Protection System for Feeder and Motor Protection

Bulletin 857, Series A

Allen-Bradley
by ROCKWELL AUTOMATION

User Manual

Original Instructions

Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

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

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

WARNING: Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.

ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.

IMPORTANT	Identifies information that is critical for successful application and understanding of the product.

Labels may also be on or inside the equipment to provide specific precautions.

SHOCK HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.

BURN HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.

ARC FLASH HAZARD: Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

Chapter 3

Protection Functions

Chapter 4

Support Functions

Measurement Functions

Chapter 5

Control Functions

Chapter 6

Chapter 7

Communications

Chapter 8

Applications

Chapter 9

Connections

Chapter 10

Specifications

Summary of Changes

Topic	Page
Updated Firmware version to 13.01_xx	13
Added IEEE/ANSI code 47	17
Added IEEE/ANSI Very Inverse and Extremely Inverse Delay graphics	161
Corrected the Holding Register values	264, 265
Added footnote around Terminal X3 optional power module	325
Added missing ground point	343

Introduction

The Allen-Bradley® 857 motor and feeder protection system includes the essential protection functions for feeders and motors in distribution networks of utilities, heavy industry, power plants, and offshore applications. The device includes many programmable functions, such as arc protection (option), thermal, trip circuit supervision, and circuit breaker protection and communication protocols for various protection and communication situations.

This user manual contains the following:

- A general description of the functions of the protection system.
- Instructions for the following:
  - Installation
  - Operation
  - Parameterization
  - Configuration
  - Change of settings
- Detailed protection function descriptions.
- Application examples.
- Technical data sheets.

This manual is representative of the latest version of 857 Protection System firmware (13.01_xx and higher). Some features are not available in all previous version of firmware. Contact your Rockwell Automation representative for further details.

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation®.

Resource	Description
SetPointPS Configuration Software Programming Manual, publication 857-PM001	Provides information on configuring, setting up, troubleshooting, and using the SetPointPS communication software
857 Protection System for Feeder and Motor Protection Quick Start, publication 857-QS001	Provides information on mounting, wiring, and installation of the 857 relay
857 Protection System Specification Guide, publication 857-SR001	Provides specifications on protective features, measuring and monitoring, arc flash protection, and cold load pickup monitoring
857-RAA/857-RAD RTD Scanner User Manual, publication 857-UM002	Provides information on layout, wiring, installation, configurations, mounting and I/O
857-VPA3CG PROFIBUS DP Option Module, publication 857-UM003	Provides information on the PROFIBUS option modules, including installation, commissioning, dimensions, and specifications
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, rok.auto/certifications.	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at rok.auto/literature.

Overview

857 Relay Protection System Features

The major features of the 857 Protection System are shown in the following list.

- Digital signal is handled with a 16-bit microprocessor, and 16-bit A/D conversion technique to measure accuracy on all setting ranges.
- Wide setting ranges for the protection functions to a sensitivity of 0.5%.
- Integrated fault location for short circuit faults.
- The Protection System can match the requirements of the application by disabling unneeded functions.
- Flexible control and digital signal control inputs (DI) and outputs (DO) for signal blocking.
- Flexible signal-grouping matrix in the device makes it adaptable to various control and alarm systems.
- Ability to control up to six objects locally (for example circuit-breakers, disconnectors).
- Status of eight objects (for example circuit breakers, disconnectors, switches).
- Configurable display with six selectable measurement values.
- Configurable schemes the are interlocking with basic logic functions.
- An event register record of events and fault values that can be read through the keypad, local HMI, or SetPointPS (a free PC-based configuration software).
- All settings, events, and indications are stored in nonvolatile memory.
- Configuration, parameterization, and reading of information through local HMI, or with SetPointPS software interface.
- Connection to any automation system through several available communication protocols. These protocols include Modbus RTU, ModbusTCP, PROFIBUS DP, IEC 60870-5-103, IEC 60870-5-101, IEC 61850, SPA-Bus, EtherNet/IP™, or DNP 3.0.
- Universal power supply handles any source within the range from 40…265V DC or V AC. An optional alternative power-supply for 18…36V DC is available.
- Built-in high-resolution disturbance recorder for evaluating analog and digital signals.
- Arc protection is also provided as an optional feature.
- Two different optional 12-channel RTD scanners available.

SetPointPS

SetPointPS is a software configuration tool for Rockwell Automation® Bulletin 857 and 865 Protection Systems. All configurations are made with a user-friendly graphical interface and the created documents can be printed and saved. User knowledge of the Rockwell Automation® 857 Protection System model or hardware is not required. SetPointPS can read all information directly from the device and configures itself. It can be obtained free of charge at www.rockwellautomation.com.

It is possible to read and evaluate disturbance recordings from Rockwell Automation® 857 and 865 Protection System. The built-in evaluator uses standard COMTRADE files for saving the records. See publication 857-PM001.

User Interface

The 857 Protection System is controlled in the following three ways:

- Locally with the push button on the 857 Protection System front panel, see 857 Protection System Front Panel on page 23).
- Locally by using a personal computer that is connected to the serial port on the front panel or on the rear panel of the Protection System. Both cannot be used simultaneously.
- By remote control over the remote control port on the Protection System rear panel.

Setting File and Firmware Compliance

The Settings files from all major revisions of firmware are not upward or downward compatible between major versions. This statement is true of products with firmware revision 10, 12, and higher firmware revisions.

IMPORTANT Do not load a Settings file between 857 Protection Systems of one version into an 857 Protection System with another firmware revision.

Operating Safety

ATTENTION: The terminals on the rear panel of the 857 Protection System can carry dangerous voltages, even if the auxiliary voltage is switched off. Do not place a live current transformer secondary-circuit in an open circuit condition. The disconnection of a live circuit can cause dangerous voltages! Any operational measures must be conducted according to national and local directives and instructions

IMPORTANT Read the operation instructions before performing any operational measures.

The comprehensive protection functions of the 857 Protection System (Table 1) make it ideal for utility, industrial, marine, and offshore power distribution applications. Because the protection system is designed for global applications, it includes both ANSI IEEE and IEC protective function numbers and symbology.

Table 1 - List of Protection Functions

IEEE/ ANSI Code	IEC Symbol	Function Name	Note
25	df/dv	Synchrocheck	
27	U< U<< U<<<	Undervoltage protection	
32	P< P<<	Reverse power protection	
37	I<	Undercurrent/Load Loss protection	
46R	$I_2>$	Current unbalance protection - Feeder protective mode	Only available when application mode is feeder protection
46	$I_2>$	Current unbalance protection - Motor protective mode	Only available when application mode is motor protection
46[1]	$I_2>>$	Phase reversal / incorrect phase sequence protection	Only available when application mode is motor protection

Table 1 - List of Protection Functions (Continued)

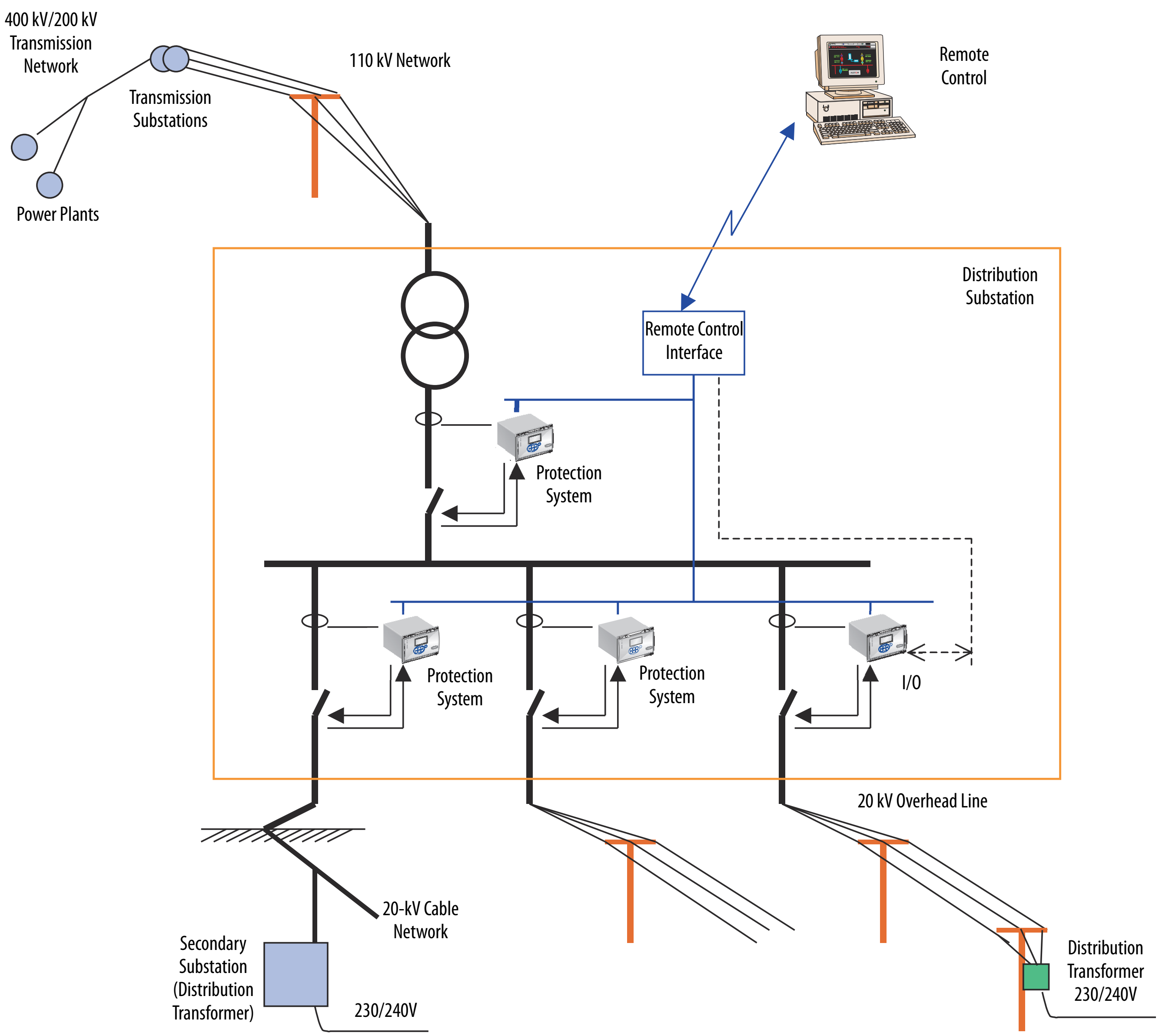
IEEE/ ANSI Code	IEC Symbol	Function Name	Note
47	I_2>>	Phase reversal/incorrect phase sequence protection	Preset to 80% ratio between negative and positive sequence current
48	I_{st}>	Stall protection	Only available when application mode is motor protection
49	T>	Thermal overload protection	
50ARC	ArcI>	Optional arc fault-protection	
50BF	CBFP	Circuit-breaker failure protection	
50N/51N 50G/51G 50GS/51GS	I_0> I_0>> I_0>>> I_0>>>>	Earth-fault protection	External connection method and protective settings define protection type.
50NARC	$ArcI_{01}$> $ArcI_{02}$>	Optional earth-fault protection	
50NC/51INC	I_0CAP	Capacitor-bank unbalance protection	
50/51	I> I>> I>>>	Overcurrent protection	
59	U> U>> U>>>	Overvoltage protection	
59N	U_0> U_0>>	Residual voltage protection	
66	N>	Frequent start protection	Only available when application mode is motor protection
67	I_φ> I_φ>> I_φ>>> I_φ>>>>	Directional overcurrent protection	
67N	$I_{0\varphi}$> $I_{0\varphi}$>>	Directional earth-fault protection	
67NI	I_{0int}>	Directional transient intermittent earth-fault protection	
68F2	U_{f2}>	Magnetizing In Rush	
68F5	U_{f5}>	Transformer overexcitation, 2nd harmonic	
79	AR	Auto-Reclose	
81	f>< f>><<	Frequency protection, 5th harmonic	
81L	f< f<<	Underfrequency protection	
81R	df/dt	Rate of change of frequency (ROCOF) protection	
86		Lockout Selection	All protective elements can be set for lockout control
99	Prg1…8	Programmable stages	

(1) Device 47 protection also provided using parameter feedback.

