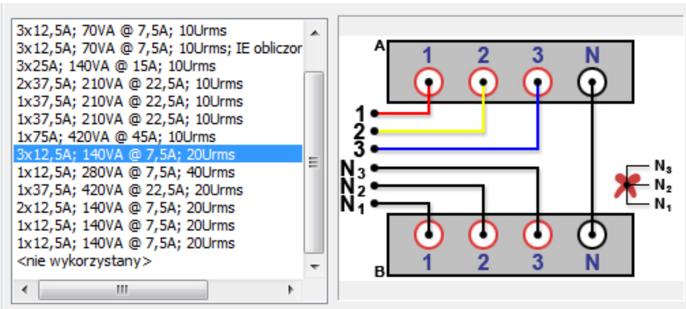
Ensure that the multimeter fuse is not open-circuited if used for CT current measurement.

Multimeter with maximum value recording of the dc voltage (to measure the dc magnitude of the trip pulse)

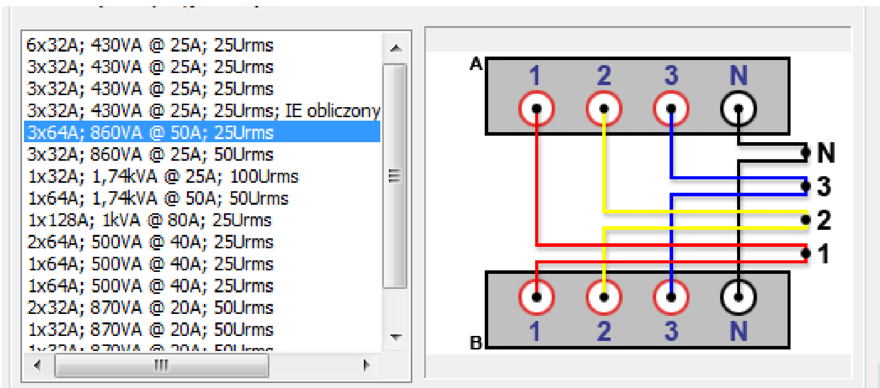
Continuity tester (if not included in multimeter).

Note: Modern test equipment may contain many of the above features in one unit.

If OMICRON is used the proper configuration of current outputs have to be applied to be sure that test device can offer enough power to supply P116 current inputs and the max voltage level not less than "20Urms". For example like for CMC256 below:



When CMC356 is used there is no problem with the voltage level , but max powered should be selected (3x64A; 860VA;25Urms or sometimes even 1x64A; 1.74kVA; 50Urms):



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3. PRODUCT CHECKS

These product checks cover all aspects of the relay and should be carried out to ensure that the unit has not been physically damaged prior to commissioning, that it is functioning correctly and that all input quantity measurements are within the stated tolerances.

If the application-specific settings have been applied to the relay prior to commissioning, it is advisable to make a copy of the settings to allow their restoration later. This could be done by:

- Obtaining a setting file from the customer.
- Extracting the settings from the relay itself (this again requires a portable PC with appropriate setting software)
- Manually creating a setting record. This could be done using a copy of the setting record located at the end of this chapter to record the settings. As the relay's menu is scrolled through sequentially via the front panel user interface.

3.1 With the relay de-energized

The following group of tests should be carried out without powering the P116 and with the trip circuit and flag indicator isolated.

The current transformer connections must be isolated from the relay for these operations to be carried out.

WARNING: NEVER OPEN CIRCUIT THE SECONDARY CIRCUIT OF A CURRENT TRANSFORMER SINCE THE HIGH VOLTAGE PRODUCED MAY BE LETHAL AND COULD DAMAGE INSULATION.

The line current transformers should be short-circuited and disconnected from the relay terminals, using the isolating trip circuit and flag indicator provided. If this is not possible to complete this operation, the wiring to these circuits must be disconnected and the exposed ends suitably short-circuited to prevent a safety hazard.

3.1.1 Visual inspection

The rating information given under the top access cover on the front of the relay should be checked. Check that the relay being tested is correct for the protected line/circuit. Ensure that the circuit reference and system details are entered onto the setting record sheet. Double-check the CT primary current rating, and be sure to record the actual CT setting used.

Carefully examine the relay to check that no physical damage has occurred since installation.

3.1.2 Insulation

Insulation resistance tests are only necessary during commissioning and if they have not been performed during installation.

Isolate all wiring from the earth and test the insulation with an electronic or brushless insulation tester at a dc voltage not exceeding 500V. Terminals of the grouped circuits should be temporarily connected together.

The main groups of relay terminals are:

Current transformer circuits,

Trip coil output

Flag indicator output (Model A)

Auxiliary voltage supply (Model A)

Binary control inputs (Model A)

Relay contacts

EIA(RS)485 communication port (Model A)

Case earth

The insulation resistance should be greater than 100 MΩ at 500 V.

On completion of the insulation resistance tests, ensure all external wiring is correctly reconnected to the relay.

3.1.3 External wiring

Check that the external wiring is correct when compared to the relevant relay and scheme diagram. Ensure as far as practical that the phase sequence is as expected. The relay diagram number appears on the rating label on the upper side of the case.

The connections should be checked against the scheme (wiring) diagram.

3.1.4 Auxiliary supply voltage (Vx) (Model A)

The relay can be operated from either a dc only or AC/DC auxiliary supply depending on the relay's nominal supply rating. The incoming voltage must be within the operating range specified in Table 1.

Without energizing the relay measure the auxiliary supply to ensure it is within the operating range.

Nominal Supply Rating DC [AC r.m.s.]		DC Operating Range	AC Operating Range
24 - 60 V	[24 - 60 V]	19 to 72 V	19 to 66 V
60 - 250 V	[60 - 240 V]	48 to 300 V	48 to 264 V

Table 1: Operational range of auxiliary supply Vx

It should be noted that the relay can withstand an ac ripple of up to 12% of the upper rated voltage on the dc auxiliary supply.

Do not energize the relay or interface unit using the battery charger with the battery disconnected as this can irreparably damage the relay's power supply circuitry.

Energize the relay only if the auxiliary supply is within the specified operating ranges. If a test block is provided, it may be necessary to link across the front of the test plug to connect the auxiliary supply to the relay.

Note: Vx nominal supply rating is common to auxiliary voltage supply and binary control inputs

3.2 With the relay energized

The following group of tests verifies that the relay hardware and software are functioning correctly and should be carried out while the P116 is powered.

MV isolators should be opened and the MV side should be connected to the earth to allow safe operation of the CB.

3.2.1 Light emitting diodes (LEDs)

On power up the green LED should have lit up and stayed on indicating that the relay is healthy. The relay has a non-volatile memory that remembers the state (on or off) of the alarm, trip and, if configured to latch, LED indicators when the relay was last energized from an auxiliary supply. Therefore these indicators may also lit up when the auxiliary supply is applied.

Latching of LEDs can be configured via MiCOM S1 setting software (USB port) or manually by the front panel

Default configuration of LEDs (except ***Trip*** LED): without latching

Note: The above default configuration can be changed using the MiCOM S1 setting software (USB port).

Trip LED is fixed to protection trip with latching.

The eight LEDs are on the front panel of the relay:

- The green ***Healthy*** LED indicates that the P116 is powered and no internal faults are detected. A flashing LED indicates a hardware problem on the P116. Not lit – P116 has no power supply
- Red ***Trip*** LED: indicates that the time-delay of the protection element set to trip has elapsed
- Yellow ***Alarm*** LED: indicates that the time-delay of the protection element set to Alarm has elapsed or that non-protection functions as issued an Alarm signal. This LED can be programmed as 4-8 LEDs too.
  Note: By default ***Alarm*** LED is not configured to Alarm. It is necessary to configure this LED for Alarm function via MiCOM S1 setting software (USB port) or manually by the front panel

The red LEDs 3 to 8 are programmable to the following signals:

- ***Protect.Trip:*** Trip by protection elements
- ***Alarm:*** Alarm signal
- ***General Start:*** Start of protection elements which is set to trip the CB
- ***Start Phase A:*** Start of the phase overcurrent element (set to trip) in phase A
- ***Start Phase B:*** Start of the phase overcurrent element (set to trip) in phase B
- ***Start Phase C:*** Start of the phase overcurrent element (set to trip) in phase C
- ***I>:*** Start of the first phase overcurrent stage
- ***I>>:*** Start of the second phase overcurrent stage
- ***I>>>:*** Start of the third phase overcurrent stage
- ***SOTF:*** - Start of the Switch On To Fault overcurrent element (model A)
- ***IN_1:*** Start of the first earth fault overcurrent stage
- ***IN_2:*** Start of the second earth fault overcurrent stage
- ***IN_3:*** Start of the third earth fault overcurrent stage
- ***AUX1:*** Trigger of the AUX1 timer (via a binary input) (Model A)
- ***AUX2:*** Trigger of the AUX2 timer (via a binary input) (Model A)
- ***AUX3:*** Trigger of the AUX3 timer (via a binary input) (Model A)
- ***AUX4:*** Trigger of the AUX4 timer (via a binary input) (Model A)
- ***AUX5:*** Trigger of the AUX5 function (via a binary input) (Model A)
- ***AUX6:*** Trigger of the AUX6 function (via a binary input) (Model A)
- ***tI>:*** Trip by the first phase overcurrent stage (if flashing: start)
- ***tI>>:*** Trip by the second phase overcurrent stage (if flashing: start)
- ***tI>>>:*** Trip by the third phase overcurrent stage (if flashing: start)
- ***tSOTF:*** Trip by the SOTF element (if flashing: start) (Model A)
- ***tIN_1:*** Trip by the first earth fault overcurrent stage (if flashing: start)
- ***tIN_2:*** Trip by the second earth fault overcurrent stage (if flashing: start)
- ***tIN_3:*** Trip by the third earth fault overcurrent stage (if flashing: start)
- ***tI2>:*** Trip by the negative sequence overcurrent element (if flashing: start) (Model A)
- ***tI<:*** Trip by the undercurrent element (if flashing: start) (Model A)

- ***t Brkn Cond:*** Trip by the Broken Conductor protection (if flashing: start) (Model A)
- ***Therm Trip: -*** Trip by Thermal Overload protection (if flashing: alarm)
- ***Therm Alarm:*** Thermal Overload protection alarm
- ***tCBF:*** Circuit Breaker Failure protection alarm
- ***tAUX1:*** Time delay tAUX1 elapsed (if flashing: start) (Model A)
- ***tAUX2:*** Time delay tAUX2 elapsed (if flashing: start) (Model A)
- ***tAUX3:*** Time delay tAUX3 elapsed (if flashing: start) (Model A)
- ***tAUX4:*** Time delay tAUX4 elapsed (if flashing: start) (Model A)
- ***[79] in Progress:*** The auto-reclose function is running (Model A)
- ***[79] F.Trip:*** Auto-reclose not successful: Final trip (Model A)
- ***[79] Lockout:*** Lockout of the auto-reclose function (Model A)
- ***[79] Blocked:*** The auto-reclose function is blocked (Model A)
- ***[79] Success*.:** The auto-reclose operation is successful (the CB remains closed) (Model A)
- ***Local CTRL Mode:*** Local Mode (Model A)
- ***CB Alarm:*** Circuit Breaker condition alarm signal (CB Open NB, Sum Amps(n), TCS 52 Fail, CB Open Time and CB Close Time) (Model A)
- ***Maintenance Mode:*** Maintenance Mode (outputs are disconnected from all functions)
- ***tCB FLT Ext.Sign.:*** An input mapped to this function detects CB problems which may influence control possibilities (for example spring problem, insufficient pressure, etc.). Signaling is active during a settable time (*GLOBAL SETTINGS/CIRCUIT BREAKER/ tCB FLT ext*) (Model A)
- ***Setting Group n:*** Setting Group n is active (Model A)

After establishing the connection between PC and P116 via the USB port, the green ***Healthy*** LED should be lit permanently (it means that the P116 is powered), even if P116 is not connected to auxiliary voltage supply or powered from current inputs.

The remaining LEDs can be checked via the “LEDs Reset” function. This function can be mapped to the L1 – L6 inputs.

In Model A, check that the correct nominal voltage and polarity are applied to opto inputs L1 – L6 (D1 - D10 terminals), then connect the field voltage to the appropriate terminals for the input being tested.

All red LEDs should be lit within 1 s.

<u>Default LEDs setting (both Setting Groups):</u>

- LED3 - LED8: not configured.

3.2.2 The electromagnetic Flag Indicators

Depends on the hardware version up to five electromagnetic flag indicators can be available (P116xxxxxxxxx**1**xxxx: the one flag indicator; P116Axxxxxxxx**5**xxxx: the five flag indicators). Flag indicators can be reset using the ⓒ key on the front panel or a signaling command (via RS485 communications, a binary input or the USB port).

NOTE: It is impossible to reset the electromagnetic flag indicators without powering (Vx or CTs) of P116. Therefore if such a function is required an external flag indicator must be used instead of the electromagnetic flag indicators.

NOTE: It is impossible to reset the electromagnetic flag indicators if P116 is powered from USB only

In Model A, the four optional electromagnetic Flag Indicators are programmable (***GLOBAL SETTINGS/OPTIONAL FLAG INDICATORS CONF.)***:

Flag Ind. tI> – Trip by the first phase overcurrent stage (if flashing: start)

Flag Ind. tI>> – Trip by the second phase overcurrent stage (if flashing: start)

Flag Ind. tI>>> – Trip by the third phase overcurrent stage (if flashing: start)

Flag Ind. tSOTF - Trip by SOTF element (if flashing: start)

Flag Ind. tIN_1 – Trip by the first earth fault overcurrent stage (if flashing: start)

Flag Ind. tIN_2 – Trip by the second earth fault overcurrent stage (if flashing: start)

Flag Ind. tIN_3 – Trip by the third earth fault overcurrent stage (if flashing: start)

Flag Ind. tI< - Trip by the undercurrent element (if flashing: start)

Flag Ind. tI2> – Trip by the negative sequence overcurrent element (if flashing: start)

Flag Ind. t Brkn Cond -Trip by the Broken Conductor protection (if flashing: start)

Flag Ind. Therm Trip -Trip by Thermal Overload protection (if flashing: alarm)

Flag Ind. CB Fail – Circuit Breaker Failure protection time-delay elapsed

Flag Ind. tAUX1 – Time delay tAUX1 elapsed (if flashing: start)

Flag Ind. tAUX2 – Time delay tAUX2 elapsed (if flashing: start)

Flag Ind. tAUX3 – Time delay tAUX3 elapsed (if flashing: start)

Flag Ind. tAUX4 – Time delay tAUX4 elapsed (if flashing: start)

Flag Ind. [79] F. Trip – Auto-reclose not successful: Final trip.

Flag Ind. [79] Lockout – Lockout of the auto-reclose function.

Flag Ind. [79] Success.- The auto-reclose operation is successful (the CB remains closed)

Default Electromagnetic Flag Indicators settings:

F1: fixed ***Trip***
F2-F5: not configured

3.2.3 Binary Inputs (Model A)

This test checks that all the binary inputs on the relay are functioning correctly.

The binary inputs should be energized one at a time, see external connection diagrams (P116/EN IN) for terminal numbers.

The P116 is fitted with an LCD display which makes it possible to view the state of the binary inputs, in the ***COMMISSIONING/Opto I/P Status*** menu cell. This information is also available via the MiCOM S1/S&R Modbus/ Measurement Viewer software. Refer to MiCOM S1 user manual for details.

If it is not possible to use the Measurement Viewer software, it is necessary to check the binary inputs by means of a functional test of the entire configuration.

Check that the correct nominal voltage and correct polarity are applied to the opto-inputs, then connect the field voltage to the appropriate terminals for the input being tested.

Note: The binary inputs may be energized from an external DC auxiliary supply (e.g. the substation battery) in some installations. Check that this is not the case before connecting the field voltage, otherwise damage to the relay may result. If an external 24/27 V, 30/34 V, 48/54 V, 110/125 V, 220/250 V supply is being used it will be directly connected to the relay's optically isolated inputs. If an external supply is being used then it must be energized for this test but only if it has been confirmed that it is suitably rated with less than 12% AC ripple.

Default factory settings:

- L1 binary input: not configured
- L2 binary input: not configured
- L3 binary input: not configured
- L4 binary input: not configured
- L5 binary input: not configured
- L6 binary input: not configured

Reverse Input Logic indicates the low state of the Binary Input triggered by a programmable function.

3.2.4 Output Relays

To check output contacts it is necessary to carry out a functional test of the entire configuration.

Note: It should be ensured that thermal ratings of anything connected to the output relays during the contact test procedure are not exceeded by the associated output relay being operated for too long. It is therefore advised that the time between application and removal of the contact test is kept to the minimum.

Default factory settings:

- In Model L: RL1 and Model A: RL1-RL6 outputs: not configured

Reverse Output Logic (Model A) means that after powering the P116, n/o contacts are closed. Output triggering via a programmable function opens the contacts (rest position).

3.2.5 Rear Communications Port (Model A)

This test should only be performed where the relay is to be accessed from a remote location and will vary depending on the communications standard adopted.

It is not the intention of the test to verify the operation of the complete system from the relay to the remote location, just the relay's rear communications port and any protocol converter necessary.

3.2.5.1 IEC60870-5-103 (VDEW) communications

IEC60870-5-103/VDEW communication systems are designed to have a local Master Station and this should be used to verify that the relay’s EIA(RS)485 port, is working.

The relay address and baud rate settings for EIA(RS)485 can be set by using local communication via the USB port (setting software) or via the relay's front panel.

<u>Default Factory Setting:</u>

- Baud Rate: 19.2 bps
- Parity: No parity
- Stop Bits: one stop bit
- Data Bits: 8 (fixed)

Also ensure that the relay's address and baud rate settings in the application software are the same as those set via the USB port.

Check that, using the Master Station, communications with the relay can be established.

3.2.5.2 MODBUS communications

Connect a portable PC running the appropriate MODBUS Master Station software to the relay’s first rear EIA(RS)485 port via an EIA(RS)485 to EIA(RS)232 interface converter. The terminal numbers for the relay's EIA(RS)485 port are up to 31.

The relay address, Parity and Baud Rate settings for EIA(RS)485 are set by using local communication via USB port (MiCOM S1 software).

<u>Default Factory Setting:</u>

- Baud Rate: 19.2 bps
- Parity: No parity
- Stop Bits: one stop bit
- Data Bits: 8 (no settable)

Ensure that the relay's address and baud rate settings in the application software are the same as those set via the USB port.

Check that communications with the relay can be established.

3.2.6 USB communications port

The USB port is used for local communications between a PC and the P116.

Note: Max current necessary to supply P116 from USB port is 450mA. USB standard offers 500mA for a one PC’s USB controller, so it is not recommended to connect any additional devices to the same PC’s USB controller. If the total power consumption from a one PC’s USB controller is greater than 500mA, P116 can be in permanent rest (P116 display and the green *Healthy* LED will be flashing)

Before connection cable to USB socket it is necessary discharge static electricity from the body by touching a metal grounded object (such as an unpainted metal surface) to prevent against ESD damage

The USB port integrates electronic boards only to allow communications with the P116 via the HMI and USB interfaces. Input (binary and current) and Output boards are not supplied.

For local communications, the MiCOM S1 setting software is used.

USB parameters (not settable in the P116):

- Protocol: Modbus RTU
- Address: 1
- Baud Rate: 115.2 kbits/s
- Data Bits: 8
- Stop bit: 1
- Parity: None

3.2.7 Current inputs

This test verifies that the accuracy of current measurement is within the acceptable tolerances.

The P116 measures the RMS and Fundamental harmonic values.

Apply a current equal to the rating of the line current transformer secondary winding to each current transformer input of the corresponding rating, in turn (see Table 1 or external connection diagram (P116/EN IN) for appropriate terminal numbers), checking its magnitude using a multimeter/test set readout. The corresponding reading can then be checked in the MEASUREMENT column of the menu or via the MiCOM S1/S&R Modbus/Measurement Viewer connected to the P116 via USB port. Refer to the PC software user manual for details.

If MiCOM S1 is not available, it is necessary to test the protection stages to measure the accuracy of analogue inputs.

Measuring accuracy of the relay:

Reference Conditions:

Sinusoidal signals with nominal frequency fn total harmonic distortion = 2 %, ambient temperature 20 °C and nominal auxiliary voltage Vx.

Deviation relative to the relevant nominal value under reference conditions.

Operating Data

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For currents up to 2 In (Ien):

Phase and earth current: ±2% at In (Ien)

Asymmetry current: ±3% at In

Fault Data

Phase and earth current:

For currents ≤ 3 In (Ien): ±5% at In (Ien)

For currents > 3 In (Ien): ±5% of measured current value

However, an additional allowance must be made for the accuracy of the test equipment being used.

4. SETTING CHECKS

The setting checks ensure that all of the application-specific relay settings (i.e. the relay's functions), for the particular installation, have been correctly applied to the relay.

Note: The trip circuit should remain isolated during these checks to prevent accidental operation of the associated circuit breaker.

4.1 Apply application-Specific Settings

There are two methods of applying the settings to the relay:

Downloading them from a pre-prepared setting file to the relay using a portable PC running the MiCOM S1 support software. Communication between the PC and the P116 is done via the relay's USB front port, located at the bottom of front panel, or rear communications port. This method is preferred for transferring function settings as it is much faster and there is less margin for error.

If a setting file has been created for the particular application and is available on an external memory disk, this will further reduce the commissioning time.

Enter them manually via the relay's operator interface.

Application notes for the setting values are given in Application Notes chapter P116/EN AP of this manual.

4.2 Demonstrate correct relay operation

The above tests have already demonstrated that the relay is within calibration, thus the purpose of these tests is as follows:

- To determine that the primary protection functions of the relay, overcurrent, earth-fault etc. can trip according to the correct application settings.
- To verify the correct assignment of the CB trip outputs and of the flag indicator output,
- by monitoring the response to a selection of fault injections.

4.2.1 Overcurrent protection testing

This test, performed on stage 1 of the overcurrent protection function, demonstrates that the relay is operating correctly at the application-specific settings.

4.2.1.1 Connection and preliminaries

The testing current is fed via terminals: A1-A2, A3-A4, and A5-A6, A7—A8 connected to CTs. The type of connection is shown in Figure 1. The external connection diagram is also available in Installation chapter P116/EN IN of this manual..

Ensure that I> is mapped to the RL1 output.

Note: The Low Energy Trip output and the Flag Indicator outputs are activated by any protection elements set to trip.

Disconnect the auxiliary voltage supply from the P116's terminals B1 and B2.

Connect the trip output or flag indicator output so that its operation will trip the test set and stop the timer.

Note: During tripping, the trip and flag indicator outputs output energy on terminals is:

- trip coil output: 0.1 Ws 24 Vdc or 0.02 Ws 12 V (ordering option)
- flag indicator output: 0.01 Ws 24 Vdc

The timer should be compatible with the above outputs.

Connect the current output of the test set to phase "A" of the relay current transformer input (terminals A1 and A2).

Ensure that the timer starts when the current is applied to the relay.

Protection accuracy of the relay:

PROTECTION ACCURACY					
Element	Range	Deviation	Trigger	Reset	Time deviation
Phase overcurrent elements (I> & I>> & I>>> & SOTF)	0.1 to 40 In	±3%±0.01In	DT: Is ± 2%±0.01In IDMT: 1.1Is ±2% ±0.01In	0.95 Is ±2%±0.001In 1.05 Is ±2%±0.01In	±2% +20…50 ms ±5% +20…50 ms
Earth fault overcurrent elements (IN_1 & IN_2 & IN_3)	0.002 to 1Ien 0.01 to 8 Ien 0.1 to 40 Ien	±3%±0.001Ien ±3%±0.002Ien ±3%±0.01Ien	DT: Ies ± 3%±0.001Ien ±3%±0.002Ien ±3%±0.01Ien	0.95 Ies ± 3%±0.001Ien ±3%±0.002Ien ±3%±0.01Ien	±2% +20…50 ms
	0.002 to 1Ien 0.01 to 8 Ien 0.1 to 40 Ien	±3%±0.001Ien ±3%±0.002Ien ±3%±0.01Ien	IDMT: 1.1Ies ± 3%±0.001Ien ±3%±0.002Ien ±3%±0.01Ien	1.05 Ies ±3% ± 3%±0.001Ien ±3%±0.002Ien ±3%±0.01Ien	±5% +20…50 ms
Negative sequence phase overcurrent elements (I2>)	0.1 to 4 In	± 3%±0.01In	DT: I2s ± 3%±0.01In IDMT: 1.1 I2s ±3%±0.01In	0.95 I2s ±3%±0.001In 1.05 I2s ±3%±0.01In	±2% +20…50 ms ±5% +20…50 ms
Phase undercurrent element (I<)	0.1 to 2 In	± 3%±0.01In	DT: I< ± 2%±0.005A	0.95 I< ±2%±0.01In	±2% +20…50 ms
Broken conductor (I2/I1).	20 to 100%	± 5%±0.01In	DT: I2/I1 ± 5%±0.01In	0.95 I2/I1 ±5%±0.01In	±2% +20…50 ms
Thermal overload (I_{therm}, θ Alarm, θ Trip)	0.10 to 3.0 In	± 3%±0.01In	I_{therm} ± 3%±0.01In	0.97 I_{therm} ±3%±0.01In	–5% +20…50 ms (ref. IEC 60255-8)

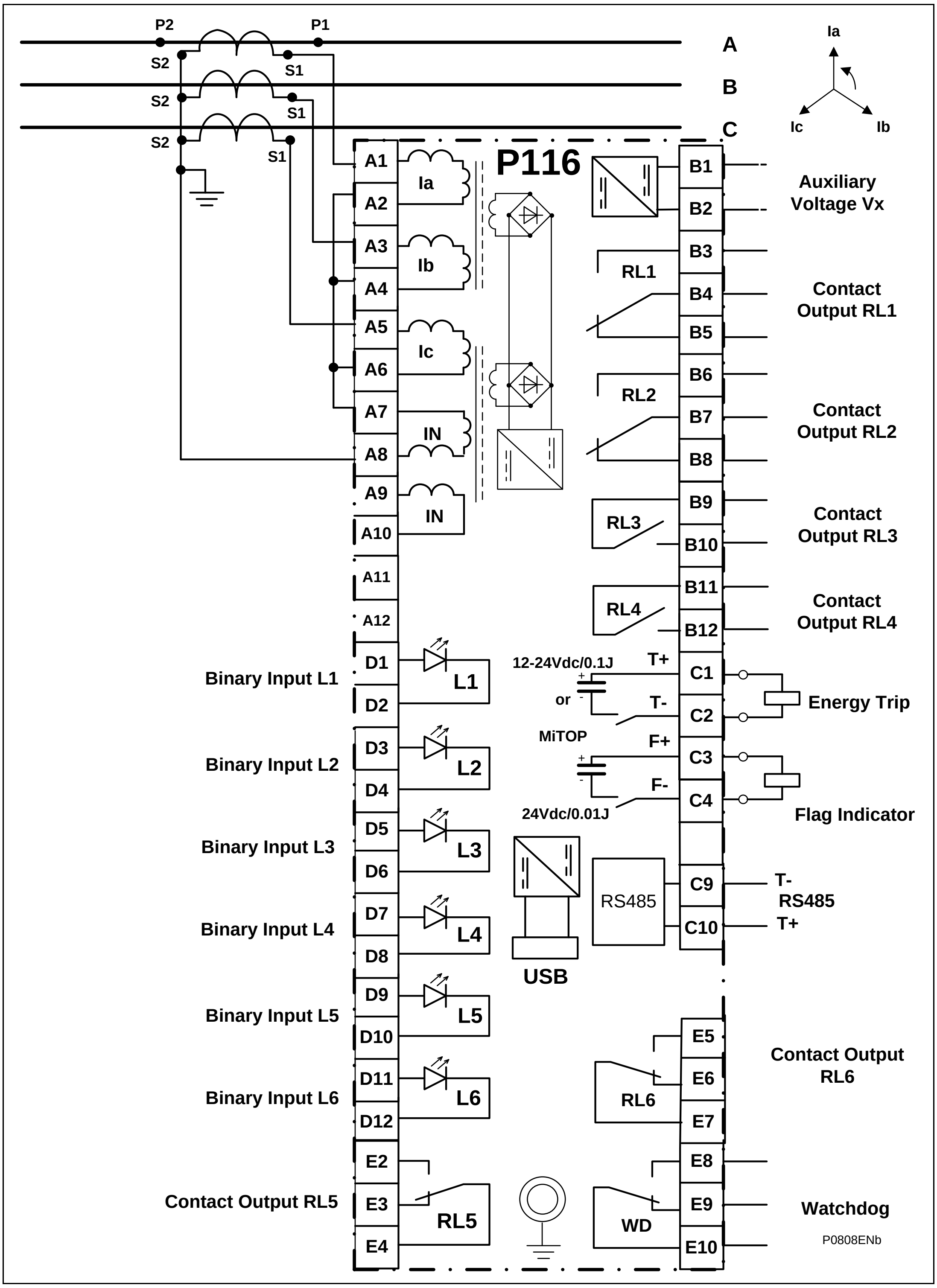

Figure 1: P116 Model A External Connection Diagram

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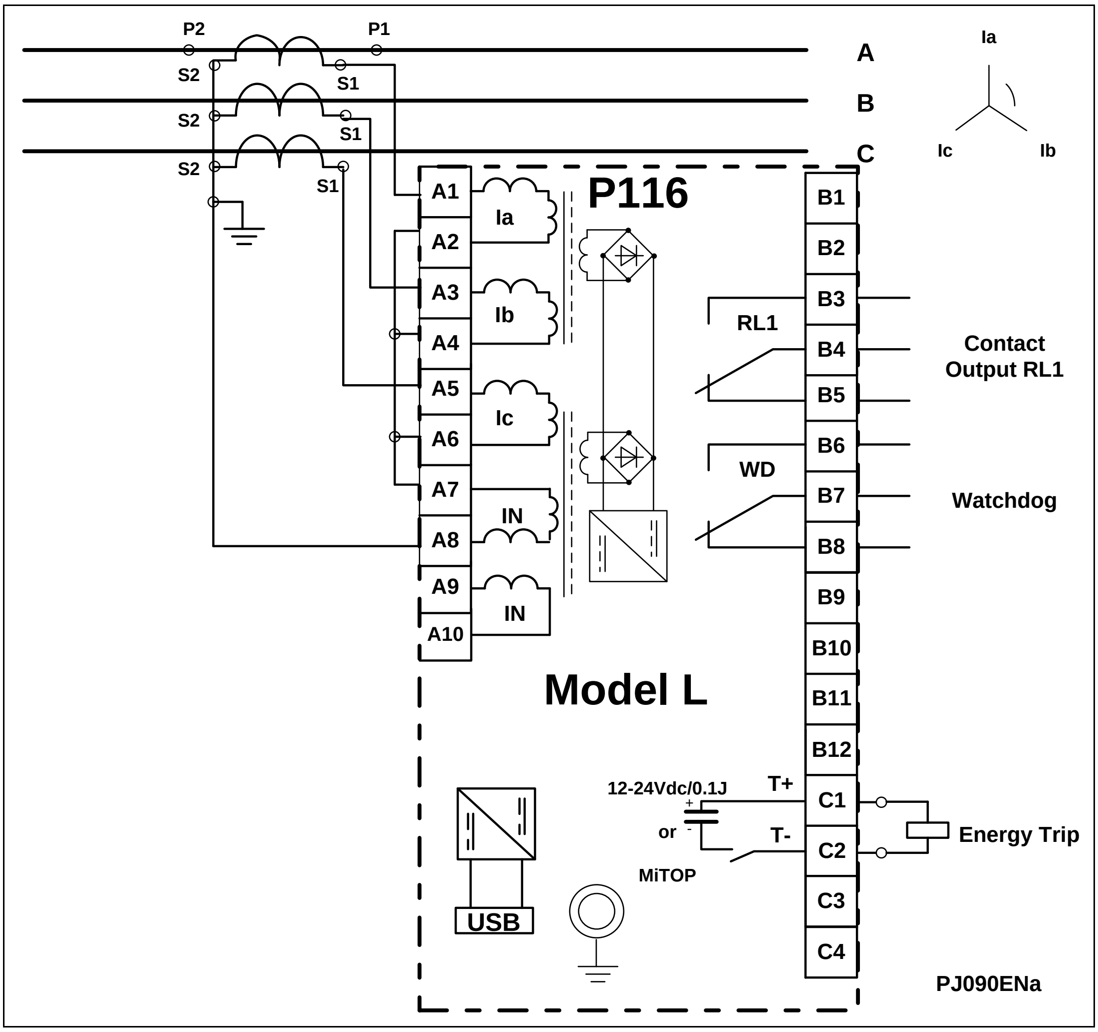

Figure 2: P116 Model L External Connection Diagram

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4.2.1.2 Perform the test

Ensure that the timer is reset.

Apply to the relay a current of twice the setting for I> (refer to chapter P116/EN ST of this manual) and make a note of the time displayed when the **chronometer** stops.

WARNING: Never open circuit the secondary circuit of a current transformer since the high voltage produced may be lethal and could damage insulation.

4.2.1.3 Check the Operating Time

Check that the operating time recorded by the timer is within the range shown in Table 2.

Notes: Except for the definite time characteristic, the operating times given in Table 2 are for a time multiplier or time dial setting of 1. Therefore, to obtain the operating time at other time multiplier or time dial settings, the time given in Table 2 must be multiplied by the setting for IDMT characteristics.

In addition, for definite time and inverse characteristics there is an additional delay of up to 0.03 seconds that may need to be added to the relay's acceptable range of operating times.

If the P116 is not connected to an auxiliary voltage supply (Vx) it is necessary to add an additional start-up time-delay (booting time). The value of this delay depends on the ratio: value current/0.2In. Refer to the Application chapter of this manual (P116/EN AP) or the Technical Data chapter of this manual (P116/EN TD). Typically it is about 0.065 seconds.

For all characteristics, allowance must be made for the accuracy of the test equipment being used.

Characteristic	Operating Time at Twice Current Setting and Time Multiplier/Time Dial Setting of 1.0	
	Nominal (Seconds)	Range (Seconds)
DT	tI> Time Delay Setting	Setting ±5%+(0.02...0.05)ms
IEC S Inverse	10.03	9.28 – 11.78
IEC V Inverse	13.50	12.49 – 14.51
IEC E Inverse	26.67	24.67 – 29.67
UK LT Inverse	120.00	111.00 – 129.00
UK ST Inverse	1.78	1.65 – 1.91
IEEE M Inverse	3.8	3.52 – 4.08
IEEE V Inverse	7.03	6.51 – 7.55
IEEE E Inverse	9.52	8.81 – 10.23
US Inverse (CO8)	2.16	2.00 – 2.32
US Inverse (CO2 P40)	12.12	11.22 – 13.02
RI Inverse	4.52	4.19 – 4.86

Table 2: Characteristic Operating Times for I>

Reconfigure to test a phase B fault. Repeat the test in section 0, this time ensuring that the breaker trip output relative to phase B operation trips correctly. Record the tripping time for phase B. Repeat for phase C fault.

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4.2.1.4 Check the Outputs

4.2.1.4.1 CB Coil Output

Ensure that the CB coil is connected to terminals C1 (+) and C2 (–).

Ensure that the I> stage is configured to trip (refer to chapter P116/EN ST of this manual).

Close the CB.

Apply a current of twice the setting for I> or use MAINTENANCE MODE to run functional test. The CB will open when the tI> time-delay elapses.

P116 should trip CB.

NOTE:

1. The voltage value on the energy output, controlled by an electronic circuit which changes a voltage value in time depends on the current value and a burden connected to the output, so it is not possible to measure voltage value if the multimeter has no pick value (max value) recording function with measuring window not greater than 10ms.
2. For tests of the energy output a test equipment like Omicron can be used. Binary input of test equipment has to be connected to this P116 output. In setting software of test equipment the "wet" option has to be selected and the nominal voltage: 24Vdc has to be set with 0.8 reset ratio.

4.2.1.4.2 Flag Indicator Output (Model A)

Ensure that the flag indicator is connected to terminals C3 (+) and C4 (–).

Reset the Flag indicator.

Apply a current of twice the setting for I> use MAINTENANCE MODE to run functional test.. The flag indicator will be triggered when the tI> time-delay elapses.

Flag indicator should be tripped.

NOTE:

1. The voltage value on the energy output, controlled by an electronic circuit which changes a voltage value in time depends on the current value and a burden connected to the output, so it is not possible to measure voltage value if the multimeter has no pick value (max value) recording function with measuring window not greater than 10ms.
2. For tests of the energy output a test equipment like Omicron can be used. Binary input of test equipment has to be connected to this P116 output. In setting software of test equipment the "wet" option has to be selected and the nominal voltage: 24Vdc has to be set with 0.8 reset ratio.

5. FUNCTIONAL TESTS

MiCOM P116 has special functions for this purpose available in COMMISIONING column.

All tests are available in ***Maintenance Mode*** only.

Note: If ***Maintenance Mode*** is not selected all test cells are hidden in P116 menu.

It is possible to set following ***Maintenance mode*** options (settings):

- "***No***" - ***Maintenance mode*** is disabled. All window cells below are hidden (***Maintenance mode*** is the latest cell in ***COMMISIONING*** column)
- "***Yes,outp.trips***" - ***Maintenance mode*** is enabled. In this mode all test cells in ***COMMISIONING*** column are shown. During tests outputs are energized.
- "***Yes,outp.block***" - ***Maintenance mode*** is enabled and all test cells in ***COMMISIONING*** column are shown. In this mode, the high state of output functions are ignored (control of outputs are blocked).

  This option allows the user to check the operation of the protection functions without actually sending any external command (Tripping or signalling).

Depends on the rear protocol selected in menu, transmission of information to SCADA is blocked (Modbus RTU) or sent (IEC 103) with additional information to know that P116 is in Maintenance mode (refer to Communication chapter and EN 60870-5-103 standard).

Changing of setting from "***No***" to "***Yes,….***" from the front panel activate this mode for **10 minutes only**. After this time the option is automatically switched to "***No***".

The selection of the maintenance mode is possible by logic input (the level), control command (rear or front port), or by front panel interface. The maintenance mode is terminated by:

- Low state of logic input assigned to ***Maintenance mode*** function,
- Control command which activate this mode (rear command or setting: "***Yes,….***") and by turning off the power supply.

Note: Maintenance rear command is available in Modbus protocol only

Maintenance Mode
1: Yes,outp.trips

When this menu is activated (set to YES: "***Yes,outp.trips***" or "***Yes,outp.block***"), and Alarm led is assigned to **Maintenance Mode** the Alarm led is lit.

In "***Yes,outp.block***" case, all the output contacts are blocked, and no command can be issued to these contacts, even if a protection threshold associated with one of these output contacts has been crossed. (If a protection threshold is crossed, all associated LEDs will be ON, even the TRIP LED, if protection element is set to ***Trip***).

The commissioning cells allow the user to check the external wiring to the relay's output contacts. This function is available after activation of ***Maintenance mode.*** To do this, the user has only to set to 1 the desired output contact's corresponding bit, and this will close the contact and allow the continuity of the wiring to be checked.

Test	TF654321
Pattern	00000000

In the cell below, the contact test time can be set:

```
Contact Test
Time          001.00s
```

If the outputs for test are selected and Time for output closing is set, the closing command can be executed in this cell:

```
Test output
0: no operation
```

To execute the test, press OK key, press the or key to select ***1: Apply test*** and confirm action by OK. The contact will be closed for the duration of the ***Contact Test Time*** pulse.