EU Directive Compliance and Other Standard Compliance

EMC Compliance	2014/30/EU	Compliance with the European Commission's EMC Directive. Product Specific Standards were used to establish conformity: EN 60255-26: 2013
Product Safety	2014/35/EU	Compliance with the European Commission's Low Voltage Directive. Compliance is demonstrated by reference to generic safety standards: EN60255-27:2014
Complies With	c-UL-us Listed Industrial Controls E334349,UL 508.	Australian Declaration of Conformity (formerly C-Tick)

Figure 1 - Application of the Feeder and Motor Protection Device



Catalog Number Explanation

	Position						
	1	*2*	*3*	*4*	*5*	*6*	*7*
857 –	**3**	**C**	**6**	**A**	**A**	**A**	**–__**
	a	*b*	*c*	*d*	*e*	*f*	*g*

a

Nom Phase Current (A) / Nom DI7-28 Activation Voltage	
3	1 A / 5 A / 24V
6	1 A / 5 A / 110V
7	1 A / 5 A / 220V

b

Nom Earth-fault Current I/01 and I/02 [A]	
C	1 A and 5 A
D	0.2 A and 1 A

c

Additional I/O (X8 Terminal)	
6	None
8	Ten outputs
9	Eight standard inputs and four outputs(1)

(1) Some options not UL Listed. Check with your Rockwell Automation® representative.

d

Supply Voltage [V]	
A	40…265V AC/DC
B	18…36V DC
C	40…265V AC/DC, arc protection option
D	18…36V DC, arc protection option
E	40…265V AC/DC, DI19, DI20, arc channel, optional
F	18…36V DC+ DI19, DI20, arc channel, optional

e

Optional Hardware (Communication port 1)

Code	Description
A	TTL/RS-232 (VCM TTL)
B	Plastic/Plastic serial fiber interface (VCM FIBRE PP)
C	N/A
D	RS-485 interface (4-wire, VCM 485-4)
E	Glass/Glass dual serial fiber interface for 857-RAD (857-VCMFIBRE GG)(1)
F	Rx Plastic/Tx Glass serial fiber interface (VCM FIBRE PG)
G	Rx Glass/Tx Plastic serial fiber interface (VCM FIBRE GP)
I	RJ45 connection (RS-232, VCM 232)
M	ST 100-Mbps Ethernet dual fiber interface including IEC 61850
N	RTD glass fiber interface for 857-RAA (857-VCMRTD)(2)

(1) Required for connection to 857-RAD Enhanced RTD Scanner. Only available in this location.
(2) Required for connection to the 857-RAA scanner only.

f

Optional Hardware (Communication port 2)	
A	None
C	RJ45 connection (RS-232, 857-VCM232)
D	RS-485 interface (2-wire, 857-VCM485-2)
L	Built-in RJ45 10-Mbps Ethernet interface(1)
M	Built in RJ45 10-Mbps interface inc. IEC 61850(1)
N	RTD interface for 857-RAA (Glass fiber, 857-VCMRTD)(2)

(1) Cannot order in combination with the following optional Communication PORT 1: (M) ST 100-Mbps EtherNet/IP fiber interface with IEC 61850
(2) Required for connection to the 857-RAA scanner only.

g

Ingress Protection Rating	
	IP 30 (standard)
I	IP 54 with conformal coating (optional)
C	IP 30 with conformal coating (optional)

Accessories

Catalogue Number	Description
857-RAA	12-channel external RTD scanner (857 must have VCMRTD fiber interface) (1)
857-RAD	Enhance external 12-channel RTD scanner, with analog I/O (857 must have VCMFIBER fiber interface) (1)
857-VEA3CG	External EtherNet/IP (external module, requires 857-VX-004-M3 cable) (2)
857-VPA3CG	External PROFIBUS I/P (requires 857-VX-007-F cable) (2)
857-VSE001	External dual fiber-optic interface (requires 857-VX022 cable) (2)
857-VSE002	External RS485 I/F module (requires 857-VX022 cable) (2)
857-VSE006	External module IEC 103 to 61850 converter (RJ45 –)
857-VSE010	External single optic interface module via 857-VCM232 (2)
857-VX003-3	857/SetPointPS programming cable, 3m serial to serial cable
857-VX004-M3	RS-232 converter cable-connects to PLC or 857-VEA3CG
857-VX007-F3	RS-232 converter cable-connects to 857-VPA3CG
857-VX022	RS-232 cable to 857-VSE modules (D9-sub connector at relay end)
857-VX049	RS-232 cable to 857-VSE modules (RJ45 connector at relay end)
857-VA1DA-6	Arc sensor - 6 meter lead wire (3)
857-VA1DA-02	Arc sensor- 20 meter lead wire (3)
857-VYX076	Raising collar - 40 mm (4)
857-VYX077	Raising collar - 60 mm (4)
857-VX080	RS-232 cable to 857-VPA3CG (RJ45 connector at relay end)
857-VYX233	Raising collar - 100 mm (4)
9300-USBS	USB to serial converter and cable (required if programming computer does not have a serial port)

(1) Interconnection to 857 via 62.5 micrometer fiber-optic cables that use ST style of connectors at each end.
(2) Some configurations can require an 857-VX049 cable, check with the factory.
(3) Maximum two per relay. Relay must have arc flash option, see Catalog Number Explanation on page 20.
(4) See Chapter 11 for further details.

Available Replacement Option Modules

Repair/replacement parts only.

Catalog Number	Description
857-VCM485-4	RS-485 interface (4-wire)
857-VCM485-2	RS-485 interface (2 wire)
857-VCMFIBER	Dual Serial fiber interface (Glass/Glass) – dual-fiber interface to 857-RAD RTD scanner
857-VCMRTD	RTD interface (Glass fiber) – single-fiber interface to 857-RAA RTD scanner
857-VCMTTL	TTL/RS-232 interface
857-VCM 232RS	RS-232 with RJ45 connector

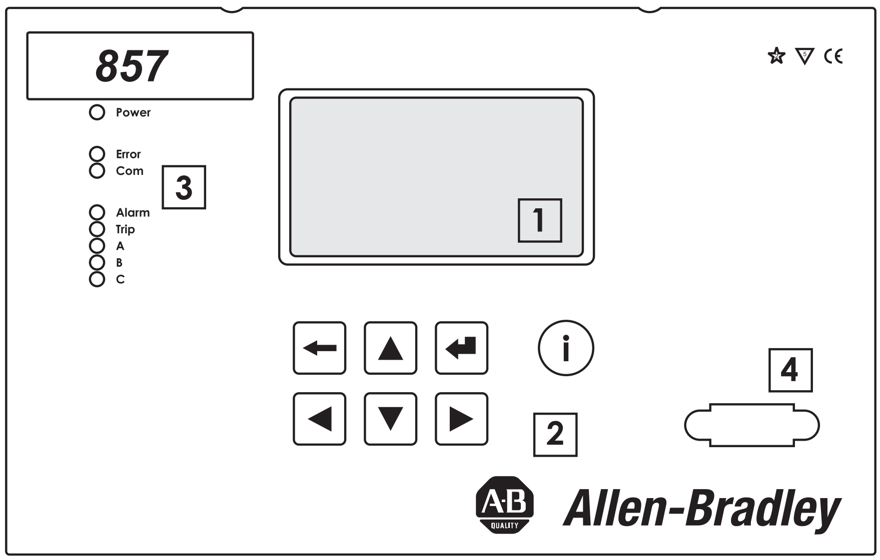
Notes:

Local Panel User Interface

857 Protection System Front Panel

Figure 2 shows the front panel of the 857 Protection System and the location of the user interface elements that are used for local control.

Figure 2 - Front Panel of 857 Protection System



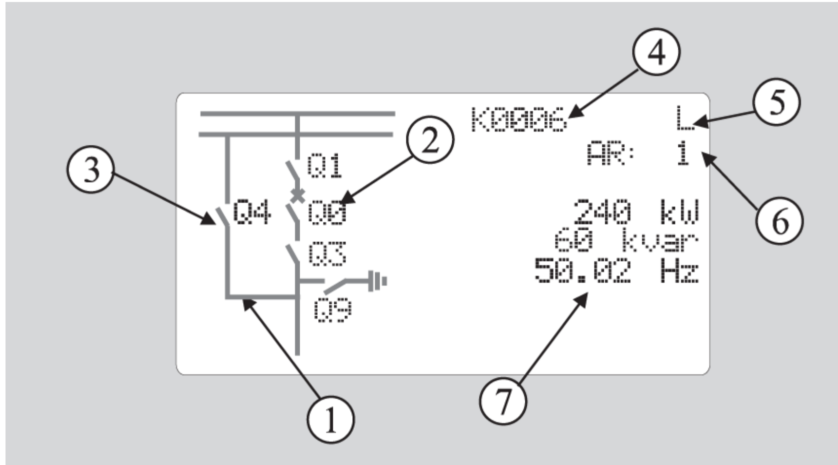
1. LCD dot-matrix display.
2. Keypad.
3. Status indicators.
4. RS-232 serial communication port for connection to a personal computer.

Display

The backlit 128 x 64 LCD dot-matrix display can show 21 characters per row and eight rows simultaneously. The display shows the following:

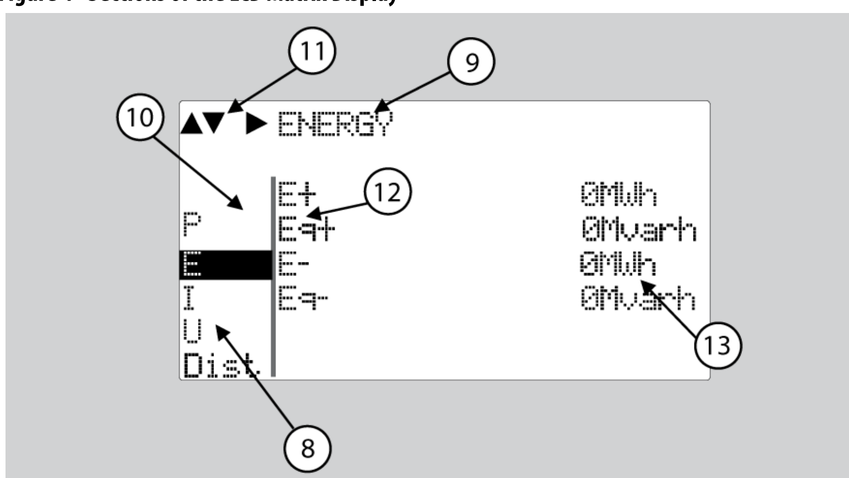
- The single-line diagram of the 857 Protection System with the object status, measurement values, identification, and so forth (Figure 3).
- The configuration and parameterization values of the 857 Protection System (Figure 4).

Figure 3 - Sections of the LCD Matrix Display



1	Freely configurable single-line diagram.
2	Five controllable objects.
3	Six object statuses.
4	Location identification.
5	Local/Remote selection.
6	Auto-reclose on/off selection (if applicable).
7	Freely selectable measurement values (max. six values).

Figure 4 - Sections of the LCD Matrix Display



8	Main menu column.
9	The heading of the active menu.
10	The cursor of the main menu.
11	Possible navigation directions.
12	Measured/setting parameter.
13	Measured/set value.

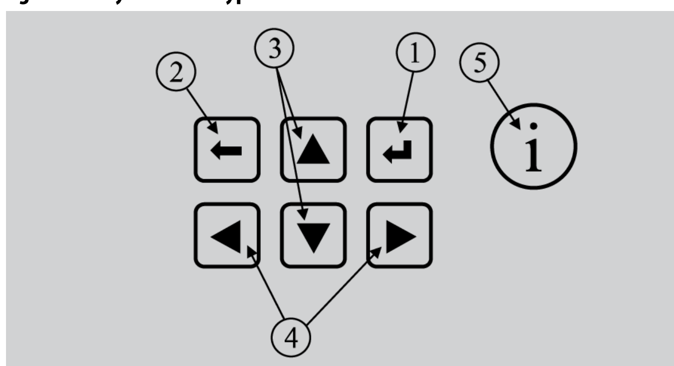
Backlight Control

To turn on the backlight, press any key on the front HMI of the 857 Protection System. The Display backlight can also be switched on with any digital input and virtual input or output by using SetPointPS software. Go to the "LOCALPANEL CONF/Display backlight ctrl" setting, which is used for selecting the trigger input for backlight control. When the selected input activates, the display backlight activated for 60 minutes.

Keypad

The keypad is used to control objects and switches on the single-line diagram display. To navigate in the menu, and set the required parameter values, use the keypad and the guidance that is given in the display.

Figure 5 - Keys on the Keypad



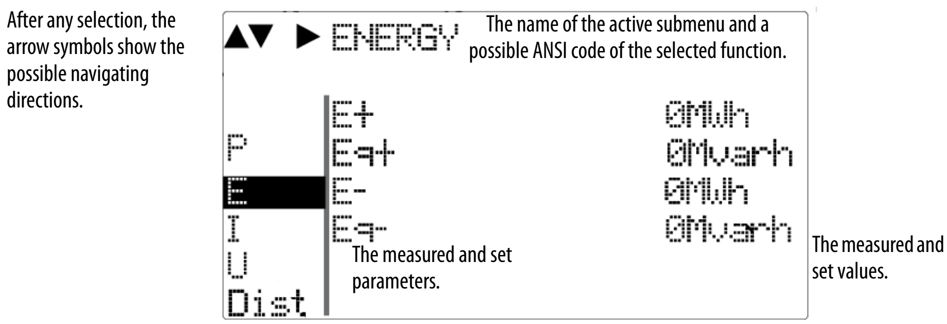
The keypad has the following keys and functions:

1	Enter and confirmation key (enter)
2	Cancel key (cancel)
3	Up/Down [Increase/Decrease] arrow keys (up/down)
4	Keys to select submenus [select a digit in a numerical value] (left/right)
5	Additional information key (info)

Menu Navigation and Pointers

Use the arrow keys up and down to move up and down in the main menu (see Keypad on page 25). The active main menu option is indicated with a cursor. The main menu option items are abbreviations, for example Evnt = events.

Figure 6 - Active Menu Options



Operation Status Indicators

The 857 Protection System has eight status indicators (Figure 7) that are listed in Table 2.

Figure 7 - Operation Status Indicators of the 857 Protection System

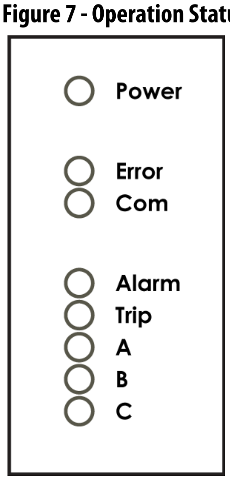


Table 2 - Operation Status Indicators

Status Indicator	Meaning	Remarks
Power	The auxiliary power is switched on.	Normal operational state
Error	Internal fault, operates in parallel with the self-supervision output 857 Protection System.	The Protection System attempts to restart. If the error indicator remains lit, call for service.
Com	The serial bus is in use and is transferring information.	Normal operational state
Alarm	One or several signals of the output Protection System matrix are activated and is assigned to output AL. One of the signals activates the output. For more information about output matrix, see Configuring the Digital Outputs DO on page 48.	The indicator is switched off when the signal that caused output Al to activate in the Output Matrix, for example the START signal, is reset. The resetting depends on the type of configuration, which is connected or latched.
Trip	One or several signals of the output Protection System matrix have been assigned to output Tr. One of the signals activates the output. For more information about output Protection System configuration, see Configuring the Digital Outputs DO on page 48.	The indicator is switched off when the signal that caused output Tr to activate, for example the TRIP signal, is reset. The resetting depends on the type of configuration, which is connected or latched.
A,B,C (LA, LB, LC)	Application-related indicators.	Configurable

Resetting Latched Indicators and Output Protection Elements

All indicators and output protection elements can be given a latching function (86) in the configuration.

The following are ways to reset latched indicators and protection elements:

- From the alarm list, press and hold the Cancel button for approximately 3 seconds. To reset the latched indicators and output protection elements press enter.
- To acknowledge each event, press the Enter button the equivalent number of times. To reset the latched indicators and output protection elements, press the Enter button in the initial display.
- Reset the latched indicators and output protection elements through a remote communication or through a digital input that is configured for that purpose.
- Cycle control power.

Adjusting the Display Contrast

The readability of the LCD varies with the brightness and the temperature of the environment. To adjust the contrast with a personal computer, use the SetPointPS software GUI. To adjust the contrast from the front of the 857 Protection System complete this procedure.

1. Press info then press enter.
2. Enter the configurator password (default password=0002). Use the up, down, and right arrow keys.
3. Press enter.
4. Press info.
5. To adjust the display level, use the up and down keys.

Local Panel Operations

The front panel can be used to control objects, change the local/remote status, read the measured values, set parameters, and to configure 857 Protection System functions. A personal computer, which is connected to a local communication port, can set some parameters.

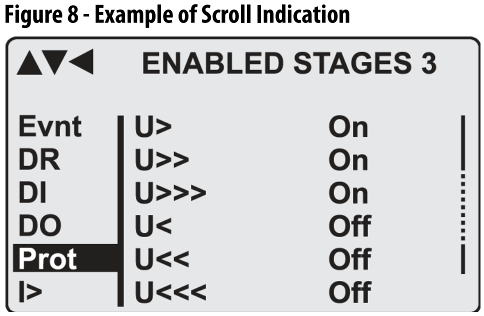
Navigating in Menus

All menu functions are based on the main menu/submenu structure. To navigate the structure, complete this procedure.

1. Use the arrow keys (up and down) to move up and down in the main menu.
2. Move to a submenu by repeatedly pressing the right key until the required submenu is shown. To return to the main menu, press the left key.
3. Press enter to confirm the submenu selection.

   If there are more than six items in the selected submenu, a black line appears to the right side of the display (Figure 8). It is then possible to scroll down in the submenu.

Figure 8 - Example of Scroll Indication

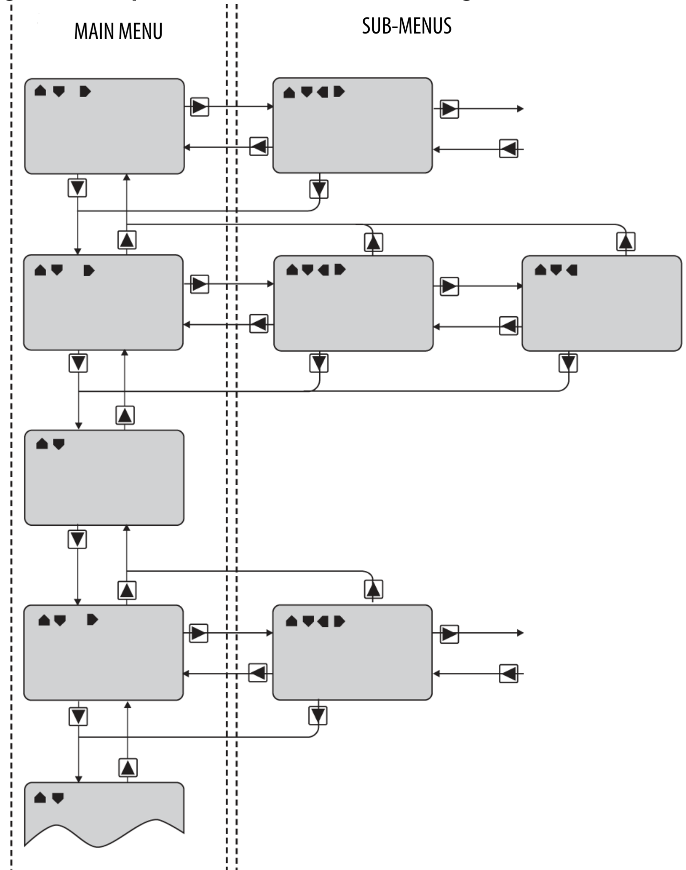


4. Cancel the selection by pressing cancel.

5. Press up or down in any position of a submenu, when it is not selected, to go one step up or down in the main menu.

The active main menu selection is indicated with black background color. The possible navigating directions in the menu are shown in the upper-left corner with black triangular symbols.

Figure 9 - Principles of the Menu Structure and Navigation in the Menus



6. Obtain additional information about any menu item by pressing info.
7. Revert to the normal display by pressing cancel.

Main Menu

The general menu structure is shown in Figure 9. The menu is dependent on the user configuration and the options according to the order code. For example, only the enabled protection stages appear in the menu.

Table 3 - List of the Local Main Menu

Main Menu	Number of Menus	Description	ANSI Code	Note
	1	Interactive mimic display		(1)
	5	Double size measurements that are user-defined		1(1)
	1	Title screen with device name, time, and firmware revision.		
P	14	Power measurements		
E	4	Energy measurements		
I	13	Current measurements		
U	15	Voltage measurements		
Dema	15	Demand values		
Umax	5	Time stamped Minimum and Maximum of voltages		
Imax	9	Time stamped Minimum and Maximum of currents		
Pmax	5	Time stamped Minimum and Maximum of power and frequency		
Mont	21	Maximum values of the last 31 days and the last 12 months		
Evnt	2	Events		
DR	2	Disturbance recorder		(2)
Runh	2	Hours run. Active time (hours) of a selected digital input and Time Stamps of the latest start and stop.		
TIMR	6	Day and week timers		
DI	5	Digital inputs including virtual inputs		
DO	4	Digital outputs (Protection Systems) and output matrix		(3)
ExtAI	3	External analog inputs		(4)
ExtAO	3	External analog outputs		(3)
ExDI	3	External digital inputs		(4)
ExDO	3	External digital outputs		(4)
Prot	27	Protection counters, combined overcurrent status, protection status, protection enabling, cold load, and inrush detection If2> and block matrix		
I>	5	First overcurrent stage	50/51	(5)
I>>	3	Second overcurrent stage	50/51	(5)
I>>>	3	Third overcurrent stage	50/51	(5)
Iφ>	6	First directional-overcurrent stage	67	(5)
Iφ>>	6	Second directional-overcurrent stage	67	(5)
Iφ>>>	4	Third directional-overcurrent stage	67	(5)
Iφ>>>>	4	Fourth directional-overcurrent stage	67	(5)
I<	3	Undercurrent stage	37	(5)
I2>	3	Current unbalance stage	46	(5)
T>	3	Thermal overload stage	49	(5)
Io>	5	First earth-fault stage	50N/51N 50G/51G	(5)

Table 3 - List of the Local Main Menu (Continued)