The next commissioning cells, which appears in ***Maintenance mode***, allows the user to check the functional output configuration of the P116. To do this, the user has only to select which protection element will be triggered, and this will close the contact assigned to this protection element and allow the continuity of the wiring to be checked.

```
Functional Test
0: I>
```

In the cell below the end of the functional test can be configured:

```
Functional Test
End 0: CB trip
```

The following options are possible:

- ***0: CB trip*** – after triggering the functional test, the test is interrupted after trip command.
- ***1: Time*** – the protection element will be triggered for the duration of the pulse time.

If the ***1: Time*** option is selected it is necessary to set the pulse length:

```
Contact Test
Time          001.00s
```

The next cell is used for functional test execution:

```
Functional Test
CTRL: no operation
```

To execute this test, press the OK key, press the or key to select ***1: Operate*** and confirm action by pressing OK. After the time delay of tested protection element, the contact will be closed for the duration of the ***Contact Test Time*** pulse.

Note: If the tested protection element is disabled, no any action will be done via ***Functional Test*** function.

6. COMMISSIONING TEST RECORD

Date:		Engineer:	
Station:		Circuit:	
		System Frequency:	Hz

P116 Front Plate Information

Overcurrent protection relay	**MiCOM P116**
Model number	
Serial number	

Test Equipment Used

This section should be completed to allow future identification of protective devices that have been commissioned using equipment, that is later found to be defective or incompatible, but may not be detected during the commissioning procedure.

Injection test set	Model: Serial No:	
Insulation tester	Model: Serial No:	
Setting software:	Type: Version:	

*Delete as appropriate

	Have all relevant safety instructions been followed?	Yes* ☐ No* ☐
1.	**Product Checks**	
1.1	**With the relay de-energized**	
1.1.1	Visual inspection	
1.1.1.1	Relay damaged?	Yes* ☐ No* ☐
1.1.1.2	Rating information correct for installation?	Yes* ☐ No* ☐
1.1.1.3	Case earth installed?	Yes* ☐ No* ☐
1.1.2	Insulation resistance >100MΩ at 500V dc	Yes* ☐ No* ☐ Not Tested* ☐
1.1.3	External wiring	
1.1.3.1	Wiring checked against diagram?	Yes* ☐ No* ☐
1.1.4	Measured auxiliary voltage supply	_____ V ac*

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1.2 With the relay energized

1.2.1 Light-emitting diodes and Watchdog Contact

1.2.1.1	Connect the auxiliary voltage supply to terminals B1 and B2. Are the green ***Healthy*** LED and the ***WD*** output contact (E8-E10) working?	Yes* ☐ No* ☐
1.2.1.2	Supply the P116 with a current above the self-powering level (0.7 In). Is the green ***Healthy*** LED and LCD display lit? ***WD*** output contact: Are terminals E8-E10 shorted?	Yes* ☐ No* ☐
1.2.1.3	Establish connection between PC and P116 via USB port. Green ***Healthy*** LED working?	Yes* ☐ No* ☐
1.2.1.4	Reset LEDs by pressing the C key on the P116's front panel up to see the default window and after that all red LEDs should flashing rapidly. Are all red LEDs flashing rapidly?	Yes* ☐ No* ☐

1.2.2 Inputs

1.2.2.1	Auxiliary voltage for binary control inputs: Value measured (see: **COMMISSIONING/Opto I/P *Status*** window of menu)	_____ V dc
1.2.2.2	L1 binary input (D1-D2 terminals) working?	Yes* ☐ No* ☐
1.2.2.3	L2 binary input (D3-D4 terminals) working?	Yes* ☐ No* ☐
1.2.2.4	L3 binary input (D5-D6 terminals) working?	Yes* ☐ No* ☐
1.2.2.5	L4 binary input (D7-D8 terminals) working?	Yes* ☐ No* ☐
1.2.2.6	L5 binary input (D9-D10 terminals) working?	Yes* ☐ No* ☐
1.2.2.7	L6 binary input (D11-D12 terminals) working?	Yes* ☐ No* ☐

1.2.3 Outputs (for tests, ***COMMISSIONING/ Test outputs*** cell can be used)

1.2.3.1 Output Relays

1.2.3.1.1	Relay 1 working?	Yes* ☐ No* ☐
1.2.3.1.2	Relay 2 working?	Yes* ☐ No* ☐
1.2.3.1.3	Relay 3 working?	Yes* ☐ No* ☐
1.2.3.1.4	Relay 4 working?	Yes* ☐ No* ☐
1.2.3.1.5	Relay 5 working?	Yes* ☐ No* ☐
1.2.3.1.6	Relay 6 working?	Yes* ☐ No* ☐

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1.2.3.2	Be sure that Tripping Energy Output is used in application. Check that C1 and C2 terminals are connected to a low energy tripping coil with nominal voltage in rage: 12Vdc – 24Vdc with required energy lower than 0.1J or MiTOP. For this test CB have to be closed. Configure ***Trip CB Order*** to Energy Output. ***SETTING GROUP1/OUTPUT RELAYS CONFIGURATION G1/*** ***Trip CB Order*** TF654321 10000000 NOTE: Be sure that you work on GROUP 1: see ***OP PARAMETRS/Active Set Group*** should be ***Group 1*** Execute Trip command from the front panel (***O*** – the trip key). Is CB is Opened? Return to previous configuration.	Yes* ☐ No* ☐
1.2.3.3	Be sure that Flag Energy Output is used in application. Check that C3 and C4 terminals are connected to an external Flag Indicator with nominal voltage: 24Vdc with required energy lower than 0.01J. Reset External Flag Indicator. Configure ***Trip CB Order*** to Energy Output. ***SETTING GROUP1/OUTPUT RELAYS CONFIGURATION G1/*** ***Trip CB Order*** TF654321 01000000 NOTE: Be sure that you work on GROUP 1: see ***OP PARAMETRS/Active Set Group*** should be ***Group 1*** Execute Trip command from the front panel (***O*** – the trip key). Is Flag Indicator is tripped? Return to previous configuration.	Yes* ☐ No* ☐
1.2.3.4	Close CB, after which apply current above setting value. CB has opened?	Yes* ☐ No* ☐

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1.2.4	Communications between PC and MiCOM S1 setting software established?	Yes* ☐ No* ☐

2. Setting Checks

2.1	Protection function timing tested?	Yes* ☐ No* ☐
	Applied current	_____ A
	Expected operating time	_____ s
	Measured operating time	_____ s

3. Final Checks

3.1	All test equipment, leads, shorts and test blocks removed safely?	Yes* ☐ No* ☐
3.2	Disturbed customer wiring re-checked?	Yes* ☐ No* ☐ N/A* ☐
3.3	All commissioning tests disabled?	Yes* ☐ No* ☐

3.4	Fault records reset (via S1 software)?	Yes* ☐ No* ☐

COMMENTS #
(# Optional, for site observations or utility-specific notes).

CM

Commissioning Engineer	Customer Witness
Date:	Date:

7. SETTING RECORD

Date: ____________ Engineer: ____________

Station: ____________ Circuit: ____________

System Frequency: ____________ Hz

CT Ratio (tap in use): ________ / ____ A

Front Plate Information

Overcurrent protection relay	**MiCOM P116**
Model number	
Serial number	
Rated phase current In	
Rated e/f current Ien	

*Delete as appropriate

Column	**Identification of Relay**	
OP PARAMETERS	Firmware version	
	Hardware version	

Column	**Global Setting Data**		
GLOBAL SETTINGS/ LOC	Language	P116xxxxxxxxxxx1xx: 0: English* ☐ 2: Francaise * ☐ 4: Portugues * ☐ P116xxxxxxxxxxx2xx: 0: English* ☐ 2: Polski * ☐ 4: Regional1* ☐	 1: Deutsch * ☐ 3: Espanol * ☐ 5: Regional* ☐ 1: Russian* ☐ 3: Turkey* ☐ 5: Regiona2l* ☐
	Default Display	0: Meas. In * ☐ 2: Control CB * ☐ 4: Control Mode* ☐	1: Meas. A* ☐ 3: [79] CTRL* ☐
	LEDs Reset	0: Manual only* ☐	1: Protect.Start* ☐
	Ltchd Outp. Reset	0: Manual only* ☐	1: Protect.Start * ☐
	Trip Info Reset	0: Manual only* ☐	1: Protect.Start * ☐
	Alarm Display	0: Self-Reset * ☐	1: Latchig * ☐
	Nominal Frequency	0: 50Hz * ☐	1: 60Hz * ☐
	Out.WD Hardware	0: Opened * ☐	1:Closed * ☐
	Control Keys Confirm.	0: No * ☐	1:Yes * ☐
GLOBAL SETTINGS/ SETTING GROUP	Number of Groups	1: One Group* ☐ 2: Two Groups * ☐	
	Setting Group	0: Group 1* ☐	1: Group 2 * ☐

CM

Column	Global Setting Data	
SELECT	t Change Settings G1→G2	s
GLOBAL SETTINGS/ CT RATIO	Line CT primary	A
	Line CT Sec	A
	E/Gnd CT primary	A
	E/Gnd CT Sec	A
	IN connection	0: terminals: A7-A8* ☐ 1: terminals A9-A10* ☐
GLOBAL SETTINGS/ CIRCUIT BREAKER	tOpen pulse min	s
	tClose Pulse	s
	Time Delay for Close	s
	tP pulse.	mn
	tCB FLT Ext. Sign.	s
	Remote CTRL Mode	0:Remote only *☐ 1:Remote+Local *☐
	52 Unblock SOTF Time	s
	TC Supervision?	Yes * ☐ No * ☐ Yes-52 * ☐
	TC Supervision tSUP	s
	CB Supervision?	0:No * ☐ 1:Yes * ☐
	Max.CB Open Time	s
	Max.CB Close Time	s
	CB Diagnostic?	0:No * ☐ 1:Yes * ☐
	Max.CB Open No.	
	Max Sum AMPS^n	MA^n
	AMPS's n=	1* ☐ 2 * ☐
GLOBAL SETTINGS/ INRUSH BLOCKING	Inrush Blocking?	0:No * ☐ 1:Yes * ☐ 2:Closing*☐
	2nd Harmonic Ratio	%
	Inrush Reset Time	s
	Unblock Inrush Time	s
GLOBAL SETTINGS/ O/C ADVANCED	[46BC] Brkn Cond I< Block	In
	IDMT Interlock by DMT	0:No * ☐ 1:Yes * ☐
GLOBAL SETTINGS/ [79] ADVANCED SETTINGS	CB FLT Monitor.?	0: No * ☐ 1: Yes *☐
	Block.via Input?	0: No * ☐ 1: Yes *☐
	Start Dead t on	0: Protect.Reset * ☐ 1: CB trips * ☐
	Rolling Demand?	0: No * ☐ 1: Yes *☐
	Max cycles No. Rol.Demand	

CM

Column	Global Setting Data	
	Time period Rol. Demand	mn
	Inhibit Time tI on Close	s
	Signaling Reset	0: No * ☐ 1: Close via 79 * ☐
GLOBAL SETTINGS/ COMMUNICATION ORDERS	Pulse Time tCOM1	s
	Pulse Time tCOM2	s
	COM2 Order Conf.	0: RS485 * ☐ 1: RS485+Button C * ☐ 2: Button C * ☐
GLOBAL SETTINGS/ OPTIONAL FLAG INDICATORS CONF	Flag Ind. tI>	Flag2 ☐ Flag3 ☐ Flag4 ☐ Flag5 ☐
	Flag Ind. tI>>	Flag2 ☐ Flag3 ☐ Flag4 ☐ Flag5 ☐
	Flag Ind. tI>>>	Flag2 ☐ Flag3 ☐ Flag4 ☐ Flag5 ☐
	Flag Ind. tSOTF	Flag2 ☐ Flag3 ☐ Flag4 ☐ Flag5 ☐
	Flag Ind. tIN_1	Flag2 ☐ Flag3 ☐ Flag4 ☐ Flag5 ☐
	Flag Ind. tIN_2	Flag2 ☐ Flag3 ☐ Flag4 ☐ Flag5 ☐
	lag Ind. tIN_3	Flag2 ☐ Flag3 ☐ Flag4 ☐ Flag5 ☐
	Flag Ind. tI<	Flag2 ☐ Flag3 ☐ Flag4 ☐ Flag5 ☐
	Flag Ind. tI2>	Flag2 ☐ Flag3 ☐ Flag4 ☐ Flag5 ☐

Column	Global Setting Data	
	Flag Ind. tBrkn Cond	Flag2 ☐ Flag3 ☐ Flag4 ☐ Flag5 ☐
	Flag Ind. Therm. Trip	Flag2 ☐ Flag3 ☐ Flag4 ☐ Flag5 ☐
	Flag Ind. tCB Fail	Flag2 ☐ Flag3 ☐ Flag4 ☐ Flag5 ☐
	Flag Ind. tAUX1	Flag2 ☐ Flag3 ☐ Flag4 ☐ Flag5 ☐
	Flag Ind. tAUX2	Flag2 ☐ Flag3 ☐ Flag4 ☐ Flag5 ☐
	Flag Ind. tAUX3	Flag2 ☐ Flag3 ☐ Flag4 ☐ Flag5 ☐
	Flag Ind. tAUX4	Flag2 ☐ Flag3 ☐ Flag4 ☐ Flag5 ☐
	[79] F.Trip	Flag2 ☐ Flag3 ☐ Flag4 ☐ Flag5 ☐
	[79] Lockout	Flag2 ☐ Flag3 ☐ Flag4 ☐ Flag5 ☐
	[79] Success.	Flag2 ☐ Flag3 ☐ Flag4 ☐ Flag5 ☐
GLOBAL SETTINGS/ GENERAL INPUT CONFIGURATION	Inp.1 Filtering? *	0: dc/ac ENA * ☐ 1: ac * ☐ 2: dc* ☐ n/a ☐
	Inp.2 Filtering? *	0: dc/ac ENA * ☐ 1: ac * ☐ 2: dc* ☐ n/a ☐
	Inp.3 Filtering? *	0: dc/ac ENA * ☐ 1: ac * ☐ 2: dc* n/a ☐

CM

Column	Global Setting Data	
	Inp.4 Filtering? *	0: dc/ac ENA * ☐ 1: ac * ☐ 2: dc* ☐ n/a ☐
	Inp.5 Filtering? *	0: dc/ac ENA * ☐ 1: ac * ☐ 2: dc* ☐ n/a ☐
	Inp.6 Filtering? *	0: dc/ac ENA * ☐ 1: ac * ☐ 2: dc* ☐ n/a ☐
	Global nominal V *	0: 220Vdc * ☐ 1: 129Vdc* ☐ 2: 110Vdc * ☐ n/a ☐
GLOBAL SETTINGS/ COMMUNICATION	Protocol	0: Modbus RTU* ☐ 1: IEC103* ☐
	Relay Address RS485	
	Baud Rate RS485	4800 * ☐ 9600 * ☐ 19200 * ☐ 38400 * ☐ 57200 * ☐ 115200 * ☐
	Parity RS485	0: No parity* ☐ 1: Odd parity * ☐ 2: Even parity* ☐
	StopBits RS485	0: 1 stop bit* ☐ 1: 2 stop bits* ☐
GLOBAL SETTINGS/ MAX & AVERAGE I CONFIGURATION	Time Window	s
GLOBAL SETTINGS/ DISTURBANCE RECORDER	Pre-Time	s
	Post Trip Time	s
	Disturbance Rec.Trig.	0: on Inst.* ☐ 1: on Trip * ☐
	Max Record Time	s

CM

OVERCURRENT G1		
SETTING GROUP 1/ PROTECTION G1/ PHASE O/C [50/51] G1		Settings
1	I> ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐ 3: Trip-Inrush Bl * ☐ 4: Trip-Latch * ☐
2	I> Threshold	In
3	Delay Type I>	
4	tI>/TMS/TD	s *
5	Reset Delay Type I>	0: DMT* ☐ 1: IDMT * ☐
6	DMT tReset I> RTD/RTMS Reset I>	
7	I>> ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐ 3: Trip-Inrush Bl * ☐ 4: Trip-Latch * ☐
8	I>> Threshold	In
9	Delay Type I>>	
10	tI>>/TMS/TD	s
11	Reset Delay Type I>>	0: DMT* ☐ 1: IDMT * ☐
12	DMT tReset I> RTD/RTMS Reset I>	
13	I>>> ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐ 3: Trip-Inrush Bl * ☐ 4: Trip-Latch * ☐
14	I>>> Threshold	In
15	tI>>>	s

SOTF G1		
SETTING GROUP 1/ PROTECTION G1/ SOTF [50/51] G1		Settings
1	SOTF?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐ 3: Trip-Inrush Bl * ☐ 4: Trip-Latch * ☐
2	SOTF Threshold	In
3	tSOTF	s

EARTH FAULT (Measured) G1		
SETTING GROUP 1/ PROTECTION G1 / E/GND FAULT [50N/51N] G1		Settings
1	IN_1 stage ?	0: Disabled* ☐ 1: IN>Trip* ☐ 2: IN> Alarm* ☐ 3: IN> Trip-Inrush Bl * ☐ 4: IN> Trip-Latch * ☐
2	IN_1 Threshold	Ien
3	Delay Type IN_1	
4	tIN_1/TMS/TD	s
5	Reset Delay Type IN_1	0: DMT* ☐ 1: IDMT * ☐
6	DMT tReset IN_1 RTD/RTMS Reset IN_1	s
7	IN_2 stage ?	0: Disabled* ☐ 1: IN>>Trip* ☐ 2: IN>> Alarm* ☐ 3: IN>> Trip-Inrush Bl * ☐ 4: IN>> Trip-Latch * ☐
8	IN_2 Threshold	
9	tIN_2	s
10	IN_3 stage ?	0: Disabled* ☐ 1: IN>>>Trip* ☐ 2: IN>>> Alarm* ☐ 3: IN>>> Trip-Inrush Bl* ☐ 4: IN>>> Trip-Latch * ☐
11	IN_3 Threshold	
12	tIN_3	s

CM

Undercurrent [37] G1		
SETTING GROUP 1/ PROTECTION G1/ UNDERCURRENT [37]		Settings
1	I< ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐ 3: Trip-Inrush Bl * ☐ 4: Trip-Latch * ☐ 5: Trip-Inhib 52A * ☐ 6: Alarm-Inhib 52 * ☐
2	I< Threshold	In
3	tI<	s

Negative Sequence O/C [46] G1		
SETTING GROUP 1/ PROTECTION G1 / NEGATIVE SEQ.O/C [46] G1		Settings
1	I2> ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐ 3: Trip-Inrush Bl * ☐ 4: Trip-Latch * ☐
2	I2> Threshold	In
3	Delay Type I2>	
4	tI2>/TMS/TD	s
5	Reset Delay Type I2>	0: DMT* ☐ 1: IDMT * ☐
6	DMT tReset I2> RTD/RTMS Reset I2>	s

Broken Conductor G1		
SETTING GROUP 1/ PROTECTION G1/ BROKEN CONDUCTOR [46BC] G1		Settings
1	Broken Cond.?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐ 3: Trip-Inrush Bl * ☐ 4: Trip-Latch * ☐
2	Ratio I2/I1	%
3	tBCond	s

[49] Thermal Overload G1		
SETTING GROUP 1/ PROTECTION G1 / THERMAL OVERLOAD [49] G1		Settings

[49] Thermal Overload G1		
SETTING GROUP 1/ PROTECTION G1 / THERMAL OVERLOAD [49] G1		Settings
1	Therm OL?	0: Disabled* ☐ 1: Enabled* ☐
2	Itherm	In
3	Te (heating)	mn
4	Tr (cooling)	mn
5	Theta Trip	%
6	Theta Trip/Reset Ratio	%
7	Alarm OL?	0: Disabled* ☐ 1: Enabled* ☐
8	Theta Alarm	%

[50BF] CB Fail G1		
SETTING GROUP 1/ PROTECTION G1 / CB Fail [50BF] G1		Settings
1	CB Fail ?	0: Disabled* ☐ 1: Retrip* ☐ 2: Alarm* ☐
2	CB Fail Time tBF	s
3	I< Threshold CBF	In
4	IN< Threshold CBF	Ien
5	Block I> ?	0: No* ☐ 1: Yes* ☐
6	Block IN> ?	0: No* ☐ 1: Yes* ☐

AUX TIMERS G1		
SETTING GROUP 1/ PROTECTION G1 / AUX TIMERS G1		Group 1 Settings
1	AUX1 ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐ 3: Trip-Inrush Bl * ☐ 4: Trip-Latch * ☐ 5: Load Shedding* ☐ 6: AR after LS Hi* ☐ 7: AR after LS Lo* ☐
2	tAUX1	s

CM

AUX TIMERS G1		
SETTING GROUP 1/ PROTECTION G1 / AUX TIMERS G1		Group 1 Settings
3	AUX2 ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐ 3: Trip-Inrush Bl * ☐ 4: Trip-Latch * ☐ 5: Load Shedding* ☐ 6: AR after LS Hi* ☐ 7: AR after LS Lo* ☐
4	tAUX2	s
5	AUX3 ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐ 3: Trip-Inrush Bl * ☐ 4: Trip-Latch * ☐ 5: Load Shedding* ☐ 6: AR after LS Hi* ☐ 7: AR after LS Lo* ☐
6	tAUX3	s
7	AUX4 ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐ 3: Trip-Inrush Bl * ☐ 4: Trip-Latch * ☐ 5: Load Shedding* ☐ 6: AR after LS Hi* ☐ 7: AR after LS Lo* ☐
8	tAUX4	s

CM

Logic Selectivity G1		
SETTING GROUP 1/ PROTECTION G1 / LOGIC SELECT. G1		Settings
1	Sel1?	0: Disabled* ☐ 1: Enabled* ☐
2	tSel1	s
3	Sel2?	0: Disabled* ☐ 1: Enabled* ☐
4	tSel2	s

Cold Load Pick Up G1		
SETTING GROUP 1/ PROTECTION G1 / COLD LOAD PU G1		Settings
1	Cold Load PU ?	0: Disabled* ☐ 1: Current+Input* ☐

Cold Load Pick Up G1		
SETTING GROUP 1/ PROTECTION G1 / COLD LOAD PU G1		Settings
		2: Input* ☐
2	Cold Load PU Level	%
3	Cold Load PU tCL	s
4	Cold Load PU I>	0: No* ☐ 1: Yes* ☐
5	Cold Load PU I>>	0: No* ☐ 1: Yes* ☐
6	Cold Load PU I>>>	0: No* ☐ 1: Yes* ☐
7	Cold Load PU IN_1	0: No* ☐ 1: Yes* ☐
8	Cold Load PU IN_2	0: No* ☐ 1: Yes* ☐
9	Cold Load PU IN_3	0: No* ☐ 1: Yes* ☐
10	Cold Load PU Brkn.Cond	0: No* ☐ 1: Yes* ☐
11	Cold Load PU Itherm	0: No* ☐ 1: Yes* ☐
12	Cold Load PU I2>	0: No* ☐ 1: Yes* ☐

Autoreclose [79] G1		
SETTING GROUP 1/ PROTECTION G1 / AUTORECLOSE [79] G1		Settings
1	Autoreclose ?	0: Disabled* ☐ 1: Enabled* ☐
2	Dead Time tD1	s
3	Dead Time tD2	s
4	Dead Time tD3	s
5	Dead Time tD4	s
6	Reclaim Time tR	s
7	Fast O/C Trip	1 Trip Shot* ☐ 2 Trip Shot * ☐ 3 Trip Shot * ☐ 4 Trip Shot * ☐ 5 Trip Shot * ☐
8	Fast O/C Trip Delay	s
9	Fast E/Gnd Trip	1 Trip Shot * ☐ 2 Trip Shot * ☐ 3 Trip Shot * ☐ 4 Trip Shot * ☐ 5 Trip Shot * ☐
10	Fast E/Gnd Trip Delay	s
11	Close Shot? tI>	1 Close Shot* ☐ 2 Close Shot* ☐ 3 Close Shot* ☐ 4 Close Shot* ☐
12	Inhib.Trip tI>: Shot	1 Close Shot* ☐

CM

Autoreclose [79] G1		
SETTING GROUP 1/ PROTECTION G1 / AUTORECLOSE [79] G1		Settings
		2 Close Shot* ☐ 3 Close Shot* ☐ 4 Close Shot* ☐
13	Close Shot? tI>>	1 Close Shot* ☐ 2 Close Shot* ☐ 3 Close Shot* ☐ 4 Close Shot* ☐
14	Inhib.Trip tI>>: Shot	1 Close Shot* ☐ 2 Close Shot* ☐ 3 Close Shot* ☐ 4 Close Shot* ☐
15	Close Shot? tI>>>	1 Close Shot* ☐ 2 Close Shot* ☐ 3 Close Shot* ☐ 4 Close Shot* ☐
16	Inhib.Trip tI>>>: Shot	1 Close Shot* ☐ 2 Close Shot* ☐ 3 Close Shot* ☐ 4 Close Shot* ☐
17	Close Shot? tIN_1	1 Close Shot* ☐ 2 Close Shot* ☐ 3 Close Shot* ☐ 4 Close Shot* ☐
18	Inhib.Trip tIN_1: Shot	1 Close Shot* ☐ 2 Close Shot* ☐ 3 Close Shot* ☐ 4 Close Shot* ☐
19	Close Shot? tIN_2	1 Close Shot* ☐ 2 Close Shot* ☐ 3 Close Shot* ☐ 4 Close Shot* ☐
20	Inhib.Trip tIN_2: Shot	1 Close Shot* ☐ 2 Close Shot* ☐ 3 Close Shot* ☐ 4 Close Shot* ☐
21	Close Shot? tIN_3	1 Close Shot* ☐ 2 Close Shot* ☐ 3 Close Shot* ☐ 4 Close Shot* ☐
22	Inhib.Trip tIN_3: Shot	1 Close Shot* ☐ 2 Close Shot* ☐ 3 Close Shot* ☐ 4 Close Shot* ☐
23	Close Shot? tAUX1	1 Close Shot* ☐ 2 Close Shot* ☐

Autoreclose [79] G1		
SETTING GROUP 1/ PROTECTION G1 / AUTORECLOSE [79] G1		Settings
		3 Close Shot* ☐ 4 Close Shot* ☐
24	Inhib.Trip tAUX1: Shot	1 Close Shot* ☐ 2 Close Shot* ☐ 3 Close Shot* ☐ 4 Close Shot* ☐
25	Close Shot? tAUX2	1 Close Shot* ☐ 2 Close Shot* ☐ 3 Close Shot* ☐ 4 Close Shot* ☐
26	Inhib.Trip tAUX2: Shot	1 Close Shot* ☐ 2 Close Shot* ☐ 3 Close Shot* ☐ 4 Close Shot* ☐

OUTPUT RELAYS CONFIGURATION G1									
SETTING GROUP 1/ OUTPUT RELAY CONFIGURATION G1		TC	FI	RL6	RL5	RL4	RL3	RL2	RL1
1	Latched outputs								
2	Reverse outp. logic								
3	Protect. Trip								
4	Prot.Trip pulse								
5	Trip CB Order								
6	Close CB Order								
7	Alarm								
8	Start Phase A								
9	Start Phase B								
10	Start Phase C								
11	start I>								
12	start I>>								
13	start I>>>								
14	Start SOTF								
15	start IN_1								
16	start IN_2								

CM

OUTPUT RELAYS CONFIGURATION G1										
SETTING GROUP 1/ OUTPUT RELAY CONFIGURATION G1		TC	FI	RL6	RL5	RL4	RL3	RL2	RL1
17	start IN_3								
18	Start I<								
19	start I2>								
20	Start Brkn Cond								
21	AUX1								
22	AUX2								
23	AUX3								
24	AUX4								
25	AUX5								
26	AUX6								
27	tI>								
28	tI>>								
29	tI>>>								
30	tSOTF								
31	tIN_1								
32	tIN_2								
33	tIN_3								
34	tI<								
35	tI2>								
36	tBrkn Cond.								
37	Thermal Trip								
38	Thermal Alarm								
39	tCB Fail								
40	tAUX1								
41	tAUX2								
42	tAUX3								
43	tAUX4								
44	Comm. Order 1								
45	Comm. Order 2								
46	[79]in Progress								
47	[79] F.Trip								
48	[79] Lockout								
49	[79] Blocked								
50	[79] Success.								
51	TCS 52 Fail								
52	CB Alarm								

OUTPUT RELAYS CONFIGURATION G1									
SETTING GROUP 1/ OUTPUT RELAY CONFIGURATION G1		TC	FI	RL6	RL5	RL4	RL3	RL2	RL1
53	Trip pulse tP								
54	tCB FLT Ext.Sign								
55	Setting Group 1								

CM

INPUTS CONFIGURATION G1							
SETTING GROUP 1/ INPUT CONFIGURATION G1		L6	L5	L4	L3	L2	L1
1	Reverse Input Logic						
2	Mainten. Mode						
3	Reset Latch Sign						
4	Reset Latchd Out						
5	Block. tI>						
6	Block. tI>>						
7	Block. tI>>						
8	Block.tSOTF						
9	Block. tIN_1						
10	Block. tIN_2						
11	Block. tIN_3						
12	Block. tI<						
13	Block. tI2>						
14	Block. tBrkn Cond						
15	Block. Itherm.						
16	Block. AUX1						
17	Block. AUX2						
18	Block. AUX3						
19	Block. CB Fail						
20	Block. [79]						
21	SEL1 tI>>						
22	SEL1 tI>>>						
23	SEL1 tIN_2						
24	SEL1 tIN_3						
25	SEL2 tI>>						
26	SEL2 tI>>>						
27	SEL2 tIN_2						
28	SEL2 tIN_3						
29	AUX1						
30	AUX2						
31	AUX3						
32	AUX4						
33	AUX5						
34	AUX6						

CM

INPUTS CONFIGURATION G1							
SETTING GROUP 1/ INPUT CONFIGURATION G1		L6	L5	L4	L3	L2	L1
35	Cold Load PU						
36	Strt tBF						
37	CB Status 52A						
38	CB Status 52B						
39	CB FLT Ext.Sign						
40	Setting Group 2						
41	Manual Close						
42	Manual Trip						
43	Trip Circ Supervis.						
44	Reset Theta val.						
45	Start Distur. R.						
46	Local CTRL Mode						
47	Time Synchr.						

LEDs CONFIGURATION G1							
SETTING GROUP 1/ LEDs CONFIGURATION G1		LED3	LED4	LED5	LED6	LED7	LED8
1	Latched LEDs						
2	Protect. Trip						
3	Alarm						
4	General Start						
5	Start Phase A						
6	Start Phase B						
7	Start Phase C						
8	Start I>						
9	Start I>>						
10	Start I>>>						
11	Start SOTF						
12	Start IN_1						
13	Start IN_2						
14	Start IN_3						
15	AUX1						
16	AUX2						
17	AUX3						
18	AUX4						
19	AUX5						
20	AUX6						
21	tI>						
22	tI>>						
23	tI>>>						
24	tSOTF						
25	tIN_1						
26	tIN_2						
27	tIN_3						
28	tI<						
29	tI2>						
30	tBrkn Cond.						
31	Thermal Trip						
32	Thermal Alarm						
33	CB Fail						
34	tAUX1						
35	tAUX2						
36	tAUX3						
37	tAUX4						
38	[79] in Progress						

LEDs CONFIGURATION G1							
SETTING GROUP 1/ LEDs CONFIGURATION G1		LED3	LED4	LED5	LED6	LED7	LED8
39	[79] F.Trip						
40	[79] Lockout						
41	[79] Blocked						
42	[79] Success.						
43	Local CRTL Mode						
44	CB Alarm						
45	Maintenance Mode						
46	tCB FLT Ext.Sign						
47	Setting Group 1						

OVERCURRENT G2		
SETTING GROUP 2/ PROTECTION G2/ PHASE O/C [50/51] G2		Settings
1	I> ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐ 3: Trip-Inrush Bl * ☐ 4: Trip-Latch * ☐
2	I> Threshold	In
3	Delay Type I>	
4	tI>/TMS/TD	s *
5	Reset Delay Type I>	0: DMT* ☐ 1: IDMT * ☐
6	DMT tReset I> RTD/RTMS Reset I>	
7	I>> ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐ 3: Trip-Inrush Bl * ☐ 4: Trip-Latch * ☐
8	I>> Threshold	In
9	Delay Type I>>	
10	tI>>/TMS/TD	s
11	Reset Delay Type I>>	0: DMT* ☐ 1: IDMT * ☐
12	DMT tReset I> RTD/RTMS Reset I>	
13	I>>> ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐ 3: Trip-Inrush Bl * ☐ 4: Trip-Latch * ☐
14	I>>> Threshold	In
15	tI>>>	s

CM

SOTF G2		
SETTING GROUP 2/ PROTECTION G2/ SOTF [50/51] G2		Settings
1	SOTF?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐ 3: Trip-Inrush Bl * ☐ 4: Trip-Latch * ☐
2	SOTF Threshold	In
3	tSOTF	s

EARTH FAULT (Measured) G2		
SETTING GROUP 2/ PROTECTION G2 / E/GND FAULT [50N/51N] G2		Settings
1	IN_1 stage ?	0: Disabled* ☐ 1: IN>Trip* ☐ 2: IN> Alarm* ☐ 3: IN> Trip-Inrush Bl * ☐ 4: IN> Trip-Latch * ☐
2	IN_1 Threshold	Ien
3	Delay Type IN_1	
4	tIN_1/TMS/TD	s
5	Reset Delay Type IN_1	0: DMT* ☐ 1: IDMT * ☐
6	DMT tReset IN_1 RTD/RTMS Reset IN_1	s
7	IN_2 stage ?	0: Disabled* ☐ 1: IN>>Trip* ☐ 2: IN>> Alarm* ☐ 3: IN>> Trip-Inrush Bl * ☐ 4: IN>> Trip-Latch * ☐
8	IN_2 Threshold	
9	tIN_2	s
10	IN_3 stage ?	0: Disabled* ☐ 1: IN>>>Trip* ☐ 2: IN>>> Alarm* ☐ 3: IN>>> Trip-Inrush Bl* ☐ 4: IN>>> Trip-Latch * ☐
11	IN_3 Threshold	
12	tIN_3	s

CM

Undercurrent [37] G2		
SETTING GROUP 2/ PROTECTION G2/ UNDERCURRENT [37]		Settings
1	I< ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐ 3: Trip-Inrush Bl * ☐ 4: Trip-Latch * ☐ 5: Trip-Inhib 52A * ☐ 6: Alarm-Inhib 52 * ☐
2	I< Threshold	In
3	tI<	s

Negative Sequence O/C [46] G2		
SETTING GROUP 2/ PROTECTION G2 / NEGATIVE SEQ.O/C [46] G2		Settings
1	I2> ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐ 3: Trip-Inrush Bl * ☐ 4: Trip-Latch * ☐
2	I2> Threshold	In
3	Delay Type I2>	
4	tI2>/TMS/TD	s
5	Reset Delay Type I2>	0: DMT* ☐ 1: IDMT * ☐
6	DMT tReset I2> RTD/RTMS Reset I2>	s

Broken Conductor G2		
SETTING GROUP 2/ PROTECTION G2/ BROKEN CONDUCTOR [46BC] G2		Settings
1	Broken Cond.?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐ 3: Trip-Inrush Bl * ☐ 4: Trip-Latch * ☐
2	Ratio I2/I1	%
3	tBCond	s

[49] Thermal Overload G2	
SETTING GROUP 2/ PROTECTION G2 / THERMAL OVERLOAD [49] G2	Settings

CM

[49] Thermal Overload G2		
SETTING GROUP 2/ PROTECTION G2 / THERMAL OVERLOAD [49] G2		Settings
1	Therm OL?	0: Disabled* ☐ 1: Enabled* ☐
2	Itherm	In
3	Te (heating)	mn
4	Tr (cooling)	mn
5	Theta Trip	%
6	Theta Trip/Reset Ratio	%
7	Alarm OL?	0: Disabled* ☐ 1: Enabled* ☐
8	Theta Alarm	%

[50BF] CB Fail G2		
SETTING GROUP 2/ PROTECTION G2 / CB Fail [50BF] G2		Settings
1	CB Fail ?	0: Disabled* ☐ 1: Retrip* ☐ 2: Alarm* ☐
2	CB Fail Time tBF	s
3	I< Threshold CBF	In
4	IN< Threshold CBF	Ien
5	Block I> ?	0: No* ☐ 1: Yes* ☐
6	Block IN> ?	0: No* ☐ 1: Yes* ☐

CM

AUX TIMERS G2		
SETTING GROUP 2/ PROTECTION G2 / AUX TIMERS G2		Group 1 Settings
1	AUX1 ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐ 3: Trip-Inrush Bl * ☐ 4: Trip-Latch * ☐ 5: Load Shedding* ☐ 6: AR after LS Hi* ☐ 7: AR after LS Lo* ☐
2	tAUX1	s
3	AUX2 ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐ 3: Trip-Inrush Bl * ☐ 4: Trip-Latch * ☐ 5: Load Shedding* ☐ 6: AR after LS Hi* ☐ 7: AR after LS Lo* ☐
4	tAUX2	s
5	AUX3 ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐ 3: Trip-Inrush Bl * ☐ 4: Trip-Latch * ☐ 5: Load Shedding* ☐ 6: AR after LS Hi* ☐ 7: AR after LS Lo* ☐
6	tAUX3	s
7	AUX4 ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐ 3: Trip-Inrush Bl * ☐ 4: Trip-Latch * ☐ 5: Load Shedding* ☐ 6: AR after LS Hi* ☐ 7: AR after LS Lo* ☐
8	tAUX4	s

CM

Logic Selectivity G2		
SETTING GROUP 2/ PROTECTION G2 / LOGIC SELECT. G2		Settings
1	Sel1?	0: Disabled* ☐ 1: Enabled* ☐
2	tSel1	s
3	Sel2?	0: Disabled* ☐ 1: Enabled* ☐

Logic Selectivity G2		
SETTING GROUP 2/ PROTECTION G2 / LOGIC SELECT. G2		Settings
4	tSel2	s

Cold Load Pick Up G2		
SETTING GROUP 2/ PROTECTION G2 / COLD LOAD PU G2		Settings
1	Cold Load PU ?	0: Disabled* ☐ 1: Current+Input* ☐ 2: Input* ☐
2	Cold Load PU Level	%
3	Cold Load PU tCL	s
4	Cold Load PU I>	0: No* ☐ 1: Yes* ☐
5	Cold Load PU I>>	0: No* ☐ 1: Yes* ☐
6	Cold Load PU I>>>	0: No* ☐ 1: Yes* ☐
7	Cold Load PU IN_1	0: No* ☐ 1: Yes* ☐
8	Cold Load PU IN_2	0: No* ☐ 1: Yes* ☐
9	Cold Load PU IN_3	0: No* ☐ 1: Yes* ☐
10	Cold Load PU Brkn.Cond	0: No* ☐ 1: Yes* ☐
11	Cold Load PU Itherm	0: No* ☐ 1: Yes* ☐
12	Cold Load PU I2>	0: No* ☐ 1: Yes* ☐

CM

Autoreclose [79] G2		
SETTING GROUP 2/ PROTECTION G2 / AUTORECLOSE [79] G2		Settings
1	Autoreclose ?	0: Disabled* ☐ 1: Enabled* ☐
2	Dead Time tD1	s
3	Dead Time tD2	s
4	Dead Time tD3	s
5	Dead Time tD4	s
6	Reclaim Time tR	s
7	Fast O/C Trip	1 Trip Shot* ☐ 2 Trip Shot * ☐ 3 Trip Shot * ☐ 4 Trip Shot * ☐ 5 Trip Shot * ☐
8	Fast O/C Trip Delay	s
9	Fast E/Gnd Trip	1 Trip Shot * ☐ 2 Trip Shot * ☐