Main Menu	Number of Menus	Description	ANSI Code	Note
Io>>	3	Second earth-fault stage	50N/51N 50G/51G	(5)
Io>>>	3	Third earth-fault stage	50N/51N 50G/51G	(5)
Io>>>>	3	Fourth earth-fault stage	50N/51N 50G/51G	(5)
Ioφ>	6	First directional earth-fault stage	67N	(5)
Ioφ>>	6	Second directional earth-fault stage	67N	(5)
Ioint>	4	Transient intermittent E/F	67NI	(5)
U>	4	First overvoltage stage	59	(5)
U>>	3	Second overvoltage stage	59	(5)
U>>>	3	Third overvoltage stage	59	(5)
U<	4	First Undervoltage stage	27	(5)
U<<	3	Second Undervoltage stage	27	(5)
U<<<	3	Third Undervoltage stage	27	(5)
Uo>	3	First residual-overvoltage stage	59N	(5)
Uo>>	3	Second residual overvoltage stage	59N	(5)
P<	3	First reverse and underpower stage	32	(5)
P<<	3	Second reverse and underpower stage	32	(5)
f><	4	First over/under-frequency stage	81	(5)
f>><<	4	Second over/under-frequency stage	81	(5)
f<	4	First underfrequency stage	81L	(5)
f<<	4	Second underfrequency stage	81L	(5)
dfdt	3	Rate of change of frequency (ROCOF) stage	81R	(5)
Prg1	3	First programmable stage		(5)
Prg2	3	Second programmable stage		(5)
Prg3	3	Third programmable stage		(5)
Prg4	3	Fourth programmable stage		(5)
Prg5	3	Fifth programmable stage		(5)
Prg6	3	Sixth programmable stage		(5)
Prg7	3	Seventh programmable stage		(5)
Prg8	3	Eighth programmable stage		(5)
If2>	3	Second harmonic O/C stage	68F2	(5)
If5>	3	Fifth harmonic O/C stage	68F5	(5)
CBFP	3	Circuit breaker failure-protection	50BF	(5)
CBWE	4	Circuit breaker wearing-supervision		(5)
AR	15	Auto-reclose	79	
CTSV	1	CT supervisor		(5)
VTSV	1	VT supervisor		(5)
ArcI>	4	Optional arc protection stage for phase-to-phase faults and delayed light signal.	50ARC	(5)
ArcIo1>	3	Optional arc protection stage for earth-faults. Current input = I01	50NARC	(5)
ArcIo2>	3	Optional arc protection stage for earth-faults. Current input = I02	50NARC	(5)

Table 3 - List of the Local Main Menu (Continued)

Main Menu	Number of Menus	Description	ANSI Code	Note
OBJ	11	Object definitions		(6)
Lgic	2	Status and counters of the user logic		(1)
CONF	12	Device setup, scaling, and so forth.		(7)
Bus	13	Serial port and protocol configuration		(8)
Diag	6	Device self-diagnosis		

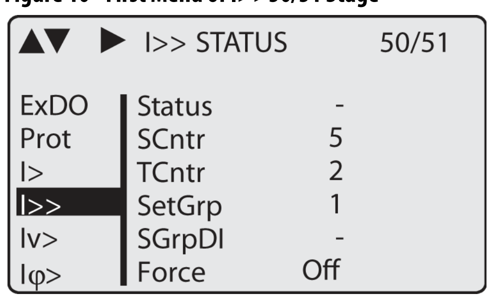
(1) Configure with SetPointPS.
(2) Read recorded files with SetPointPS.
(3) Configure for N.O. or N.C.
(4) The menu is visible only if protocol "External I/O" is selected for one of the serial ports. Serial ports are configured in menu "Bus".
(5) The menu is visible only if the stage is enabled.
(6) Objects are circuit breakers, disconnects, and so forth. Their position or status can be displayed and controlled in the interactive mimic display.
(7) There are two extra menus, which are visible only if the access level "operator" or "configurator" has been opened with the corresponding password.
(8) Detailed protocol configuration is done with SetPointPS.

Menu Structure of Protection Functions

The general structure of all protection function menus is similar, but the details differ from stage to stage. For example, the details of the second overcurrent stage I>> menus are shown in Figure 10.

FIRST MENU OF I>> 50/51 STAGE

Figure 10 - First Menu of I>>50/51 Stage



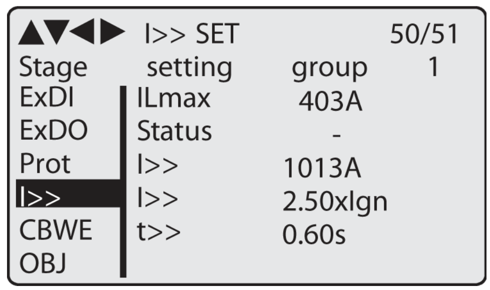
The status, start, trip counter, and setting group menu content, as shown in Figure 10, is explained in the following list:

- **Status –** The stage is not detecting any fault at the moment. If the operating level is "Configurator" and the Force flag is set to On, the stage can be forced to pick up or trip. See Operating Levels on page 36 for more details.
- **SCntr 5 –** The stage has picked-up a fault five times since the last reset of restart. This value can be cleared if the operating level is at least Setting Groups on page 64"Operator".
- **TCntr 1 –** The stage has tripped twice since the last reset of restart. This value can be cleared if the operating level is at least "Operator".

- **SetGrp 1** – The active setting group is one. This value can be edited if the operating level is at least “Operator”. How to set groups is explained in Setting Groups on page 64.
- **SGrpDI** – A digital input does not control this setting group. This value can be edited if the operating level is at least “Configurator”.
- **Force Off** – The forcing function for status forcing and output Protection System forcing are disabled. This force flag status can be set to “On” or back to “Off” if the operating level is at least “Configurator”. If a front panel key is not pressed within 5 minutes, and there is no SetPointPS communication, the force flag is set to “Off” position. The forcing is explained in Signal Forcing Control on page 42.

SECOND MENU OF I>> 50/51 STAGE

Figure 11 - Second Menu (Next to the Right) of I>>50/51 Stage

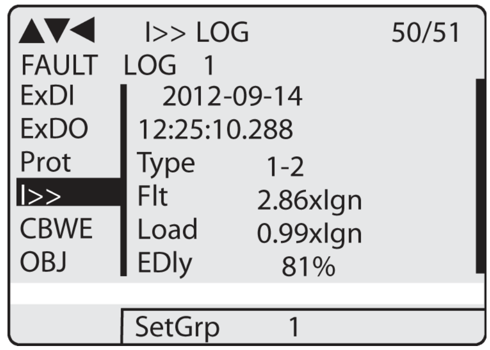


The content of the main setting menu shown in Figure 11 is explained in the following list:

- **Stage setting group 1** – The group 1 setting values. To view the other setting group, press enter and then right or left. How to set groups is explained in Setting Groups on page 64.
- **Ilmax 403A** – The maximum of the three measured phase currents is at the moment 403 A. The value that the stage is supervising.
- **Status** – The status of the stage. A copy of the status value in the first menu.
- **I>> 1013A** – The pick-up limit is 1013 A in primary value.
- **I>> 2.50 x I_n** – The pick-up limit is 2.50 times the rated current of the protected object. This value can be edited if the operating level is at least “Operator”. The operating levels are explained in Operating Levels on page 36.
- **t>> 0.60s** – The total operation delay is set to 600 Ms. This value can be edited if the operating level is at least “Operator”.

THIRD MENU OF I>> 50/51 STAGE

Figure 12 - Third and Last Menu (Next to the Right) of I>>50/51 Stage



This menu is for registered values by the I>> stage. Fault logs are explained in Fault Log on page 36.

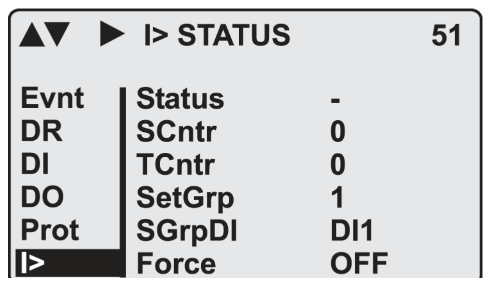
- **FAULT LOG 1** – The latest of the eight available logs. Press enter and right or left to move between logs.
- **2012-09-14** – Date of the log.
- **12:25:10.288** – Time of the log.
- **Type 1-2** – The overcurrent fault has been detected in phases L1 and L2 (A and B, red and yellow, R and S, u and v).
- **Flt 2.86 x I_n** – The fault current has been 2.86 per units.
- **Load 0.99 x I_n** – The average load current before the fault has been 0.99 pu.
- **EDly 81%** – The elapsed operation delay has been 81% of the setting 0.60 s = 0.49 s. Any registered elapsed delay less than 100% means that the stage has not tripped, because the fault duration has been shorter than the delay setting.
- **SetGrp 1** – The setting group has been 1. To reach this line, press enter and then down several times.

Setting Groups

Most of the protection functions have four setting groups (SetGrp1, SetGrp2, SetGrp3, and SetGrp4). These groups are useful, for example, when the network topology is changed frequently. To change the active group, use a digital input, through remote communication or locally by using the local panel.

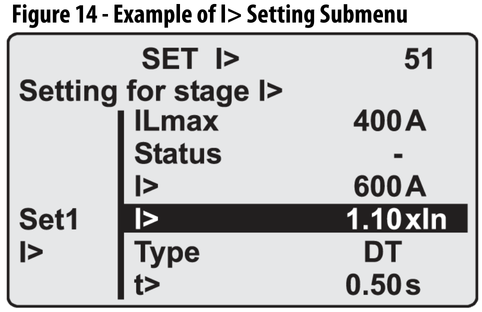
The active setting group of each protection function can be selected separately. Figure 13 shows an example where the changing of the I> setting group is handled with digital input one (SGrpDI). If the digital input is TRUE, the active setting group is group two. If the digital input is FALSE, the active group is group one. If no digital input is selected (SGrpDI = -), the active group can be selected by changing the value of the parameter SetGrp.

Figure 13 - Example of Protection Submenu with Setting Group



Scroll to the desired submenu and press enter to select the submenu. The selected setting group is in the lower left corner (Figure 14). Set1 is setting group one, Set2 is setting group two, Set3 is setting group three, and Set4 is setting group four. Press left or right to select another group. Left is used when the active setting group is 2 and right is used when the active setting group is 1.

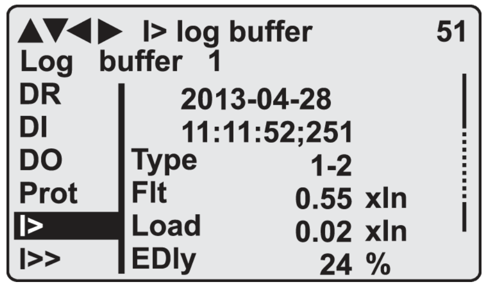
Figure 14 - Example of I> Setting Submenu



Fault Log

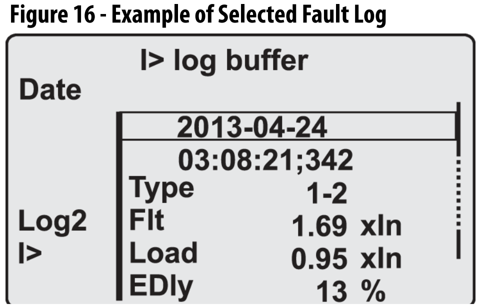
All protection functions include fault logs that can register up to eight different faults with time stamp information and fault values. The fault logs are stored in nonvolatile memory, and are not cleared when the power is switched off. To clear all logs use SetPointPS. Each function has its own logs (see Figure 15).

Figure 15 - Example of Fault Log



To see the values of log two, press enter to select the current log (log one). The current log number is then indicated in the lower left corner of the display (see Figure 16, Log2 = log two). Press the right once to select Log two.