Autoreclose [79] G2		
SETTING GROUP 2/ PROTECTION G2 / AUTORECLOSE [79] G2		Settings
		3 Trip Shot * ☐ 4 Trip Shot * ☐ 5 Trip Shot * ☐
10	Fast E/Gnd Trip Delay	s
11	Close Shot? tI>	1 Close Shot* ☐ 2 Close Shot* ☐ 3 Close Shot* ☐ 4 Close Shot* ☐
12	Inhib.Trip tI>: Shot	1 Close Shot* ☐ 2 Close Shot* ☐ 3 Close Shot* ☐ 4 Close Shot* ☐
13	Close Shot? tI>>	1 Close Shot* ☐ 2 Close Shot* ☐ 3 Close Shot* ☐ 4 Close Shot* ☐
14	Inhib.Trip tI>>: Shot	1 Close Shot* ☐ 2 Close Shot* ☐ 3 Close Shot* ☐ 4 Close Shot* ☐
15	Close Shot? tI>>>	1 Close Shot* ☐ 2 Close Shot* ☐ 3 Close Shot* ☐ 4 Close Shot* ☐
16	Inhib.Trip tI>>>: Shot	1 Close Shot* ☐ 2 Close Shot* ☐ 3 Close Shot* ☐ 4 Close Shot* ☐
17	Close Shot? tIN_1	1 Close Shot* ☐ 2 Close Shot* ☐ 3 Close Shot* ☐ 4 Close Shot* ☐
18	Inhib.Trip tIN_1: Shot	1 Close Shot* ☐ 2 Close Shot* ☐ 3 Close Shot* ☐ 4 Close Shot* ☐
19	Close Shot? tIN_2	1 Close Shot* ☐ 2 Close Shot* ☐ 3 Close Shot* ☐ 4 Close Shot* ☐

CM

Autoreclose [79] G2		
SETTING GROUP 2/ PROTECTION G2 / AUTORECLOSE [79] G2		Settings
20	Inhib.Trip tIN_2: Shot	1 Close Shot* ☐ 2 Close Shot* ☐ 3 Close Shot* ☐ 4 Close Shot* ☐
21	Close Shot? tIN_3	1 Close Shot* ☐ 2 Close Shot* ☐ 3 Close Shot* ☐ 4 Close Shot* ☐
22	Inhib.Trip tIN_3: Shot	1 Close Shot* ☐ 2 Close Shot* ☐ 3 Close Shot* ☐ 4 Close Shot* ☐
23	Close Shot? tAUX1	1 Close Shot* ☐ 2 Close Shot* ☐ 3 Close Shot* ☐ 4 Close Shot* ☐
24	Inhib.Trip tAUX1: Shot	1 Close Shot* ☐ 2 Close Shot* ☐ 3 Close Shot* ☐ 4 Close Shot* ☐
25	Close Shot? tAUX2	1 Close Shot* ☐ 2 Close Shot* ☐ 3 Close Shot* ☐ 4 Close Shot* ☐
26	Inhib.Trip tAUX2: Shot	1 Close Shot* ☐ 2 Close Shot* ☐ 3 Close Shot* ☐ 4 Close Shot* ☐

CM

OUTPUT RELAYS CONFIGURATION G2									
SETTING GROUP 2/ OUTPUT RELAY CONFIGURATION G2		TC	FI	RL6	RL5	RL4	RL3	RL2	RL1
1	Latched outputs								
2	Reverse outp. logic								
3	Protect. Trip								
4	Prot.Trip pulse								
5	Trip CB Order								
6	Close CB Order								
7	Alarm								
8	Start Phase A								
9	Start Phase B								
10	Start Phase C								
11	start I>								
12	start I>>								
13	start I>>>								
14	Start SOTF								
15	start IN_1								
16	start IN_2								
17	start IN_3								
18	Start I<								
19	start I2>								
20	Start Brkn Cond								
21	AUX1								
22	AUX2								
23	AUX3								
24	AUX4								
25	AUX5								
26	AUX6								
27	tI>								
28	tI>>								
29	tI>>>								
30	tSOTF								
31	tIN_1								
32	tIN_2								
33	tIN_3								
34	tI<								

OUTPUT RELAYS CONFIGURATION G2									
SETTING GROUP 2/ OUTPUT RELAY CONFIGURATION G2		TC	FI	RL6	RL5	RL4	RL3	RL2	RL1
35	tI2>								
36	tBrkn Cond.								
37	Thermal Trip								
38	Thermal Alarm								
39	tCB Fail								
40	tAUX1								
41	tAUX2								
42	tAUX3								
43	tAUX4								
44	Comm. Order 1								
45	Comm. Order 2								
46	[79]in Progress								
47	[79] F.Trip								
48	[79] Lockout								
49	[79] Blocked								
50	[79] Success.								
51	TCS 52 Fail								
52	CB Alarm								
53	Trip pulse tP								
54	tCB FLT Ext.Sign								
55	Setting Group 2								

CM

INPUTS CONFIGURATION G2							
SETTING GROUP 2/ INPUT CONFIGURATION G2		L6	L5	L4	L3	L2	L1
1	Reverse Input Logic						
2	Mainten. Mode						
3	Reset Latch Sign						
4	Reset Latchd Out						
5	Block. tI>						
6	Block. tI>>						
7	Block. tI>>						
8	Block.tSOTF						
9	Block. tIN_1						
10	Block. tIN_2						
11	Block. tIN_3						
12	Block. tI<						
13	Block. tI2>						
14	Block. tBrkn Cond						
15	Block. Itherm.						
16	Block. AUX1						
17	Block. AUX2						
18	Block. AUX3						
19	Block. CB Fail						
20	Block. [79]						
21	SEL1 tI>>						
22	SEL1 tI>>>						
23	SEL1 tIN_2						
24	SEL1 tIN_3						
25	SEL2 tI>>						
26	SEL2 tI>>>						
27	SEL2 tIN_2						
28	SEL2 tIN_3						
29	AUX1						
30	AUX2						
31	AUX3						
32	AUX4						
33	AUX5						
34	AUX6						

CM

INPUTS CONFIGURATION G2							
SETTING GROUP 2/ INPUT CONFIGURATION G2		L6	L5	L4	L3	L2	L1
35	Cold Load PU						
36	Strt tBF						
37	CB Status 52A						
38	CB Status 52B						
39	CB FLT Ext.Sign						
40	Setting Group 2						
41	Manual Close						
42	Manual Trip						
43	Trip Circ Supervis.						
44	Reset Theta val.						
45	Start Distur. R.						
46	Local CTRL Mode						
47	Time Synchr.						

LEDs CONFIGURATION G2							
SETTING GROUP 2/ LEDs CONFIGURATION G2		LED3	LED4	LED5	LED6	LED7	LED8
1	Latched LEDs						
2	Protect. Trip						
3	Alarm						
4	General Start						
5	Start Phase A						
6	Start Phase B						
7	Start Phase C						
8	Start I>						
9	Start I>>						
10	Start I>>>						
11	Start SOTF						
12	Start IN_1						
13	Start IN_2						
14	Start IN_3						
15	AUX1						
16	AUX2						
17	AUX3						
18	AUX4						
19	AUX5						
20	AUX6						
21	tI>						
22	tI>>						
23	tI>>>						
24	tSOTF						
25	tIN_1						
26	tIN_2						
27	tIN_3						
28	tI<						
29	tI2>						
30	tBrkn Cond.						
31	Thermal Trip						
32	Thermal Alarm						
33	CB Fail						
34	tAUX1						
35	tAUX2						
36	tAUX3						
37	tAUX4						
38	[79] in Progress						

CM

LEDs CONFIGURATION G2							
SETTING GROUP 2/ LEDs CONFIGURATION G2		LED3	LED4	LED5	LED6	LED7	LED8
39	[79] F.Trip						
40	[79] Lockout						
41	[79] Blocked						
42	[79] Success.						
43	Local CRTL Mode						
44	CB Alarm						
45	Maintenance Mode						
46	tCB FLT Ext.Sign						
47	Setting Group 2						

CM

Commissioning Engineer

Customer Witness

Date:

Date:

CM

MAINTENANCE

MT

Date:	**17th November 2013**
Hardware Suffix:	**A**
Software Version:	**1C**
Connection Diagrams:	**10P11602**

CONTENTS

Maintenance

1.1 Maintenance period

It is recommended that products supplied by SCHNEIDER ELECTRIC ENERGY receive periodic monitoring after installation. In view of the critical nature of protective relays and their infrequent operation, it is desirable to confirm that they are operating correctly, at regular intervals.

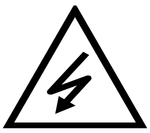
SCHNEIDER ELECTRIC ENERGY protective relays are designed for a life in excess of 20 years.

MiCOM relays are self-monitoring and so require less maintenance than earlier designs of relay. Most problems will set off an alarm so that remedial action can be taken. However, some periodic tests should be carried out to ensure that the relay is functioning correctly and that the external wiring is intact.

1.2 Maintenance checks

Although some functionality checks can be performed from a remote location by utilizing the communications ability of the relays, these are predominantly restricted to checking that the relay is measuring the applied currents accurately. Therefore it is recommended that maintenance checks are performed locally (i.e. at the substation itself).

Before carrying out any work on the equipment, the user should be familiar with the contents of the Safety Guide SFTY/4L M/E11 or later issue, OR the safety and technical data section of the technical manual and also the ratings on the equipment rating label.



For safety reasons, no work must be carried out on the P116 until all power sources to the unit have been disconnected.

1.2.1 Binary Inputs (Model A)

Binary inputs can be checked to ensure that the relay responds to its energization by repeating the commissioning test detailed in section 3.2.3 of the Commissioning chapter (P116/EN CM).

1.2.2 Outputs

Output relays' operation can be checked by repeating the commissioning test detailed in section 3.2.4 of the Commissioning chapter (P116/EN CM).

1.2.3 Measurement Accuracy

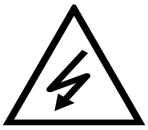
If the power system is energized, the values measured by the relay can be compared with known system values to check that they are in the approximate expected range.. If they are, then the analogue/digital conversion and calculations are being performed correctly by the relay. Suitable test methods can be found in sections 3.2.7 of the Commissioning chapter (P116/EN CM).

Alternatively, the values measured by the relay can be checked against known values injected into the relay via the test block, if fitted, or injected directly into the relay terminals. These tests will prove the calibration accuracy is being maintained.

1.3 Method of Repair

It is recommended that the P116 relay is returned to an SCHNEIDER ELECTRIC ENERGY service centre for repair.

Before carrying out any work on the equipment, the user should be familiar with the contents of the Safety Guide SFTY/4L M/E11 or later issue, OR the safety and technical data section of the technical manual and also the ratings on the equipment rating label.



For safety reasons, no work must be carried out on the P116 until all power sources to the unit have been disconnected.

1.4 Cleaning

Before cleaning the equipment ensure that all current transformers and voltage input connections are isolated to prevent any possibility of an electric shock whilst cleaning.

The equipment may be cleaned using a lint-free cloth moistened with clean water. The use of detergents, solvents or abrasive cleaners is not recommended as they may damage the relay's surface and leave a conductive residue.

TROUBLESHOOTING

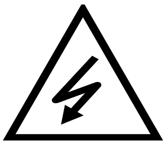
TS

Date:	**17th November 2013**
Hardware Suffix:	**A**
Software Version:	**1C**
Connection Diagrams:	**10P11602**

CONTENTS

1. INTRODUCTION

BEFORE CARRYING OUT ANY WORK ON THE EQUIPMENT, THE USER SHOULD BE FAMILIAR WITH THE CONTENTS OF THE SAFETY GUIDE SFTY/4L M/E11 OR LATER ISSUE, or THE SAFETY AND TECHNICAL DATA SECTION OF THE TECHNICAL MANUAL AND ALSO THE RATINGS ON THE EQUIPMENT RATING LABEL.



For safety reasons, no work must be carried out on the P116 until all power sources to the unit have been disconnected.

The purpose of this section of the service manual is to allow an error condition on the relay to be identified so that appropriate corrective action can be taken.

In cases where a faulty relay is being returned to the manufacturer or one of their approved service centers, a completed copy of the Repair/Modification Return Authorization Form located at the end of this section should be included.

2. INITIAL PROBLEM IDENTIFICATION

Consult the table below to find the description that best matches the problem experienced, then consult the section referenced to perform a more detailed analysis of the problem.

Symptom	Refer To
Relay fails to power up	Section 3
Maloperation of the relay during testing	Section 4

Table 1: Problem identification

3. POWER UP ERRORS

P116 can be powered up using the following power sources:

- USB connection to PC
- Auxiliary voltage (Vx) (Model A)
- Current inputs

If the relay does not appear to power up then the following procedure can be used to determine whether the fault is in the external wiring or in the power supply module of the relay.

Note: Max current necessary to supply P116 from USB port is 450mA. USB standard offers 500mA for a one PC's USB controller, so it is not recommended to connect any additional devices to the same PC's USB controller. If the total power consumption from a one PC's USB controller is greater than 500mA, P116 can be in permanent rest (P116 display and the green *Healthy* LED will be flashing)

Test	Check	Action
1	1. Connect the P116 to a PC via the USB port. 2. Disconnect the PC from the P116 USB port.	(i) If the green "Healthy" LED and display are lit then proceed to test 2. (ii) If the green "Healthy" LED and display are not lit then proceed to test 2.
2 (Model A)	1. Apply a Vx auxiliary voltage on terminals B1-B2 (check the level on the P116 nominal label) 2. Check whether the green "Healthy" LED on the P116 front panel is lit. 3. Disconnect the ac auxiliary voltage from terminals B1-B2.	(i) If the green "Healthy" LED and display are lit then proceed to test 3. (ii) If the green "Healthy" LED and display are not lit then send the relay back to SCHNEIDER ELECTRIC ENERGY's repair centre.
3	1. Connect the Current Test equipment to the current input terminals: A1-A2. 2. Apply 0.8 In current 3. Disconnect the Current Test equipment from current input terminals: A1-A2. 4. Repeat procedure for terminals: A3-A4, A5-A6 and A7-A8 (0.8 Ien)	(i) If the green "Healthy" LED and display are not lit in all four tests, it means that P116 is damaged. Send the relay back to SCHNEIDER ELECTRIC ENERGY's repair centre. (ii) If the green "Healthy" LED and display are lit in test 1 and 2 but not lit in test 3, check the current circuit wiring. If all connections are OK, send the relay and CTs back to SCHNEIDER ELECTRIC ENERGY's repair centre. (iii) Model A: If the green "Healthy" LED and display are lit in test 1 and 3 but not lit in test 2, check the auxiliary voltage level on terminals B1-B2 and connections in that circuit. If all connections are OK and the voltage level is in the required range (refer to Technical Data chapter of this manual), send the relay back to SCHNEIDER ELECTRIC ENERGY's repair centre.

Table 2: Failure of relay to power up

4. MALOPERATION OF THE RELAY DURING TESTING

4.1 Failure of Binary Inputs (Model A)

The binary inputs are configured in the ***SETTING GROUPx/INPUTS CONFIGURATION*** column for each setting group. If an input does not appear to be recognized by the relay scheme logic the ***COMMISSIONING/Opto I/P Status*** menu option can be used to verify whether the problem is in the binary input itself or the mapping of its signal to the scheme logic functions. If the binary input appears to be read correctly then it is necessary to examine its configuration.

Ensure the voltage rating for the opto inputs has been configured correctly with applied voltage. If the binary input state is not read correctly by the relay the applied signal should be tested. Verify the connections to the binary input using the correct wiring diagram. Next, using a voltmeter verify that 80% opto setting voltage is present on the terminals of the binary input in the energized state. If the signal is being correctly applied to the relay then the failure may be on the input card itself.

Notes: 1. If the P116 is exclusively powered from the USB port, only some of the relay's electronic circuits (necessary for communications) are supplied. For this reason, inputs are in high state (independent of the voltage at the terminals). Any action pertaining to binary inputs is blocked.

2. Only the logical state of the inputs is given in the ***COMMISSIONING /Opto I/P Status*** cell, not presence of voltage at the terminals. For example: If Vx (high state) and Reverse Input Logic are set (function active in low state of binary input) at the terminals of a binary input in the **COMMISSIONING /Opto I/P Status** cell, the logical state of the input is low (logical status after application of the Reverse Input Logic function).

4.2 Failure of Output Contacts

An apparent failure of the relay's output contacts may be caused by the relay configuration; the following tests should be performed to identify the real cause of the failure. Tests of outputs can be performed using the ***COMMISSIONING/Test outputs*** cell. The command is executed and the configured outputs (***COMMISSIONING/Test Pattern***) will be energized for the duration of ***Contact Test Time*** (***COMMISSIONING***).

Test	Check	Action
1	Is the Out of Service LED illuminated?	Illumination of this LED may indicate that the relay is in test mode or that the protection has been disabled due to a hardware verify error (see Table 2).
2	Examine the ***Test outputs*** in the Commissioning section of the menu.	If the relevant bits of the contact status are operated then proceed to test 4, if not proceed to test 3.
3	Verify by examination of the fault record whether the protection element is operating correctly.	If the protection element does not operate verify whether the test is being correctly applied. If the protection element operates then it is necessary to check the configuration, to ensure that the configuration of the protection element to the contacts is correct.
4	Using the procedure described in the Commissioning chapter (P116/EN CM) energize every output (note the correct external connection diagram should be consulted). A continuity tester can be connected at the rear of the relay for this purpose.	If the output relay operates then the problem must be situated in the external wiring to the relay. If the output relay does not operate this could indicate a failure of the output relay contacts (note that the self-tests verify that the relay coil is being energized). Ensure that the closed resistance is not too high for the continuity tester to detect.

Table 3: Failure of Output Contacts

TS

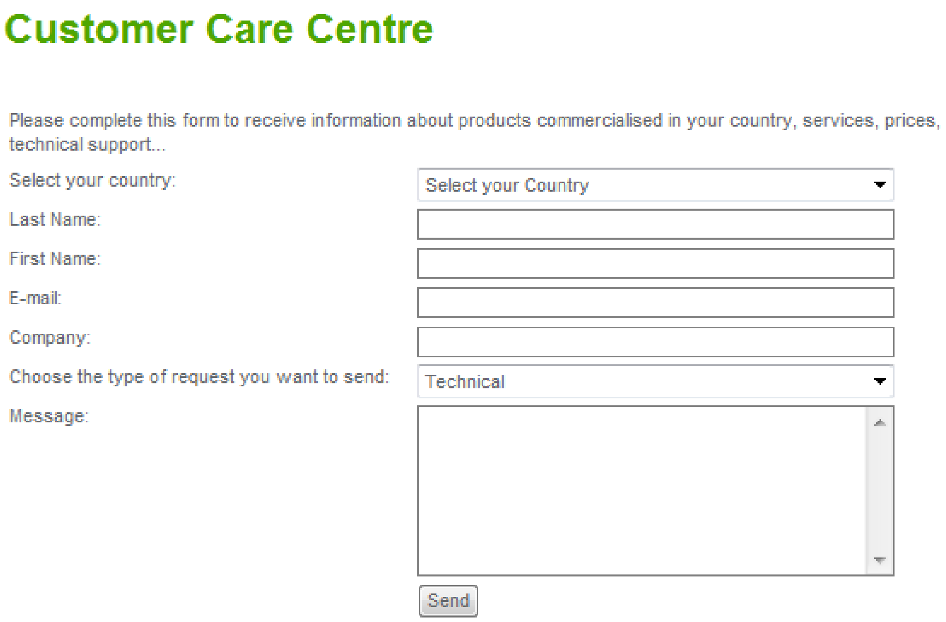
5. LOST PASSWORD

The password lost

If the password is lost please contact with Schneider Electric organization in the country or use the Website link:

http://www.schneider-electric.com/CCC

Complete the form (see below)


Customer Care Centre

Please complete this form to receive information about products commercialised in your country, services, prices, technical support...

Select your country: Select your Country

Last Name:

First Name:

E-mail:

Company:

Choose the type of request you want to send: Technical

Message:

Send

In the "Massage" field, write information that it is a problem with forgotten password, add information about the type of the relay and serial number of P116..

Note: MiCOM P116 serial number can be read from the nominal plate on the case (for example: **SN**00036046) or in the main: "OP Parameters" column of the menu (for example: 00036046)

For example:

"Massage:

Protection password for my MiCOM P116 is lost.

Send me the temporary password for P116 serial number: SN00036046"

If the temporary password is known, navigate to the ***SETTING CHANGE MODE*** main header (see Figure 9 Getting Started chapter of the manual), then press the key:

enter the temporary password in the window like below:

```
Edit settings?
Enter PSWD
```

Press the OK navigation key.

```
Edit settings?
Enter PSWD 0000
```

The **0** digit furthest to the right is flashing.

TS

Enter the password:

1. If the digit is flashing, change the digit to the required value by pressing the key or the key.
2. Change the flashing digit by pressing the key or key.
3. Continue as above to set the whole password (4 digits)
4. If the correct password is set, press the OK navigation key

The following cell will be displayed:

```
Setting change:
      Protected
```

After above operation all passwords (administrator, protection, test control) will be deleted and set to the default value: **0000**

For more information about password changing see: Getting Started chapter point 2.4 of the manual

6. REPAIR AND MODIFICATION PROCEDURE

Please follow these 5 steps to return an Automation product to us:

1. **Get the Repair and Modification Authorization Form (RMA)**

   Find a copy of the RMA form at the end of this section.

   To obtain an electronic version of the RMA form for e-mailing, please connect your lical Schneider Electric Energy service.

2. **Fill in RMA form**

   Fill in only the white part of the form.

   Please ensure that all fields marked **(M)** are completed such as:

   - Equipment model
   - Model No. and Serial No.
   - Description of failure or modification required (please be specific)
   - Value for customs (in case the product requires export)
   - Delivery and invoice addresses
   - Contact details

3. **Send RMA form to your local contact**

4. **Receive shipping information from local service contact**

   Your local service contact will provide you with all the information:

   - Pricing details
   - RMA n°
   - Repair center address

   If required, an acceptance of the quote must be delivered before going to the next step. .

5. **Send the product to the repair center**

   - Address the shipment to the repair center specified by your local contact
   - Ensure all items are protected by appropriate packaging: anti-static bag and foam protection
   - Ensure a copy of the import invoice is enclosed with the unit being returned
   - Ensure a copy of the RMA form is enclosed with the unit being returned
   - E-mail or fax a copy of the import invoice and air waybill to your local contact.

SYMBOLS AND GLOSSARY

Date:	**17th November 2013**
Hardware Suffix:	**A**
Software Version:	**1C**
Connection Diagrams:	**10P11602**

Logic Symbols

Symbols	Explanation
>	**Greater than:** Used to indicate an “over” threshold, such as overcurrent (current overload).
C/O	**A changeover contact having normally closed and normally open connections:** Often called a “form C” contact.
CB	Circuit breaker.
CT	Current transformer.
Dly	Time delay.
DT	**Abbreviation of “Definite Time”:** An element which always responds with the same constant time-delay on operation.
E/F	**Earth fault:** Directly equivalent to ground fault.
FLC	**Full load current:** The nominal rated current for the circuit.
Flt.	**Abbreviation of “Fault”:** Typically used to indicate faulted phase selection.
FN	Function.
Gnd.	**Abbreviation of “Ground”:** Used in distance settings to identify settings that relate to ground (earth) faults.
I	Current.
I>>	**First stage of phase overcurrent protection:** Could be labeled 51-1 in ANSI terminology.
I>>	**Second stage of phase overcurrent protection:** Could be labeled 51-2 in ANSI terminology.
I>>>	**Third stage of phase overcurrent protection:** Could be labeled 51-3 in ANSI terminology.
IN>	**Earth Fault current:** Equals the neutral current measured at the analog input.
I2>	**Negative sequence overcurrent protection** Could be labeled 46 in ANSI terminology.
I2	**Negative sequence current**.
I1	**Positive sequence current**.
IA	**Phase A current:** Might be phase L1, red phase.. or other, in customer terminology.
IB	**Phase B current:** Might be phase L2, yellow phase.. or other, in customer terminology.
IC	**Phase C current:** Might be phase L3, blue phase.. or other, in customer terminology.
IDMT	**Inverse definite minimum time:** A characteristic whose trip time depends on the measured input (e.g. current) according to an inverse-time curve.

Symbols	Explanation
In	**The rated nominal current of the CT:** Software selectable as 1 amp or 5 amp to match the line CT input.
Ien	**The rated nominal current of the E/F CT:** Software selectable as 1 amp or 5 amp to match the line E/F CT input.
IN	**Neutral current, or residual current:** This results from an external summation of the three measured phase currents.
Inst.	**An element with “instantaneous” operation:** i.e. having no deliberate time delay.
I/O	**Abbreviation of “Inputs and Outputs”:** Used in connection with the number of opto-coupled inputs and output contacts within the relay.
I/P	Abbreviation of “Input”.
LD	**Abbreviation of “Level Detector”:** An element responding to a current or voltage below its set threshold.
LED	**Light emitting diode:** Red or green indicator on the relay front-panel.
N	**Indication of “Neutral” involvement in a fault:** i.e. a ground (earth) fault.
N/A	Not applicable.
N/C	**A normally closed or “break” contact:** Often called a “form B” contact.
N/O	**A normally open or “make” contact:** Often called a “form A” contact.
O/P	Abbreviation of “output”.
Opto	**An opto-coupled logic input:** Alternative terminology: binary input.
PCB	Printed circuit board.
Ph	**Abbreviation of “Phase”:** Used in distance settings to identify settings that relate to phase-phase faults.
IN_1	The first stage of earth fault protection element [50/50N]
IN_2	The second stage of earth fault protection element [50/50N]
Rx	**Abbreviation of “Receive”:** Typically used to indicate a communication receive line/pin.
T	A time delay.
TE	**A standard for measuring the width of a relay case:** One inch = 5TE units.
TMS	The time multiplier setting applied to IEC or UK inverse-time curves
TD	The time multiplier setting applied to IEEE or US inverse-time curves
Tx	**Abbreviation of “Transmit”:** Typically used to indicate a communication transmit line/pin.

INSTALLATION

Date:	**17th November 2013**
Hardware Suffix:	**A**
Software Version:	**1C**
Connection Diagrams:	**10P11602**

IN

CONTENTS

FIGURES

1. RECEIPT OF RELAYS

Upon receipt, relays should be examined immediately to ensure no external damage has been sustained in transit. If damage has been sustained, a claim should be made to the transport contractor and SCHNEIDER ELECTRIC ENERGY should be promptly notified.

Relays that are supplied unmounted and not intended for immediate installation should be returned to their protective polythene bags and delivery carton. Section 3 of P116/EN IN gives more information about the storage of relays.

2. HANDLING OF ELECTRONIC EQUIPMENT

A person's normal movements can easily generate electrostatic potentials of several thousand volts. Discharge of these voltages into semi-conductor devices when handling electronic circuits can cause serious damage that, although not always immediately apparent can reduce the reliability of the circuit. The relay's electronic circuits are protected from electrostatic discharge when housed in the case. Do not expose them to risk by removing the front panel or printed circuit boards unnecessarily.

Each printed circuit board incorporates the highest practicable protection for its semi-conductor devices. However, if it becomes necessary to remove a printed circuit board, the following precautions should be taken to preserve the high reliability and long life for which the relay has been designed and manufactured.

Before removing a printed circuit board, ensure that you are at the same electrostatic potential as the equipment by touching the case.

Handle analog input modules by the front panel, frame or edges of the circuit boards. Printed circuit boards should only be handled by their edges. Avoid touching the electronic components, printed circuit tracks or connectors.

Do not pass the module to another person without first ensuring you are both at the same electrostatic potential. Shaking hands achieves equipotential.

Place the module on an anti-static surface, or on a conducting surface that is at the same potential as you.

If it is necessary to store or transport printed circuit boards removed from the case, place them individually in electrically conducting anti-static bags.

In the unlikely event that you are making measurements on the internal electronic circuitry of a relay in service, it is preferable that you are earthed to the case with a conductive wrist strap. Wrist straps should have a resistance to ground between 500 kΩ and 10 MΩ. If a wrist strap is not available you should maintain regular contact with the case to prevent a build-up of electrostatic potential. Instrumentation which may be used for making measurements should also be earthed to the case whenever possible.

More information on safe working procedures for all electronic equipment can be found in BS EN 100015: Part 1:1992. It is strongly recommended that detailed investigations on electronic circuitry or modification work should be carried out in a special handling area such as described in the British Standard document.

3. STORAGE

If relays are not to be installed immediately upon receipt, they should be stored in a place free from dust and moisture in their original cartons. Where de-humidifier bags have been included in the packing they should be retained.

Care should be taken on subsequent unpacking that any dust, which has collected on the carton, does not fall inside. In locations of high humidity the carton and packing may become impregnated with moisture and the de-humidifier crystals will lose their efficiency.

Prior to installation, relays should be stored at a temperature of between –25°C to +70°C (-13°F to +158°F).

4. UNPACKING

Care must be taken when unpacking and installing the relays so that none of the parts are damaged and additional components are not accidentally left in the packing or lost. Ensure that any User’s CD ROM or technical documentation is NOT discarded – this should accompany the relay to its destination substation.

Relays must only be handled by qualified persons.

The site should be well lit to facilitate inspection, clean, dry and reasonably free from dust and excessive vibration.

5. RELAY MOUNTING

5.1 Flush version with Cassette

5.1.1 MICOM P116 removal from the Cassette.


Pic. 1

Step 1 Unscrew the two screw marked with an arrow (as shown in the picture).


Pic. 2

Step 2 In order to remove MICOM pull it out of the Cassette.


Pic. 3

Step 3 MICOM outside of the Cassette.

Assembly the device in reverse order

5.1.2 Assembly of MICOM P116 & Cassette set.

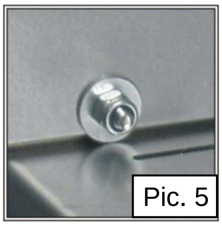
	051-174-40-120	BN2723
	058-044-40-1	PZP014-03 M4
	053-047-40-1	BN161 M4

Mounting Kit

- screw M4x12 4 pcs
- protective washer M4 4 pcs
- nut M4 4 pcs

Pic. 4

The first variant of the assembly
Fasten the Cassette with only screws

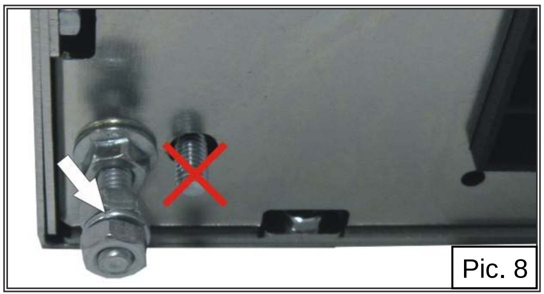


Pic. 5

Pic. 6

The second variant of the assembly Fasten the Cassette with screws, protective washers and nuts

Pic. 7



Pic. 8

The earthing wire should be connected to the bold marked with an arrow.

CAUTION
Do not connect any wires or put any nuts to the bolt marked with an **X** (the bolt is to be used only when MICOM is fastened without the Cassette)

5.2 Flush version without Cassette

5.2.1 Assembly of MICOM P116 without the Cassette.

	051-174-40-200	BN2723 M4x20
	058-044-40-1	PZP014-03 M4
	053-047-40-1	BN161 M4
	021-319-00-011	

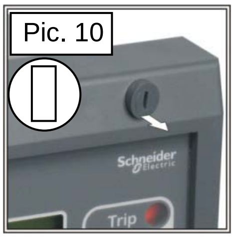
Mounting Kit

-	screw M4x20	4 pcs
-	protective washer M4	4 pcs
-	nut M4	4 pcs
-	bushing	4 pcs

To remove screw blinding plugs turn each by 90 degrees to the right (to vertical position)

Pull screw blinding plugs.

Pic. 9


Pic. 10


Pic. 11

On the rear side of the frame push four bushings.


Pic. 12

Pic. 13

The first variant of the assembly
Fasten the Cassette with only screws

The second variant of the assembly
Fasten the Cassette with screws, protective washers and nuts


Pic. 14

Pic. 15

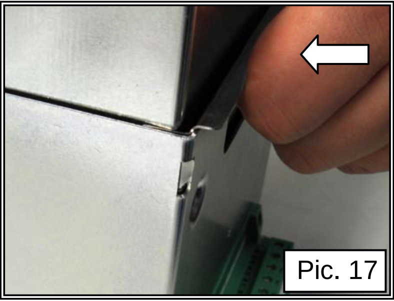
Insert the screw blinding plugs in horizontal position (as shown in the picture no. 15)

IN

5.3 Wall version

5.3.1 Instruction for MICOM P116 removal from the Adapter.

Pic. 16



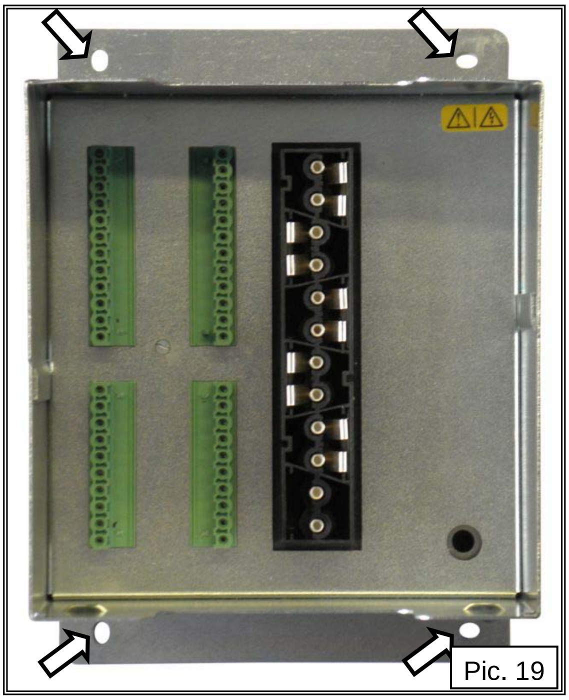
Pic. 17

Step 1
Push as shown in the picture no.16 and unlock.

Pic. 18

Step 2
Remove MICOM pull it out of the Adapter.

5.3.2 Assembly of MICOM P116 – Wall version



Pic. 19

Prepare 4 holes M4 and assembly device mount the adapter using screws included in the package

Assembly the device in reverse order

6. RELAY UNMOUNTING

Removing MICOM P116 after installation depends on the case variant.

<u>The basic withdrawable case.</u>

In the basic case 5 external plug in terminal blocks (1 current plug and 4 signal plugs) are removable after unscrew fixing screws. The current plug enables a safe disconnect of MICOM from energized system – the plug itself shorts CT circuits. After that follow instruction included in section: 5.RELAY MOUNTING in this chapter, but in the opposite direction.

P116 with the optional flush mounting cassette.

Step 1
Unscrew the two screw marked with an arrow
(as shown the picture).

Step 2
In order to remove MICOM pull it out of the Cassette.

Step 3
MICOM outside of the Cassette.

The basic P116 case can be put into the Cassette in following steps:

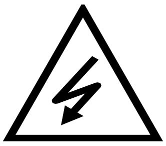
Step 1
Push MICOM into the Cassette

Step 2
Tighten the 2 screws marked with an arrow (as shown the picture).

Step 3
MICOM inside of the Cassette.

7. RELAY WIRING

BEFORE CARRYING OUT ANY WORK ON THE EQUIPMENT, THE USER SHOULD BE FAMILIAR WITH THE CONTENTS OF THE SAFETY GUIDE SFTY/4L M/E11 OR LATER ISSUE, OR THE SAFETY AND TECHNICAL DATA SECTION OF THE TECHNICAL MANUAL AND ALSO THE RATINGS ON THE EQUIPMENT RATING LABEL.



For safety reasons, no work must be carried out on the P116 until all power sources to the unit have been disconnected.

The measuring current inputs of the P116 should be connected to the secondary wires of the power system CTs as shown in the connection diagrams in section 9. ” External Connection Diagram” of this chapter P116/EN IN.

The CT types which can be connected to the P116’s current input terminals are shown in section 3 of the Applications chapter P116/EN AP.

7.1 Terminal Block Connections

AC Current Input Terminals

Loose relays are supplied with sufficient M4 screws for making connections to the rear mounted terminal blocks using ring terminals, with a recommended maximum of two crimp ring terminals per relay terminal.

M4 90° crimp ring terminals () have different sizes depending on wire size, so follow recommendation of a crimp ring terminals producer for max./min. wire size.

Due to the limitations of the ring terminal, the maximum wire size that can be used for AC current inputs is 6.0mm^2.

If a larger wire size is required, two wires should be used in parallel, each terminated in a separate ring terminal at the relay

If M4 crimp ring terminals are un-insulated, to maintain the terminal block insulation requirements for safety, an insulating sleeve should be fitted over the ring terminal after crimping.

Recommended minimum wire size: 2.5mm^2

General Input/Output Terminals

Recommended minimum wire size:

- power supply: 1.5mm^2
- EIA(RS)485 Port: See separate section
- Other Circuits 1.0mm^2

<u>Flush mounting case (basic case or flush mounting cassette):</u>

For power supply, binary inputs, contact output contacts and COM for rear communications.

Threaded M3 screw-type plug-in terminals (MSTB 2.5/xx-ST-5.08)

- 0.2 - 4 mm^2 single-core
- 0.2 - 2.5 mm^2 finely stranded

<u>Wall mounting cassette:</u>

For power supply, binary inputs, contact output contacts and COM for rear communications.

Threaded M2.5 screw-type plug-in terminals (FRONT-MSTB 2.5/xx-STF-5.08), with wire protection for conductor cross-section

- 0.2 – 2.5 mm^2 single-core
- 0.2 - 2.5 mm^2 finely stranded

Connections to the equipment must only be made using single strand wire or stranded wire with the use of insulated crimp terminals to maintain insulation requirements.

The length of connecting wires between Impulse Outputs (Terminals: C1, C2, C3, C4) and low energy CB tripping coil/Striker/MiTOP/Flag Indicator must be less than 3 m.

Where UL Listing of the equipment is not required the recommended fuse type for external wiring is a high rupture capacity (HRC) type with a maximum current rating of 16 Amps and a minimum DC rating of 250 Vdc, for example the Red Spot NIT or TIA type.

To maintain UL and CUL Listing of the equipment for North America a UL Listed fuse shall be used. The UL Listed type shall be a Class J time delay fuse, with a maximum current rating of 15 A and a minimum DC rating of 250 Vdc, for example type AJT15.

The protective fuse(s) should be located as close to the unit as possible.

7.2 USB Port

Connection to the USB port can be made by means of an USB cable. The USB port allows the user to download settings or fault records from the P116 or change I/O configuration.

To access this port it is necessary to remove the cover plate (protection against unauthorized setting changes) on the P116 front panel.

A typical cable specification would be:

- Type of cable: USB 2.0
- Connectors:

  PC: type A male

  P116: type mini B 5-pin male

  USB Cable: minimum 1P*28AWG/2C*24AWG, max : 2m

Communication software: MiCOM S1 Studio

The virtual COM port for USB communications should be set in as follows:

Address	Baud rate	Data bit	Stop bit	Parity
1	115 200 bits/s	8	1	None

Max current necessary to supply P116 from USB port is 450mA. USB standard offers 500mA for a one PC's USB controller, so it is not recommended to connect any additional devices to the same PC's USB controller. If the total power consumption from a one PC's USB controller is greater than 500mA, P116 can be in permanent rest (P116 display and the green *Healthy* LED will be flashing)

Before connection cable to USB socket it is necessary discharge static electricity from the body by touching a metal grounded object (such as an unpainted metal surface) to prevent against ESD damage

7.3 Rear Communications Port

EIA(RS)485 signal levels, two wire

Connections located on the general-purpose terminal block

Isolation to SELV level

For screened twisted pair cable, distance to be bridged: multi-endpoint link: max. 100 m, with a maximum 200nF total cable capacitance. A typical cable specification would be:

- A two core screened cable, each core: 16/0.2mm copper conductors; PVC insulated
- Nominal conductor area: 0.5mm^2 per core
- Screen: Overall braid, PVC sheathed
- Linear capacitance between conductor and earth: 100pF/m

It is strongly recommended to use termination resistors for any length of RS485 line (even for short line).

If the network cable is close to a source of disturbances or too long, undesirable transmission line effects could arise. The best method for mitigating energy on transmission conductor is to dissipate the energy as heat by terminating resistors.

The resistance of the resistors should be equal to the characteristic impedance of the line. The most common RS485 twisted pair has a characteristic impedance of 100-120 ohms.

Termination resistor should be connected between two transmission lines ("TR+" and "TR-") and installed on both side of RS485 line: on the beginning (RTU) and on the end (the most distant point).

The screen of RS485 line must be earthed in a one point only: on the beginning (RTU) or on the end of RS485 line, due to noise which can be caused by a potential current flowing between two (or more) earthing points of the screen.

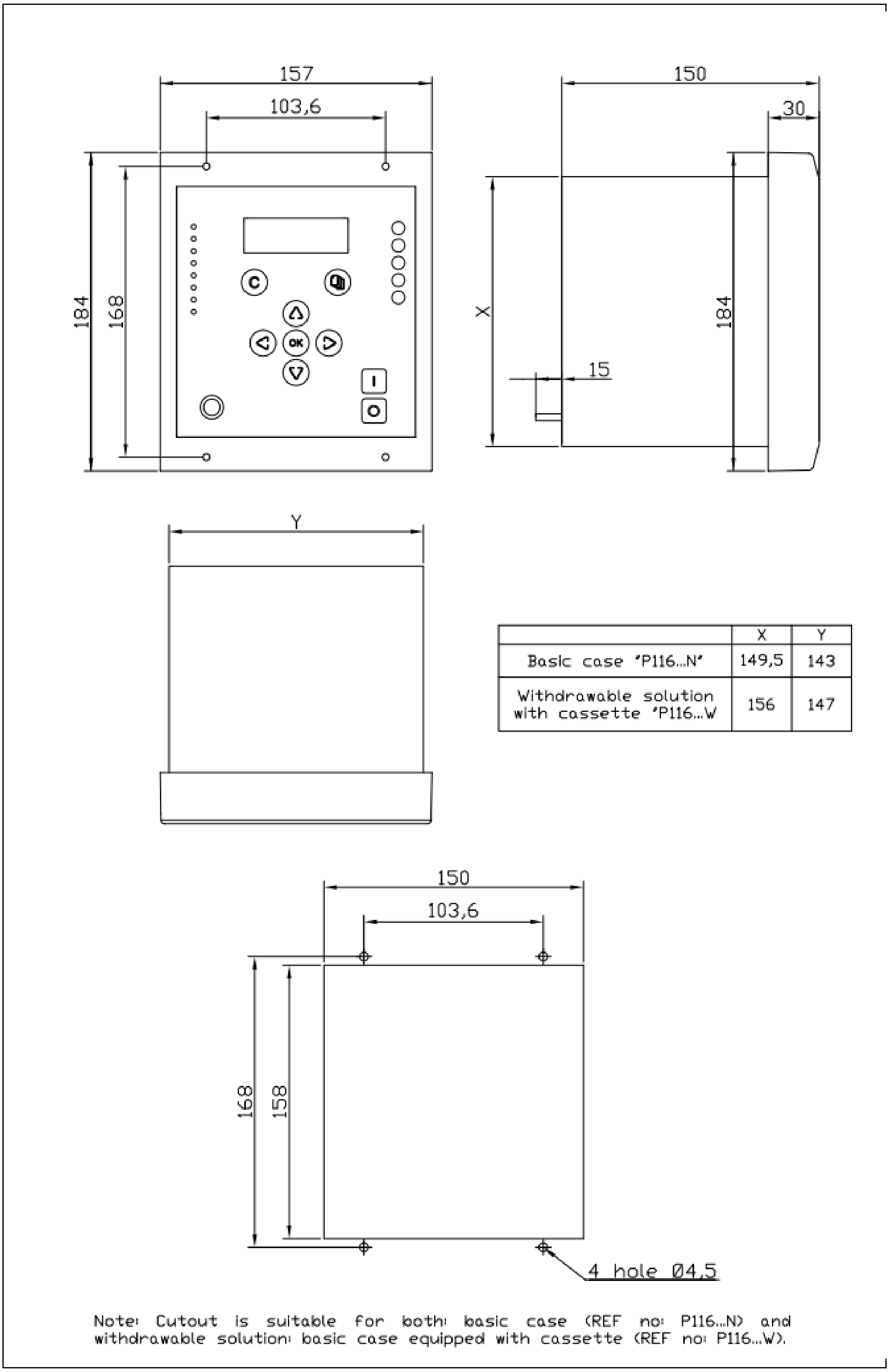
7.4 Protective Conductor (Earthing)

The equipment must be connected to the protective conductor  via the M4 earth terminal (refer point 6.) marked with the earth symbol. We recommend a wire of minimal cross section of 2,5 mm².

To prevent any electrolytic risk between copper conductor or brass conductors and the back plate of the equipment, it is necessary to take precautions to isolate them one from the other. This can be done in several ways, for example by inserting between the conductor and the case a plated nickel washer or by using tinned terminations.

8. P116 CASE DIMENSIONS

8.1 Flush version with/without Cassette



	X	Y
Basic case 'P116...N'	149,5	143
Withdrawable solution with cassette 'P116...W	156	147

Figure 1: Dimensions: P116 flush mounting case – basic and withdrawable solution with cassette

8.2 Wall version with Adapter

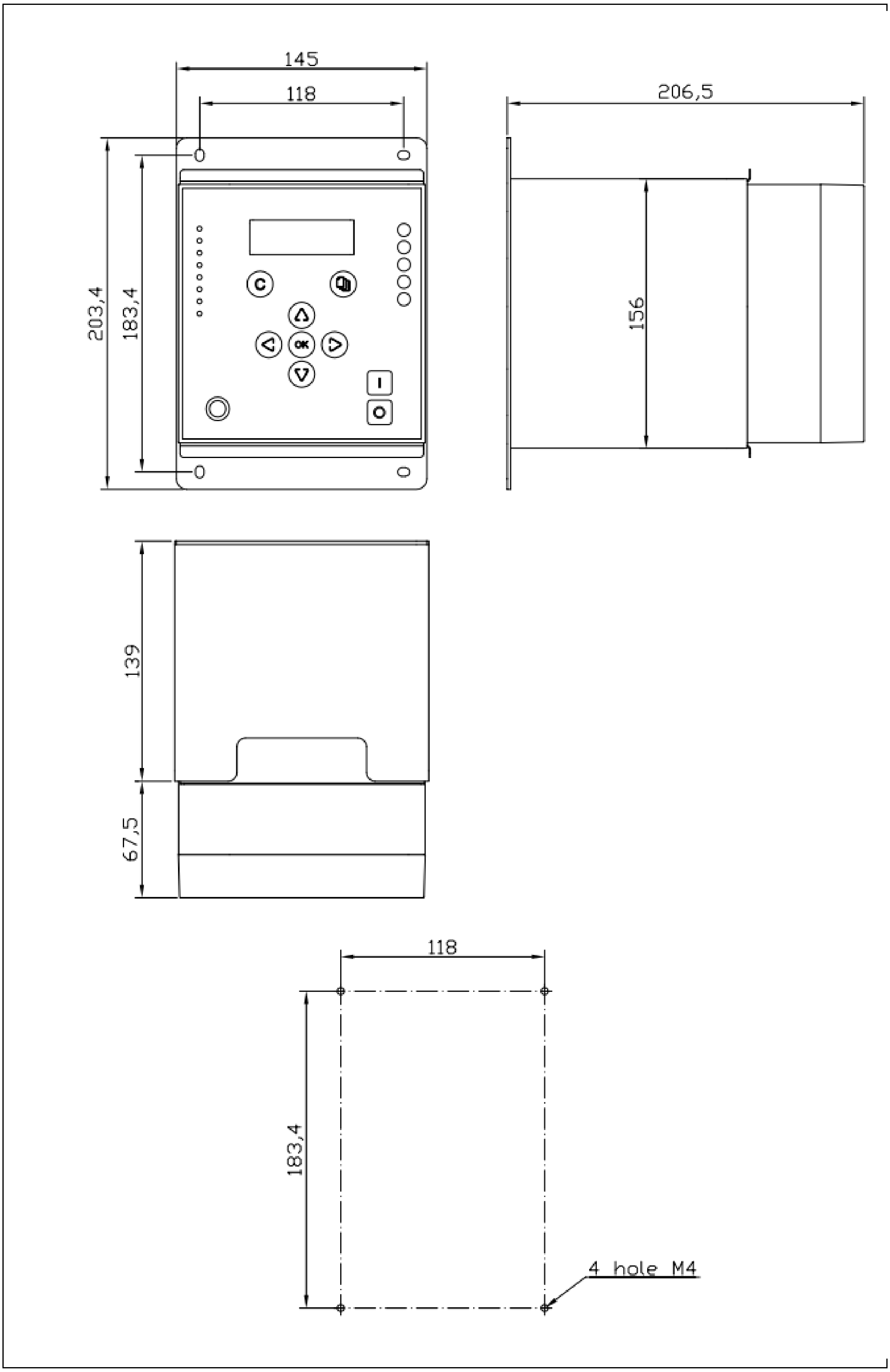


Figure 2: Dimensions: P116 wall mounting basic case

9. EXTERNAL CONNECTION DIAGRAMS

Note: The current leads should be connected exactly as shown in Figures: 3 to 6.

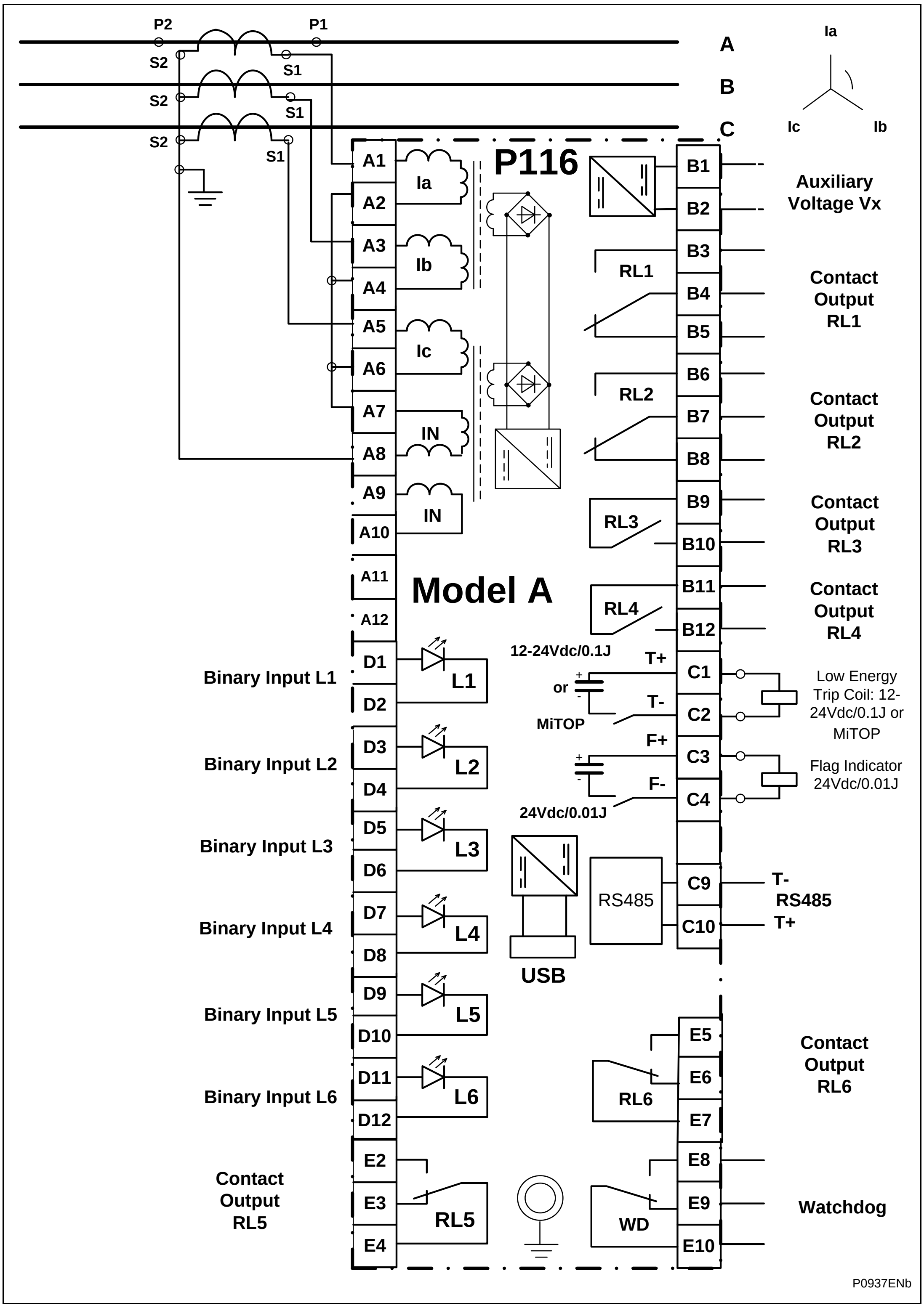


Figure 3: Model A - Typical Connection to 3 Phase CTs

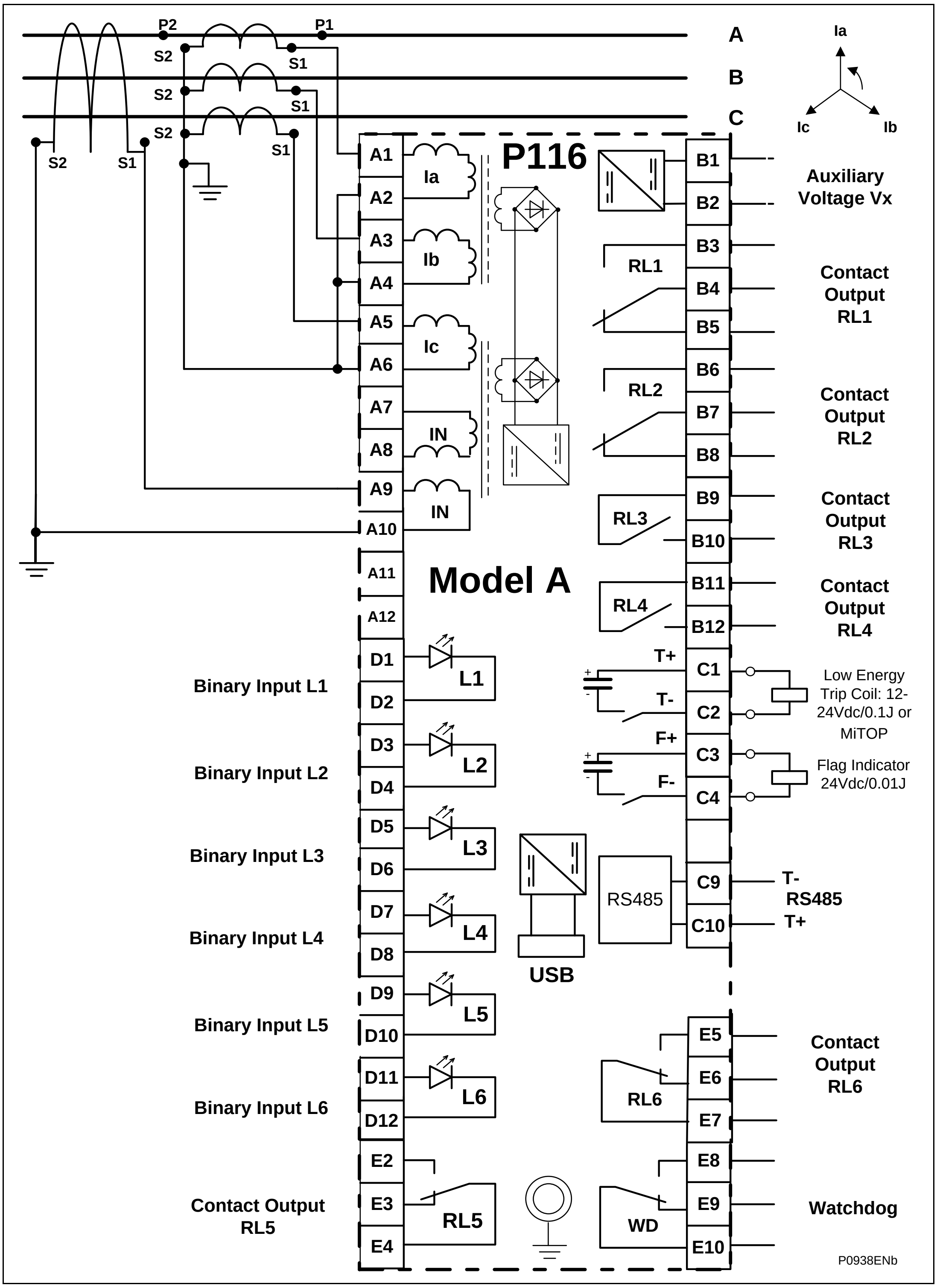


Figure 4: Model A - Typical Connection to 3 Phase CTs + a Core Balance CT

The P116 Model A is not supplied via a core balance CT.
An auxiliary voltage source should be connected to terminals B1-B2 in order to ensure that the P116 is supplied for earth fault currents below 0.2 In. Refer to Application chapter: P116/EN AP.

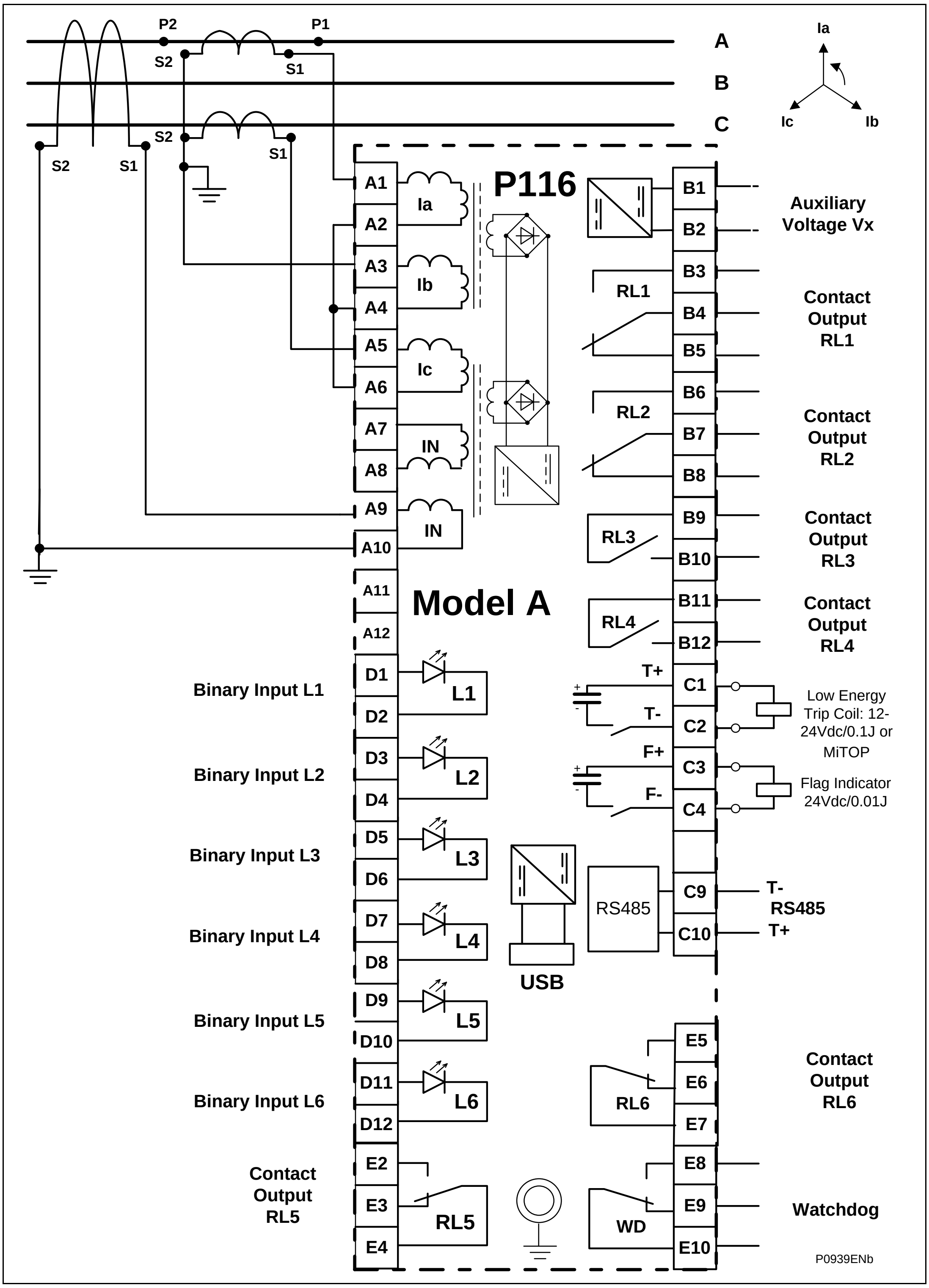


Figure 5: Model A - Typical Connection to 2 Phase CTs + a Core Balance CT

The P116 is not supplied via a core balance CT.
An auxiliary voltage source should be connected to terminals B1-B2 in order to ensure that the P116 is supplied for earth fault currents below 0.2 In.
Refer to Application chapter: P116/EN AP.

IN

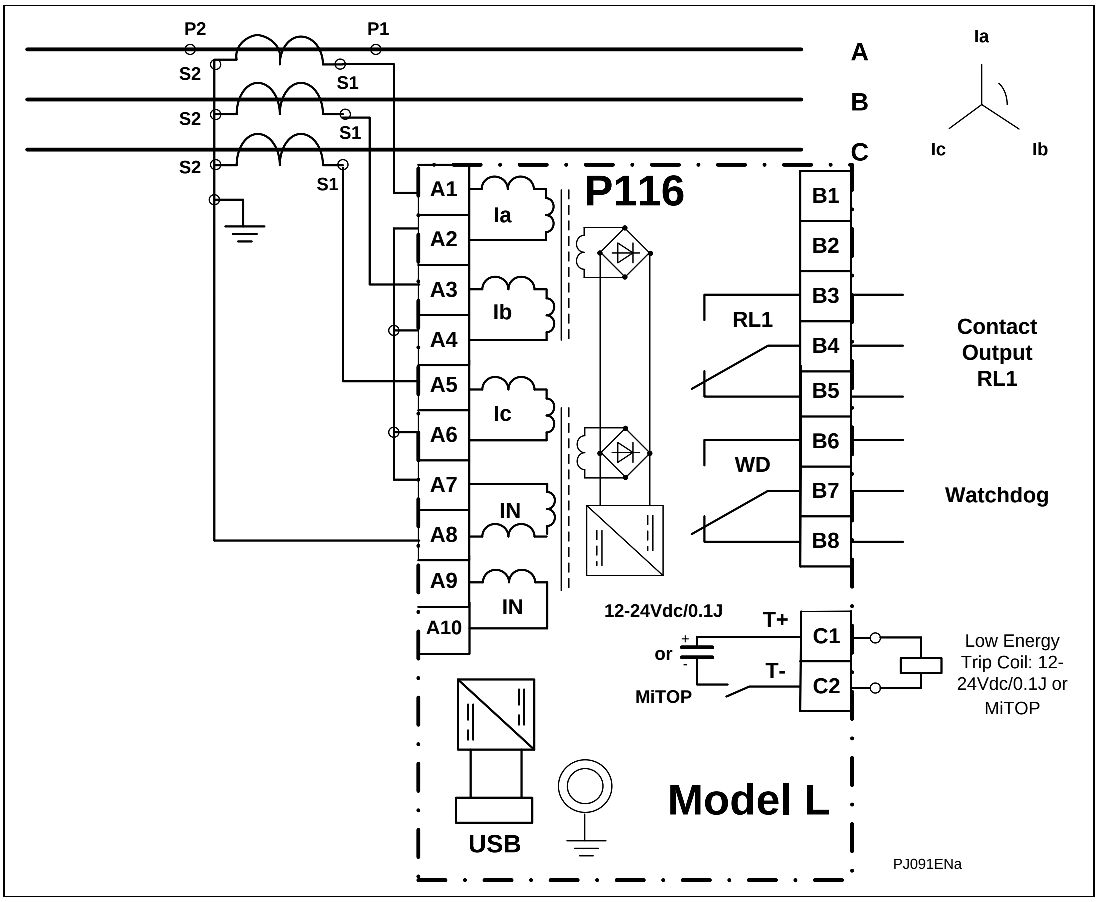


Figure 6: Model L - Typical Connection to 3 Phase CTs

10. APPLICATION CONNECTION DIAGRAMS

10.1 Tripping CB using energy provided by an external capacitor unit

Connecting an E124 Capacitor Trip Unit

The MiCOM E124 capacitor trip unit is an auxiliary device typically used to provide energy to the trip coil of a circuit breaker in distribution systems. The trip unit can be used in all cases where a battery and charger would otherwise be necessary to trip the circuit breaker. Such is the case in substations where there is no auxiliary supply, and where protection relays draw their auxiliary power from current and voltage transformer circuits. The easiest way to store the energy for trip coils is in a capacitor trip unit.

Serially connected with a protection relay, it will release its full energy (300V / 59J) to the trip coil upon closure of the relay's trip contact.

E124 auxiliary supply: 48-230Vac or 48-250Vdc.

E124 key features:

- Extended autonomy (over 8 days without recharge)
- - Two independent capacitor banks, monitored by a microprocessor to guarantee two consecutive trips at maximum power (300V / 59J) without recharge
- Connection in parallel possible to control the trip coil if it requires more than 59J.
- Available output power: 118J (2*59J)
- Output impedance (per capacitor bank): 10 Ohms
- Capacitance: two capacitor banks of 1320 µF each
- Power consumption to charge the capacitors (under 100V): <5 VA or 2.5W
- Power consumption when the capacitors are charged (under 100V): <1.5 VA or 0.25 W

Note: The current leads should be connected exactly as shown in Figures 7 to 8.

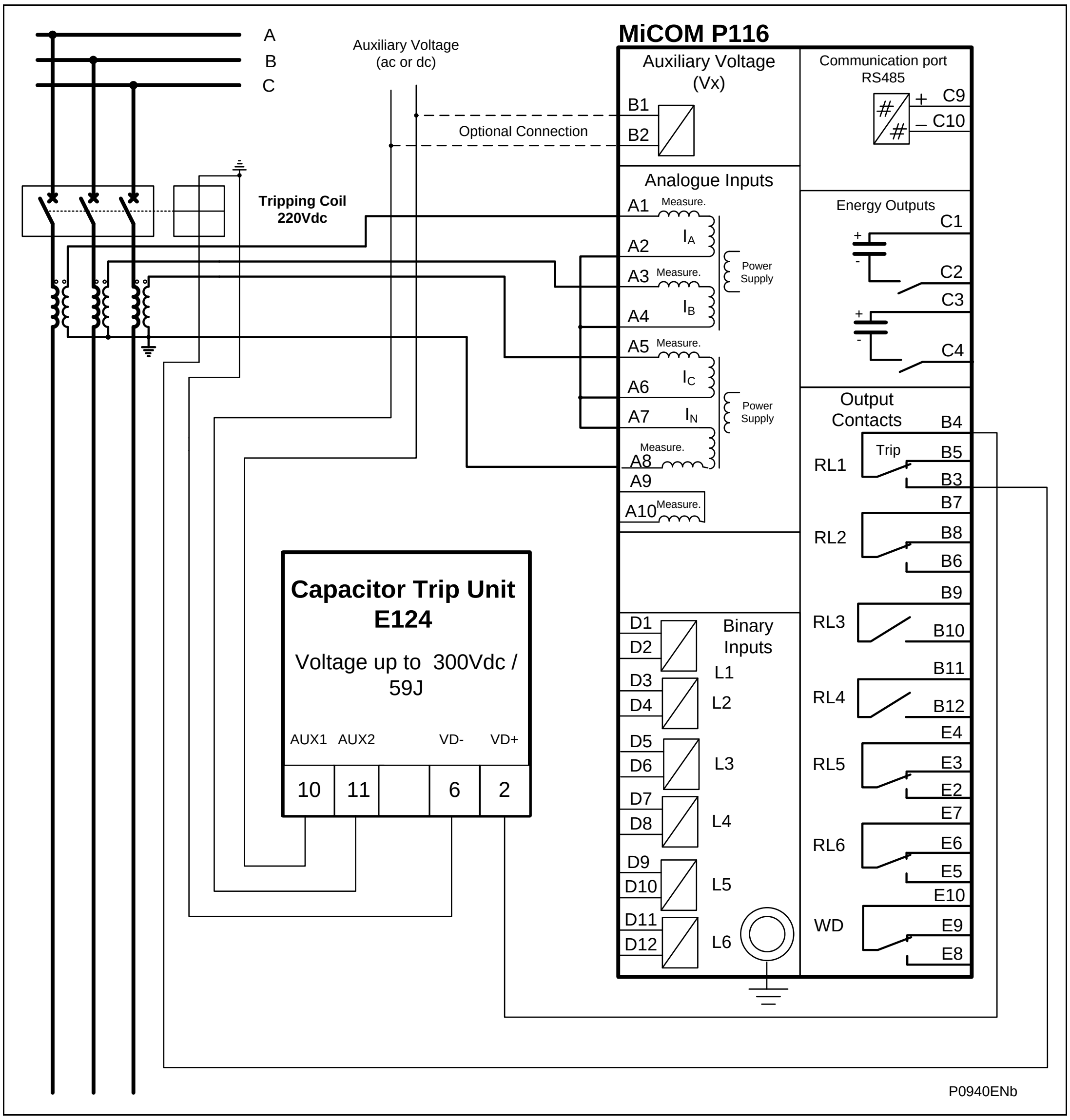


Figure 7: Model A - Connection example for a P116 powered by an E124 and with a 4-pole connection (A-B-C-N)

The earth input supplies the relay (refer to Application chapter: P116/EN AP).

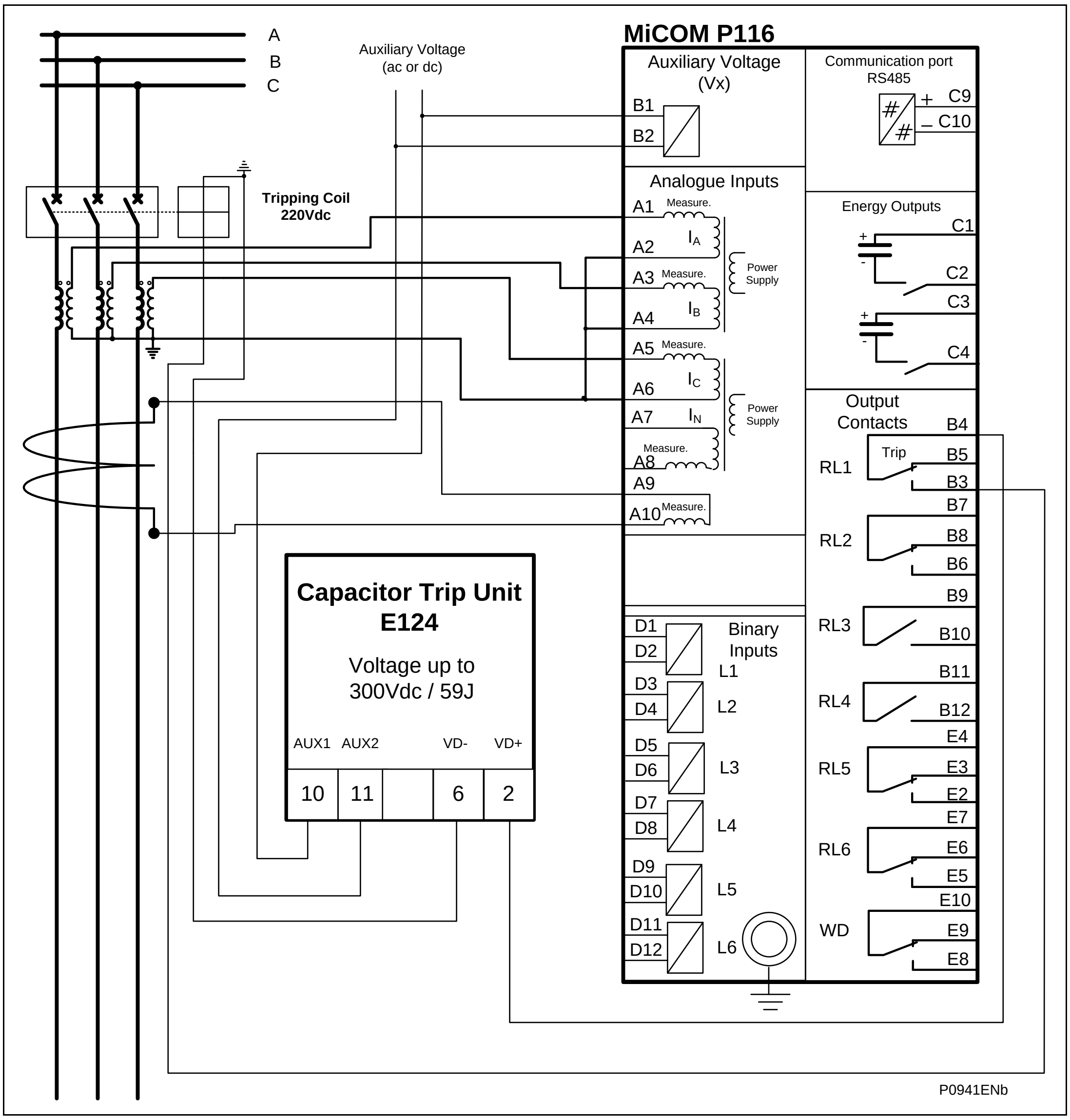


Figure 8: Model A - Connection example for a P116 powered by an E124 and with a 4-pole connection (A-B-C-N)

The P116 is not supplied via the earth input.
(refer to Application chapter: P116/EN AP).

10.2 The CB using energy from a tripping transformer

Design of the Main Current Transformers

The main current transformer load is composed essentially of the P116's power consumption, the consumption of the supply conductors wiring, and, in the event of transformer current tripping, the consumption of the tripping transformer that is normally short-circuited on the secondary side. In the event of transformer current tripping the maximum load occurs during closing of the tripping device. The CT requirements of the P116 are given in the technical data chapter. When selecting the main current transformers one should keep in mind that the impedances of the protection device and of the tripping transformer decrease when the current increases, due to saturation. The current transformers rating matching the overcurrent factor and the short-circuit withstand capability can be based on the corresponding low loads. These main current transformers can be considerably overburdened in the nominal current range even when the fault does not exceed the accuracy class rating. Typically, main current transformers having a nominal power rating of 15 VA 10 P10 or 30 VA10 P5 should be provided, but in any case, the required parameters of the main current transformers must be defined as a result of calculation analysis (refer to Application chapter: P116/EN AP).

Connecting the Tripping Transformers

The measured variable is fed into the P116 through the primary winding of the tripping transformer, WA 25 O. During fault-free operation the secondary side of the tripping transformer is short-circuited via one of the P115's contacts. In the event of a trip the contact opens and the circuit breaker is actuated (see Figures 9 to 11).