Figure 16 - Example of Selected Fault Log



Operating Levels

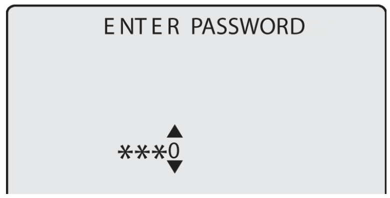
The 857 Protection System has three access levels User, Operator, and Configurator. The access levels mitigate accidental change of protection system configurations, parameters, or settings.

	USER Level	OPERATOR Level	CONFIGURATION Level
Use	To read parameter values, measurements, and events.	Control objects and to change the settings of the protection stages.	Needed during the commissioning of the Protection System. The scaling of the voltage and current transformers can be set by using this level and all other parameters can be changed.
Password Protected?	No; levels permanently open.	Yes; default configuration password is 0001.	Yes; default configuration password is 0002.
Setting State		Press enter	Press enter
Logout	Closing that is not required.	Automatically closes after 10-minutes idle time. To close enter password 9999.	Automatically closes after 10-minutes idle time. To close enter password 9999.

To Gain Access

1. Press info and enter on the front panel.

Figure 17 - Opening the Access Level



2. Enter the password that is needed for the desired level.

   The password can contain four digits. Digits are supplied, one by one.

3. Move to the position of the digit by using the right key.
4. Set the desired digit value by using the up key.
5. Press enter.

Password Management

The passwords can only be changed using SetPointPS software that is connected to the local RS-232 port on the 857 Protection System with an 857-VX003-3 cable.

Restoring a Lost Password

To restore a lost or forgotten password, a special 857 Protection System-script program is needed and only done by Rockwell Automation service personnel. Default serial-port settings are 38400 bps, eight data bits, no parity, and one stop bit. The serial bit rate is configurable by using the front panel of the Protection System.

Command	Description
get pwd_break	Get the break code (Example: 6569403)
get serno	Get the serial number of the 857 Protection System (Example: 12345)

Send both the numbers to Rockwell Automation and ask for a password break. A device-specific break code is sent back. The code is valid for two weeks for the specific device.

Command	Description
set pwd_break=4435876	Restore the default configuration passwords ("4435876" is just an example; the actual code must be requested from the Rockwell Automation support team.

Now the passwords are restored to the default values (see Operating Levels on page 36).

Operating Measures

Control Functions

The default display on the local panel is a single-line (MIMIC) diagram. It includes the 857 Protection System identification, Local/Remote indication, Auto-reclose on/off selection, and user-selectable analog measurement values.

The operator password must be active to control the objects, see To Gain Access on page 37.

Toggling Local/Remote Control

1. Press enter. The previously activated object starts to blink.
2. To select the Local/Remote object (“L” or “R” squared), use the arrow keys.
3. Press enter.

   The L/R dialog appears.
4. Select “REMOTE” to enable remote control and disable local control. Select “LOCAL” to enable local control and disable remote control.
5. Press enter. The Local/Remote state changes.

Object Control

1. Press enter. The previously activated object starts to blink.
2. To select the object to control, use the arrow keys. Only controllable objects can be selected,
3. Press enter.

   A control dialog appears.
4. To select the “Open” or “Close” commands, use the up and down arrow keys.
5. Press enter to confirm the operation. The state of the object changes.

Toggling Virtual Inputs

1. Press enter, the previously activated object starts to blink.
2. Select the virtual input object (empty or black square)

   The dialog appears.
3. Select “VIon” to activate the virtual input or select “VIoff” to deactivate the virtual input.

Measured Data

The measured values can be read from the main menus and their submenus. Any measurement value in this table can be displayed on the main view next to the single-line diagram. Up to six selectable measurements can be shown on the default main display and 30 more on addition measurement screens.

Table 4 - Measured Values

Value	Menu/Submenu	Description
P	P/POWER	Active power [kW]
Q	P/POWER	Reactive power [kVAR]
S	P/POWER	Apparent power [kVA]
?	P/POWER	Active power angle [?]
P.F.	P/POWER	Power factor [ ]
f	P/POWER	Frequency [Hz]
Pda	P/15 MIN POWER	Active power [kW]
Qda	P/15 MIN POWER	Reactive power [kVAR]
Sda	P/15 MIN POWER	Apparent power [kVA]
Pfda	P/15 MIN POWER	Power factor [ ]
fda	P/15 MIN POWER	Frequency [Hz]
PL1	P/POWER/PHASE 1	Active power of phase 1 [kW]
PL2	P/POWER/PHASE 1	Active power of phase 2 [kW]
PL3	P/POWER/PHASE 1	Active power of phase 3 [kW]
QL1	P/POWER/PHASE 1	Reactive power of phase 1 [kVAR]
QL2	P/POWER/PHASE 1	Reactive power of phase 2 [kVAR]
QL3	P/POWER/PHASE 1	Reactive power of phase 3 [kVAR]
SL1	P/POWER/PHASE 2	Apparent power of phase 1 [kVA]
SL2	P/POWER/PHASE 2	Apparent power of phase 2 [kVA]
SL3	P/POWER/PHASE 2	Apparent power of phase 3 [kVA]
PF_L1	P/POWER/PHASE 2	Power factor of phase 1 [ ]
PF_L2	P/POWER/PHASE 2	Power factor of phase 2 [ ]
PF_L3	P/POWER/PHASE 2	Power factor of phase 3 [ ]
cos	P/COS and TAN	Cosine phi [ ]
tan	P/COS and TAN	Tangent phi [ ]
cosL1	P/COS and TAN	Cosine phi of phase L1 [ ]
cosL2	P/COS and TAN	Cosine phi of phase L2 [ ]
cosL3	P/COS and TAN	Cosine phi of phase L3 [ ]
Iseq	P/PHASE SEQUENCIES	Actual, current phase sequence [OK; Reverse;??]
Useq	P/PHASE SEQUENCIES	Actual, voltage phase sequence [OK; Reverse;??]
Io1φ	P/PHASE SEQUENCIES	I/O/Uo angle [o]
Io2φ	P/PHASE SEQUENCIES	I/O2/Uo angle [o]
fAdop	P/PHASE SEQUENCIES	Adopted frequency [Hz]
E+	E/ENERGY	Exported energy [MWh]

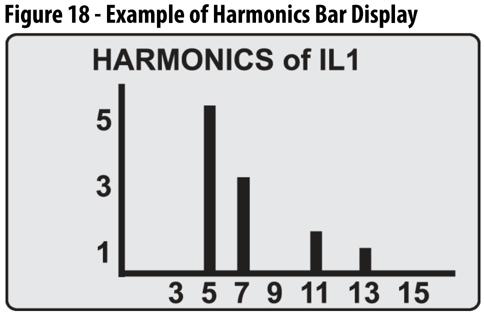
Table 4 - Measured Values (Continued)

Value	Menu/Submenu	Description
Eq+	E/ENERGY	Exported reactive energy [Mvar]
E-	E/ENERGY	Imported energy [MWh]
Eq-	E/ENERGY	Imported reactive energy [Mvar]
E+.nn	E/DECIMAL COUNT	Decimals of exported energy [ ]
Eq.nn	E/DECIMAL COUNT	Decimals of reactive energy [ ]
E-.nn	E/DECIMAL COUNT	Decimals of imported energy [ ]
Ewrap	E/DECIMAL COUNT	Energy control
E+	E/E-PULSE SIZES	Pulse size of exported energy [kWh]
Eq+	E/E-PULSE SIZES	Pulse size of exported reactive energy [kVAR]
E-	E/E-PULSE SIZES	Pulse size of imported energy [kWh]
Eq-	E/E-PULSE SIZES	Pulse duration of imported reactive energy [ms]
E+	E/E-PULSE DURATION	Pulse duration of exported energy [ms]
Eq+	E/E-PULSE DURATION	Pulse duration of exported reactive energy [ms]
E-	E/E-PULSE DURATION	Pulse duration of imported energy [ms]
Eq-	E/E-PULSE DURATION	Pulse duration of imported reactive energy [ms]
E+	E/E-pulse TEST	Test the exported energy pulse [ ]
Eq+	E/E-pulse TEST	Test the exported reactive energy [ ]
E-	E/E-pulse TEST	Test the imported energy [ ]
Eq-	E/E-pulse TEST	Test the imported reactive energy [ ]
IL1	I/PHASE CURRENTS	Phase current IL1 [A]
IL2	I/PHASE CURRENTS	Phase current IL2 [A]
IL3	I/PHASE CURRENTS	Phase current IL3 [A]
IL1da	I/PHASE CURRENTS	15-min average for IL1 [A]
IL2da	I/PHASE CURRENTS	15-min average for IL2 [A]
IL3da	I/PHASE CURRENTS	15-min average for IL3 [A]
Io1	I/SYMMETRIC CURRENTS	Primary value of zero sequence/ residual current I/0 [A]
Io2	I/SYMMETRIC CURRENTS	Primary value of zero-sequence/residual current I/02 [A]
IoCalc	I/SYMMETRIC CURRENTS	Calculated ground (earth) current [A]
I1	I/SYMMETRIC CURRENTS	Positive sequence current [A]
I2	I/SYMMETRIC CURRENTS	Negative sequence current [A]
I2/I1	I/SYMMETRIC CURRENTS	Negative sequence current that is related to positive sequence current (for unbalance protection) [%]
THDIL	I/HARM. DISTORTION	Total harmonic distortion of the mean value of phase currents [%]
THDIL1	I/HARM. DISTORTION	Total harmonic distortion of phase current IL1 [%]
THDIL2	I/HARM. DISTORTION	Total harmonic distortion of phase current IL2 [%]
THDIL3	I/HARM. DISTORTION	Total harmonic distortion of phase current IL3 [%]
Diagram	I/HARMONICS of IL1	Harmonics of phase current IL1 [%] (See Figure 18)
Diagram	I/HARMONICS of IL2	Harmonics of phase current IL2 [%] (See Figure 18)
Diagram	I/HARMONICS of IL3	Harmonics of phase current IL3 [%] (See Figure 18)

Table 4 - Measured Values (Continued)

Value	Menu/Submenu	Description
Uline	U/LINE VOLTAGES	Average value for the three line voltages [V]
U12	U/LINE VOLTAGES	Phase-to-phase voltage U12 [V]
U23	U/LINE VOLTAGES	Phase-to-phase voltage U23 [V]
U31	U/LINE VOLTAGES	Phase-to-phase voltage U31 [V]
UL	U(PHASE VOLTAGES	Average for the three phase voltages [V]
UL1	U/PHASE VOLTAGES	Phase-to-earth voltage UL1 [V]
UL2	U/PHASE VOLTAGES	Phase-to-earth voltage UL2 [V]
UL3	U/PHASE VOLTAGES	Phase-to-earth voltage UL3 [V]
Uo	U/SYMMETRIC VOLTAGES	Residual voltage Uo [%]
U1	U/SYMMETRIC VOLTAGES	Positive sequence voltage [%]
U2	U/SYMMETRIC VOLTAGES	Negative sequence voltage [%]
U2/U1	U/SYMMETRIC VOLTAGES	Negative sequence voltage that is related to positive sequence voltage [%]
THDU	U/HARM. DISTORTION	Total harmonic distortion of the mean value of voltages [%]
THDUa	U/HARM. DISTORTION	Total harmonic distortion of the voltage input a [%]
THDUb	U/HARM. DISTORTION	Total harmonic distortion of the voltage input b [%]
THDUc	U/HARM. DISTORTION	Total harmonic distortion of the voltage input c [%]
Diagram	U/HARMONICS of Ua	Harmonics of voltage input Ua [%] (See Figure 18)
Diagram	U/HARMONICS of Ub	Harmonics of voltage input Ub [%] (See Figure 18)
Diagram	U/HARMONICS of Uc	Harmonics of voltage input Uc [%] (See Figure 18)
Count	U/VOLT. INTERRupTS	Voltage interrupts counter [ ]
Prev	U/VOLT. INTERRupTS	Previous interruption [ ]
Total	U/VOLT. INTERRupTS	Total duration of voltage interruptions [days, hours]
Prev	U/VOLT. INTERRupTS	Duration of previous interruption [s]
Status	U/VOLT. INTERRupTS	Voltage status [LOW; NORMAL]

Figure 18 - Example of Harmonics Bar Display

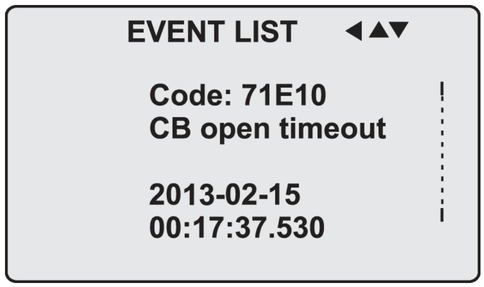


Reading the Event Register

The event register can be read from the Event submenu by using the following steps.