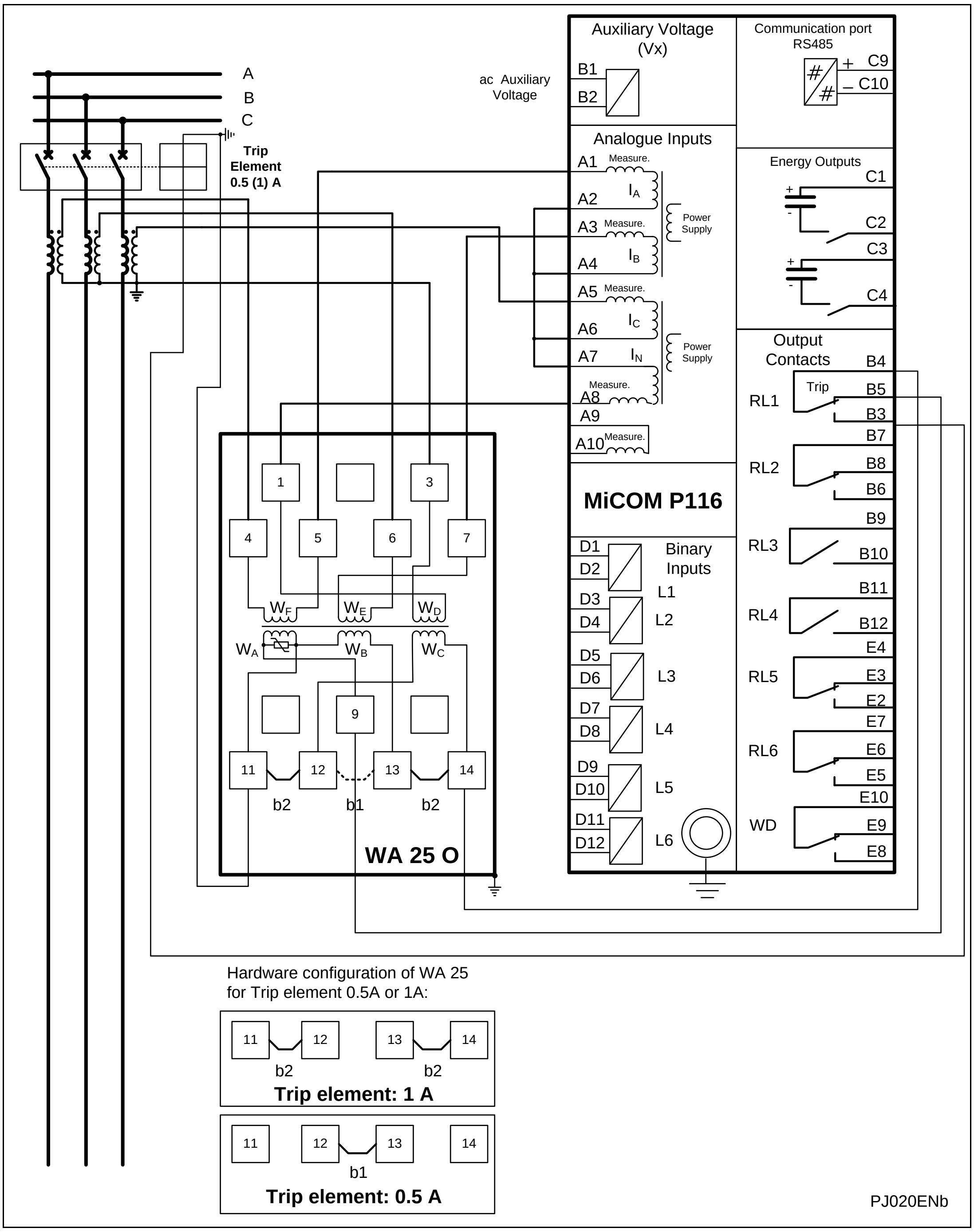


Figure 9: Model A - Connection example for a P116 powered by a WA 25 O and with a 4-pole connection (A-B-C-N)

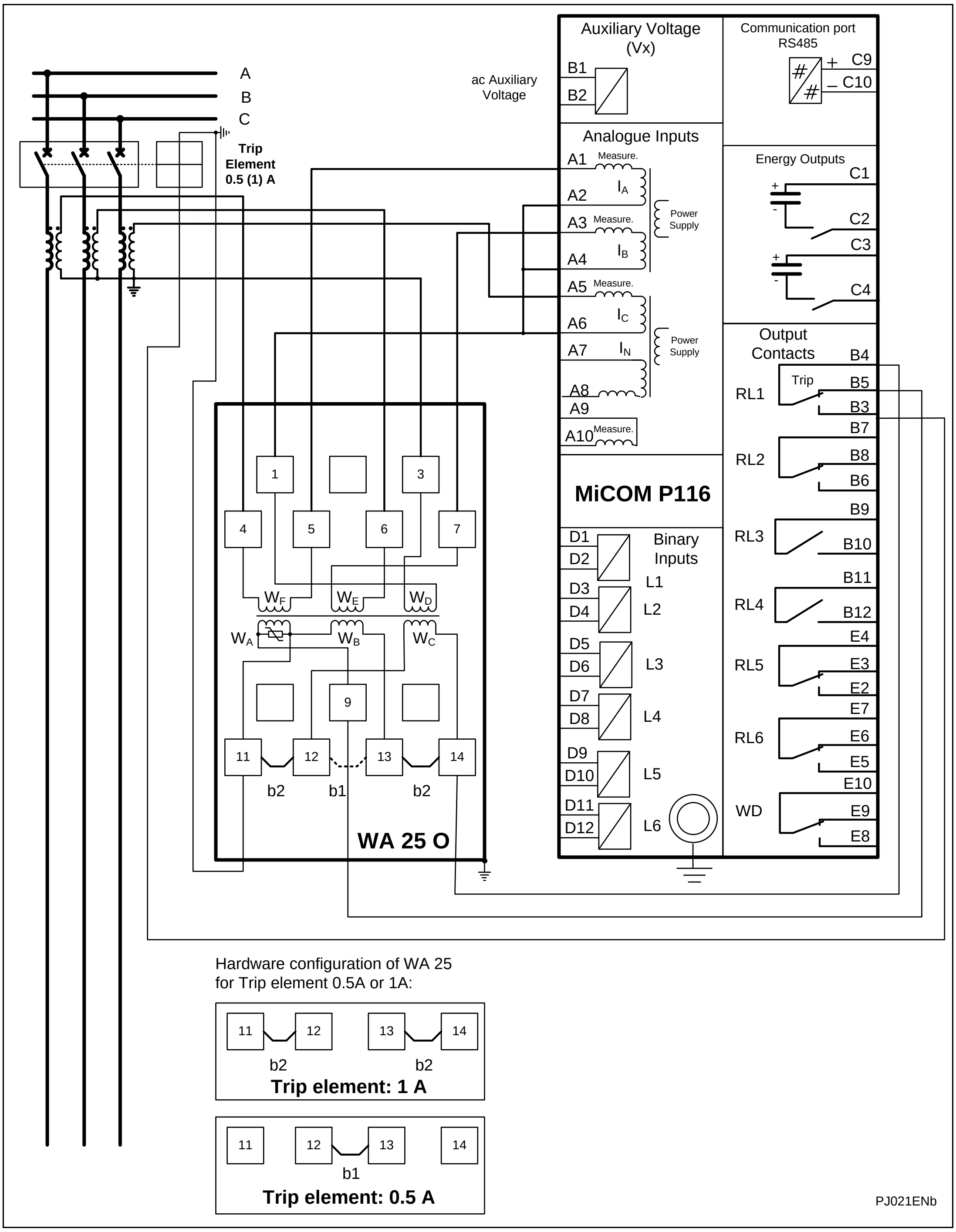


Figure 10: Model A - Connection example for a P116 powered by a WA 25 O and with a 3-pole connection (A-B-C)

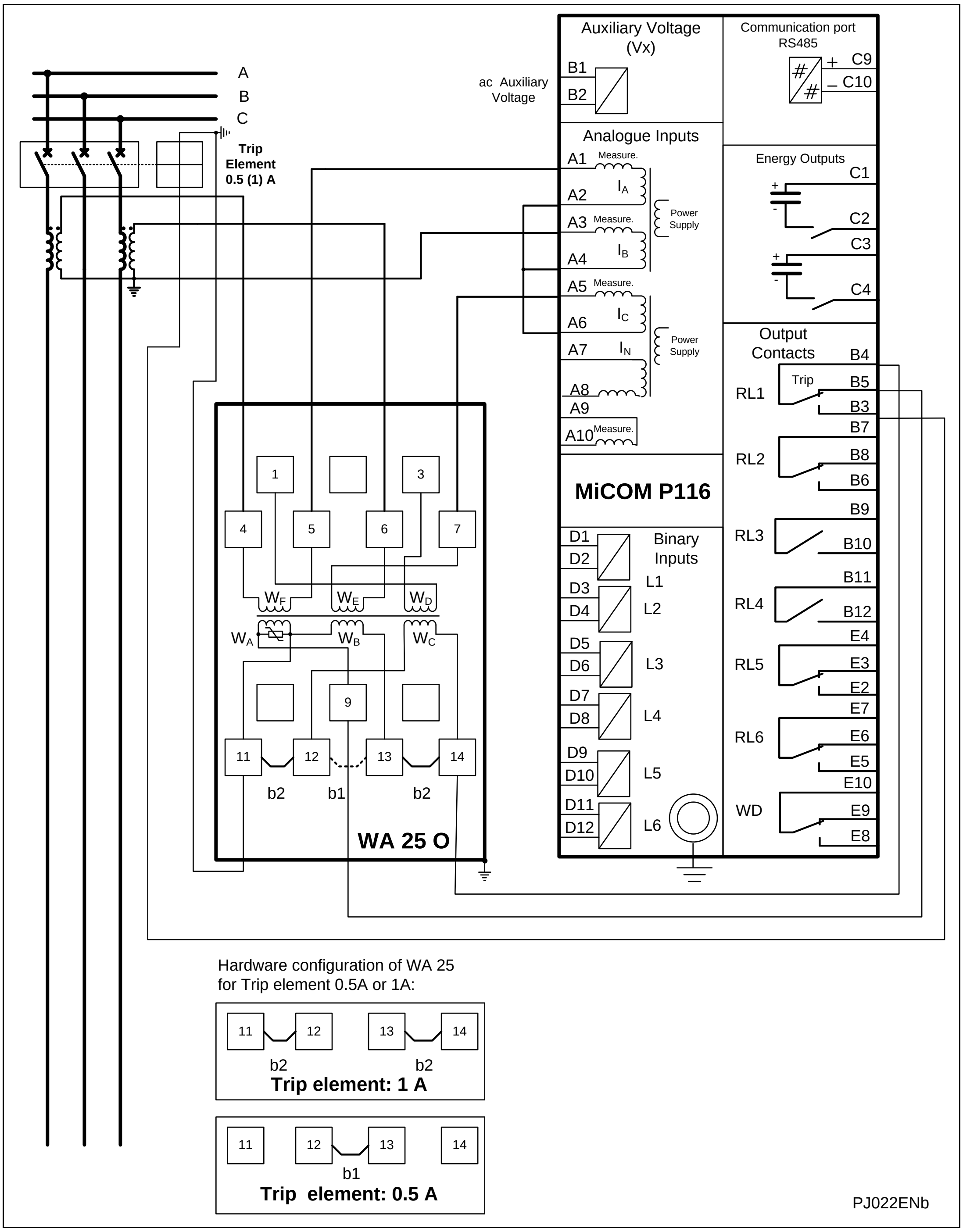


Figure 11: Model A - Connection example for a P116 powered by a WA 25 O and with a 2-pole connection (A-C)

IN

COMMUNICATION DATABASE

(P116 Model A)

CT

Date:	**17th November 2013**
Hardware Suffix:	**A**
Software Version:	**1C**
Connection Diagrams:	**10P11602**

CONTENT

1. INTRODUCTION

1.1 Purpose of this document

This document describes the characteristics of the different communication protocol of MiCOM P116 relay.

The available communication protocols of MiCOM P116 relay are as follows:

- MODBUS.
- IEC 60870-5-103.

1.2 Glossary

IA, IB, IC : currents measured on the concerned phases (A, B, C)

IN : residual current measured by earth input (= 3.I zero sequence)

pf : soft weight of a word of 16 bits

PF : heavy weight of a word of 16 bits.

2. MODBUS PROTOCOL

MiCOM P116 relay can communicate by a RS 485 link behind the unit following the MODBUS MODICON RTU protocol.

2.1 Technical characteristics of the MODBUS connection

2.1.1 Parameters of the MODBUS connection

The different parameters of the MODBUS connection are as follows :

- Isolated two-point RS485 connection (2kV 50Hz),
- MODBUS MODICON line protocol in RTU mode
- Communication speed can be configured by an operator dialog in the front panel of the relay :

Baud rate
4800
9600
38400
57600
115200

Transmission mode of the configured characters by operator dialog:

Mode
1 start / 8 bits / 1 stop : total 10 bits
1 start / 8 bits / even parity / 1 stop : total 11 bits
1 start / 8 bits / odd parity / 1 stop : total 11 bits
1 start / 8 bits / 2 stop : total 11 bits

2.1.2 Synchronisation of exchanges messages

All character received after a silence on the line with more or equal to a transmission time of 3 characters is considered as a firm start.

2.1.3 Message validity check

The frame validity is working with a cyclical redundancy code CRC with 16 bits. The generator polynomial is:

$1 + x^2 + x^{15} + x^{16}$ = 1010 0000 0000 0001 binary = A001h

Address of the MiCOM relays

The address of the MiCOM relay on a same MODBUS network is situated between 1 and 255. The address 0 is reserved for the broadcast messages

2.2 MODBUS functions of the MiCOM relays

The MODBUS functions implemented on the MiCOM relays are :

Function 3 or 4 : Reading of n words

Function 5 : Writing of 1 bit

Function 6 : Writing of 1 word

Function 7 : Fast reading of 8 bits

Function 16 : Writing of n words

2.3 Presentation of the MODBUS protocol

Master slave protocol, all exchange understands a master query and a slave response

Frame size received from MiCOM P116 Dual-powered relay

Frame transmitted by the master (query) :

Slave number	Function code	Information	CRC1 6
1 byte	1 byte	n bytes	2 bytes
0 à FFh	1 à 10h		

Slave number:

The slave number is situated between 1 and 255.

A frame transmitted with a slave number 0 is globally addressed to all pieces of equipment (broadcast frame)

Function code:

Requested MODBUS function (1 to 16)

Information:

Contains the parameters of the selected function.

CRC16:

Value of the CRC16 calculated by the master.

Note: The MiCOM relay does not respond to globally broadcast frames sent out by the master.

2.3.1 Format of frames sent by the MiCOM relay

Frame sent by the MiCOM relay (response)

Slave number	Function code	Data	CRC16
1 byte	1 byte	n bytes	2 bytes
1 à FFh	1 à 10h		

Slave number :

The slave number is situated between 1 and 255.

Function code :

Processed MODBUS function (1 to 16) .

<u>Data :</u>

Contains reply data to master query .

<u>CRC 16:</u>

Value of the CRC 16 calculated by the slave.

2.3.2 Messages validity check

When MiCOM P116 relay receive a master query, it validates the frame :

- If the CRC is false, the frame is invalid. MiCOM P116 relay do not reply to the query. The master must retransmit its query. Excepting a broadcast message, this is the only case of non-reply by MiCOM P116 relay to a master query.
- If the CRC is good but the MiCOM relay can not process the query, it sends an exception response.

<u>Warning frame sent by the MiCOM relay (response)</u>

Slave number	Function code	Warning code	CRC16
1 byte	1 byte	1 byte	2 bytes
1 to FFh	81h or 83h or 8Ah or 8Bh		pf ... PF

<u>Slave number :</u>

The slave number is situated between 1 and 255.

<u>Function code :</u>

The function code returned by the MiCOM relay in the warning frame is the code in which the most significant bit (b7) is forced to 1.

<u>Warning code :</u>

On the 8 warning codes of the MODBUS protocol, the MiCOM relay manages two of them :

- code 01 : function code unauthorised or unknown.
- code 03 : a value in the data field is unauthorised (incorrect data).

Control of pages being read

Control of pages being written

Control of addresses in pages

Length of request messages

<u>CRC16:</u>

Value of the CRC16 calculated by the slave.

2.4 MiCOM P116 Dual-powered relay database organisation

2.4.1 Description of the application mapping

2.4.1.1 Settings

MiCOM P116 application mapping has 9 pages of parameters.

Page 0h: Product information, remote signalling, measurements

Page 1h: General remote parameters

Page 2h: Setting group 1 remote parameters

Page 3h: Setting group 2 remote parameters

Page 4h: Remote controls

Pages 5h/6h: Reserved pages

Pages 7h: Quick reading byte

Pages 8h: Time synchronisation

2.4.1.2 Disturbance Records

Before uploading any disturbance record, a service request must be send to select the record number to be uploaded.

The answer following this request contain the following information:

- Numbers of samples (pre and post time)
- Phase CT ratio
- Earth CT ratio
- Internal phase and earth ratios
- Number of the last disturbance mapping page
- Number of samples in this last disturbance mapping page

The mapping pages used for this service request are from 38h to 3Ch.

Pages 9h to 21h : Contain the disturbance data (25 pages)

A disturbance mapping page contains 250 words:

0900 to 09FAh : 250 disturbance data words
0A00 to 0AFAh : 250 disturbance data words
0B00 to 0BFAh : 250 disturbance data words

......
2100 to 21FAh : 250 disturbance data words

The disturbance data pages contain the sample of a single channel from a record.

Page 22h : contains the index of the disturbance

Page 38h to 3Ch : Selection of the disturbance record and channel

Page 3Dh : A dedicated request allows to know the number of disturbance records stored in FRAM memory.

2.4.1.3 Event records

To upload the event records two requests are allowed:

Page 35h: Request to upload an event record without acknowledge of this event.

Used addresses:

3500h : EVENT 1

.....
3563h : EVENT 100

Page 36h: Request to upload the non-acknowledged oldest stored event record.

Two modes are available for the acknowledgement: automatic acknowledgement or manual acknowledgement

The mode depends of the state of bit 12 of telecommand word (address 400 h).

If this bit is set, then the acknowledgement is manual else the acknowledgement is automatic.

In automatic mode, the reading of the event acknowledges the event.

In manual mode, it is necessary to write a specific command to acknowledge the oldest event

(set the bit 13 of control word 400 h)

2.4.1.4 Fault records

Page 37h: Page dedicated to upload fault record

Used addresses:

3700h : FAULT 1
3701h : FAULT 2

.....
3704h : FAULT 5

Page 3Eh: Request to upload the non-acknowledged oldest stored fault record.

Two modes are available for the acknowledgement: automatic acknowledgement or manual acknowledgement

The mode depends of the state of bit 12 of telecommand word (address 400 h).

If this bit is set, then the acknowledgement is manual else the acknowledgement is automatic.

In automatic mode, the reading of the fault acknowledges automatically the event.

In manual mode, it is necessary to write a specific command to acknowledge the oldest fault.

(set the bit 14 of control word 400 h)

2.4.1.5 Characteristics

Page 0h can only be read through communication.

Pages 1h, 2h, 3h and 4h can be read and write.

Page 7h can be access in quick reading only.

Page 8h can be write.

They are describe more precisely in the following chapters.

2.4.2 Page 0h : Product information, remote signalling, measurements

Read access only

Address	Group	Description	Values range	Step	Unit	Format	Default Value
0000	Product Information	Relay description characters 1 and 2	32-127	1	-	F10	P1
0001		Relay description characters 3 and 4	32-127	1	-	F10	16
0002		Relay description characters 5 and 6	32-127	1	-	F10	
0003		Unit reference characters 1 and 2	32-127	1	-	F10	SE
0004		Unit reference characters 3 and 4	32-127	1	-	F10	
0005		Software Version	10 to 99		-	F15	
0006		Hardware Version	0 to 3		-	F17	
0007		Line CT Sec	0 to 1		-	F23	
0008		E/Gnd CT Sec	0 to 1		-	F23A	
0009		Active Set Group	0 to 1		-	F32	0
000A		Nominal frequency	0 to 1	1	-	F57	0
000B		Special (DC) Inputs hardware board	0 to 1	1	-	F68	1
000C		4 Additional Flags Installed	0 to 1	1	-	F68	1
000D-000F		Reserved			-		
0010	Remote signalling	Logical inputs	0 to 15	1	bits	F11	
0011		Current Protection disable status (1)	0 to 15	1	bits	F12	
0012		Protection Function disable status (2)	0 to 15	1	bits	F12A	
0013		Output contacts status	0 to 15	1	bits	F24	
0014		Logical LEDs status	0 to 15	1	bits	F25	
0015		Output information: Current Protection starting status (1)	0 to 15	1	bits	F28	
0016		Output information: Protection Function starting status (2)	0 to 15	1	bits	F28A	
0017		Output information: Currrent Protection trip status (1)	0 to 15	1	bits	F29	
0018		Output information: Protection Function trip status (2)	0 to 15	1	bits	F29A	
0019		Output information: Currrent Protection Alarm status 1	0 to 15	1	bits	F31	
001A		Output information: Protection Function Alarm status 2	0 to 15	1	bits	F31A	
001B		CB status	0 to 15	1	-	F30	
001C		[79] Status	0 to 15	1	-	F59	
001D		[79] Blocking Status	0 to 15	1	-	F60	

Address	Group	Description	Values range	Step	Unit	Format	Default Value
001E		Local/Romote Mode Status	0 to 15	1	-	F61	
001F		Maintance Mode	0 to 15	1	-	F63	
0020		Hardware Warning	0 to 15	1	-	F26	
0021		Output information: I>	0 to 15	1	bits	F37	
0022		Output information: I>>	0 to 15	1	bits	F37	
0023		Output information: I>>>	0 to 15	1	bits	F37	
0024		Output information: IN_1 stage	0 to 15	1	bits	F50	
0025		Output information: IN_2 stage	0 to 15	1	bits	F50	
0026		Output information: IN_3 stage	0 to 15	1	bits	F50	
0027		Output information: AUX1	0 to 15	1	bits	F51	
0028		Output information: AUX2	0 to 15	1	bits	F51	
0029		Output information: CB Fail	0 to 15	1	bits	F51	
002A		Output information: tCB ext. sign	0 to 15	1	bits	F51	
002B		Output information: SOTF	0 to 15	1	bits	F37	
002C		Output information: I<	0 to 15	1	bits	F50	
002D		Output information: I2>	0 to 15	1	bits	F50	
002E		Output information: Brkn.Cond	0 to 15	1	bits	F50	
002F		Output information: Thermal OL	0 to 15	1	bits	F50	
0030		Output information: AUX3	0 to 15	1	bits	F51	
0031		Output information: AUX4	0 to 15	1	bits	F51	
0032		Output information: Input Protection blocking 1	0 to 15	1	bits	F101	
0033		Output information: Input Protection blocking 2	0 to 15	1	bits	F102	
0034		Output information: Input Selective logic 1	0 to 15	1	bits	F103	
0035		Output information: Input logic data	0 to 15	1	bits	F104	
0036		Output information: Internal logic data	0 to 15	1	bits	F105	
0037 to 003F		Reserved					
0040	Remote measurements	Phase IA (L1) current [A]	0 to 60 000	1	[A]/100	F1	
0041		Phase IB (L2) current [A]	0 to 60 000	1	[A]/100	F1	
0042		Phase IC (L3) current [A]	0 to 60 000	1	[A]/100	F1	
0043		E/GND IN (IE) current [A] - 0.1-40Ien - 0.01-8Ien - 0.002-1Ien	0 to 60 000	1	 [A] x100 [A] x1000 [A] x1000	F1	
0044		I2 (negative sequence) current [A]	0 to 60 000		[A] x 100	F1	
0044		I1 (positive sequence) current	0 to 60 000		[A] x 100	F1	

CT

Address	Group	Description	Values range	Step	Unit	Format	Default Value
		[A]					
0045-004F		Reserved					
0050		Phase IA (L1) current [In]	0 to 60 000		[In]	F1	
0051		Phase IB (L2) current [In]	0 to 60 000	1	[In]	F1	
0052		Phase IC (L3) current [In]	0 to 60 000	1	[In]	F1	
0053		E/F current [Ien]	0 to 60 000	1	[Ien]	F1	
0054		I2 (negative sequence) current [In]	0 to 60 000	1	[In]	F1	
0055		I1 (positive sequence) current [In]	0 to 60 000	1	[In]	F1	
0056-005F		Reserved					
0060		I2/I1 current [%]	0 to 100	1	[%]	F1	
0061		Thermal Overload [%]	0 to 300	1	[%]	F1	
0062		2th harmonic [%] Phase A	0 to 100	1	[%]	F1	
0063		2th harmonic [%] Phase B	0 to 100	1	[%]	F1	
0064		2th harmonic [%] Phase C	0 to 100	1	[%]	F1	
0066-007F		Reserved					
0080		Max IA [In]	0 to 60 000	1	[In]	F1	
0081		Max IB [In]	0 to 60 000	1	[In]	F1	
0082		Max IC [In]	0 to 60 000	1	[In]	F1	
0083		Average IA [In]	0 to 60 000	1	[In]	F1	
0084		Average IB [In]	0 to 60 000	1	[In]	F1	
0085		Average IC [In]	0 to 60 000	1	[In]	F1	
0086		Max IA [A]	0 to 60 000	1	[A]x100	F1	
0087		Max IB [A]	0 to 60 000	1	[A]x100	F1	
0088		Max IC [A]	0 to 60 000	1	[A]x100	F1	
0089		Average IA [A]	0 to 60 000	1	[A]x100	F1	
008A		Average IB [A]	0 to 60 000	1	[A]x100	F1	
008B		Average IC [A]	0 to 60 000	1	[A]x100	F1	
008C-00FF		Reserved					

2.4.3 Page 1h, MiCOM P116 : general remote parameters

Read and write access

Address	Group	Description	Values range	Step	Unit	Format	Default Value
0100	Remote parameters	Address	1 to 254	1	-	F1	254
0101		Protocol for RS485	0 to 1	1		F56	1
0102		Baud Rate	0 to 5	1		F19	2
0103		Parity	0 to 2	1		F20	0
0104		Stop bits	0 to 1	1		F22	0
0105-010F		Reserved					
0110	Counters	Trips Number	0 to 65535	1	-	F1	0
0111		Close Number	0 to 65535	1	-	F1	0
0112		Fault Trips Number	0 to 65535	1	-	F1	0
0113		Fault Start Number	0 to 65535	1	-	F1	0
0114		Alarm Number	0 to 65535	1	-	F1	0
0115		HW Warnings Number	0 to 65535	1	-	F1	0
0116		79 Action Total	0 to 65535	1	-	F1	0
0117		79 Total Trips&Lockout	0 to 65535	1	-	F1	0
0118		79 Successful Number	0 to 65535	1	-	F1	0
0119		79 Cycle 1 Recloses	0 to 65535	1	-	F1	0
011A		79 Cycle 2 Recloses	0 to 65535	1	-	F1	0
011B		79 Cycle 3 Recloses	0 to 65535	1	-	F1	0
011C		79 Cycle 4 Recloses	0 to 65535	1	-	F1	0
011D		CB close Monitoring	0 to 65535	1	-	F1	0
011E		CB open Monitoring	0 to 65535	1	-	F1	0
011F		CB AMPS Value	0 to 65535	1	-	F1	0
0116-011F		Reserved					
0120	CT Ratio	Line CT primary	1 to 30000	1	A	F1	
0121		Reserved					
0122		E/Gnd CT Primary	1 to 30000	1	A	F1	
0123		Reserved					
0124		IN connection	0 to 1	0	-	F93	0
0125-012F		Reserved					
0130	Blocking Inrush	Inrush Blocking ?	0 to 2	1	-	F74	0
0131		2nd Harmonic Ratio	10 to 50	1	%	F1	20
0132		Inrush Reset Time	0 to 20000	1	1/100 s	F1	100
0133		Unblock Inrush Time	0 to 20000	1	1/100 s	F1	100
0134-013F		Reserved					
0137	**O/C Advanced Settings**	**I< stage for Broken Conductor**	**10 to 100**	**1**	[In]/100	F1	10

Address	Group	Description	Values range	Step	Unit	Format	Default Value
0138		IDMT interlock by DMT stage	0 to 1	1	-	F88	0
GLOBAL SETTINGS							
0140	LOC	Language	0 to 5	1	-	F52	0
0141		Default display	0 to 2	1	-	F53	0
0142		LEDs Reset by	0 to 1	1	-	F54	0
0143		Ltchd Outp Reset	0 to 1	1	-	F54	0
0144		Trip Info Reset	0 to 1	1	-	F54	0
0145		Alarm Display Reset	0 to 1	1	-	F55	0
0146		Nominal frequency	0 to 1	1	-	F57	0
0147		Control Keys Confirmation	0 to 1	1	-	F82	0
0148		Reserved					
0149		Hardware Warning Mode	0 to 1	1	-	F78	0
014A-014F		Reserved					
0150	SETTING GROUP SELECT	Number of Setting Groups	0 to 1	1	-	F71	0
0151		Setting group change	0 to 1	1	-	F32	0
0152		t Change Setting G1->G2	0 to 20000	1	1/100 s	F1	0
0153-015F		Reserved					
0160	[79] ADVANCED SETTINGS	[79] CB Healthy Monit?	0 to 1	1	-	F63	
0161		[79] Block via Input ?	0 to 1	1	-	F63	0
0162		[79] Start Dead t On	0 to 1	1	-	F64	1
0163		Rolling Demand?	0 to 1	1	-	F63	0
0164		Max cycles Nb Rol.Demand	2 to 100	1	-	F1	2
0165		Time Period Rol.Demand	1 to 1410	1	mn	F1	
0166		[79] Time Inhibit on Close	1 to 60000	1	1/100 s	F1	100
0167		[79] Reset Signaling on Close	0 to 1	1	-	F106	0
0168-016F		Reserved					
0170	COMMUNICATION ORDERS	Pulse Time tCOM1	1 to 60000	1	1/100 s	F1	0
0171		Pulse Time tCOM2	1 to 60000	1	1/100 s	F1	0
0172		COM2 order configuration	0 to 2	1	-	F89	0
0173		Reserved					
0174	GENERAL INPUT CONFIGURATION	Input 1: Filtering	0 to 2	1	-	F69	0
0175		Input 2: Filtering	0 to 2	1	-	F69	0
0176		Input 3: Filtering	0 to 2	1	-	F69	0
0177		Input 4: Filtering	0 to 2	1	-	F69	0

Address	Group	Description	Values range	Step	Unit	Format	Default Value
0178		Input 5: Filtering	0 to 2	1	-	F69	0
0179		Input 6: Filtering	0 to 2	1	-	F69	0
017A-017D		Reserved					
017E		Global Nominal Voltage	0 to 2	1	-	F70	0
017F		Reserved					
0180	CIRCUIT BREAKER	tOpen pulse min	10 to 1000	1	1/100 s	F1	50
0181		tClose Pulse	10 to 1000	1	1/100 s	F1	50
0182		Time Delay for close Command	0 to 20000	1	1/100 s	F1	0
0183		tP Pulse	1 to 65000	1	mn	F1	1
0184		tCB FLT ext.sign.	1 to 200	1	S	F1	16
0185		Remote Mode	0 to 1	1	-	F73	
0186		52 Unblock SOTF Time	10 to 20000	1	1/100 s	F1	100
0187		TC Supervision?	0 to 1	1	-	F107	0
0188		tSUP	10 to 1000		1/100 s	F1	10
0189		CB Supervision?	0 to 1	1	-	F63	0
018A		Max CB Open Time	1 to 1000	1	1/100 s	F1	10
018B		Max CB Close Time	1 to 1000	1	1/100 s	F1	10
018C		CB Diagnostic?	0 to 1	1	-	F63	0
018D		Max CB Open No.	0 to 65535	1	-	F1	0
018E		Max Sum AMPS^n	0 to 65535	1	-	F1	0
018F		AMPS's n=	1 to 2	1	-	F1	2
0190		Reserved					
0191	MAX&AVERAGE I CONFIGURATION	Time Window	1 to 3600	1	s	F1	900
0192-0199		Reserved					
019A	DISTURBANCE RECORDER	Pre-Time	10 to 700	1	1/100 s	F1	10
019B		Post TripTime	10 to 100	1	1/100 s	F1	10
019C		Distrurb Rec Trig	0 to 1	1	-	F65	0
019D		Max record Time	150 to 750	1	1/100 s	F1	10
019E-01A4		Reserved					
01A5	COMMISIONING	Maintenace Mode	0 to 1	1	-	F62	0
01A6		Test Pattern			bits	F40	00000000
01A7		Contact Test Time	0-20000	1	1/100 s	F1	10
01A8		Test Outputs	0 to 1	1	-	F75	0
01A9		Functional Test Pattern	0 to 12	1	-	F76	0

Address	Group	Description	Values range	Step	Unit	Format	Default Value
01AA		Functional Test End	0 to 1	1	-	F77	0
01AB		Functional Test Time	10-20000	1	1/100 s	F1	10
01AC		Functional Test	0 to 1	1	-	F75	0
01AD-01AF		Reserved					
01B0	OPTIONAL FLAG INDICATORS CONF.	tI>	0 to 1	1	bits	F108	0000
01B1		tI>>	0 to 1	1	bits	F108	0000
01B2		tI>>>	0 to 1	1	bits	F108	0000
01B3		tSOTF	0 to 1	1	bits	F108	0000
01B4		tIN_1 stage	0 to 1	1	bits	F108	0000
01B5		tIN_2 stage	0 to 1	1	bits	F108	0000
01B6		tIN_3 stage	0 to 1	1	bits	F108	0000
01B7		tI<	0 to 1	1	bits	F108	0000
01B8		tI2>	0 to 1	1	bits	F108	0000
01B9		tBrkn Cond	0 to 1	1	bits	F108	0000
01BA		Therm.Trip	0 to 1	1	bits	F108	0000
01BB		CB Fail	0 to 1	1	bits	F108	0000
01BC		tAUX1	0 to 1	1	bits	F108	0000
01BD		tAUX2	0 to 1	1	bits	F108	0000
01BE		tAUX3	0 to 1	1	bits	F108	0000
01BF		tAUX4	0 to 1	1	bits	F108	0000
01C0		[79] Final Trip	0 to 1	1	bits	F108	0000
01C1		[79] Lockout	0 to 1	1	bits	F108	0000
01C2		[79] Success.	0 to 1	1	bits	F108	0000
01C3-01FF		Reserved					

2.4.4 Page 2h : setting Group 1

Access in reading and in writing

Address	Group	Description	Values range	Step	Unit	Format	Default Value
0200	Setting Group 1 / Protection G1 /Phase O/C	I> ?	0-4	1	-	F16	0
0201		I> threshold	10 to 4000	1	In/100	F1	140
0202		ItI>/TMS/TD	2 to 20000	1	1/100 s	F1	100
0203		I> Delay Type	0 to 15	1	-	F18	1
0204		I> Reset Delay Type	0 -1	1	-	F41	0
0205		I> DMT/RTMS tReset	0 to 20000	1	1/100 s	F1	0
0206		I>>?	0-4	1	-	F16	0
0207		I>> Threshold	10 to 4000	1	In/100	F1	140
0208		tI>>/TMS/TD	2 to 20000	1	1/100 s	F1	100
0209		*I>> Delay Type*	0 to 15	1	-	F18	1
020A		*I>> Reset Delay Type*	0 -1	1	-	F41	0
020B		*I>> DMT/RTMS tReset*	0 to 20000	1	1/100 s	F1	0
020C		*I>>>?*	0-4	1	-	F16	0
020D		I>>> Threshold	10 to 4000	1	In/100	F1	400
020E		tI>>>	0 to 20000	1	1/100 s	F1	100
020F	Setting Group 1 / Protection G1 /SOTF G1	*SOTF?*	0-4		-	F16	0
0210		SOTF Threshold	10 to 4000	1	In/100	F1	400
0211		tSOTF	0 to 60000	1	1/100 s	F1	100
0212	Setting Group 1 / Protection G1 /E/GND Fault	IN_1 stage?	0-4	1	-	F84	0
0213		IN_1 Threshold	Ref TD	1	Ien/100	F1	10 50 100
0214		tIN_1/TMS/TD	2 to 20000	1	1/100 s	F1	100
0215		IN_1 Delay Type	0 to 12	25	-	F18	1
0216		IN_1 Reset Delay Type	0 -1	5	-	F41	0
0217		IN_1 DMT tReset	0 to 20000	1	1/100 s	F1	0
0218		IN_2?	0-2	0-2	-	F84	0
0219		IN_2 Threshold	Ref TD	1	Ien/100	F1	options
021A		tIN_2	0 to 20000	1	1/100 s	F1	10
021B		IN_3?	0-2	0-2	-	F84	0
021C		IN_3 Threshold	Ref TD	1	Ien/100	F1	options
021D		tIN_3	0 to 20000	1	1/100 s	F1	10
021E	Setting Group 1 / Protection G1	I<?	0-6	1	-	F112	0

CT

Address	Group	Description	Values range	Step	Unit	Format	Default Value
	/Undercurrent						
021F		I< Threshold	10 to 200	1	In/100	F1	400
0220		tI<	0 to 20000	1	1/100 s	F1	100
0221	Setting Group 1 / Protection G1 /Neg.Seq.O/C	I2>?	0-4	1	-	F16	0
0222		I2> threshold	10 to 400	1	In/100	F1	140
0223		tI2>/TMS/TD	2 to 20000	1	1/100 s	F1	100
0224		I2> Delay Type	0 to 15	1	-	F18	1
0225		I2> Reset Delay Type	0 -1	25	-	F41	0
0226		I2> DMT/RTMS tReset	0 to 60000	5	1/100 s	F1	0
0227	Setting Group 1 / Protection G1 /Broken Conductor	Broken Cond.?	0-4	1	-	F16	0
0228		Ratio I2/I1	20 to 100	1	%	F1	20
0229		tBCond	0 to 60000	1	1/100 s	F1	100
022A	Setting Group 1 / Protection G1 /Thermal Overload	Therm OL?	0-1	1	-	F109	0
022B		Itheta>	10 to 300	1	In/100	F1	140
022C		Therm Alarm?	0-1	1	-	F109	0
022D		Te	1 to 200	1	min	F1	1
022E		Tr	1 to 999	1	min	F1	1
022F		Theta Trip	50 to 200	1	%	F1	100
0230		Theta Reset	20 to 99	1	%	F1	95
0231		Theta Alarm	20 to 200	1	%	F1	80
0232	Setting Group 1 / Protection G1 /Aux Timers	AUX1?	0-7	1	-	F110	0
0233		tAUX1	0 to 60000	1	1/100 s	F1	0
0234		AUX2?	0-7	1	-	F110	0
0235		tAUX2	0 to 60000	1	1/100 s	F1	0
0236		AUX3?	0-7	1	-	F110	0
0237		tAUX3	0 to 60000	1	1/100 s	F1	0
0238		AUX4?	0-7	1	-	F110	0
0239		tAUX5	0 to 60000	1	1/100 s	F1	0
023A	Setting Group 1 / Protection G1 /CB Fail	CB Fail?	0-2	1	-	F111	0
023B		CB Fail Time tBF	0 to 1000	1	1/100 s	F1	20
023C		I< Threshold CBF	10 to 200	1	In/100	F1	10
023D		IN< Threshold CBF	10 to 200	1	Ien/100	F1	10
023E		Block I>	0 to 1	1	-	F63	0

Address	Group	Description	Values range	Step	Unit	Format	Default Value
023F		Block IN>	0 to 1	1	-	F63	0
0240	Setting Group 1 / Protection G1 /Logic Selective	Sel1?	0-1	1	-	F109	0
0241		tSEL1	0 to 60000	5	1/100 s	F1	0
0242		Sel2?	0-1	1	-	F109	0
0243		tSEL2	0 to 60000	5	1/100 s	F1	0
0244	Setting Group 1 / Protection G1 /Cold Load PU	Cold Load PU?	0-1	1	-	F109	0
0245		Cold Load PU Level	20 to 999	1	%	F1	100
0246		Cold Load PU tCL	0 to 60000	1	1/100 s	F1	0
0247		Cold Load PU I>	0 -1	1	-	F63	0
0248		Cold Load PU I>>	0 -1	1	-	F63	0
0249		Cold Load PU I>>>	0 -1	1	-	F63	0
024A		Cold Load PU IN_1	0 -1	1	-	F63	0
024B		Cold Load PU IN_2	0 -1	1	-	F63	0
024C		Cold Load PU IN_3	0 -1	1	-	F63	0
024D		Cold Load PU Brkn Cond	0 -1	1	-	F63	0
024E		Cold Load PU Itherm	0 -1	1	-	F63	0
024F		Cold Load PU I2>	0 -1	1	-	F63	0
0250	Setting Group 1 / Protection G1 /Autoreclose	Autoreclose?	0 -1	1	-	F109	0
0251		Dead Time tD1	0 to 60000	1	1/100 s	F1	0
0252		Dead Time tD2	0 to 60000	1	1/100 s	F1	0
0253		Dead Time tD3	0 to 60000	1	1/100 s	F1	0
0254		Dead Time tD4	0 to 60000	1	1/100 s	F1	0
0255		Dead Time tR	0 to 60000	1	1/100 s	F1	0
0256		Fast O/C Trip	0 to 1	1	bits	F72	00000
0257		Fast O/C Trip Delay	0 to 999	1	1/100 s	F1	0
0258		Fast E/GND Trip	0 to 1	1	bits	F72	00000
0259		Fast E/GND Trip Delay	0 to 999	1	1/100 s	F1	0
025A		tI> Close Shot ?	0 to 1	1	bits	F67	0000
025B		tI> Inhibit Trip : Shot	0 to 1	1	bits	F67	00000
025C		tI>> Close Shot ?	0 to 1	1	bits	F67	0000
025D		tI>> Inhibit Trip : Shot	0 to 1	1	bits	F67	00000
025E		tI>>> Close Shot ?	0 to 1	1	bits	F67	0000
025F		tI>>> Inhibit Trip : Shot	0 to 1	1	bits	F67	00000
0260		tIN_1 Close Shot ?	0 to 1	1	bits	F67	0000
0261		tIN_1 Inhibit Trip : Shot	0 to 1	1	bits	F67	00000
0262		tIN_2 Close Shot ?	0 to 1	1	bits	F67	0000
0263		tIN_2 Inhibit Trip : Shot	0 to 1	1	bits	F67	00000

Address	Group	Description	Values range	Step	Unit	Format	Default Value
0264		tIN_3 Close Shot ?	0 to 1	1	bits	F67	0000
0265		tIN_3 Inhibit Trip : Shot	0 to 1	1	bits	F67	00000
0266		tAUX1 Close Shot ?	0 to 1	1	bits	F67	0000
0267		tAUX1 Inhibit Trip : Shot	0 to 1	1	bits	F67	00000
0268		tAUX2 Close Shot ?	0 to 1	1	bits	F67	0000
0269		tAUX2 Inhibit Trip : Shot	0 to 1	1	bits	F67	00000
026A	Setting group 1 /Inputs configuration	Reverse Input Logic	0 to 1	1	bits	F35	000000
026B		Maintenance Mode	0 to 1	1	bits	F35	000000
026C		Reset Latched Signaling	0 to 1	1	bits	F35	000000
026D		Reset Latched Outputs	0 to 1	1	bits	F35	000000
026E		Blocking tI>	0 to 1	1	bits	F35	000000
026F		Blocking tI>>	0 to 1	1	bits	F35	000000
0270		Blocking tI>>>	0 to 1	1	bits	F35	000000
0271		Blocking tSOTF	0 to 1	1	bits	F35	000000
0272		Blocking tIN_	0 to 1	1	bits	F35	000000
0273		Blocking tIN_2	0 to 1	1	bits	F35	000000
0274		Blocking tIN_3	0 to 1	1	bits	F35	000000
0275		Blocking tI<	0 to 1	1	bits	F35	000000
0276		Blocking tI2>	0 to 1	1	bits	F35	000000
0277		Blocking tBroken Conductor	0 to 1	1	bits	F35	000000
0278		Blocking Itherm	0 to 1	1	bits	F35	000000
0279		Blocking tAUX1	0 to 1	1	bits	F35	000000
027A		Blocking tAUX2	0 to 1	1	bits	F35	000000
027B		Blocking tAUX3	0 to 1	1	bits	F35	000000
027C		Blocking CB Fail	0 to 1	1	bits	F35	000000
027D		Blocking Autoreclose [79]	0 to 1	1	bits	F35	000000
027E		Selectivity Logic 1 tI>>	0 to 1	1	bits	F35	000000
027F		Selectivity Logic 1 tI>>>	0 to 1	1	bits	F35	000000
0280		Selectivity Logic 1 tIN_2	0 to 1	1	bits	F35	000000
0281		Selectivity Logic 1 tIN_3	0 to 1	1	bits	F35	000000
0282		Selectivity Logic 2 tI>>	0 to 1	1	bits	F35	000000
0283		Selectivity Logic 2 tI>>>	0 to 1	1	bits	F35	000000
0284		Selectivity Logic 2 tIN_2	0 to 1	1	bits	F35	000000
0285		Selectivity Logic 2 tIN_3	0 to 1	1	bits	F35	000000
0286		AUX1	0 to 1	1	bits	F35	000000
0287		AUX2	0 to 1	1	bits	F35	000000
0288		AUX3	0 to 1	1	bits	F35	000000
0289		AUX4	0 to 1	1	bits	F35	000000
028A		AUX5	0 to 1	1	bits	F35	000000

Address	Group	Description	Values range	Step	Unit	Format	Default Value
028B		AUX6	0 to 1	1	bits	F35	000000
028C		Cold Load Pick Up	0 to 1	1	bits	F35	000000
028D		Start tBF (CB Fail)	0 to 1	1	bits	F35	000000
028E		CB status 52A	0 to 1	1	bits	F35	000000
028F		*CB status 52B*	0 to 1	1	bits	F35	000000
0290		CB Faulty External Signal	0 to 1	1	bits	F35	000000
0291		Setting Group 2	0 to 1	1	bits	F35	000000
0292		Manual Close	0 to 1	1	bits	F35	000000
0293		Manual Trip	0 to 1	1	bits	F35	000000
0294		Trip Circuit Supervision	0 to 1	1	bits	F35	000000
0295		Reset Theta value	0 to 1	1	bits	F35	000000
0296		Start Disturbance Recorder	0 to 1	1	bits	F35	000000
0297		Local CTRL Mode	0 to 1	1	bits	F35	000000
0298		Time Synchronization	0 to 1	1	bits	F35	000000
0299	Setting group 1 /Outputs relays configuration	Latched outputs	0 to 1	1	bits	F36	000000
029A		Reverse output Logic	0 to 1	1	bits	F36	000000
029B		Protection Trip	0 to 1	1	bits	F40	00000000
029C		Protection Trip (pulse)	0 to 1	1	bits	F36	000000
029D		Trip CB order	0 to 1	1	bits	F40	00000000
029E		Close CB order	0 to 1	1	bits	F36	000000
029F		Alarm	0 to 1	1	bits	F33	0000000
02A0		Start Phase A	0 to 1	1	bits	F36	000000
02A1		Start Phase B	0 to 1	1	bits	F36	000000
02A2		Start Phase C	0 to 1	1	bits	F36	000000
02A3		Start I>	0 to 1	1	bits	F36	000000
02A4		Start I>>	0 to 1	1	bits	F36	000000
02A5		Start I>>>	0 to 1	1	bits	F36	000000
02A6		Start SOTF	0 to 1	1	bits	F36	000000
02A7		Start IN_1	0 to 1	1	bits	F36	000000
02A8		Start IN_2	0 to 1	1	bits	F36	000000
02A9		Start IN_3	0 to 1	1	bits	F36	000000
02AA		Start I<	0 to 1	1	bits	F36	000000
02AB		Start I2>	0 to 1	1	bits	F36	000000
02AC		Start Broken Conductor	0 to 1	1	bits	F36	000000
02AD		AUX1	0 to 1	1	bits	F36	000000
02AE		AUX2	0 to 1	1	bits	F36	000000
02AF		AUX3	0 to 1	1	bits	F36	000000
02B0		AUX4	0 to 1	1	bits	F36	000000
02B1		AUX5	0 to 1	1	bits	F36	000000
02B2		AUX6	0 to 1	1	bits	F36	000000
02B3		tI>	0 to 1	1	bits	F40	00000000
02B4		tI>>	0 to 1	1	bits	F40	00000000
02B5		tI>>>	0 to 1	1	bits	F40	00000000

Address	Group	Description	Values range	Step	Unit	Format	Default Value
02B6		tSOTF	0 to 1	1	bits	F40	00000000
02B7		tIN_1	0 to 1	1	bits	F40	00000000
02B8		tIN_2	0 to 1	1	bits	F40	00000000
02B9		tIN_3	0 to 1	1	bits	F40	00000000
02BA		tI<	0 to 1	1	bits	F40	00000000
02BB		tI2>	0 to 1	1	bits	F40	00000000
02BC		t Broken Conductor	0 to 1	1	bits	F40	00000000
02BD		Thermal Trip	0 to 1	1	bits	F40	00000000
02BE		Thermal Alarm	0 to 1	1	bits	F33	0000000
02BF		CB Fail	0 to 1	1	bits	F40	00000000
02C0		tAUX1	0 to 1	1	bits	F40	00000000
02C1		tAUX2	0 to 1	1	bits	F40	00000000
02C2		tAUX3	0 to 1	1	bits	F40	00000000
02C3		tAUX4	0 to 1	1	bits	F40	00000000
02C4		Communication Order 1 (remote via RS485)	0 to 1	1	bits	F40	00000000
02C5		Communication Order 2 (remote via RS485)	0 to 1	1	bits	F40	00000000
02C6		[79] Autoreclose in progress	0 to 1	1	bits	F36	000000
02C7		[79] Autoreclose Final Trip	0 to 1	1	bits	F40	00000000
02C8		[79] Autoreclose Lockout (internal block)	0 to 1	1	bits	F33	0000000
02C9		[79] Autoreclose blocked (external blocking)	0 to 1	1	bits	F33	0000000
02CA		79 Autoreclose Successful	0 to 1	1	bits	F33	0000000
02CB		TCS Trip Circuit Supervision (52) : CB Fail	0 to 1	1	bits	F33	0000000
02CC		CB Alarm (CB diagnostic)	0 to 1	1	bits	F33	0000000
02CD		Trip pulse tP	0 to 1	1	bits	F36	000000
02CE		tCB Faulty detection based on External Signal (input)	0 to 1	1	bits	F33	0000000
02CF		Setting Group 1 is set	0 to 1	1	bits	F36	000000
02D0	Setting group 1 /LEDs configuration	Latched LEDs	0 to 1	1	bits	F39	111111
02D1		Protection Trip	0 to 1	1	bits	F39	000000
02D2		Alarm	0 to 1	1	bits	F39	000000
02D3		General Start	0 to 1	1	bits	F39	000000
02D4		Start Phase A	0 to 1	1	bits	F39	000000
02D5		Start Phase B	0 to 1	1	bits	F39	000000
02D6		Start Phase C	0 to 1	1	bits	F39	000000
02D7		Start I>	0 to 1	1	bits	F39	000000
02D8		Start I>>	0 to 1	1	bits	F39	000000
02D9		Start I>>>	0 to 1	1	bits	F39	000000
02DA		Start SOTF	0 to 1	1	bits	F39	000000
02DB		Start IN_1	0 to 1	1	bits	F39	000000
02DC		Start IN_2	0 to 1	1	bits	F39	000000
02DD		Start IN_3	0 to 1	1	bits	F39	000000

Address	Group	Description	Values range	Step	Unit	Format	Default Value
02DE		AUX1	0 to 1	1	bits	F39	000000
02DF		AUX2	0 to 1	1	bits	F39	000000
02E0		AUX3	0 to 1	1	bits	F39	000000
02E1		AUX4	0 to 1	1	bits	F39	000000
02E2		AUX5	0 to 1	1	bits	F39	000000
02E3		AUX6	0 to 1	1	bits	F39	000000
02E4		tI>	0 to 1	1	bits	F39	000000
02E5		tI>>	0 to 1	1	bits	F39	000000
02E6		tI>>>	0 to 1	1	bits	F39	000000
02E7		tSOTF	0 to 1	1	bits	F39	000000
02E8		tIN_1	0 to 1	1	bits	F39	000000
02E9		tIN_2	0 to 1	1	bits	F39	000000
02EA		tIN_3	0 to 1	1	bits	F39	000000
02EB		tI<	0 to 1	1	bits	F39	000000
02EC		tI2>	0 to 1	1	bits	F39	000000
02ED		tBroken Conductor	0 to 1	1	bits	F39	000000
02EE		Thermal Trip	0 to 1	1	bits	F39	000000
02EF		Thermal Alarm	0 to 1	1	bits	F39	000000
02F0		tCB Fail	0 to 1	1	bits	F39	000000
02F1		tAUX1	0 to 1	1	bits	F39	000000
02F2		tAUX2	0 to 1	1	bits	F39	000000
02F3		tAUX3	0 to 1	1	bits	F39	000000
02F4		tAUX4	0 to 1	1	bits	F39	000000
02F5		[79] Autoreclose in progress	0 to 1	1	bits	F39	000000
02F6		[79] Autoreclose Final Trip	0 to 1	1	bits	F39	000000
02F7		[79] Autoreclose Lockout (internal block)	0 to 1	1	bits	F39	000000
02F8		[79] Autoreclose blocked (external blocking)	0 to 1	1	bits	F39	000000
02F9		[79] Autoreclose Successful	0 to 1	1	bits	F39	000000
02FA		Local CTRL Mode	0 to 1	1	bits	F39	000000
02FB		CB Alarm (CB diagnostic)	0 to 1	1	bits	F39	000000
02FC		Maintenance Mode	0 to 1	1	bits	F39	000000
02FD		tCB Faulty detection based on External Signal (input)	0 to 1	1	bits	F39	000000
02FE		Setting Group 1 is set	0 to 1	1	bits	F39	000000

2.4.5 Page 3h : setting Group 2

Access in reading and in writing

Address	Group	Description	Values range	Step	Unit	Format	Default Value
0300	Setting Group 1 / Protection G2 /Phase O/C	I> ?	0-4	1	-	F16	0
0301		I> threshold	10 to 4000	1	In/100	F1	140
0302		ItI>/TMS/TD	2 to 20000	1	1/100 s	F1	100
0303		I> Delay Type	0 to 15	1	-	F18	1
0304		I> Reset Delay Type	0 -1	1	-	F41	0
0305		I> DMT/RTMS tReset	0 to 20000	1	1/100 s	F1	0
0306		I>>?	0-4	1	-	F16	0
0307		I>> Threshold	10 to 4000	1	In/100	F1	140
0308		tI>>/TMS/TD	2 to 20000	1	1/100 s	F1	100
0309		*I>> Delay Type*	0 to 15	1	-	F18	1
030A		*I>> Reset Delay Type*	0 -1	1	-	F41	0
030B		*I>> DMT/RTMS tReset*	0 to 20000	1	1/100 s	F1	0
030C		*I>>>?*	0-4	1	-	F16	0
030D		I>>> Threshold	10 to 4000	1	In/100	F1	400
030E		tI>>>	0 to 20000	1	1/100 s	F1	100
030F	Setting Group 2 / Protection G2 /SOTF G1	*SOTF?*	0-4		-	F16	0
0310		SOTF Threshold	10 to 4000	1	In/100	F1	400
0311		tSOTF	0 to 60000	1	1/100 s	F1	100
0312	Setting Group 2 / Protection G2 /E/GND Fault	IN_1 stage?	0-4	1	-	F84	0
0313		IN_1 Threshold	Ref TD	1	Ien/100	F1	10 50 100
0314		tIN_1/TMS/TD	2 to 20000	1	1/100 s	F1	100
0315		IN_1 Delay Type	0 to 12	25	-	F18	1
0316		IN_1 Reset Delay Type	0 -1	5	-	F41	0
0317		IN_1 DMT tReset	0 to 20000	1	1/100 s	F1	0
0318		IN_2?	0-2	0-2	-	F84	0
0319		IN_2 Threshold	Ref TD	1	Ien/100	F1	options
031A		tIN_2	0 to 20000	1	1/100 s	F1	10
031B		IN_3?	0-2	0-2	-	F84	0
031C		IN_3 Threshold	Ref TD	1	Ien/100	F1	options
031D		tIN_3	0 to 20000	1	1/100 s	F1	10
031E	Setting Group 2 / Protection	I<?	0-6	1	-	F112	0

Address	Group	Description	Values range	Step	Unit	Format	Default Value
	/Undercurrent G2						
031F		I< Threshold	10 to 200	1	In/100	F1	400
0320		tI<	0 to 20000	1	1/100 s	F1	100
0321	Setting Group 2 / Protection G2 /Neg.Seq.O/C	I2>?	0-4	1	-	F16	0
0322		I2> threshold	10 to 400	1	In/100	F1	140
0323		tI2>/TMS/TD	2 to 20000	1	1/100 s	F1	100
0324		I2> Delay Type	0 to 15	1	-	F18	1
0325		I2> Reset Delay Type	0 -1	25	-	F41	0
0326		I2> DMT/RTMS tReset	0 to 60000	5	1/100 s	F1	0
0327	Setting Group 2 / Protection G /Broken Conductor	Broken Cond.?	0-4	1	-	F16	0
0328		Ratio I2/I1	20 to 100	1	%	F1	20
0329		tBCond	0 to 60000	1	1/100 s	F1	100
032A	Setting Group 2 / Protection G2 /Thermal Overload	Therm OL?	0-1	1	-	F109	0
032B		Itheta>	10 to 300	1	In/100	F1	140
032C		Therm Alarm?	0-1	1	-	F109	0
032D		Te	1 to 200	1	min	F1	1
032E		Tr	1 to 999	1	min	F1	1
032F		Theta Trip	50 to 200	1	%	F1	100
0330		Theta Reset	20 to 99	1	%	F1	95
0331		Theta Alarm	20 to 200	1	%	F1	80
0332	Setting Group 2 / Protection G2 /Aux Timers	AUX1?	0-7	1	-	F110	0
0333		tAUX1	0 to 60000	1	1/100 s	F1	0
0334		AUX2?	0-7	1	-	F110	0
0335		tAUX2	0 to 60000	1	1/100 s	F1	0
0336		AUX2?	0-7	1	-	F110	0
0337		tAUX2	0 to 60000	1	1/100 s	F1	0
0338		AUX2?	0-7	1	-	F110	0
0339		tAUX2	0 to 60000	1	1/100 s	F1	0
033A	Setting Group 2 / Protection G2 /CB Fail	CB Fail?	0-2	1	-	F111	0
033B		CB Fail Time tBF	0 to 1000	1	1/100 s	F1	20
033C		I< Threshold CBF	10 to 200	1	In/100	F1	10
033D		IN< Threshold CBF	10 to 200	1	Ien/100	F1	10
033E		Block I>	0 to 1	1	-	F63	0

Address	Group	Description	Values range	Step	Unit	Format	Default Value
033F		Block IN>	0 to 1	1	-	F63	0
0340	Setting Group 2 / Protection G2 /Logic Selective	Sel1?	0-1	1	-	F109	0
0341		tSEL1	0 to 60000	5	1/100 s	F1	0
0342		Sel2?	0-1	1	-	F66	0
0343		tSEL2	0 to 60000	5	1/100 s	F1	0
0344	Setting Group 2 / Protection G2 /Cold Load PU	Cold Load PU?	0-1	1	-	F109	0
0345		Cold Load PU Level	20 to 999	1	%	F1	100
0346		Cold Load PU tCL	0 to 60000	1	1/100 s	F1	0
0347		Cold Load PU I>	0 -1	1	-	F63	0
0348		Cold Load PU I>>	0 -1	1	-	F63	0
0349		Cold Load PU I>>>	0 -1	1	-	F63	0
034A		Cold Load PU IN_1	0 -1	1	-	F63	0
034B		Cold Load PU IN_2	0 -1	1	-	F63	0
034C		Cold Load PU IN_3	0 -1	1	-	F63	0
034D		Cold Load PU Brkn Cond	0 -1	1	-	F63	0
034E		Cold Load PU Itherm	0 -1	1	-	F63	0
034F		Cold Load PU I2>	0 -1	1	-	F63	0
0350	Setting Group 2 / Protection G2 /Autoreclose	Autoreclose?	0 -1	1	-	F109	0
0351		Dead Time tD1	0 to 60000	1	1/100 s	F1	0
0352		Dead Time tD2	0 to 60000	1	1/100 s	F1	0
0353		Dead Time tD3	0 to 60000	1	1/100 s	F1	0
0354		Dead Time tD4	0 to 60000	1	1/100 s	F1	0
0355		Dead Time tR	0 to 60000	1	1/100 s	F1	0
0356		Fast O/C Trip	0 to 1	1	bits	F72	00000
0357		Fast O/C Trip Delay	0 to 999	1	1/100 s	F1	0
0358		Fast E/GND Trip	0 to 1	1	bits	F72	00000
0359		Fast E/GND Trip Delay	0 to 999	1	1/100 s	F1	0
035A		tI> Close Shot ?	0 to 1	1	bits	F67	0000
035B		tI> Inhibit Trip : Shot	0 to 1	1	bits	F67	00000
035C		tI>> Close Shot ?	0 to 1	1	bits	F67	0000
035D		tI>> Inhibit Trip : Shot	0 to 1	1	bits	F67	00000
035E		tI>>> Close Shot ?	0 to 1	1	bits	F67	0000
035F		tI>>> Inhibit Trip : Shot	0 to 1	1	bits	F67	00000
0360		tIN_1 Close Shot ?	0 to 1	1	bits	F67	0000
0361		tIN_1 Inhibit Trip : Shot	0 to 1	1	bits	F67	00000
0362		tIN_2 Close Shot ?	0 to 1	1	bits	F67	0000
0363		tIN_2 Inhibit Trip : Shot	0 to 1	1	bits	F67	00000

Address	Group	Description	Values range	Step	Unit	Format	Default Value
0364		tIN_3 Close Shot ?	0 to 1	1	bits	F67	0000
0365		tIN_3 Inhibit Trip : Shot	0 to 1	1	bits	F67	00000
0366		tAUX1 Close Shot ?	0 to 1	1	bits	F67	0000
0367		tAUX1 Inhibit Trip : Shot	0 to 1	1	bits	F67	00000
0368		tAUX2 Close Shot ?	0 to 1	1	bits	F67	0000
0369		tAUX2 Inhibit Trip : Shot	0 to 1	1	bits	F67	00000
036A	Setting group 2 /Inputs configuration G2	Reverse Input Logic	0 to 1	1	bits	F35	000000
036B		Maintenance Mode	0 to 1	1	bits	F35	000000
036C		Reset Latched Signaling	0 to 1	1	bits	F35	000000
036D		Reset Latched Outputs	0 to 1	1	bits	F35	000000
036E		Blocking tI>	0 to 1	1	bits	F35	000000
036F		Blocking tI>>	0 to 1	1	bits	F35	000000
0370		Blocking tI>>>	0 to 1	1	bits	F35	000000
0371		Blocking tSOTF	0 to 1	1	bits	F35	000000
0372		Blocking tIN_	0 to 1	1	bits	F35	000000
0373		Blocking tIN_2	0 to 1	1	bits	F35	000000
0374		Blocking tIN_3	0 to 1	1	bits	F35	000000
0375		Blocking tI<	0 to 1	1	bits	F35	000000
0376		Blocking tI2>	0 to 1	1	bits	F35	000000
0377		Blocking tBroken Conductor	0 to 1	1	bits	F35	000000
0378		Blocking Itherm	0 to 1	1	bits	F35	000000
0379		Blocking tAUX1	0 to 1	1	bits	F35	000000
037A		Blocking tAUX2	0 to 1	1	bits	F35	000000
037B		Blocking tAUX3	0 to 1	1	bits	F35	000000
037C		Blocking CB Fail	0 to 1	1	bits	F35	000000
037D		Blocking Autoreclose [79]	0 to 1	1	bits	F35	000000
037E		Selectivity Logic 1 tI>>	0 to 1	1	bits	F35	000000
037F		Selectivity Logic 1 tI>>>	0 to 1	1	bits	F35	000000
0380		Selectivity Logic 1 tIN_2	0 to 1	1	bits	F35	000000
0381		Selectivity Logic 1 tIN_3	0 to 1	1	bits	F35	000000
0382		Selectivity Logic 2 tI>>	0 to 1	1	bits	F35	000000
0383		Selectivity Logic 2 tI>>>	0 to 1	1	bits	F35	000000
0384		Selectivity Logic 2 tIN_2	0 to 1	1	bits	F35	000000
0385		Selectivity Logic 2 tIN_3	0 to 1	1	bits	F35	000000
0386		AUX1	0 to 1	1	bits	F35	000000
0387		AUX2	0 to 1	1	bits	F35	000000
0388		AUX3	0 to 1	1	bits	F35	000000
0389		AUX4	0 to 1	1	bits	F35	000000
038A		AUX5	0 to 1	1	bits	F35	000000

Address	Group	Description	Values range	Step	Unit	Format	Default Value
038B		AUX6	0 to 1	1	bits	F35	000000
038C		Cold Load Pick Up	0 to 1	1	bits	F35	000000
038D		Start tBF (CB Fail)	0 to 1	1	bits	F35	000000
038E		CB status 52A	0 to 1	1	bits	F35	000000
038F		*CB status 52B*	0 to 1	1	bits	F35	000000
0390		CB Faulty External Signal	0 to 1	1	bits	F35	000000
0391		Setting Group 2	0 to 1	1	bits	F35	000000
0392		Manual Close	0 to 1	1	bits	F35	000000
0393		Manual Trip	0 to 1	1	bits	F35	000000
0394		Trip Circuit Supervision	0 to 1	1	bits	F35	000000
0395		Reset Theta value	0 to 1	1	bits	F35	000000
0396		Start Disturbance Recorder	0 to 1	1	bits	F35	000000
0397		Local CTRL Mode	0 to 1	1	bits	F35	000000
0398		Time Synchronization	0 to 1	1	bits	F35	000000
0399	Setting group 2 /Outputs relays configuration G2	Latched outputs	0 to 1	1	bits	F36	0000
039A		Reverse output Logic	0 to 1	1	bits	F36	000000
039B		Protection Trip	0 to 1	1	bits	F40	00000000
039C		Protection Trip (pulse)	0 to 1	1	bits	F36	000000
039D		Trip CB order	0 to 1	1	bits	F40	00000000
039E		Close CB order	0 to 1	1	bits	F36	000000
039F		Alarm	0 to 1	1	bits	F33	0000000
03A0		Start Phase A	0 to 1	1	bits	F36	000000
03A1		Start Phase B	0 to 1	1	bits	F36	000000
03A2		Start Phase C	0 to 1	1	bits	F36	000000
03A3		Start I>	0 to 1	1	bits	F36	000000
03A4		Start I>>	0 to 1	1	bits	F36	000000
03A5		Start I>>>	0 to 1	1	bits	F36	000000
03A6		Start SOTF	0 to 1	1	bits	F36	000000
03A7		Start IN_1	0 to 1	1	bits	F36	000000
03A8		Start IN_2	0 to 1	1	bits	F36	000000
03A9		Start IN_3	0 to 1	1	bits	F36	000000
03AA		Start I<	0 to 1	1	bits	F36	000000
03AB		Start I2>	0 to 1	1	bits	F36	000000
03AC		Start Broken Conductor	0 to 1	1	bits	F36	000000
03AD		AUX1	0 to 1	1	bits	F36	000000
03AE		AUX2	0 to 1	1	bits	F36	000000
03AF		AUX3	0 to 1	1	bits	F36	000000
03B0		AUX4	0 to 1	1	bits	F36	000000
03B1		AUX5	0 to 1	1	bits	F36	000000
03B2		AUX6	0 to 1	1	bits	F36	000000
03B3		tI>	0 to 1	1	bits	F40	00000000
03B4		tI>>	0 to 1	1	bits	F40	00000000
03B5		tI>>>	0 to 1	1	bits	F40	00000000

Address	Group	Description	Values range	Step	Unit	Format	Default Value
03B6		tSOTF	0 to 1	1	bits	F40	00000000
03B7		tIN_1	0 to 1	1	bits	F40	00000000
03B8		tIN_2	0 to 1	1	bits	F40	00000000
03B9		tIN_3	0 to 1	1	bits	F40	00000000
03BA		tI<	0 to 1	1	bits	F40	00000000
03BB		tI2>	0 to 1	1	bits	F40	00000000
03BC		t Broken Conductor	0 to 1	1	bits	F40	00000000
03BD		Thermal Trip	0 to 1	1	bits	F40	00000000
03BE		Thermal Alarm	0 to 1	1	bits	F33	0000000
03BF		CB Fail	0 to 1	1	bits	F40	00000000
03C0		tAUX1	0 to 1	1	bits	F40	00000000
03C1		tAUX2	0 to 1	1	bits	F40	00000000
03C2		tAUX3	0 to 1	1	bits	F40	00000000
03C3		tAUX4	0 to 1	1	bits	F40	00000000
03C4		Communication Order 1 (remote via RS485)	0 to 1	1	bits	F40	00000000
03C5		Communication Order 2 (remote via RS485)	0 to 1	1	bits	F40	00000000
03C6		[79] Autoreclose in progress	0 to 1	1	bits	F36	000000
03C7		[79] Autoreclose Final Trip	0 to 1	1	bits	F40	00000000
03C8		[79] Autoreclose Lockout (internal block)	0 to 1	1	bits	F33	0000000
03C9		[79] Autoreclose blocked (external blocking)	0 to 1	1	bits	F33	0000000
03CA		79 Autoreclose Successful	0 to 1	1	bits	F33	0000000
03CB		TCS Trip Circuit Supervision (52) : CB Fail	0 to 1	1	bits	F33	0000000
03CC		CB Alarm (CB diagnostic)	0 to 1	1	bits	F33	0000000
03CD		Trip pulse tP	0 to 1	1	bits	F36	000000
03CE		tCB Faulty detection based on External Signal (input)	0 to 1	1	bits	F33	0000000
03CF		Setting Group 2 is set	0 to 1	1	bits	F36	000000
03D0	Setting group 2 /LEDs configuration G2	Latched LEDs	0 to 1	1	bits	F39	111111
03D1		Protection Trip	0 to 1	1	bits	F39	000000
03D2		Alarm	0 to 1	1	bits	F39	000000
03D3		General Start	0 to 1	1	bits	F39	000000
03D4		Start Phase A	0 to 1	1	bits	F39	000000
03D5		Start Phase B	0 to 1	1	bits	F39	000000
03D6		Start Phase C	0 to 1	1	bits	F39	000000
03D7		Start I>	0 to 1	1	bits	F39	000000
03D8		Start I>>	0 to 1	1	bits	F39	000000
03D9		Start I>>>	0 to 1	1	bits	F39	000000
03DA		Start SOTF	0 to 1	1	bits	F39	000000
03DB		Start IN_1	0 to 1	1	bits	F39	000000
03DC		Start IN_2	0 to 1	1	bits	F39	000000
03DD		Start IN_3	0 to 1	1	bits	F39	000000

Address	Group	Description	Values range	Step	Unit	Format	Default Value
03DE		AUX1	0 to 1	1	bits	F39	000000
03DF		AUX2	0 to 1	1	bits	F39	000000
03E0		AUX3	0 to 1	1	bits	F39	000000
03E1		AUX4	0 to 1	1	bits	F39	000000
03E2		AUX5	0 to 1	1	bits	F39	000000
03E3		AUX6	0 to 1	1	bits	F39	000000
03E4		tI>	0 to 1	1	bits	F39	000000
03E5		tI>>	0 to 1	1	bits	F39	000000
03E6		tI>>>	0 to 1	1	bits	F39	000000
03E7		tSOTF	0 to 1	1	bits	F39	000000
03E8		tIN_1	0 to 1	1	bits	F39	000000
03E9		tIN_2	0 to 1	1	bits	F39	000000
03EA		tIN_3	0 to 1	1	bits	F39	000000
03EB		tI<	0 to 1	1	bits	F39	000000
03EC		tI2>	0 to 1	1	bits	F39	000000
03ED		tBroken Conductor	0 to 1	1	bits	F39	000000
03EE		Thermal Trip	0 to 1	1	bits	F39	000000
03EF		Thermal Alarm	0 to 1	1	bits	F39	000000
03F0		tCB Fail	0 to 1	1	bits	F39	000000
03F1		tAUX1	0 to 1	1	bits	F39	000000
03F2		tAUX2	0 to 1	1	bits	F39	000000
03F3		tAUX3	0 to 1	1	bits	F39	000000
03F4		tAUX4	0 to 1	1	bits	F39	000000
03F5		[79] Autoreclose in progress	0 to 1	1	bits	F39	000000
03F6		[79] Autoreclose Final Trip	0 to 1	1	bits	F39	000000
03F7		[79] Autoreclose Lockout (internal block)	0 to 1	1	bits	F39	000000
03F8		[79] Autoreclose blocked (external blocking)	0 to 1	1	bits	F39	000000
03F9		[79] Autoreclose Successful	0 to 1	1	bits	F39	000000
03FA		Local CTRL Mode	0 to 1	1	bits	F39	000000
03FB		CB Alarm (CB diagnostic)	0 to 1	1	bits	F39	000000
03FC		Maintenance Mode	0 to 1	1	bits	F39	000000
03FD		tCB Faulty detection based on External Signal (input)	0 to 1	1	bits	F39	000000
03FE		Setting Group 2 is set	0 to 1	1	bits	F39	000000

2.4.6 Page 4h : remote controls

Access in writing. (MODBUS Function 5)

Address	Group	Description	Values range	Step	Unit	Format	Default Value
0400	Remote control	Remote control word 1	0 to 15	bits	-	F38	0
0401		Remote control word 2	0 to 15	bits	-	F38A	0
0402		Remote control word 3	0 to 15	bits	-	F38B	0

2.4.7 Pages 5h/6h

These pages are reserved

2.4.8 Page 7h

Access in quick reading only (MODBUS 07 function)

Address	Group	Description	Values range	Step	Unit	Format	Default Value
0700	Quick reading byte	Relay status description		1	-	F49	0

2.4.9 Page 8h : time synchronisation

Access in writing for n words (function 16). The time synchronisation format is based on 8 bits (4 words) (Inverted IEC 870-5-4 CP56Time2a):.

Timer	Address (hex)	Nb bytes	Mask (hex)	Values range	Unit
	0800	1 (Hi)			
Year		1 (Lo)	7F	0 – 99 (2000-2093)	Year
Month	0801	1 (Hi)	0F	1 - 12	month
Day of week		1 (Lo)	E0	1 – 7 (Monday – Sunday)	Day
day of month		1 (Lo)	1F	1 – 31	Day
Season	0802	1 (Hi)	80	0 – 1 (summer-winter) Not used	
Hour		1 (Hi)	1F	0-23	Hour
Invalidity		1 (Lo)	80	0 -1 (valid – invalid)	
Minute		1 (Lo)	3F	0-59	Minute
Millisecond pF+pf	0803	2	FFFF	0 – 59999	ms

2.4.10 Mapping access characteristics

- Description of accessible addresses in reading of words (function 03 and 04).

PAGE 00h 0000h to 0054h	PAGE 01h 0100h to 0184h	PAGE 02h 0200h to 02FAh

PAGE 03h
0300h to 03F6h

- Definition of accessible addresses in writing of 1 word (**function 06**).

PAGE 01h 0100h to 0184h	PAGE 02h 0200h to 02FAh	PAGE 03h 0300h to 03FAh

- Definition of accessible addresses in writing of n words (**function 16**).

PAGE 01h 0100h to 0184h	PAGE 02h 0200h to 02FAh	PAGE 03h 0300h to 03FAh

PAGE 08h
0800h to 0803h

- Definition of accessible addresses in reading of bits (**function 01** and **02**).

Not available

- Definition of accessible addresses in writing of 1 bit (**function 05**).

PAGE 04h
0400h to 0402h

WARNING: THE BITS NUMBER MUST NOT BE HIGHER THAN 16.

2.4.11 Page 9h to 21h: disturbance record data (25 pages)

Access in words writing (**function 03**)
Each disturbance mapping page contain 250 words.

Address	Contents
0900h to 09FAh	250 disturbance data words
0A00h to 0AFAh	250 disturbance data words
0B00h to 0BFAh	250 disturbance data words
0C00h to 0CFAh	250 disturbance data words
0D00h to 0DFAh	250 disturbance data words
0E00h to 0DFAh	250 disturbance data words
0F00h to 0FFAh	250 disturbance data words
1000h to 10FAh	250 disturbance data words
1100h to 11FAh	250 disturbance data words
1200h to 12FAh	250 disturbance data words
1300h to 13FAh	250 disturbance data words
1400h to 14FAh	250 disturbance data words
1500h to 15FAh	250 disturbance data words
1600h to 16FAh	250 disturbance data words
1700h to 17FAh	250 disturbance data words
1800h to 18FAh	250 disturbance data words
1900h to 19FAh	250 disturbance data words
1A00h to 1AFAh	250 disturbance data words
1B00h to 1BFAh	250 disturbance data words
1C00h to 1CFAh	250 disturbance data words
1D00h to 1DFAh	250 disturbance data words
1E00h to 1EFAh	250 disturbance data words
1F00h to 1FFAh	250 disturbance data words
2000h to 20FAh	250 disturbance data words
2100h to 21FAh	250 disturbance data words

NB: The disturbance data pages contain values of one channel from one given disturbance record.