1. Press the right arrow once.

   The EVENT LIST appears. The display contains a list of events that are configured to be included in the event register.



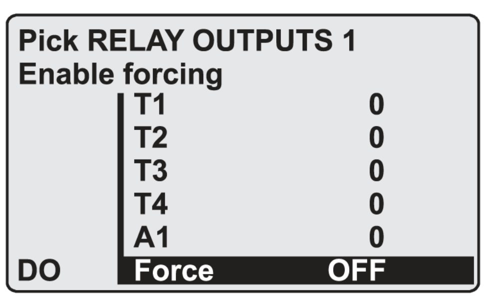
2. Press up and down to scroll through the event list.
3. Press left to exit the even list.

To set the order in which the events are sorted, set the “Order” parameter to “New-Old”. In the EVENT LIST, the first event is the most recent event.

Signal Forcing Control

In some menus, it is possible to switch a function on and off by using a force function. This feature can be used, for instance, for testing a certain function. The force function can be activated by using these steps:

1. Open the CONFIGURATION access level.
2. Move to the setting state of the desired function, for example DO (see Configuration and Parameter Setting on page 43).
3. Select the Force function (the background color of the force text is black).



4. Press enter.
5. Press up or down to change from “OFF” to “ON”, to activate the Force function.

6. Press enter to return to the selection list. Choose the signal that Force controls with the up and down keys, for instance the T1 signal.
7. Press enter to confirm the selection. Force now controls Signal T1.
8. Press up or down to change the selection from "0" (not alert) to "1" (alert) or vice versa.
9. Press enter to execute the forced control operation of the selected function. For example, when making the output Protection System of T1 pickup.
10. Repeat steps 7 and 8 to alternate between the on and off state of the function.
11. Repeat steps 1…4 to exit the Force function.
12. Return to the main menu by pressing cancel.

ATTENTION: All interlockings and blockings are bypassed when the force control is used. Use ONLY in an off-line test condition.

Configuration and Parameter Setting

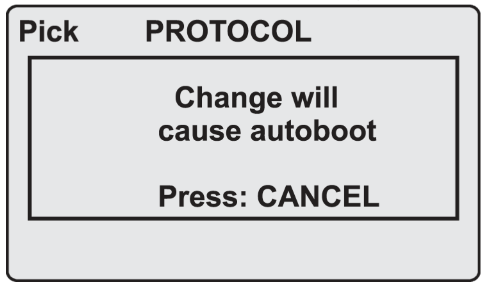
The minimum procedure to configure an 857 Protection System is as follows.

1. Open the access level "Configurator". The default password for configurator access level is 0002.
2. Set the rated values in menu [CONF] including at least current transformers and a potential (voltage) transformer rating and motor data if applicable. The date and time settings are in this same main menu.
3. Enable the needed protection functions and disable the rest of the protection functions in main menu [Prot].
4. Set the setting parameter of the enable protection stages according to the application.
5. Connect the output Protection Systems to the start and trip signals of the enabled protection stages with the output matrix. This connection can be done in main menu [DO], although the SetPointPS program is recommended for output matrix editing.
6. Configure the needed digital inputs in main menu [DI].
7. Configure blocking and interlockings for protection stages with the block matrix. This configuration can be done in main menu [Prot], although SetPointPS is recommended for block matrix editing.

Some of the parameters can only be changed through the RS-232 serial port with the SetPointPS software. These parameters (for example passwords, blockings, and mimic configuration) are normally set only during the commission process.

Some of the parameters require the restarting of the Protection System, which is automatic. If a parameter change requires the restarting, of the Protection System the display shows as Figure 19. A similar warning is displayed when using SetPointPS.

Figure 19 - Example of Auto-reset Display



To return to the setting view, press CANCEL. If a parameter must be changed, press enter again. The parameter can now be set. When the parameter change is confirmed by pressing enter, [RESTART]- text appears to the top-right corner of the display to indicate that auto-resetting is pending. If no key is pressed, the auto-reset is executed within seconds.

WARNING: Do not cycle control power to the 857 Protection System; the Protection System automatically restarts.

Parameter Setting

SetPointPS software is recommended to change parameters (see SetPointPS Personal Computer Software on page 55). It is a more efficient method than using the front panel controls only.

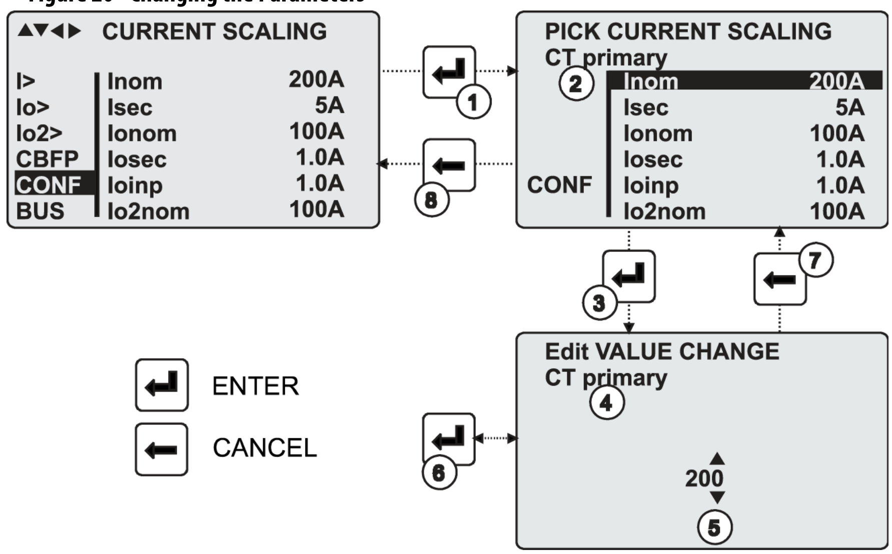
These instructions use the front panel controls.

1. Press enter to move to the setting state of the desired menu (for example, CONF/CURRENT SCALING). The Pick text appears in the upper-left part of the display.
2. Press info. Enter the password that is associated with the configuration level by pressing the arrow keys (default value is 0002). Press enter.

   For more information about the access levels, see Operating Levels on page 36.
3. Press up and down to scroll through the parameters. A parameter can be set when the background color of the line is black. If the parameter cannot be set, the parameter is framed.

4. Press enter to select the desired parameter (for example Inom).
5. Press up and down to change a parameter value. If the value contains multiple digits, press left and right to shift from digit to digit, and up and down to change the digits.
6. Press enter to accept a new value. To leave the parameter value unchanged, exit the edit state by pressing cancel.

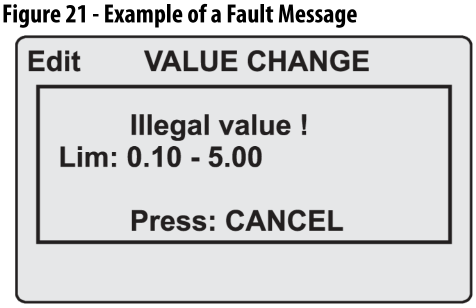
Figure 20 - Changing the Parameters



Setting Range Limits

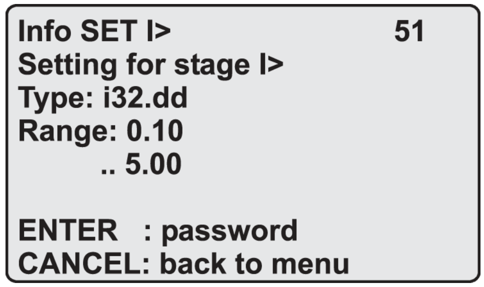
If the given parameter setting values are out-of-range values, a fault message is shown when the setting is confirmed with the enter key. Adjust the setting so it is within the allowed range.

Figure 21 - Example of a Fault Message



The allowed setting range is shown in the display in the setting mode. To view the range, press info. To return to the setting mode press CANCEL.

Figure 22 - Allowed Setting Ranges Shown in the Display



Disturbance Recorder Menu DR

Through the sub menus of the disturbance recorder menu, these functions and features can be read and set.

1. Disturbance Settings
2. Manual trigger (ManTrg)
3. Status (Status)
4. Clear oldest record (Clear)
5. Clear all records (ClrAll)
6. Recording completion (Stored)
7. Count of ready records (ReadyRec)

Sub Menu	Functions/Features
Disturbance recorder	Maximum time (MaxLen) Sample rate (Rate) Record time (Time) Pre trig time (PreTrig) Manual trigger (MnlTrig) Count of ready records (ReadyRe)
Rec. Coupling	Add a link to the recorder (AddLink) Clear all links (ClrLnks)
Available signal links	DO, DI Uline, Uphase IL U2/U1, U2, U1 I2/In, I2/I1, I2, I1, IoCalc Cosphi PF, S, Q, P, f Uo UL3, UL2, UL1 U31, U23, U12 Io2, Io1 IL3, IL2, IL1 Prms, Qrms, Srms Tan phi THDIL1, THDIL2, THDIL3 THDUa, THDUb, THDUc IL1RMS, IL2RMS, IL3RMS ILmin, ILmax, ULLmin, ULLmax, ULNmin, ULNmax U12y, U12z, fy, fz

Configuring the Digital Inputs DI

These functions can be read and set through the submenus of the digital inputs menu.

- The status of digital inputs (DIGITAL INPUTS 1-20/24/32).
- Operation counters (DI COUNTERS).
- Operation delay (DELAYs for DigIn).
- The polarity of the input signal (INPUT POLARITY). Normally open (NO) or normally closed (NC) circuit.
- To enable Event, EVENT MASK1.

Configuring the Digital Outputs DO

These functions can be read and set through the submenus of the digital outputs menu.

- The status of the output protection systems relays (RELAY OUTPUTS 1, 2, 3, and 4).
- The forcing of the output protection systems relays (RELAY OUTPUTS 1, 2, 3, and 4) (only if Force = ON):
  - Forced control (0 or 1) of the Trip relays.
  - Forced control (0 or 1) of the Alarm relays.
  - Forced control (0 or 1) of the S relay.
- The configuration of the output signals to the output relays. The configuration of the status indicators Alarm and Trip and application-specific alarm status indicators A, B, and C (the output relay matrix).

TIP The quantity of Trip and Alarm relays depends on the Protection System type and optional hardware.

Protection Menu (Prot)

These functions can be read and set through the submenus of the Prot menu.

- Reset all counters (PROTECTION SET/ClAll).
- Read the status of all protection functions (PROTECT STATUS 1-x).
- Enable and disable protection functions (ENABLED STAGES 1-x).
- Define the interlockings between signals (only with SetPointPS).

Each stage of the protection functions can be disabled or enabled individually in the Prot menu. When a stage is enabled, it is in operation immediately without a need to reset the relay.