2.4.11.1 Meaning of each value channel

- IA, IB, IC and IN channels:

The value is an signed 16 bits word equivalent to the ADC value

Calculation formula for phase current values

Values in Amps can be calculated in following way:

$$\text{Value IA} = \sqrt{2} \cdot \frac{\text{sample\_IA} \cdot \text{Internal\_PhA} \cdot \text{Phase\_Primary\_CT\_In}}{\text{Phase\_ Secondary \_CT\_In} \cdot 2000}$$

$$\text{Value IB} = \sqrt{2} \cdot \frac{\text{sample\_IB} \cdot \text{Internal\_PhB} \cdot \text{Phase\_Primary\_CT\_In}}{\text{Phase\_ Secondary \_CT\_In} \cdot 2000}$$

$$\text{Value IC} = \sqrt{2} \cdot \frac{\text{sample\_IC} \cdot \text{Internal\_PhC} \cdot \text{Phase\_Primary\_CT\_In}}{\text{Phase\_ Secondary \_CT\_In} \cdot 2000}$$

Where:
Internal_PhA, Internal_PhB, Internal_PhC: Internal scalling (see point 2.4.17 (Page 38h to 3Ch))

Calculation formula for earth current values

Value in Amps can be calculated in following way:

$$\text{Value IN} = \sqrt{2} \cdot \frac{\text{sample\_IN} \cdot \text{Internal\_N} \cdot \text{Earth\_Primary\_CT\_Ien}}{\text{Earth\_ Secondary \_CT\_Ien} \cdot 2000}$$

Where:
Internal_N: Internal scalling (see point 2.4.17 (Page 38h to 3Ch))

- Frequency channel:

Time between two samples in microseconds

- Logic channels:

Logic channel	Contents
Bit 0	Binary Input 1
Bit 1	Binary Input 2
Bit 2	Binary Input 3
Bit 3	Binary Input 4
Bit 4	Binary Input 5
Bit 5	Binary Input 6
Bit 6	None (reserved)
Bit 7	None (reserved)
Bit 8	Output RL1
Bit 9	Output RL2
Bit 10	Output RL3
Bit 11	Output RL4
Bit 12	Output RL5
Bit 13	Output RL6
Bit 14	Protection Trip
Bit 15	Start of protection which trips

2.4.12 Page 22h: disturbance record index frame

Access in word reading (function 03)

Address	Contents
2200h	Disturbance data index frame

Disturbance record index frame

Word	Contents
n° 1	Disturbance record number
n° 2	Disturbance record finish date (second)
n° 3	Disturbance record finish date (second)
n° 4	Disturbance record finish date (millisecond)
n° 5	Disturbance record finish date (millisecond)
n° 6	Disturbance record starting condition : 1 : tripping 2 : instantaneous 3 : remote command 4 : logic input
n° 7	Frequency at the post-time beginning

2.4.13 Page 35h (addresses 3500h to 354Ah) : event record data (9 words)

Word n° 1: Event meaning

Word n° 2: MODBUS associated value

Word n° 3: MODBUS address

Word n° 4: *Reserved*

Words n° 5 & 6 & 7 & 8: Event date is Inverted IEC 870-5-4 CP56Time2a:

See format Page 8h

Word n° 9: Acknowledge
0=event non acknowledged
1= event acknowledged)

Code	Meaning of the event	Type	MODBUS address
00	No event	-	
01	CB closing (Remote/menu HMI)	F38 ↑	0400h (bit 15)
02	CB tripping (Remote/menu HMI)	F38 ↑	0400h (bit 7)
03	Reset latched outputs (Remote)	F38 ↑	0400h (bit 2)
04	Reset signaling (Remote)	F38 ↑	0400h (bit 1)
05	Reset signaling and latched outputs (Remote)	F38 ↑	0400h (bit 3)
06	Clear fault and disturbance recorder	F38A ↑	0401h (bit 0)
07	Clear event recorder	F38A ↑	0401h (bit 1)
08	Reserved		
09	Warm restart	↑	-

CT

Code	Meaning of the event	Type	MODBUS address
10	Reserved		
11	Current Protection disable status	↑↓	-
12	START I>	F37↑↓	0021h (bit 0)
13	START I>>	F37↑↓	0022h (bit 0)
14	START IN_1	F50 ↑↓	0024h (bit 0)
15	START IN_2	F50 ↑↓	0025h (bit 0)
16	tI>	F37↑↓	0021h (bit 6)
17	tI>>	F37↑↓	0022h (bit 6)
18	tIN_1	F50 ↑↓	0024h (bit 6)
19	tIN_2	F50 ↑↓	0025h (bit 6)
20	tAUX1	F51 ↑↓	0027h (bit 6)
21	CB status: opened	F30 ↑	001Bh (value 0)
22	CB status: closed	F30 ↑	001Bh (value 1)
23	CB status: faulty	F30 ↑	001Bh (value 3)
24	CB status: undefined	F30 ↑	001Bh (value 4)
25	tCB Faulty External Signal.	F31A ↑	001Ah (bit 10)
26	Start tCB Fail Ext.	F51 ↑↓	002Ah (bit 0)
27	CHANGE OF INPUT LOGIC STATE	F11 ↑↓	0010h
28	CHANGE OF OUTPUT LOGIC STATE	F24 ↑↓	0013h
29	START I>>>	F37↑↓	0023h (bit 0)
30	tI>>>	F37↑↓	0023h (bit 6)
31	Start I2>	F50 ↑↓	002Dh (bit 0)
32	tI2>	F50 ↑↓	002Dh (bit 6)
33	tAUX2	F51 ↑↓	0028 (bit 6)
34	tCB Fail	F51 ↑↓	0029h (bit 6)
35	Setting Group 1 active	F32↑	0009h (bit 0)
36	Setting Group 2 active	F32↑	0009h (bit 1)
37	tI> Alarm	F31↑↓	0019h (bit 0)
38	tI>> Alarm	F31↑↓	0019h (bit 1)
39	tI>>> Alarm	F31↑↓	0019h (bit 2)
40	tIN_1 Alarm	F31 ↑↓	0019h (bit 4)
41	tIN_2 Alarm	F31 ↑↓	0019h (bit 5)
42	tAUX1 Alarm	F31A ↑↓	0020h (bit 5)
43	tAUX2 Alarm	F31A ↑↓	0020h (bit 6)
44	tI2> Alarm	F31 ↑↓	0019h (bit 8)
45	tCB Fail Alarm	F31 ↑↓	0019h (bit 10)
46	Start AUX1	F51 ↑↓	0027h (bit 0)
47	Start AUX2	F51 ↑↓	0028h (bit 0)
48	[79] Autoreclose blocked (Remote/menu HMI)	F38 ↑	0400h (bit 8)

Code	Meaning of the event	Type	MODBUS address
49	[79] Autoreclose unblocked (Remote/menu HMI)	F38 ↑	0400h (bit 9)
50	Reset latched Alarms	F38 ↑	0400h (bit 5)
51	Reserved		
52	Reserved		
53	Reserved		
54	Reserved		
55	Acknowledgement of the hardware alarm	F38A↑	0401h (bit 9)
56	Disturbance recorder start (Remote)	F38A↑	0401h (bit 5)
57	Communication order 1	F38A↑	0401h (bit 14)
58	Communication order 2	F38A↑	0401h (bit 15)
59	Thermal state reset (Remote/menu HMI)	↑	
60	Recloser counters reset (Remote/menu HMI)	F38A↑	0401h (bit 3)
61	Fault counters reset (Remote/menu HMI)	F38A↑	0401h (bit 10)
62	Control couters reset (Remote/menu HMI)	F38A↑	0401h (bit 12)
63	Maintenance mode	F38A↑	0401h (bit 13)
64	End of maintenance mode	F38A↑	0401h (bit 6)
65	START IN_3	F38A	0401h (bit 7)
66	tIN_3	F50 ↑↓	0026h (bit 0)
67	tIN_3 Alarm	F50 ↑↓	0026h (bit 6)
68	Start SOTF	F31 ↑↓	0019h (bit 6)
69	tSOTF	F37 ↑↓	002Bh (bit 0)
70	tSOTF Alarm	F37 ↑↓	002Bh (bit 6)
71	Start I<	F31 ↑↓	0019h (bit 3)
72	tI<	F50 ↑↓	002Ch (bit 0)
73	I< Alarm	F50 ↑↓	002Ch (bit 6)
74	Start Broken Counductor	F31 ↑↓	0019h (bit 7)
75	tBroken Conductor	F50 ↑↓	002Eh (bit 0)
76	tBroken Conductor Alarm	F50 ↑↓	002Eh (bit 6)
77	Itherm>	F31 ↑↓	0019h (bit 9)
78	Thermal OL Trip	F50 ↑↓	002Fh (bit 0)
79	Thermal OL Alarm	F50 ↑↓	002Fh (bit 6)
80	START AUX3	F31 ↑↓	0019h (bit 11)
81	tAUX3	F51 ↑↓	0030h (bit 0)
82	tAUX3 Alarm	F51 ↑↓	0030h (bit 6)
83	Start AUX4	F31A ↑↓	001Ah (bit 7)
84	tAUX4	F51 ↑↓	0031h (bit 0)
85	tAUX4 Alarm	F51 ↑↓	0031h (bit 6)
86	Peak and rolling value reset (Remote/menu HMI)	F31A ↑	001Ah (bit 8)
87	Max. values of the averag. in sub period reset (Remote/menu HMI)	F38A↑	0401h (bit 4)

CT

Code	Meaning of the event	Type	MODBUS address
88	Acknowledgement of the hardware alarm	F38A↑	0401h (bit 11)
89-95	Reserved		
96	Local CTRL mode	F61↑	001Eh (value: 2)
97	Remote CTRL mode	F61↑	001Eh (value: 1)
98	Local and remote CTRL mode	F61↑	001Eh (value: 0)
99	Setting change to Group 1 (Remote)	F38↑	0400h (bit 6)
100	Setting change to Group 2 (Remote)	F38↑	0400h (bit 11)
101	Protection Function disable status	↑↓	
102	Setting Group 2 set via Input	F104↑↓	0035h (bit 8)
103	Relays Test (Commissiong Test) active	↑	-
104	Test I> On	↑	-
105	Test I> Off	↑	-
106	Test I>> On	↑	-
107	Test I>> Off	↑	-
108	Test I>>> On	↑	-
109	Test I>>> Off	↑	-
110	Test SOTF On	↑	-
111	Test SOTF Off	↑	-
112	Test IN_1 On	↑	-
113	Test IN_1 Off	↑	-
114	Test IN_2 On	↑	-
115	Test IN_2 Off	↑	-
116	Test IN_3 On	↑	-
117	Test IN_3 Off	↑	-
118	Test I< On	↑	-
119	Test I< Off	↑	-
120	Test I2> On	↑	-
121	Test I2> Off	↑	-
122	Test Brkn. Cond. On	↑	-
123	Test Brkn. Cond. Off	↑	-
124	Test Thermal OL On	↑	
125	Test Thermal OL Off	↑	
126	Test CBF On	↑	-
127	Test CBF Off	↑	-
128	Blocking tI> active	F101↑↓	0032h (bit 0)
129	Blocking tI>> active	F101↑↓	0032h (bit 1)
130	Blocking tI>>> active	F101↑↓	0032h (bit 2)
131	Blocking tSOTF active	F101↑↓	0032h (bit 3)
132	Blocking tIN_1 active	F101↑↓	0032h (bit 4)

Code	Meaning of the event	Type	MODBUS address
133	Blocking tIN_2 active	F101↑↓	0032h (bit 5)
134	Blocking tIN_3 active	F101↑↓	0032h (bit 6)
135	Blocking tI< active	F101↑↓	0032h (bit 7)
136	Blocking tI2> active	F101↑↓	0032h (bit 8)
137	Blocking tBrkn. Conductor active	F101↑↓	0032h (bit 9)
138	Blocking Itherm. Active	F101↑↓	0032h (bit 11)
139	Blocking tAUX1 active	F102↑↓	0033h (bit 5)
140	Blocking tAUX2 active	F102↑↓	0033h (bit 6)
141	Blocking tAUX3 active	F102↑↓	0033h (bit 7)
142	Blocking CB Fail active	F101↑↓	0032h (bit 10)
143	Blocking [79] active	F102↑↓	0033h (bit 0)
144	Sel1 tI>> active	F103↑↓	0034h (bit 0)
145	Sel1 tI>>> active	F103↑↓	0034h (bit 1)
146	Sel1 tIN_2 active	F103↑↓	0034h (bit 2)
147	Sel1 tIN_3 active	F103↑↓	0034h (bit 3)
148	reserved		
149	Sel2 tI>> ACTIVE	F103↑↓	0034h (bit 4)
150	Sel2 tI>>> ACTIVE	F103↑↓	0034h (bit 5)
151	Sel2 tIN_2 ACTIVE	F103↑↓	0034h (bit 6)
152	Sel2 tIN_3 ACTIVE	F103↑↓	0034h (bit 7)
153	reserved		
154	Cold Load PU active	F104↑↓	0035h (bit 3)
155	Manual Close via Input	↑	-
156	Manual Close via Function Key	↑	-
157	Manual Trip via Input	↑	-
158	Manual trip via Function Key	↑	-
159	TC Supervision alarm	F31A↑↓	001Ah (bit 11)
160	Theta Reset via Input	F104↑↓	0035h (bit 12)
161	Start Disturbance recorder via Input	↑	-
162	Changing CTRL mode via Input	F104↑	0035h (bit 14)
163	Changing CTRL mode (Remote/menu HMI)	F38↑	0400h (bit 4)
164	Active [79] in Progress	F59↑↓	001Ch (bit 1)
165	[79] Final trip	F59↑↓	001Ch (bit 4)
166	[79] Lockout	F59↑↓	001Ch (bit 6)
167	[79] Blocked	F59↑↓	001Ch (bit 0)
168	[79] Successful	F59↑↓	001Ch (bit 5)
169	[79] tD1 counting	F59↑↓	001Ch (bit 8)
170	[79] tD2 counting	F59↑↓	001Ch (bit 9)
171	[79] tD3 counting	F59↑↓	001Ch (bit 10)

Code	Meaning of the event	Type	MODBUS address
172	[79] tD4 counting	F59↑↓	001Ch (bit 11)
173	[79] tR counting	F59↑↓	001Ch (bit 12)
174	Fast O/C trip Delay Elapsed	F59↑	001Ch (bit 13)
175	Fast E/GND Trip Delay Elapsed	F59↑	001Ch (bit 14)
176	[79] Reclose order	F59↑	001Ch (bit 3)
177	[79] Inhibit Trip tI> active	↑	-
178	[79] Inhibit Trip tI>> active	↑	-
179	[79] Inhibit Trip tI>>> active	↑	-
180	[79] Inhibit Trip tIN_1 active	↑	-
181	[79] Inhibit Trip tIN_2 active	↑	-
182	[79] Inhibit Trip tIN_3 active	↑	-
183	[79] Inhibit Trip tAUX1 active	↑	-
184	[79] Inhibit Trip tAUX2 active	↑	-
185	[79] Rolling demand blocking active	↑	-
186	[79] Inhibit time on close counting	F60↑↓	001Dh (bit 2)
187	Autoreclose : T-C	↑	-
188	Autoreclose : T-C-T	↑	-
189	Autoreclose : T-C-T-C	↑	-
190	Autoreclose : T-C-T-C-T	↑	-
191	Autoreclose : T-C-T-C-T-C	↑	-
192	Autoreclose : T-C-T-C-T-C-T	↑	-
193	Autoreclose : T-C-T-C-T-C-T-C	↑	-
194	Autoreclose : T-C-T-C-T-C-T-C-T	↑	-
195	Reserved	↑	-
196	HD Warning Alarm	F31A↑↓	001Ah (bit 15)
197	CB Time Supervision Alarm	F31A↑↓	001Ah (bit 12)
198	Unblock SOTF active	↑↓	-
199	tReset I> active	F37↑↓	0021h (bit 5)
200-399	Reserved		
400	tReset I>> active	F37↑↓	0022h (bit 5)
401	tReset IN_1 active	F50 ↑↓	0024h (bit 5)
402	tReset I2> active	F50 ↑↓	002Dh (bit 5)
403	Administrator password entered	↑	-
404	Protection password entered	↑	-
405	Control password entered	↑	-
406	Reset signaling and latched outputs via C clear key	↑	-
407	Reset signalling via Input	F104↑	0035h (bit 1)
408	Reset latched outputs via Input	F104↑	0035h (bit 2)
409	Inrush threshold active	F28A ↑↓	0016h (bit 4)

Code	Meaning of the event	Type	MODBUS address
410	Inrush unblock active	↑↓	-
411	Reset Signalling via Close command	↑	
412	State of CB Alarm	F31A↑↓	001Ah (bit 2)
413	[79] Rolling demand Alarm	F31A↑↓	001Ah (bit 9)
414	CB current diagnostic Alarm	F31A↑↓	001Ah (bit 0)
415	CB number diagnostic Alarm	F31A↑↓	001Ah (bit 1)
416	Settings change	↑	-
417	79 Lockout – no Vx	↑	-

Note: The double arrow ↑↓ means the event is generated on event occurrence (↑) and on event disappearance (↓).

On event occurrence, the corresponding bit of the associated format is set to « 1 ».

On event disappearance, the corresponding bit of the associated format is set to « 0 ».

2.4.14 Page 36h

Most older event data

Access in word reading (**function 03**)

Address	Contents
3600h	Most older event data

2.4.15 Page 37h : fault record value data

Access in word reading (**function 03**)

Address	Contents
3700h	Fault value record n°1
3701h	Fault value record n°2
3702h	Fault value record n°3
3703h	Fault value record n°4
3704h	Fault value record n°5
3705h	Fault value record n°6
3706h	Fault value record n°7
3707h	Fault value record n°8
3708h	Fault value record n°9
3709h	Fault value record n°10
3710h	Fault value record n°11
3711h	Fault value record n°12
3712h	Fault value record n°13
3713h	Fault value record n°14
3714h	Fault value record n°15
3715h	Fault value record n°16
3716h	Fault value record n°17

Address	Contents
3717h	Fault value record n°18
3718h	Fault value record n°19
3719h	Fault value record n°20

Word n° 1 : Fault number

Words n° 2 & 3 : Fault date (second) number of seconds since 01/01/94

Words n° 4 & 5 : Fault date (millisecond)

Word n° 6 : Fault date (season)
0= winter (not available in P116)
1= summer (not available in P116)
2= undefined (default value in P116)

Word n° 7 : Active setting group during the fault (1 or 2)

Word n° 8 : Fault origin

0= none
1= phase A
2= phase B
3= phase C
4= phases A-B
5= phases A-C
6= phases B-C
7= phases A-B-C
8= earth

Word n° 9: Fault recording starting origin

Fault nature code meaning

Code	Fault origin
00	Null event
01	Reserved
02	Thermal Overload
03	tI> trip
04	tI>> trip
05	tI>>> trip
06	tIN_1 trip
07	tIN_2 trip
08	tIN_3 trip
09	tI< trip
10	tBrkn Cond
11	t Aux 1 trip
12	t Aux 2 trip
13	tI2> trip
14	Reserved
15	t Aux 3 trip
16	t Aux 4 trip

Code	Fault origin
17	CB Fail trip
18	tSOTF
19	Reserved
20	CBext trip

Word n° 10: Fault value current (nominal value)

Word n° 11: Phase A current value (nominal value)

Word n° 12: Phase B current value (nominal value)

Word n° 13: Phase C current value (nominal value)

Word n° 14: Earth current value (nominal value)

Word n° 15: Acknowledge of fault 0 : fault non-acknowledged
1 : fault acknowledged

2.4.15.1 Calculation formula for phase current values

Line phase current value (primary value) = phase sampled value (e.g. word 10, 11, 12 or 13) * {line primary CT ratio (address 0120h)/Line CT sec (address 0121h)} A/100

2.4.15.2 Calculation formula for earth current values

The formula depends of nominal earth current :

0.002 to 1 Ien and 0.01-8Ien range
Line earth current value (primary value) = earth sampled value (e.g. word 10 or 14) * {line primary CT ratio (address 0122h)/Line CT sec (address 0123h)} A/1000

0.1 to 40 Ien range
Line earth current value (primary value) = earth sampled value (e.g. word 10 or 14) * {line primary CT ratio (address 0122h)/Line CT sec (address 0123h)} A/100

2.4.16 Page 3Eh : most older Fault record value data

Access in word reading (**function 03**)

Address	Contents
3E00h	Most older Fault record

2.4.17 Page 38h to 3Ch: Disturbance recorder

Selection of the disturbance record and channel (36 bytes are uploaded for each address reading)

Access in word reading (**function 03**)

Address	Disturbance record number	Format
3800h	1	IA
3801h	1	IB
3802h	1	IC
3803h	1	IN
3804h	1	Frequency

3805h	1	Logic input and outputs
3900h	2	IA
3901h	2	IB
3902h	2	IC
3903h	2	IN
3904h	2	Frequency
3905h	2	Logic input and outputs
3A00h	3	IA
3A01h	3	IB
3A02h	3	IC
3A03h	3	I_E
3A04h	3	Frequency
3A05h	3	Logic input and outputs
3B00h	4	IA
3B01h	4	IB
3B02h	4	IC
3B03h	4	IN
3B04h	4	Frequency
3B05h	4	Logic input and outputs
3C00h	1	IA
3C01h	1	IB
3C02h	1	IC
3C03h	1	IN
3C04h	1	Frequency
3C05h	1	Logic input and outputs

Word n° 1 : Number of samples included in the mapping
Word n° 2 : Sample number in pre-time
Word n° 3 : Sample number in post-time
Word n° 4 : Line CT primary nominal current **(*Phase_Primary_CT_In*)**
Word n° 5 : Line CT secondary nominal current **(*Phase_ Secondary _CT_In*)**
Word n° 6 : E/GND CT primary nominal current **(*Earth_Primary_CT_Ien*)**
Word n° 7 : E/GND CT secondary nominal current **(*Earth_ Secondary _CT_Ien*)**
Float[1)] n° 1 : Phase A Internal PhA ratio (***Internal_PhA***)
Float[1)] n° 2 : Phase B internal PhB ratio (***Internal_PhB***)
Float[1)] n° 3 : Phase C internal PhC ratio (***Internal_PhC***)
Float[1)] n° 4 : Earth internal ratio (***Internal_N***)
Word n° 8 : Mapping last page number
Word n° 9 : Number of words in the mapping last page

CT

1) Float – 4 bytes floating point number

2.4.17.1 Calculation formula for phase current values

Values in Amps can be calculated in following way:

$$\text{Value IA} = \sqrt{2} \cdot \frac{\text{sample\_IA(e.g.3800h)} \cdot \text{Internal\_PhA} \cdot \text{Phase\_Primary\_CT\_In}}{\text{Phase\_ Secondary \_CT\_In} \cdot 2000}$$

$$\text{Value IB} = \sqrt{2} \cdot \frac{\text{sample\_IB (e.g.3801h)} \cdot \text{Internal\_PhB} \cdot \text{Phase\_Primary\_CT\_In}}{\text{Phase\_ Secondary \_CT\_In} \cdot 2000}$$

$$\text{Value IC} = \sqrt{2} \cdot \frac{\text{sample\_IC (e.g.3802h)} \cdot \text{Internal\_PhC} \cdot \text{Phase\_Primary\_CT\_In}}{\text{Phase\_ Secondary \_CT\_In} \cdot 2000}$$

2.4.17.2 Calculation formula for earth current values

Value in Amps can be calculated in following way:

$$\text{Value IN} = \sqrt{2} \cdot \frac{\text{sample\_IN (e.g.3803h)} \cdot \text{Internal\_N} \cdot \text{Earth\_Primary\_CT\_Ien}}{\text{Earth\_ Secondary \_CT\_Ien} \cdot 2000}$$

2.4.18 Pages 3Dh : number of disturbance records available

Access in word reading (function 03)

Address	Contents
3D00h	Number of disturbance records available

Word n° 1 : Number of disturbance records available

Word n° 2: Oldest disturbance record number (n)
Words n° 3 & 4 : Oldest disturbance record date (second)
Words n° 5 & 6 : Oldest disturbance record date (millisecond)
Word n° 7 : Disturbance record starting origin
1= Protection trip
2= instantaneous threshold
3= remote command
4= logic input
Word n° 8 : Acknowledge

Word n° 9 : Disturbance record previous number (n+1)
Words n° 10 & 11: Previous disturbance record date (second)
Words n° 12 & 13: Previous disturbance record date (millisecond)
Word n° 14 : Disturbance record starting origin
1= Protection trip
2= instantaneous threshold
3= remote command
4= logic input
Word n° 15 : Acknowledge
Word n° 16 : Disturbance record previous number (n+2)
Words n° 17 & 18: Previous disturbance record date (second)
Words n° 19 & 20: Previous disturbance record date (millisecond)
Word n° 21 : Disturbance record starting origin
1= Protection trip
2= instantaneous threshold
3= remote command
4= logic input
Word n° 22 : Acknowledge
Word n° 23 : Disturbance record previous number (n+3)
Words n° 24 & 25: Previous disturbance record date (second)
Words n° 26 & 27: Previous disturbance record date (millisecond)
Word n° 28 : Disturbance record starting origin
1= Protection trip
2= instantaneous threshold
3= remote command
4= logic input

Word n° 29 :	Acknowledge
Word n° 30 :	Disturbance record previous number (n+4)
Words n° 31 & 32:	Previous disturbance record date (second)
Words n° 33 & 34:	Previous disturbance record date (millisecond)
Word n° 35 :	Disturbance record starting origin 1= Protection trip 2= instantaneous threshold 3= remote command 4= logic input
Word n° 36 :	Acknowledge

2.4.19 Description of the mapping format, MiCOM P116 Dual-powered

CODE	DESCRIPTION
F1	Unsigned integer – numerical data : 1 – 65535
F10	Characters ASCII byte 1 : ASCII character 32-127 byte 2 : ASCII character 32-127
F11	Unsigned integer -Binary input status bit 0 : logic input 1 bit 1 : logic input 2 bit 2 : logic input 3 bit 3 : logic input 4 bit 4 : logic input 5 bit 5 : logic input 6 bit: 6-15 reserved
F12	Unsigned integer – Current Protection disable status bit 0 : I> disabled bit 1 : I>> disabled bit 2 : I>>> disabled bit 3 : SOTF disabled bit 4 : IN_1 disabled bit 5 : IN_2 disabled bit 6 : IN_3 disabled bit 7 : I< disabled bit 8 : I2> disabled bit 9 : Brkn Cond. disabled bit 10 : CB Fail disabled bit 11 : Thermal OL disabled bit 12 to 15 : reserved
F12A	Unsigned integer –Protection Function disable status bit 0 : 79 Autoreclose disabled bit 1 : SEL1 disabled bit 2 : SEL2 disabled bit 3 : Cold Load PU disabled bit 4 : Blocking Inrush disabled bit 5 : AUX1 disabled bit 6 : AUX2 disabled bit 7 : AUX3 disabled bit 8 : AUX4 disabled bit 9 to 15 : reserved
F13	Unsigned integer – numerical data : 1 – 65535
F15	Two-digit decimal number - Firmware version 1st digit - major version 2nd digit - minor version 10: 1A 11: 1B 12: 1C 13: 1D etc
F16	Unsigned integer – Configuration 0 : disabled 1 : enable Trip 2 : enable Alarm 3 : enable Trip with Inrush Blocking 4 : enable Trip with Latching
F17	Unsigned integer - Hardware version 10: A 11: B

CODE	DESCRIPTION
F18	Unsigned integer – curves type 0: DTM 1 : SI IEC 2 : VI IEC 3 : EI IEC 4 : LTI (IEC) 5: STI (IEC) 6 : RC Rectifier curve 7: RI curve 8: MI IEEE 9 : VI IEEE 10 : EI IEEE 11: STI (US C02-P20) 12: LTI (US CO8) 13: RXIDG 14: BPN EDF 15: STI (US C02-P40)
F19	Unsigned integer - Baud rate value 0 : 4800 baud 1 : 9600 baud 2 : 19200 baud 3 : 38400 baud 4 : 57600 baud 5 : 115200 baud
F20	Unsigned integer – Parity 0 : NONE 1 : EVEN 2 : ODD
F22	Unsigned integer – Stop 0 : 1 stop 1 : 2 stop
F23	Unsigned integer – Line CT sec 0 : 1A 1 : 5A
F23A	Unsigned integer – E/GND CT sec 0 : 1A 1 : 5A
F24	Unsigned integer - Logical output status bit 0 : logic output RL1 bit 1 : logic output RL2 bit 2 : logic output RL3 bit 3 : logic output RL4 bit 4 : logic output RL5 bit 5 : logic output RL6 bit 6 : logic output WD bit 7-15: reserved
F25	Unsigned integer - Logical LED status bit 0: Healthy bit 1 : Trip bit 2 : Alarm bit 3 : LED4 bit 4 : LED5 bit 5 : LED6 bit 6: LED7 bit 7: LED8 bit 8-15: reserved
F26	Unsigned integer - Logical healthy status bit 0 to 3 reserved bit 4 : Healthy bit10-15: reserved
F27	Unsigned Integer

CODE	DESCRIPTION
F28	Unsigned integer - Protection start status bit 0 : I> bit 1 : I>> bit 2 : I>>> bit 3 : SOTF bit 4 : IN_1 bit 5 : IN_2 bit 6 : IN_3 bit 7 : I< bit 8 : I2> bit 9 : Brkn Cond. bit 10 : tCB Fail Start bit 11 : Itherm Start bit 12 : starting in phase A bit 13 : starting in phase B bit 14: starting in phase C bit 15 : starting in N
F28A	Unsigned integer - Protection start status bit 0 : 79 in progress bit 1 : SEL1 active bit 2 : SEL2 active bit 3 : Cold Load PU active bit 4 : Blocking Inrush active bit 5 : AUX1 bit 6 : AUX2 bit 7 : AUX3 bit 8 : AUX4 bit 9-15 : Reserved
F29	Unsigned integer – Current Protection trip status bit 0 : tI> bit 1 : tI>> bit 2 : tI>>> bit 3 : tSOTF bit 4 : tIN_1 bit 5 : tIN_2 bit 6 : tIN_3 bit 7 : tI< bit 8 : tI2> bit 9 : tBrkn Conductor bit 10 : CB Fail bit 11 : Thermal Overload bit 12 : starting in phase A bit 13 : starting in phase B bit 14 : starting in phase C bit 15 : starting in N
F29A	Unsigned integer - Protection Function trip status bit 0 : 79 Final Trip bit 1 : reserved bit 2 : reserved bit 3 : reserved bit 4 : reserved bit 5 : tAUX1 bit 6 : tAUX2 bit 7 : tAUX3 bit 8 : tAUX4 bit 9 : tCB Fail external signal bit 10 : reserved bit 11 : reserved bit 12 : reserved bit 13 : reserved bit 14 : reserved bit 15 : reserved

CODE	DESCRIPTION
F30	Unsigned integer - CB status 0 : CB opened 1 : CB closed 2 : reserved 3 : CB position faulty 4: CB position undefined 5:-15: reserved
F31	Unsigned integer (bit)- Protection Alarm status bit 0 : tI> bit 1 : tI>> bit 2 : tI>>> bit 3 : tSOTF bit 4 : tIN_1 bit 5 : tIN_2 bit 6 : tIN_3 bit 7 : tI< bit 8 : tI2> bit 9 : tBrkn Conductor bit 10 : tCB Fail bit 11 : Thermal Overload bit 12 : reserved bit 13 : reserved bit 14 : reserved bit 15 : reserved
F31A	Unsigned integer - Alarm Function status it 0: CB current Diagnostic (Square Amps sum overreach) bit 1: CB number Diagnostic (operation number overreach) bit 2 : State of CB (not correct) bit 3 : reserved bit 4 : reserved bit 5 : tAUX1 bit 6 : tAUX2 bit 7 : tAUX3 bit 8 : tAUX4 bit 9 : [79] Rolling Demand bit 10 : t CB Faulty ext sign bit 11 : TC Supervision (Trip circuit self-test) bit 12 : CB Time Supervision (time overreach) bit 13 : 79 Autoreclose close time overreach bit 14 : 79 Autoreclose Fail (lockout) bit 15 : Hardware Warning
F32	Unsigned integer - Setting group 0: Setting group 1 1: Setting group 2
F33	Unsigned integer -Output configuration bit 0: RL1 bit 1: RL2 bit 2: RL3 bit 3: RL4 bit 4: RL5 bit 5: RL6 bit 6: Flag indicator bit 5-15: reserved
F35	Unsigned integer -Input configuration bit 0: Input L1 bit 1: Input L2 bit 2: Input L3 bit 3: Input L4 bit 4: Input L5 bit 5: Input L6 bit 6-15: reserved

CODE	DESCRIPTION
F36	Unsigned integer -Output configuration bit 0: RL1 bit 1: RL2 bit 2: RL3 bit 3: RL4 bit 4: RL5 bit 5: RL6 bit 6-15: reserved
F37	Unsigned integer: I> or I>> or I>>> or SOTF threshold phase information status: bit 0: information thresold exceeded bit 1: Instantaneous IA bit 2: Instantaneous IB bit 3: Instantaneous IC bit 4: Blocking signal active bit 5: tReset active bit 6: Time delay elapsed bit 7 to 15: reserved
F38	Unsigned integer - Remote control word bit 0: Warm restart bit 1: Reset LEDs bit 2: Reset Outputs bit 3: Reset LEDs and Outputs bit 4: Local Mode bit 5: Reset latched Alarms bit 6: Setting change to Group 1 bit 7: Remote or HMI CB open order bit 8: Remote or HMI [79] Autoreclose blocking bit 9: Remote or HMI [79] Autoreclose unblocking bit 10: Remote Mode bit 11: Setting change to Group 2 bit 12: Disable automatic acknowledgement of events bit 13: Oldest event acknowledge bit 14: Oldest fault acknowledge bit 15: Remote or via HMI CB close order
F38A	Unsigned integer - Remote control word bit 0: Clear Recorders bit 1: Clear Events bit 2: reserved bit 3: Thermal state reset bit 4: Peak and rolling value reset bit 5: Disturbance record remote start bit 6: Maintenance mode bit 7: End of maintenance mode bit 8: Acknowledgement of the oldest disturbance record bit 9: Acknowledgment of the hardware RAM alarm bit 10: Recloser reset counters bit 11: Reset of maximum values of the averages in sub period bit 12: Reset Fault counters bit 13: Reset control counters bit 14: Communication Order 1 bit 15: Communication Order 2
F38B	Unsigned integer - Remote control word bit 0 : [79] Unlockout bit 1: Enable automatic acknowledgement of events bit 1-15: reserved
F39	Unsigned integer - LED function bit 0 : LED3 bit 1 : LED4 bit 2 : LED5 bit 3 : LED6 bit 4: LED7 bit 5: LED8 bit 6-15: reserved

CODE	DESCRIPTION
F40	Unsigned integer -Output configuration (bit fields) bit 0 : RL1 bit 1 : RL2 bit 2 : RL3 bit 3 : RL4 bit 4 : RL5 bit 5 : RL6 bit 6 : Flag indicator bit 7: Trip Output bit 6-15: reserved
F41	Unsigned integer - Curve Type 0 : DT 1 : IDMT
F49	Unsigned integer - relay status bit 0 : Relay status (major alarms) bit 1: Minor hardware alarm bit 2: Presence of non-acknowledged event bit 3: Synchronisation state bit 4:Presence of non-acknowledged disturbance record bit 5: Presence of non-acknowledged fault record Bit 6: Local Maintance Ack state bit 7-15: reserved
F50	Unsigned integer: current protection IN_1, IN_2, IN_3, I2>, I<, Brkn Cond, Itheta> information status: bit 0: information threshold exceeded bit 1: reserved bit 2: reserved bit 3: reserved bit 4: Blocking signal active bit 5: tReset active bit 6: Time delay elapsed bit 7: Alarm information - Therm OL only bit 8 to 15: reserved
F51	Unsigned integer: information status about additional protection AUX1, AUX2, AUX3, AUX4, CB Fail or CB Fail ext. sign. status: bit 0: start bit 1: reserved bit 2: reserved bit 3: reserved bit 4: reserved bit 5: start (after blocking) bit 6: Time delay elapsed bit 7 to 15: reserved
F52	Unsigned integer: information about language in menu 0: English; 1 : German; 2 : French; 3 : Spanish 4: Portuguese 5: Russian 6: Turkish 7 : Language 8
F53	Unsigned integer: information about language in menu 0: Measurements refered to In or Ien 1: Measurements refered to A 2: CB CTRL window 3: 79 CTRL window 4: CTRL Mode (Local/Remote)
F54	Unsigned integer 0: Manual Reset 1: Protection Start 2: Close Command

CODE	DESCRIPTION
F55	Unsigned integer - Alarm Display Reset 0: Self-Reset 1: Manual Reset
F56	Unsigned integer - Protocol 0: Modbus 1: IEC103
F57	Unsigned integer – Nominal Frequency 0: 50Hz 1: 60Hz
F58	Unsigned integer – Hardware version 0: Standard 1: reserved; 2: Standard + DC Binary Inputs; 3: reserved; 4: Standard+optional 4 HMI Flags; 5: Standard+DC Binary Inputs+Optional 4 HMI Flags; 6: reserved
F59	Unsigned integer - [79] status bit 0: Recloser blocked bit 1: Recloser in progress bit 2: reserved bit 3: Closing command executed via Autorecloser bit 4: Recloser final trip bit 5: Recloser successful bit 6: Recloser lockout bit 7: Trip locked via Recloser (inhibit of protection stage) bit 8: Dead Time tD1 counting bit 9: Dead Time tD2 counting bit 10: Dead Time tD3 counting bit 11: Dead Time tD4 counting bit 12: Reclaim Time tR counting bit 13: Fast O/C Trip Delay elapsed bit 14: Fast E/GND Trip Delay elapsed bit 15: reserved
F60	Unsigned integer - [79] blocking status 0: Ready 1: In progress 2: Temporary blocked (after close signal) 3: Lockout 4: Blocked via CTRL (HMI+RS485) 5: Blocked via input 6: Disabled
F61	Unsigned integer - Local/Remote Mode 0: Local and Remote 1: Remote only 2: Local only
F62	Unsigned integer –Maintenance Mode 0: No 1: Yes, outp trips 2: Yes, outp blocks 3-15: reserved
F63	Unsigned integer 0: No 1: Yes
F64	Unsigned integer – 79 dead time configuration 0: Protection reset 1: CB trips
F65	Unsigned integer – Disturbance recorder configuration 0: On Instantenous 1: On Trip

CODE	DESCRIPTION
F66	Unsigned integer –Configuration 0: Disabled 1: Current+Input 2: Input only
F67	Unsigned integer (bit) - Close Shot bit 0: First Reclose Shot bit 1: Second Reclose Shot bit 2 : Third Reclose shot bit 3 : Fourth Reclose shot bit 4-15: reserved
F68	Unsigned integer - Presences of boards 0 : not installed 1 : installed
F69	Unsigned integer - Input Filtering 0 : dc/ac ENA 1 : ac 2: dc
F70	Unsigned integer – Global nominal Voltage of Binary Inputs: 0 : 220Vdc 1 : 129Vdc 2: 110Vdc
F71	Unsigned integer - Number of setting groups: 0 : One Group 1 :Two Groups
F72	Unsigned integer - AR trips cycle bit 0: First trip shot bit 1: Second trip shot bit 2: Third trip shot bit 3: Fourth trip shot bit 4: Fifth trip shot bit 5-15: reserved
F73	Unsigned integer - Remote Mode configuration 0 : Remote Only 1 :Remote + Local
F74	Unsigned integer - Inrush Blocking configuration 0 : No 1: Yes 2: Closing
F75	Unsigned integer 0 : No operation 1: Apply Test
F76	bit 0 : tI> bit 1 : tI>> bit 2 : tI>>> bit 3 : tSOTF bit 4 : tIN_1 bit 5 : tIN_2 bit 6 : tIN_3 bit 7 : tI< bit 8 : tI2> bit 9 : tBrkn Conductor bit 10 : Thermal OL Trip bit 11 : CB Fail bit 12-15 : reserved
F77	Unsigned integer - Functional Test End 0: CB Trip 1: Time elapsed
F78	Unsigned integer - Hardware Warning Mode 0: Opened 1: Closed

CODE	DESCRIPTION
F82	Unsigned integer – Control key confirmation 0: without confirmation 1: with confirmation 2-15: reserved
F84	Unsigned integer - Configuration: 0: disable 1: IN_x Trip 2: IN_x Alarm 3: IN_x Trip with Inrush Blocking 4: IN_x Trip with Latching 5-15: reserved
F88	Unsigned integer – IDMT Interlock by DMT 0: No 1: Yes 2: 20Is
F89	Unsigned integer –COM2 order config. 0: RS485 1: RS485+ HMI “C” key 2: HMI “C” key
F90	Unsigned Integer - Software Version Number: numeric Data 0-99
F93	Unsigned integer - IN Connections 0: Terminals A7-8 1: Terminals A9-10
F94	Unsigned integer - TC Supervision 0: No 1: Yes 2: Yes-52A
F101	Input Protection Blocking 1 (bits) bit 0 : tI> bit 1 : tI>> bit 2 : tI>>> bit 3 : tSOTF bit 4 : tIN_1 bit 5 : tIN_2 bit 6 : tIN_3 bit 7 : tI< bit 8 : tIs2> bit 9 : tBCond bit 10 : tCB Fail bit 11 : Thermal OL bit 12-15: reserved
F102	Input Protection Blocking 2 (bits) bit 0: blocking [79] Autoreclose bit 1-4: reserved bit 5 : AUX1 bit 6 : AUX2 bit 7 : AUX3 bit 8 : AUX4 bit 9-15: Reserved
F103	Input Selective Logic (bits) bit 0 : SEL1 tI>> bit 1 : SEL1 tI>>> bit 2 : SEL1 tIN_2 bit 3 : SEL1 tIN_3 bit 4 : SEL2 tI>> bit 5 : SEL2 tI>>> bit 6 : SEL2 tIN_2 bit 7 : SEL2 tIN_3 bit 8-15: Reserved

CODE	DESCRIPTION
F104	Input Logic Data (bits) bit 0: Maintenance Mode bit 1: Reset Latched Signalling bit 2: Reset Latched Outputs bit 3: Cold Load PU bit 5: CB status 52a bit 6: CB status 52b bit 7: CB FLT External Signal bit 8: Setting Group 2 bit 9: Manual Close bit 10: Manual Trip bit 11: Trip Circuit Supervision bit 12: Reset Theta value bit 13: Start Disturbance Recorder bit 14: Local CTRL Mode bit 15: reserved
F105	Internal Logic Data (bits) bit 0: Protection trip latched bit 1-15: reserved
F106	Unsigned integer – Signaling Reset on 0 : No 1: Close via 79 bit 2-15: reserved
F107	Unsigned integer – TC supervision? 0 : No 1: Yes 2: Yes-52a bit 3-15: reserved
F108	Unsigned integer – Flag function bit 0 : Flag 2 bit 1 : Flag 3 bit 2 : Flag 4 bit 3 : Flag 5 bit 6-15: reserved
F109	Unsigned integer –Configuration 0: Disabled 1: Enabled
F110	Unsigned integer –Configuration 0: Disabled 1 : enable Trip 2 : enable Alarm 3 : enable Trip with Inrush Blocking 4 : enable Trip with Latching 5: Load shedding 6: AR after LS Hi 7: AR after LS Lo bit 8-15: reserved
F111	Unsigned integer –Configuration 0: Disabled 1: Retrip 2: Alarm
F112	Unsigned integer – Configuration 0 : disabled 1 : enable Trip 2 : enable Alarm 3 : enable Trip with Inrush Blocking 4 : enable Trip with Latching 5. Enable Trip inhibit 52A 6. Enable Alarm inhibit 52A bit 7-15: reserved

2.4.20 Request to retrieve the oldest non-acknowledge event

Slave number	Function code	Word address	Word number	CRC
xx	03h	36h 00	00 09h	xx xx

This event request may be answered an error message with the error code :

EVT_EN_COURS_ECRIT (5) : An event is being written into the saved FRAM.

Note :

1. On event retrieval, two possibilities exist regarding the event record acknowledgement :
   a) Automatic event record acknowledgement on event retrieval.
   b) Non automatic event record acknowledgement on event retrieval.
2. Those two settings are kept in case of relay reset.
3. Automatic event record acknowledgement works for RS485 communication ports only. Events record acknowledgement is not applied for communication via USB port .

a) Automatic event record acknowledgement on event retrieval :

The bit12 of the remote order frame (format F38 – mapping address 0400h) shall be set to 0. On event retrieval, this event record is acknowledged.

b) Non automatic event record acknowledgement on event retrieval :

The bit12 of the remote order frame (format F38 – mapping address 0400h) shall be set to 1. On event retrieval, this event record is not acknowledged. To acknowledge this event, an other remote order shall be sent to the relay. The bit 13 of this frame (format F38 – mapping address 0400h) shall be set to 1.

2.4.21 Request to retrieve a dedicated event

Slave number	Function code	Word address	Word number	CRC
xx	03h	Refer to mapping	00 09h	xx xx

This event request may be answered an error message with the error code :

EVT_EN_COURS_ECRIT (5) : An event is being written into the saved FRAM.

Note : This event retrieval does not acknowledge this event.

2.4.22 Modbus request definition used to retrieve the fault records

Two ways can be followed to retrieve a fault record :

- Send a request to retrieve the oldest non-acknowledge fault record.
- Send a request to retrieve a dedicated fault record.