The Protection System includes several protection functions. The number of functions that can be active simultaneously is limited by the processor capacity.

Configuration Menu (CONF)

The Configuration Menu contains functions and features that can be read and set through the submenus of the configuration menu, from the front of the 857 Protection System.

Device Setup

- Set the bit rate for the command-line interface in ports X4 and the front panel. The front panel uses this setting. If SPA-Bus is selected for the rear-panel local port X4, the bit rate is according to SPA-Bus settings.
- Displays the access level [Acc]
- Personal computer access level [PCAcc]

Language

A list of available languages in the 857 Protection System.

Current Scaling

- Rated phase CT primary current (Inom).
- Rated phase CT secondary current (Isec).
- Rated input of the relay [Iinput]. 5 A or 1 A, as specified in the order code of the device.
- Rated value of I_{01} CT primary current (Ionom).
- Rated value of I_{01} CT secondary current (Iosec).
- Rated I_{01} input of the Protection System [Ioinp]. 5 A or 1 A, as specified in the order code of the device.
- Rated value of I_{02} CT primary current (Io2nom).
- Rated value of I_{02} CT secondary current (Io2sec).
- Rated I_{02} input of the Protection System [Io2inp]. 5A, 1 A or 0.2, as specified in the order code of the device.

The rated input values are equal to the rated secondary value of the CT.

The rated CT secondary can be greater than the rated input, but the continuous current must be less than four times the rated input. In compensated, high impedance that is earthed, and isolated networks with a cable transformer to measure residual current I_0, a relay used. The relay has 1 A or 0.2 A input, and the CT is 5 A or 1 A, which increases the measurement accuracy.

The rated CT secondary can also be less than the rated input, but the measurement accuracy near zero current decreases.

Motor Currents

Displayed ONLY if the Protection System is in Motor protective mode.

- Rated current of the motor (Imot).

Voltage Scaling

- Rated VT primary voltage (Uprim).
- Rated VT secondary voltage (Usec).
- Rated U_0 VT secondary voltage (Uosec).
- Voltage measuring-mode (Umode).

Frequency Adaption

- Mode (Auto, Fixed, Manual).
- Adapted Frequency (fAdop).

Units For Mimic Display

- Unit for voltages. The choices are V (Volt) or kV (kilovolt).
- Scaling for active, reactive, and apparent power [Power]. The choices are k (for kW, kVAR, and kVA) or M (for MW, Mvar, and MVA).

Fundemantal/RMS

- Energy (Fundamental, RMS).
- Display Fundamental (On/Off).
- Display RMS (On/Off).

Device info

- Protection System type (857).
- Serial number (SerN).
- Software version (PrgVer).
- Bootcode version (BootVer).

Date/Time Setup

- Day, month, and year (Date).
- Time of day (Time).
- Date format (yyyy-mm-dd, dd.mm.yyyy, or mm/dd/yyyy).

Clock Synchronization

- Digital input for minute sync pulse (SyncDI). If any digital input is not used for synchronization, select "-".
- Daylight Savings Time for NTP synchronization (DST).
- Detected source of synchronization (SyScr).
- Synchronization message counter (MsgCnt).
- Latest synchronization deviation (Dev).

These parameters are visible only when the access level is higher than “User”.

- Offset, that is constant error, of the synchronization source (SyOS).
- Auto adjust interval (AAIntv).
- Average drift direction (AvDrft): “Lead” or “lag”.
- Average synchronization deviation (FilDev).

Software Options

- Application Mode (Feeder, Motor).
- Dist. Earth-fault (On/Off).
- MIMIC (On/Off).

Protocol Menu (Bus)

There are multiple communication ports on the rear panel. Protocol availability depends on the communication options ordered. In addition, there is a connector in the front panel. This connector takes control when the 857-VX003-3 cable is attached, which overrules the local port in the rear panel.

Remote Port

- Communication protocol for remote port X5 [Protocol].
- Message counter [Msg#]. Can be used to verify that the device is receiving messages.
- Communication error counter [Errors].
- Communication time-out error counter [Tout].
- Information of bit rate/data bits/parity/stop bits.
  This value is not directly editable. An edit is done in the protocol setting menus. The counters are useful when testing the communication.

Local Port

This port is disabled if the 857-VX003-3 cable is connected to the front panel connector.

- Communication protocol for the local port X4 [Protocol]. For SetPointPS use “None”.
- Message counter [Msg#]. Can be used to verify that the device is receiving messages.
- Communication error counter [Errors].
- Communication time-out error counter [Tout].
- Information of bit rate/data bits/parity/stop bits.
  This value is not directly editable. An edit is done in the protocol setting menus. For SetPointPS and protocol “None”, the setting is done in Protection System menu CONF/DEVICE SETup.

Personal Computer (LOCAL/SPA-Bus)

A second menu for local port X4. The SetPointPS communication status is shown.

- Bytes/size of the transmitter buffer [Tx].
- Message counter [Msg#]. Can be used to verify that the device is receiving messages.
- Communication error counter [Errors].
- Communication time-out error counter [Tout].
- Same information as in the previous menu.

Extension Port[1]

- Communication protocol for extension port X4 [Protocol]. For connection to the 857-RAD enhanced RTD scanner, select External I/O. See publication 857-UM002 for complete details.
- Message counter [Msg#]. Used to verify that the device is receiving messages.
- Communication error counter [Errors].
- Communication time-out error counter [Tout].
- Information of bit rate/data bits/parity/stop bits.
- This value is not directly editable. An edit is done in the protocol setting menus.

Ethernet Port

These parameters are used by the Ethernet interface. For changing the nnn.nnn.nnn.nnn Ethernet port settings, SetPointPS is recommended.

- Ethernet port protocol [Protoc].
- IP Port for protocol [Port].
- IP address [IpAddr].
- Net mask [NetMsk].
- Gateway [Gatew].
- Name server [NameSw].
- Network time protocol (NTP) server [NTPSvr].
- IP Port for SetPointPS [VS Port].
- TCP Keep alive interval [KeepAlive]
- Media access control address [MAC]
- Message counter [Msg#].
- Error counter [Errors].
- Timeout counter [Tout].

(1) Used with 857-RAD enhanced RTD scanner.

Modbus

- TCP Keep alive interval [Keepalive].
- Modbus address for this slave device [Addr]. This address must be unique within the system.
- Modbus bit rate [bit/s]. Default is “9600”.
- Parity [Parity]. Default is “Even”.

See Chapter 7 for details.

External I/O Protocol

External I/O is a set of protocols that are used with the extension I/O modules that are connected to the extension port. Only one instance of this protocol is possible. The selectable protocols are:

- **Modbus:** is a selectable protocol.
  - Bit rate [bit/s]. Default is “9600”.
  - Parity [Parity]. Default is “Even”.
- **RTD Input:** This protocol is used together with the 857-RAA scanner.
  - Bit rate [bit/s]. Default is “9600”.
  - Parity [Parity]. Default is “Even”.

See publication 857-UM002 for details.

SPA-Bus

Several instances of this protocol are possible.

- SPA-Bus address for this device [Addr]. This address must be unique within the system.
- Bit rate [bit/s]. Default is “9600”.
- Event number style [Emode]. Default is “Channel”.

See Chapter 7 for details.

IEC 60870-5-103

Only one instance of this protocol is possible.

- Address for this device [Addr]. This address must be unique within the system.
- Bit rate [bit/s]. Default is “9600”.
- Minimum measurement response-interval [MeasInt].
- ASDU6 response time mode [SyncRe].

See Chapter 7 for details.

IEC 103 Disturbance Recordings

See Chapter 7 for details.

PROFIBUS

Only one instance of this protocol is possible.

- [Mode]
- Bit rate [bit/s] must be 2400 bps. This parameter is the bit rate between the main CPU and the PROFIBUS ASIC. The PROFIBUS master sets the PROFIBUS bit rate and can be up to 12 Mbit/s.
- Event number style [Emode].
- Size of the PROFIBUS Tx buffer [InBuf].
- Size of the PROFIBUS Rx buffer [OutBuf].
- When configuring the PROFIBUS master system, the lengths of these buffers are needed. The size of both buffers is set indirectly when configuring the data items for PROFIBUS.
- Address for this slave device [Addr]. This address must be unique within the system.
- PROFIBUS converter type [Conv]. If the shown type is a dash "-": PROFIBUS protocol has not been selected. Or the device has not restarted after protocol change. Or there is a communication problem between the main CPU and the PROFIBUS ASIC.

See PROFIBUS DP on page 275 and Rockwell Automation® publication 857-UM003 for GSD file content and additional details.

DNP 3.0

Only one instance of this protocol is possible.

- Bit rate [bit/s]. Default is "9600".
- [Parity].
- Address for this device [SlvAddr]. This address must be unique within the system.
- Master address [MstrAddr].

See Chapter 7 for details.

IEC 60870-5-101

- Bit rate [bit/s]. Default is "9600".
- [Parity].
- Link layer address for this device [LLAddr].
- ASDU address [ALAddr].

See Chapter 7 for details.

SetPointPS Personal Computer Software

SetPointPS is a free personal computer program available for configuration and setting of Allen-Bradley® 857 and 865 protection systems. Obtain the latest SetPointPS software from www.ab.com. See 857-PM001 for more information.

The personal computer user-interface can be used for the following tasks:

- Do the on-site parameter settings of the protection system.
- Load protection system software from a computer.
- Read measured values, registered values, and events to a computer.
- Do a continuous monitoring of all values and events.
- Inject digital voltage and current signals for protection validation and troubleshooting.

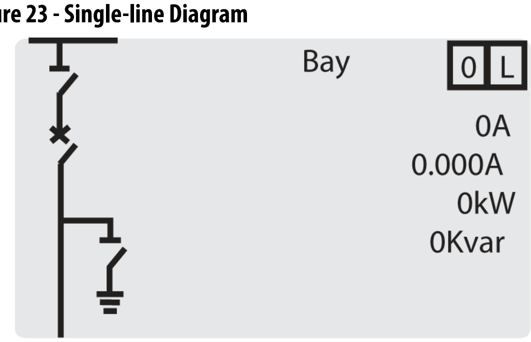
Two RS-232 serial ports can be available for connecting a local personal computer with SetPointPS to the protection system. One on the front panel (standard) and one on the rear panel of the protection system (optional). These two serial ports are connected in parallel. If the connection cables are connected to both ports, only the port on the front panel is active. To connect a personal computer to a serial port, use a connection cable Bulletin 857-VX003-3.

The SetPointPS program can also use an Ethernet TCP/IP LAN connection. An optional Ethernet communication-port is required.

Single-line Diagram Editing

The single-line diagram is drawn with the SetPointPS software. For more information, see the SetPointPS manual, publication 857-PM001.

Figure 23 - Single-line Diagram



Blocking and Interlocking Configuration

The configuration of the blockings and interlockings is done with the SetPointPS software. Any start or trip signal can be used for blocking the operation of any protection stage. The interlocking between objects can be configured in the same blocking matrix of the SetPointPS software. For more information, see publication 857-PM001.

Webset Through Hypertext Transfer Protocol (HTTP) Server

The Webset HTTP configuration interface can configure the device with a web browser (Explorer, Mozilla Firefox, or Google Chrome). The feature is available on 857 protection systems that are equipped with a built-in or optional Ethernet card and firmware revision 12.001 or newer installed. Webset provides a subset of features that are provided by SetPointPS, the configuration software. The same group lists and group views are available except for the LOGIC and the MIMIC groups, which are configurable only through SetPointPS.