2.4.22.1 Request to retrieve the oldest non-acknowledge fault record

Slave number	Function code	Word address	Word number	CRC

CT

xx	03h	3Eh 00	00 0Fh	xx xx

Note : On fault retrieval, two possibilities exist regarding the fault record acknowledgement:
a) Automatic fault record acknowledgement on event retrieval.
b) Non automatic fault record acknowledgement on event retrieval.

a) Automatic fault record acknowledgement on fault retrieval :

The bit12 of the remote order frame (format F38 – mapping address 0400h) shall be set to 0. On fault retrieval, this fault record is acknowledged.

b) Non automatic fault record acknowledgement on fault retrieval :

The bit12 of the remote order frame (format F38 – mapping address 0400h) shall be set to 1. On fault retrieval, this fault record is not acknowledged.
To acknowledge this fault, an other remote order shall be sent to the relay. The bit 14 of this frame (format F38 – mapping address 0400h) shall be set to 1.

2.4.22.2 Request to retrieve a dedicated fault record

Slave number	Function code	Word address	Word number	CRC
xx	03h	Refer to mapping	00 0Fh	xx xx

Note : This fault value retrieval does not acknowledge this fault record.

3. IEC60870-5-103 INTERFACE

The IEC60870-5-103 interface is a master/slave interface with the relay as the slave device. This protocol is based on the VDEW communication protocol. The relay conforms to compatibility level 2, compatibility level 3 is not supported.

The following IEC60870-5-103 facilities are supported by this interface:

Initialisation (Reset)

Time Synchronisation

Event Record Extraction

General Interrogation

Cyclic Measurements

General Commands

Physical connection and link layer

Connection is available for IEC60870-5-103 through the rear RS485 port. It is possible to select both the relay address and baud rate using the front panel interface. Following a change, a reset command is required to re-establish communications.

The parameters of the communication are the following:

Even Parity

8 Data bits

1 stop bit

Data rate 9600 or 19200 bauds

Initialisation

Initialisation is implemented according to clause 7.4.1 of IEC 60870-5-103.

Whenever the relay has been powered up, or if the communication parameters have been changed a reset command is required to initialise the communications. The relay will respond to either of the two reset commands (Reset CU or Reset FCB), the difference being that the Reset CU will clear any unsent messages in the relay's transmit buffer.

The relay will respond to the reset command with an identification message ASDU 5, the Cause Of Transmission COT of this response will be either Reset CU or Reset FCB depending on the nature of the reset command. The following information will be contained in the data section of this ASDU:

Manufacturer Name: SE MiCOM

According to the specification "Communication Architecture (ACA), Part 4: Communication based on IEC 60870-5-103" (Issue H, April 2010) the Software Identification Section will contain the relay model number and the version number to identify the type of relay.

Software Identification Section, Byte 0:	Numerical part of device type, hex, low
Software Identification Section, Byte 1:	Numerical part of device type, hex, low
Software Identification Section, Byte 2:	Software version, hex, low
Software Identification Section, Byte 3:	Software version, hex, high

Letters in the software version are converted to numerical values according to the following rule: A=0, B=1, C=2, D=3 etc.

The Software Identification Section of P116, version 1A, will then contain '116' and '10' as hexadecimal coded values:

Byte 0: 74H

Byte 1: 00H

Byte 2: 10H

Byte 3: 00H

In addition to the above identification message, if the relay has been powered up it will also produce a power up event.

Time synchronisation

Time synchronisation is implemented according to clause 7.4.2 of IEC 60870-5-103.

The relay time and date can be set using the time synchronisation feature of the IEC60870-5-103 protocol. The relay will correct for the transmission delay as specified in IEC60870-5-103. If the time synchronisation message is sent as a send/confirm message then the relay will respond with a confirm. Whether the time synchronisation message is sent as a send confirm or a broadcast (send/no reply) message, a time synchronisation message will be returned as Class 1 data.

Spontaneous events

The events created by the relay will be passed to the master station using the compatible range and the private range of IEC 60870-5-103 function types and information numbers.

Events are categorised using the following information:

Common Address

Function Type

Information number

3.10-3.14 contains a complete listing of all events produced by the relay.

General interrogation

General interrogation is implemented according to clause 7.4.3 of IEC 60870-5-103.

The GI request can be used to read the status of the relay, the function numbers, information numbers and common address offsets that will be returned during the GI cycle are indicated in 3.10-3.14.

Cyclic measurements

The relay will produce measured values using ASDU 3 and ASDU 9 on a cyclical basis. They can be read from the relay using a Class 2 poll.

It should be noted that the measurands transmitted by the relay are sent as a proportion of 2.4 times the rated value of the analogue value. The selection of 2.4 for a particular value is indicated in 3.10-3.14.

Commands

Command transmission is implemented according to clause 7.4.4 of IEC 60870-5-103.

A list of the supported commands is contained in 3.10-3.14. The relay will respond to all other commands with an ASDU 1, with a cause of transmission (COT) of negative acknowledgement of a command

Blocking of monitor direction

The relay does not support a facility to block messages in the Monitor direction.

Spontaneous messages managed by MiCOM P116

These messages includes a sub-assembly of events which are generated on the relay, because some generated events are not registered in VDEW. They are the most priority messages.

An event is always generated on the rising edge of the information.

Some events can be generated on the rising or lowering edge.

In the list below, events only generated on rising edge will be tagged with a ‘*’.

The following list of processed events contains the messages for the compatible and the private range.for all Overcurrent protection functions, with the associated FUNCTION TYPE, INFORMATION NUMBER, ASDU TYPE, CAUSE OF TRANSMISSION

FUN <160>: Function type in Public range for Overcurrent Protections (compatible).

FUN <162> ,<163>, <164>, <165>, <168>:: Function type in Private range (Reserved for Overcurrent Protections).

Status indications in monitor direction (Type Identification 1)

Indication (LEDs+Flags) reset: FUN<160>;INF <19>; COT<1,7,11,12,20,21>; <ADDR>,*

Reset Latch. Sign Inp FUN<162>;INF<223>; COT<1,7>,<ADDR>*

Reset Latched Outputs (Inp+COM): FUN<162>; INF<46>; COT<1,7,11,12,20,21>,<ADDR>*

Reset Latched Signaling. and Outputs(HMI+COM):
FUN<249>;INF<131>;COT<1,7,11,12,20,21>,<ADDR>*

Reset Latched Outputs (Inp); FUN<162>; INF <86>; COT<1,7>,<ADDR>*

Maintenance (Test) Mode Inp; FUN<162>; INF <157>; COT<1,7>,<ADDR>

Maintenance Mode (Test Mode): FUN<160>; INF<21>; COT<11> <ADDR>

Local Mode : FUN<160> ; INF<22> ; COT <11> <ADDR>

Relay Blocked/faulty (Hardware Warning); FUN<160>;INF <47>; COT<1,7>,<ADDR>

Setting Group number 1: FUN<160>;INF <23>; COT<1,7,11,12,20,21>,<ADDR>

Setting Group number 2: FUN<160>;INF <24>; COT<1,7,11,12,20,21>,<ADDR>

Order Command 1: FUN<249>;INF <129>; COT<1,7,12,20,21>,<ADDR>*

Order Command 2: FUN<249>;INF <130>; COT<1,7,12,20,21>,<ADDR>*

Auxiliary input AUX1: FUN<160>;INF <27>; COT<1,7,11>,<ADDR>

Auxiliary input AUX2: FUN<160>;INF <28>; COT<1,7,11>,<ADDR>

Auxiliary input AUX3: FUN<160>;INF <29>; COT<1,7,11>,<ADDR>

Auxiliary input AUX4: FUN<160>;INF <30>; COT<1,7,11>,<ADDR>

Auxiliary input AUX5: FUN<163>;INF <81>; COT<1,7,11>,<ADDR>

Auxiliary input AUX6: FUN<163>;INF <82>; COT<1,7,11>,<ADDR>

Input 1: FUN<163>;INF <160>; COT<1,7>,<ADDR>

(Presence of the voltage on the input terminals)

Input 2: FUN<163>;INF <161>; COT<1,7>,<ADDR>

(Presence of the voltage on the input terminals)

Input 3: FUN<163>;INF <162>; COT<1,7>,<ADDR>

(Presence of the voltage on the input terminals)

Input 4: FUN<163>;INF <163>; COT<1,7>,<ADDR>

(Presence of the voltage on the input terminals)

Input 5: FUN<163>;INF <164>; COT<1,7>,<ADDR>

(Presence of the voltage on the input terminals)

Input 6: FUN<163>;INF <165>; COT<1,7>,<ADDR>

(Presence of the voltage on the input terminals)

Logical output 1: FUN<249>;INF <1,7>,<ADDR>

(Logical state of the output - before Reverse Logic. Logical state of the output can differ from Physical state - terminals if Reverse Logic for this output is set)

Logical output 2: FUN<249>;INF <2>; COT<1,7>,<ADDR>

(Logical state of the output - before Reverse Logic. Logical state of the output can differ from Physical state - terminals if Reverse Logic for this output is set)

Logical output 3: FUN<249>;INF <3>; COT<1,7>,<ADDR>

(Logical state of the output - before Reverse Logic. Logical state of the output can differ from Physical state - terminals if Reverse Logic for this output is set)

Logical output 4: FUN<249>;INF <4>; COT<1,7>,<ADDR>

(Logical state of the output - before Reverse Logic. Logical state of the output can differ from Physical state - terminals if Reverse Logic for this output is set)

Logical output 5: FUN<249>;INF <5>; COT<1,7>,<ADDR>

(Logical state of the output - before Reverse Logic. Logical state of the output can differ from Physical state - terminals if Reverse Logic for this output is set)

Logical output 6: FUN<249>;INF <6>; COT<1,7>,<ADDR>

(Logical state of the output - before Reverse Logic. Logical state of the output can differ from Physical state - terminals if Reverse Logic for this output is set)

Therm: Starting Itherm>: FUN<162>; INF<194>; COT<1,7>,<ADDR>

Therm: Trip signal: FUN<162>; INF<67>; COT<1,7>,<ADDR>*

Therm: Reset Theta Val. (Inp); FUN<162>; INF <234>; COT<1,7>,<ADDR>*

Therm: Thermal Alarm; FUN<162>; INF <226>; COT<1,7>,<ADDR>

Therm: Reset replica (HMI+RS485+Inp); FUN<162>; INF <231>; COT<1,7>,<ADDR>*

Term: Block Itherm Ext (Inp); FUN<162>;INF <214>; COT<1,7>,<ADDR>

37: Blocking tI< Ext (Inp); FUN<165>;INF <10>; COT<1,7>,<ADDR>

46 Blocking tI2> Ext (Inp); FUN<162>;INF <38>; COT<1,7>,<ADDR>

SOTF: Blocking tSOTF Ext (Inp); FUN< 165 >;INF < 34 >; COT<1,7>,<ADDR>

46BC Blocking tBrkCond Ext (Inp); FUN<165>;INF <35>; COT<1,7>,<ADDR>

AUX: Blocking tAUX1 Ext (Inp); FUN<165>;INF <36>; COT<1,7>,<ADDR>

AUX: Blocking tAUX2 Ext (Inp); FUN<165>;INF <37>; COT<1,7>,<ADDR>

AUX: Blocking tAUX3 Ext (Inp); FUN<165>;INF <38>; COT<1,7>,<ADDR>

ARC: CB drive ready Ext (Inp) : FUN<162>; INF<150>; COT<1,7>,<ADDR>

ARC: Blocked/Lockout FUN<162>; INF<185>; COT<1,7>,<ADDR>

(Blocked = Tempor.Block or Lockout or Block:CTRL or Block:Input or Disabled)

ARC: Enabled FUN<160>; INF<16>; COT<1,7,11,12,20,21>,<ADDR>

(Enabled = NOT(Block:CTRL or Block:Input or Disabled))

ARC: Reclaim time running; FUN<162>; INF<218>; COT<1,7>,<ADDR>

ARC: Blocking EXT (Inp); FUN<162>; INF<152>; COT<1,7>,<ADDR>

ARC: Reclosure successful; FUN<163>; INF<73>; COT<1,7>,<ADDR>

ARC: Reclosure final trip; FUN<165>; INF<40>; COT<1,7>,<ADDR>

ARC: Running; FUN<162>; INF<233>; COT<1,7>,<ADDR>

ARC: Dead time runn; FUN<162>; INF<236>; COT<1,7>,<ADDR>

ARC: (Re)close signal close (first shot); FUN<160>; INF<128>; COT<1,7>,<ADDR>*

ARC: (Re)close signal closes (2nd to 4th shot) FUN<160>; INF<129>; COT<1,7>,<ADDR>*

ARC: Fast Trip Phase; FUN<165>; INF<41>; COT<1,7>,<ADDR>*

ARC: Fast Trip Earth; FUN<165>; INF<42>; COT<1,7>,<ADDR>*

ARC: Not ready; FUN<160>; INF<130>; COT<1,7>,<ADDR>

ARC: Ext./user enabled; FUN<162>; INF<144>; COT<1,7>,<ADDR>

(Ext./user Enabled = NOT(Block:CTRL or Block:Input))

ARC: Recloser Lockout; FUN<165>; INF<43>; COT<1,7>,<ADDR>

(Lockout: ARC internally blocked up to Signalling reset)

ARC: Recloser Rolling Demand Alarm; FUN<165>; INF<44>; COT<1,7>,<ADDR>

(too many of ARC cycles in settable monitoring window)

Manual. Trip Ext (Inp); FUN<162>; INF <148>; COT<1,7>,<ADDR>*

Trip CB Order (Inp+HMI+RS485); FUN<162>; INF <9>; COT<1,7>,<ADDR>*

Manual. Close Ext (Inp); FUN<162>; INF <47>; COT<1,7>,<ADDR>*

Manual. Close Command (Inp+HMI); FUN<162>; INF <246>; COT<1,7>,<ADDR>*

Close CB Order (Inp+HMI+RS485+79); FUN<162>; INF <239>; COT<1,7>,<ADDR>*

CB Status 52A Inp; FUN<163>; INF <253>; COT<1,7>,<ADDR>

CBM: CB Trip Number Diagnostic Alarm ; FUN<164>;INF <210>; COT<1,7>,<ADDR>

CBM: CB Trip Current Diagnostic Alarm; FUN<164>;INF <212>; COT<1,7>,<ADDR>

CBM: tCB FLT (faulty) Ext. Alarm; FUN<165>;INF <45>; COT<1,7>,<ADDR>

CBM: TCS Trip Curcuit Supervision Alarm; FUN<165>;INF <16>; COT<1,7>,<ADDR>

CBM: CB Time Monitoring Alarm; FUN<165>;INF <46>; COT<1,7>,<ADDR>*

CBM: State of CB (not correct) ALARM; FUN<165>;INF <47>; COT<1,7>,<ADDR>

FT_RC: Faulty time tag; FUN<163>; INF <74>; COT<1,7>,<ADDR>*

Fault Indications in monitor direction (Type Identification 2)

General Start / pick-up I>, I>>, I>>>, SOTF, IN_1, IN_2, IN_3; FUN<160>;INF <84>; COT<1,7>,<ADDR>

General Trip : FUN<160>;INF <68>; COT<1,7>,<ADDR>,*

Start / pick-up A; FUN<160>; INF <64>; COT<1,7>,<ADDR>

50/51: Start / pick-up B; FUN<160>; INF <65>; COT<1,7>,<ADDR>

50/51: Start / pick-up C; FUN<160>; INF <66>; COT<1,7>,<ADDR>

50/51: Start / pick-up N; FUN<160>; INF <67>; COT<1,7>,<ADDR>

Inrush restr. trig.; FUN<165>;INF <48>; COT<1,7>,<ADDR>

50/51: Start / pick-up I>: FUN<162>;INF <111>; COT<1,7>,<ADDR>

50/51: Blocking tI> Ext (Inp); FUN<162>;INF <32>; COT<1,7>,<ADDR>

50/51: tI> elapsed; FUN<162>; INF <169>; COT<1,7>,<ADDR>*

50/51: Trip tI>: FUN<160>;INF <90>; COT<1,7>,<ADDR>,*

50/51: Start / pick-up I>>: FUN<162>;INF <96>; COT<1,7>,<ADDR>

50/51: Blocking tI>> Ext (Inp); FUN<162>;INF <33>; COT<1,7>,<ADDR>

50/51: tI>> elapsed; FUN<162>; INF <162>; COT<1,7>,<ADDR>*

50/51: Trip tI>>: FUN<160>;INF <91>; COT<1,7>,<ADDR>,*

50/51: Start / pick-up I>>>: FUN<162>;INF <56>; COT<1,7>,<ADDR>

50/51: Blocking tI>>> Ext (Inp); FUN<162>;INF <82>; COT<1,7>,<ADDR>

50/51: tI>>> elapsed; FUN<162>; INF <163>; COT<1,7>,<ADDR>*

50/51: Trip tI>>>: FUN<162>;INF <141>; COT<1,7>,<ADDR>,*

SOTF: Start / pick-up SOTF: FUN<165>;INF <32>; COT<1,7>,<ADDR>

SOTF: tSOTF elapsed; FUN<165>; INF<33>; COT<1,7>,<ADDR>*

SOTF: Trip tSOTF: FUN< 162 >;INF < 211 >; COT<1,7>,<ADDR>,*

50/51N: Start / pick-up IN_1 stage (IN>): FUN<162>;INF <114>; COT<1,7>,<ADDR>

50/51N: Blocking t N_1 stage (IN>) Ext (Inp); FUN<162>;INF <83>; COT<1,7>,<ADDR>

50/51N: t IN_1 stage (IN>) elapsed; FUN<162>; INF <164>; COT<1,7>,<ADDR>*

50/51N: Trip tIN_1 stage (IN>): FUN<160>;INF <92>; COT<1,7>,<ADDR>,*

50/51N: Start / pick-up IN_2 stage (IN>>): FUN<162>;INF <97>; COT<1,7>,<ADDR>

50/51N: Blocking t IN_2 stage (IN>>) Ext (Inp); FUN<162>;INF <84>; COT<1,7>,<ADDR>

50/51N: t IN_2 stage (IN>>) elapsed; FUN<162>; INF <186>; COT<1,7>,<ADDR> *

50/51N: Trip tIN_2 stage (IN>>): FUN<160>;INF <93>; COT<1,7>,<ADDR>,*

50/51N: Start / pick-up IN_3 stage (IN>>>): FUN<162>; INF<57>; COT<1,7>,<ADDR>

50/51N: Blocking tIN_3 stage (IN>>>) Ext (Inp); FUN<162>;INF <85>; COT<1,7>,<ADDR>

50/51N: tIN_3 stage (IN>>>) elapsed; FUN<162>; INF <74>; COT<1,7>,<ADDR>*

50/51N: Trip signal tIN_3 stage (IN>>>): FUN<162>; INF<93>; COT<1,7>,<ADDR>*

37: Start / pick-up I<: FUN<165>; INF<11>; COT<1,7>,<ADDR>

37: tI< elapsed; FUN<165>;INF <12>; COT<1,7>,<ADDR>*

37: Trip signal tI<; FUN<165>; INF<13>; COT<1,7>,<ADDR>*

46: Start / pick-up I2>; FUN<162>; INF <41>; COT<1,7>,<ADDR>

46: tI2> elapsed; FUN<162>; INF <182>; COT<1,7>,<ADDR>*

46: Trip signal tI2>; FUN<162>; INF<171>; COT<1,7>,<ADDR>*

46BC: Start / pick-up BrkCond; FUN<165>; INF <15>; COT<1,7>,<ADDR>

46BC: tBrkCond elapsed; FUN<165>; INF <49>; COT<1,7>,<ADDR>*

46BC: Trip signal tBrkCond; FUN<165>; INF<17>; COT<1,7>,<ADDR>*

CBF: CBF running; FUN<164>; INF <240>; COT<1,7>,<ADDR>*

CBF: Start tBF (Inp): FUN<165>; INF<20>; COT<1,7>,<ADDR>

CBF: tCBF elapsed: FUN<160>; INF<85>; COT<1,7>,<ADDR>*

CBF: Trip signal CBF: FUN<164>; INF<241>; COT<1,7>,<ADDR>*

AUX: Start AUX1: FUN<163>;INF <93>; COT<1,7>,<ADDR>

AUX: tAUX1 elapsed: FUN<163>;INF <94>; COT<1,7>,<ADDR>

AUX: Trip tAUX1: FUN<165>;INF <22>; COT<1,7>,<ADDR>*

AUX: Start AUX2: FUN<163>;INF <95>; COT<1,7>,<ADDR>

AUX: tAUX2 elapsed: FUN<163>;INF <96>; COT<1,7>,<ADDR>

AUX: Trip tAUX2: FUN<165>;INF <23>; COT<1,7>,<ADDR> *

AUX: Start AUX3: FUN<163>;INF <97>; COT<1,7>,<ADDR>

AUX: tAUX3 elapsed: FUN<163>;INF <98>; COT<1,7>,<ADDR>

AUX: Trip tAUX3: FUN<165>;INF <24>; COT<1,7>,<ADDR>*

AUX: Start AUX4: FUN<163>;INF <99>; COT<1,7>,<ADDR>

AUX: tAUX4 elapsed: FUN<163>;INF <100>; COT<1,7>,<ADDR>

AUX: Trip tAUX4: FUN<165>;INF <25>; COT<1,7>,<ADDR> *

FT_RC:System disturb. runn; FUN<162>; INF <241>; COT<1,7>,<ADDR>

FT_RC: Record. in progress; FUN<162>; INF <220>; COT<1,7>,<ADDR>

FT_RC: Start Distur. Recorder INP+COM; FUN<162>; INF <172>; COT<1,7>,<ADDR>

FT_RC: Trigger INP; FUN<162>; INF <22>; COT<1,7>,<ADDR>

Control indications in monitor direction:

CB monitoring : FUN<242>;INF <1>; COT<1, 7,11>,<ADDR>

NOTE: The value of CB monitoring DPI can have 4 stages:

DPI
<0000 0000> "Undefined / Between closed and opened"

<0000 0001> "opened"

<0000 0010> "closed"

<0000 0011> "Undefined / Faulty"

List of data contained in General Interrogation

It is given in the answer to the General Interrogation (GI).

Relay state information are Class 1 data, they are systematically sent to the master station, during a General Interrogation.

The list of processed data, following a General Interrogation, is given below: it is a sub-assembly of the spontaneous message list, so like spontaneous messages, these data are generated on rising and lowering edge.

Status indications (monitor direction):

Maintenance (Test) Mode Inp; FUN<162>; INF <157>; COT<9>,<ADDR>

Maintenance Mode (Test Mode): FUN<160>; INF<21>; COT<9> <ADDR>

Local Mode : FUN<160> ; INF<22> ; COT <9> <ADDR>

Relay Blocked/faulty (Hardware Warning); FUN<160>;INF <47>; COT<9>,<ADDR>

Setting Group number 1: FUN<160>;INF <23>; COT<9>,<ADDR>

Setting Group number 2: FUN<160>;INF <24>; COT<9>,<ADDR>

Auxiliary input AUX1: FUN<160>;INF <27>; COT<9>,<ADDR>

Auxiliary input AUX2: FUN<160>;INF <28>; COT<9>,<ADDR>

Auxiliary input AUX3: FUN<160>;INF <29>; COT<9>,<ADDR>

Auxiliary input AUX4: FUN<160>;INF <30>; COT<9>,<ADDR>

Auxiliary input AUX5: FUN<163>;INF <81>; COT<9>,<ADDR>

Auxiliary input AUX6: FUN<163>;INF <82>; COT<9>,<ADDR>

Input 1: FUN<163>;INF <160>; COT<9>,<ADDR>

(Presence of the voltage on the input terminals)

Input 2: FUN<163>;INF <161>; COT<9>,<ADDR>

(Presence of the voltage on the input terminals)

Input 3: FUN<163>;INF <162>; COT<9>,<ADDR>

(Presence of the voltage on the input terminals)

Input 4: FUN<163>;INF <163>; COT<9>,<ADDR>

(Presence of the voltage on the input terminals)

Input 5: FUN<163>;INF <164>; COT<9>,<ADDR>

(Presence of the voltage on the input terminals)

Input 6: FUN<163>;INF <165>; COT<9>,<ADDR>

(Presence of the voltage on the input terminals)

Logical output 1: FUN<249>;INF <1>; COT<9>,<ADDR>

(Logical state of the output - before Reverse Logic. Logical state of the output can differ from Physical state - terminals if Reverse Logic for this output is set)

Logical output 2: FUN<249>;INF <2>; COT<9>,<ADDR>

(Logical state of the output - before Reverse Logic. Logical state of the output can differ from Physical state - terminals if Reverse Logic for this output is set)

Logical output 3: FUN<249>;INF <3>; COT<9>,<ADDR>

(Logical state of the output - before Reverse Logic. Logical state of the output can differ from Physical state - terminals if Reverse Logic for this output is set)

Logical output 4: FUN<249>;INF <4>; COT<9>,<ADDR>

(Logical state of the output - before Reverse Logic. Logical state of the output can differ from Physical state - terminals if Reverse Logic for this output is set)

Logical output 5: FUN<249>;INF <5>; COT<9>,<ADDR>

(Logical state of the output - before Reverse Logic. Logical state of the output can differ from Physical state - terminals if Reverse Logic for this output is set)

Logical output 6: FUN<249>;INF <6>; COT<9>,<ADDR>

(Logical state of the output - before Reverse Logic. Logical state of the output can differ from Physical state - terminals if Reverse Logic for this output is set)

Therm: Starting Itherm>: FUN<162>; INF<194>; COT<9>,<ADDR>

Therm: Thermal Alarm; FUN<162>; INF <226>; COT<9>,<ADDR>

Term: Block Itherm Inp; FUN<162>;INF <214>; COT<9>,<ADDR>

37: Blocking tI< Ext (Inp); FUN<165>;INF <10>; COT<9>,<ADDR>

46 Blocking tI2> Inp; FUN<162>;INF <38>; COT<9>,<ADDR>

SOTF: Blocking tSOTF Ext (Inp); FUN< 165 >;INF < 34 >; COT<9>,<ADDR>

46BC Blocking tBrkCond Inp; FUN<165>;INF <35>; COT<9>,<ADDR>

AUX: Blocking tAUX1 Ext (Inp); FUN<165>;INF <36>; COT<9>,<ADDR>

AUX: Blocking tAUX2 Ext (Inp); FUN<165>;INF <37>; COT<9>,<ADDR>

AUX: Blocking tAUX3 Ext (Inp); FUN<165>;INF <38>; COT<9>,<ADDR>

ARC: CB drive ready Ext (Inp) : FUN<162>; INF<150>; COT<9>,<ADDR>

ARC: Blocked/Lockout FUN<162>; INF<185>; COT<9>,<ADDR>

(Blocked = Tempor.Block or Lockout or Block:CTRL or Block:Input or Disabled)

ARC: Enabled FUN<160>; INF<16>; COT<9>,<ADDR>

(Enabled = NOT(Block:CTRL or Block:Input or Disabled))

ARC: Reclaim time running; FUN<162>; INF<218>; COT<9>,<ADDR>

ARC: Blocking EXT (Inp); FUN<162>; INF<152>; COT<9>,<ADDR>

ARC: Reclosure successful; FUN<163>; INF<73>; COT<9>,<ADDR>

ARC: Reclosure final trip; FUN<165>; INF<40>; COT<9>,<ADDR>

ARC: Running; FUN<162>; INF<233>; COT<9>,<ADDR>

ARC: Dead time runn; FUN<162>; INF<236>; COT<9>,<ADDR>

ARC: Fast Trip Phase; FUN<165>; INF<41>; COT<9>,<ADDR>

ARC: Fast Trip Earth; FUN<165>; INF<42>; COT<9>,<ADDR>

ARC: Not ready; FUN<160>; INF<130>; COT<9>,<ADDR>

ARC: Ext./user enabled; FUN<162>; INF<144>; COT<9>,<ADDR>

(Ext./user Enabled = NOT(Block:CTRL or Block:Input))

ARC: Recloser Lockout; FUN<165>; INF<43>; COT<9>,<ADDR>

(Lockout: ARC internally blocked up to Signalling reset)

ARC: Recloser Rolling Demand Alarm; FUN<165>; INF<44>; COT<9>,<ADDR>

(too many of ARC cycles in settable monitoring window)

CB Status 52A Inp; FUN<163>; INF <253>; COT<9>,<ADDR>

CBM: CB Trip Number Diagnostic Alarm ; FUN<164>;INF <210>; COT<9>,<ADDR>

CBM: CB Trip Current Diagnostic Alarm; FUN<164>;INF <212>; COT<9>,<ADDR>

CBM: tCB FLT (faulty) Ext. Alarm; FUN<165>;INF <45>; COT<9>,<ADDR>

CBM: TCS Trip Curcuit Supervision Alarm; FUN<165>;INF <16>; COT<9>,<ADDR>

CBM: State of CB (not correct) ALARM; FUN<165>;INF <47>; COT<9>,<ADDR>

Fault Indications in monitor direction

General Start / pick-up I>, I>>, I>>>, SOTF: FUN<160>;INF <84>; COT<9>,<ADDR>

Start / pick-up A; FUN<160>; INF <64>; COT<9>,<ADDR>

50/51: Start / pick-up B; FUN<160>; INF <65>; COT<9>,<ADDR>

50/51: Start / pick-up C; FUN<160>; INF <66>; COT<9>,<ADDR>

50/51: Start / pick-up N; FUN<160>; INF <67>; COT<9>,<ADDR>

Inrush restr. trig.; FUN<165>;INF <48>; COT<9>,<ADDR>

50/51: Start / pick-up I>: FUN<162>;INF <111>; COT<9>,<ADDR>

50/51: Blocking tI> Ext (Inp); FUN<162>;INF <32>; COT<9>,<ADDR>

50/51: Start / pick-up I>>: FUN<162>;INF <96>; COT<9>,<ADDR>

50/51: Blocking tI>> Ext (Inp); FUN<162>;INF <33>; COT<9>,<ADDR>

50/51: Start / pick-up I>>>: FUN<162>;INF <56>; COT<9>,<ADDR>

50/51: Blocking tI>>> Ext (Inp); FUN<162>;INF <82>; COT<9>,<ADDR>

SOTF: Start / pick-up SOTF: FUN<165>;INF <32>; COT<9>,<ADDR>

50/51N: Start / pick-up IN_1 stage (IN>): FUN<162>;INF <114>; COT<9>,<ADDR>

50/51N: Blocking t N_1 stage (IN>) Ext (Inp); FUN<162>;INF <83>; COT<9>,<ADDR>

50/51N: Start / pick-up IN_2 stage (IN>>): FUN<162>;INF <97>; COT<9>,<ADDR>

50/51N: Blocking t IN_2 stage (IN>>) Ext (Inp); FUN<162>;INF <84>; COT<9>,<ADDR>

50/51N: Start / pick-up IN_3 stage (IN>>>): FUN<162>; INF<57>; COT<9>,<ADDR>

50/51N: Blocking tIN_3 stage (IN>>>) Ext (Inp); FUN<162>;INF <85>; COT<9>,<ADDR>

37: Start / pick-up I<: FUN<165>; INF<11>; COT<9>,<ADDR>

46: Start / pick-up I2>; FUN<162>; INF <41>; COT<9>,<ADDR>

46BC: Start / pick-up BrkCond; FUN<165>; INF <15>; COT<9>,<ADDR>

CBF: Start tBF (Inp): FUN<165>; INF<20>; COT<1,7>,<ADDR>

AUX: Start AUX1: FUN<163>;INF <93>; COT<9>,<ADDR>

AUX: tAUX1 elapsed: FUN<163>;INF <94>; COT<9>,<ADDR>

AUX: Start AUX2: FUN<163>;INF <95>; COT<9>,<ADDR>

AUX: tAUX2 elapsed: FUN<163>;INF <96>; COT<9>,<ADDR>

AUX: Start AUX3: FUN<163>;INF <97>; COT<9>,<ADDR>

AUX: tAUX3 elapsed: FUN<163>;INF <98>; COT<9>,<ADDR>

AUX: Start AUX4: FUN<163>;INF <99>; COT<9>,<ADDR>

AUX: tAUX4 elapsed: FUN<163>;INF <100>; COT<9>,<ADDR>

FT_RC:System disturb. runn; FUN<162>; INF <241>; COT<9>,<ADDR>

FT_RC: Record. in progress; FUN<162>; INF <220>; COT<9>,<ADDR>

FT_RC: Start Distur. Recorder INP; FUN<162>; INF <172>; COT<9>,<ADDR>

FT_RC: Trigger; FUN<162>; INF <22>; COT<9>,<ADDR>

Control indications in monitor direction:

CB monitoring : FUN<242>;INF <1>; COT<9>,<ADDR>

NOTE: The value of CB monitoring DPI can have 4 stages:

DPI	
<0000 0000>	"Undefined / Between closed and opened"
<0000 0001>	"opened"
<0000 0010>	"closed"
<0000 0011>	"Undefined / Faulty"

CT

Processed Commands

System Commands:

Synchronization Command (ASDU 6): FUN<255>,INF <0>; TYP <6>;COT<8>

This command can be sent to a specific relay, or global. The time sent by master is the time of the first bit of the frame. The relay synchronizes with this time, corrected by the frame transmission delay. After updating its time, the relay send back an acknowledge to the master, by giving its new current time.

This acknowledge message will be an event of ASDU 6 type.

General Interrogation Initialization command (ASDU 7):

FUN<255>;INF <0>;TYP <7>; COT<9>

This command starts the relay interrogation:

The relay then sends a list of data containing the relay state (see list described above).

The GI command contains a scan number which will be included in the answers of the GI cycle generated by the GI command.

If a data has just changed before extracted by the GI, the new state is sent to the master station.

When an event is generated during the GI cycle, the event is sent in priority, and the GI cycle is temporarily interrupted. The end of the GI consists in sending an ASDU 8 to the master station.

If, during a General Interrogation cycle, another GI Initialization command is received, the precedent answer is stopped, and the new GI cycle started.

General Commands (ASDU 20) (Control direction): Availability

LED Reset and Sign. reset:
This command reset LEDs, signaling:
FUN<160>;INF<19>, TYP<20>, COT <20>,<ADDR>

In LED Reset control command the allowed value is:

DCO <0000 0010> "Reset"

Output Reset:
This command reset Latched Outputs:
FUN<162>;INF<46>, TYP<20>, COT <20>,<ADDR>

In Latched Outputs Reset control command the allowed value is:

DCO <0000 0010> "Reset"

Setting group number 1: FUN<160>;INF<23>, TYP<20>, COT <20>,<ADDR>

In Setting group number 1 control command the allowed value is:

DCO <0000 0010> "Set Group 1”

CT

Setting group number 2: FUN<160>;INF<24>, TYP<20>, COT <20>,<ADDR>

In Setting group number 2 control command the allowed value is:

DCO <0000 0010> "Set Group 2”

Order Command 1: FUN<249>;INF <129>; COT<20>,<ADDR>

In Order Command 1 control command the allowed value is:

DCO <0000 0001> “OFF”

DCO <0000 0010> “ON”

Order Command 2: FUN<249>;INF <130>; COT<20>,<ADDR>

In Order Command 2 control command the allowed value is:

DCO <0000 0001> “OFF”

DCO <0000 0010> “ON”

Reset Latched Signaling and Outputs : FUN<249>;INF <131>; COT<20>,<ADDR>
Note: *Reset Latched Signaling and Outputs* is used for command and indication (see: ***Status indications in monitor direction Type Identification***).

Reset via RS485 the allowed value is:

DCO <0000 0001> “OFF”

DCO <0000 0010> “ON”

CB control Open command : FUN<242>;INF <65>; TYP <20>; COT<20>,<ADDR>

In CB control command the DCO allowed values are:

DCO <0000 0001> “OFF”: "Close CB"

<0000 0010> “ON”: "Open CB"

CB control Close command FUN<242>;INF <66>; TYP <20>; COT<20>,<ADDR>

In CB control command the DCO allowed values are:

DCO <0000 0001> “OFF”:"Open CB"

<0000 0010> “ON”: "Close CB"

ARC: Enabled FUN<160>; INF<16>; COT<20>,<ADDR>

Note: ARC: Enabled is used for command and indication (see: ***Status indications in monitor direction Type Identification***).

In ARC: Enabled command the DCO allowed values are:

DCO <0000 0001> "OFF"

<0000 0010> "ON"

General commands are processed according to clause 7.4.4 of IEC 60870-5-103.

After executing one of these commands, the relay sends an positive or negative acknowledge message, which contains the result of command execution.

If a state change is the consequence of the command, it must be sent in a ASDU 1 with COT 12 (remote operation).

If the relay receives another command message from the master station before sending the acknowledge message for the previous command, it will be discarded and a negative acknowledge message will be sent.

Commands which are not processed by the relay are rejected with a negative acknowledge message.

Relay re initialization

In case of relay re initialization, the relay send to the master station:

A message indicating relay start/restart (FUN<160>;INF <5>; TYP <5> COT <5>) or a message indicating Reset CU (FUN<160>;INF <5>; TYP <3> COT <4>) or a message indicating Reset FCB (FUN<160>;INF <5>; TYP <2> COT <3>)

Manufacturer name and software indentification see 0

Cyclic Messages (ASDU9 and ASDU3)

Only measurements can be stored in these messages.

The measured values are stored in lower levels of communication, before polling by master station.

Ia, Ib, Ic are transmitted with ASDU 9 (FUN<160>,INF<148>).

IN is transmitted with ASDU 3(FUN<160>,INF<147>).

All other measurmentss are unused in ASDU 3 and ASDU 9.

The values are stored with a rate of 2,4 * nominal value = 4096.

Thermal Overload value is transmitted with ASDU 3 (FUN<162>,INF<23>).

Scalling: 1% * value (range: 0-200)

FIRMWARE AND SERVICE MANUAL VERSION HISTORY

Date:	**17th November 2013**
Hardware Suffix:	**A**
Software Version:	**1C**
Connection Diagrams:	**10P11602**

Relay type: P116 …

Software Version		Hardware Suffix	Original Date of Issue	Description of Changes	S1 Compatibility	Technical Documentation
Major	Minor					
1	A	A	April 2011	✓ Original Issue	V2.14	P116/EN M/A11
1	B	A	February 2012	1. Editable ***CB MONITORING COUNTER*** 2. ***GLOBAL SETTINGS/LOC:*** Configurable WD contacts (N/O or N/C) 3. ***GLOBAL SETTINGS/LOC:*** Control Keys configuration (with confirmation or without) was added 4. ***GLOBAL SETTINGS/O/C ADVANCED*** column added with following new configuration cell: a. Settable undercurrent stage in [46BC] b. Selectable IDMT interlock by DMT o/c protection elements 1. ***GLOBAL SETTINGS/COMMUNICATION ORDERS: COM2*** configuration – C clear key can be added to COM2 order 2. A new IDMT characteristics are added: RXIDG, BPN EDF 3. In CL PU the current criteria was added (configurable options: ***Curent+Input*** or ***Input***) 4. In Trip Circuit Supervision the new option was added: “2.Yes-52” which can be selected if the Circuit Breaker don’t allow to supervise trip circuit in opened position. 5. The functional tests in ***GLOBAL SETTINGS/COMMISSIONIG*** were added and Maintenance Mode was improved 6. Autoreclose function added		P116/EN M/A11 v2.2
1	C	A	April 2012	1. A new IDMT characteristics are added: CO2: P20 and CO2 P40 2. Current Criteria for Cold Load Pick Up was added 3. A new languages in menu were added: Spanish, French 4. IEC103 and Modbus protocol was improved	Yes	P116/EN M/A11 v2.3

Setting File Software Version	Relay Software Version																									
	1A	1B	1C																							
1A	✓	✓	✓																							
1B	✓	✓	✓																							
1C	✓	✓	✓																							

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