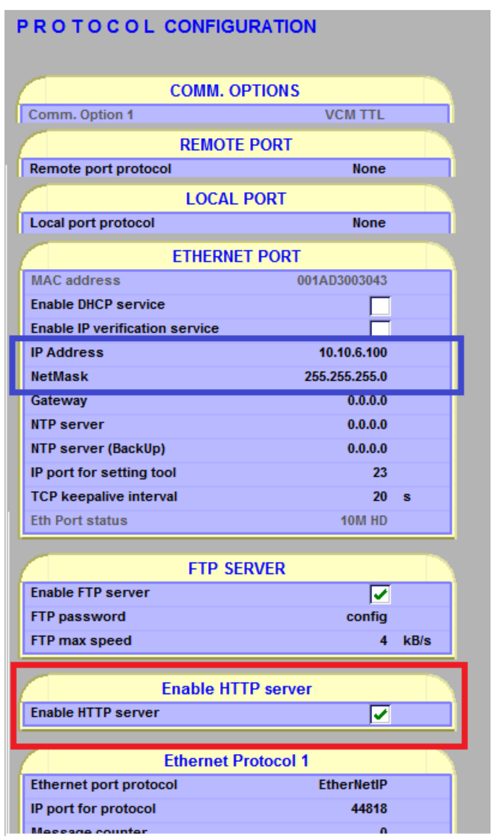
For web access to the 857 protection system, configure the protection system to enable HTTP services.

Enable the HTTP Server

The HTTP server can be enabled[1] within the 857 protection system by using these methods:

1. With SetPointPS – By checking the box to *Enable HTTP server* in the PROTOCOL CONFIGURATION group view as seen in Figure 24.
2. With the 857 HMI – By navigating to Bus > ETHERNET PORT > HTTP srvr and setting the value to *On*.

Figure 24 - Configuration Field for Enabling/disabling the HTTP Server in SetPointPS



(1) Configurator access level is required to enable the HTTP server. The 857 Protection System requires a restart before this feature is enabled.

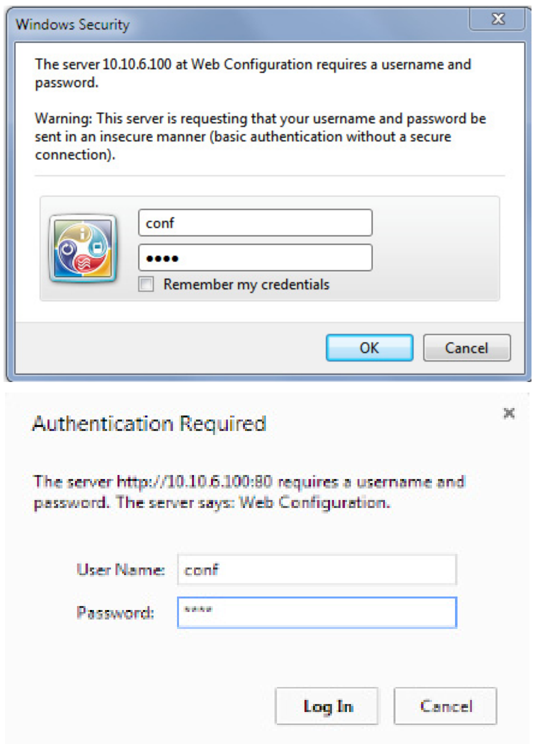
Connect to the 857 Protection System with a Web Browser

If the Ethernet port connection of the protection system is properly configured, the protection system connects to a personal computer.

1. Open a web browser window.
2. In the browser type, the IP address of the protection system. See Figure 24 for location of the IP address.
3. Press Enter.

   A prompt is displayed (Figure 25).

Figure 25 - Authorization Prompts in Various Browser Types



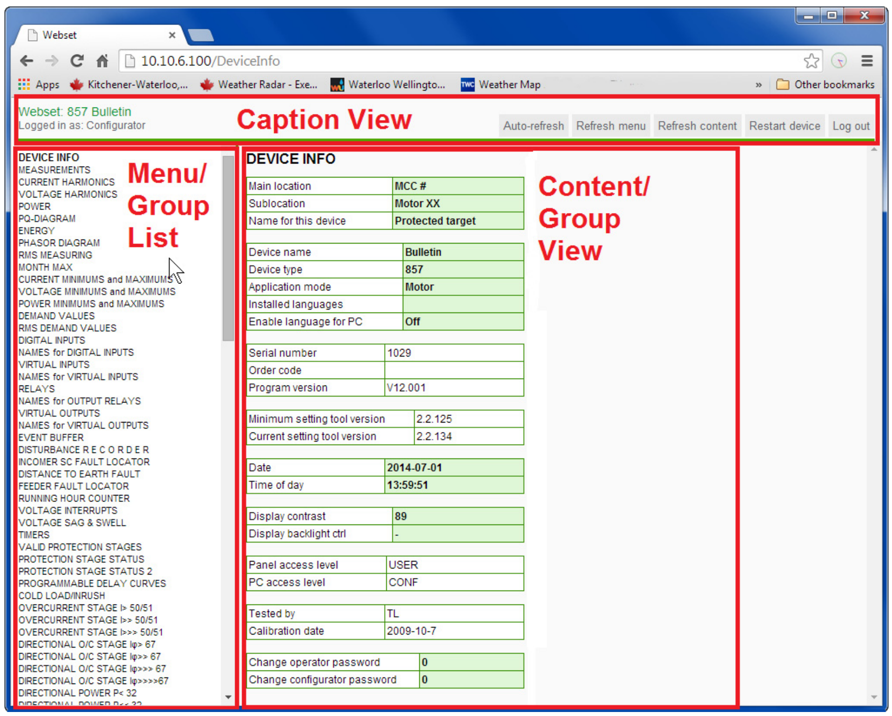
1. In the User Name field type one of the following:
   a. For configurator access level, type *conf*.
   b. For operator access level, type *operator*.
   c. For user access level, type *user*.
2. Enter the password in the password field:
   - By default, the password for Configurator Access Level is 2 or 0002, and for Operator Access Level is 1 or 0001.
   - The User Access Level does not require a password.
   - These passwords can be changed using the SetPointPS software. See 857-PM001.
3. Press OK or Login. The main page loads in the browser.

Configure the 857 Protection System Through Webset HTTP Server

Once connected, an interactive interface similar to that of SetPointPS is displayed (Figure 26). It features the ability to interrogate and revise the program settings of the 857 Protection System. It also provides the graphical abilities to monitor metering and energy-related data.

ATTENTION: Unlike the SetPointPS interface, interaction with the web interface is directly on-line to the857 Protection System. Any changes are immediately sent to the protection system. It is highly recommended the process/load being protected by the Protection System is not operating or being protected when changes are made through Webset.

Figure 26 - Main Page and the Functional Areas of the Configurator Mode on a Bulletin 857



Using the Webset HTTP Server

There are several interactive controls that are included with the Webset configurator. See Figure 26 for the functional areas within the Webset interface.

Fields that are styled with a light green color and bold font are editable. The exception is that matrices are shown in this style.

Caption View

The Caption View in Webset features a row of menu buttons (see Figure 26). The basic interaction and use of these buttons is as follows(1):

- **Auto-Refresh:** a toggle-button for enabling/disabling automatic periodic content refresh from a menu item from the 857 Protection System. The button changes to a dark green when enabled. If another menu selection is made, the Auto Refresh is automatically disengaged. The refresh interval depends on the size of the current page being displayed. Its use is recommended mostly for monitoring the metering values, such as those in the MEASUREMENTS group.
- **Refresh Menu:** refreshes the current Group View one time.
- **Refresh Content:** refreshes the Group View menu-item contents, one time.
- **Restart Device:** issues a restart command to the 857 Protection System, after clicking OK in the popup prompt. The Cancel command can be used from this popup prompt.(2)
- **Log out:** logs the user out of the web-based session.

Menu/Group List

The menu/group list functionality mimics the functions available by using SetPointPS programming software (see publication 857-PM001). The list is generated based on the options that are available in the device connected. To scroll down the list, use the slider bar on the right side of this portion of the control window.

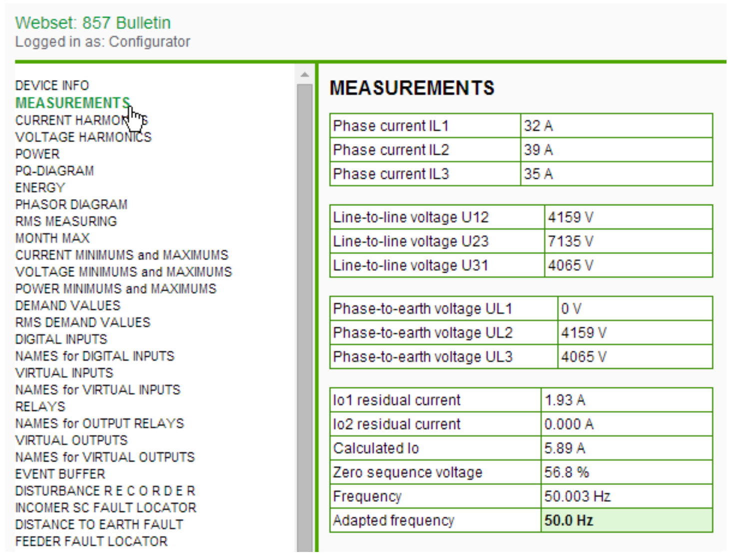
Content/Group View

To edit the settings, click the element name in the Content/Group View area. See Figure 27.

(1) The web interface is an online real-time interaction service. Any changes that are made are sent to the Protection System immediately. Some pages could take up to 10 seconds to load in some browsers version. Subsecond response is typical.

(2) Configurator access level is required. The 857 Protection System key restarts once the command is initiated which could result in a change of state of all output 857 Protection Systems.

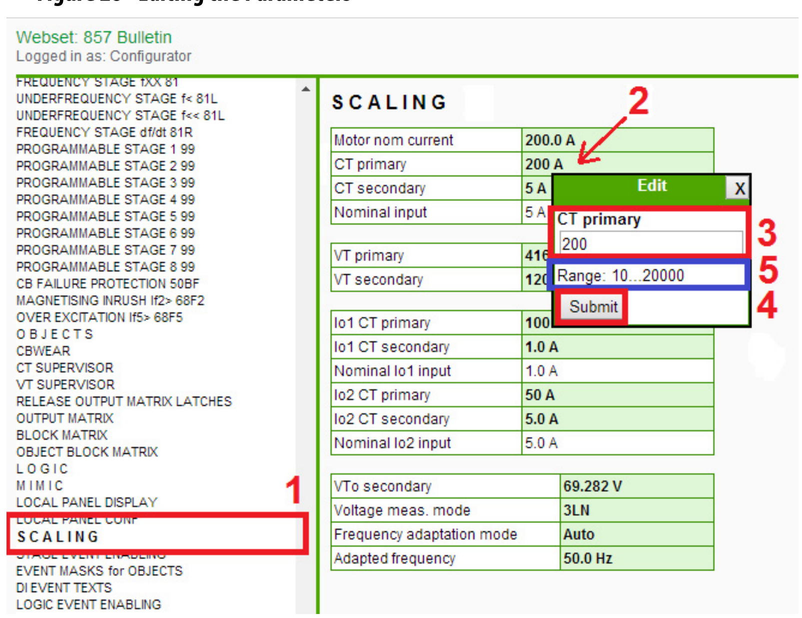
Figure 27 - View of Measurements Item



To change a parameter, follow these steps.

1. Select the desired main parameter item popup to change.
2. Select the variable within the setting parameter or protection elements. These areas are shown in light green. A popup window appears which permits the changing of that given parameter.
3. Shown in figure Figure 28 is the selection of the primary ratio of the main current transformers. Enter the desired value into the appropriate area of the editor prompt.
4. Click **Submit**.
5. The valid range for the specific element being changed is in the area below the entry box within the window.

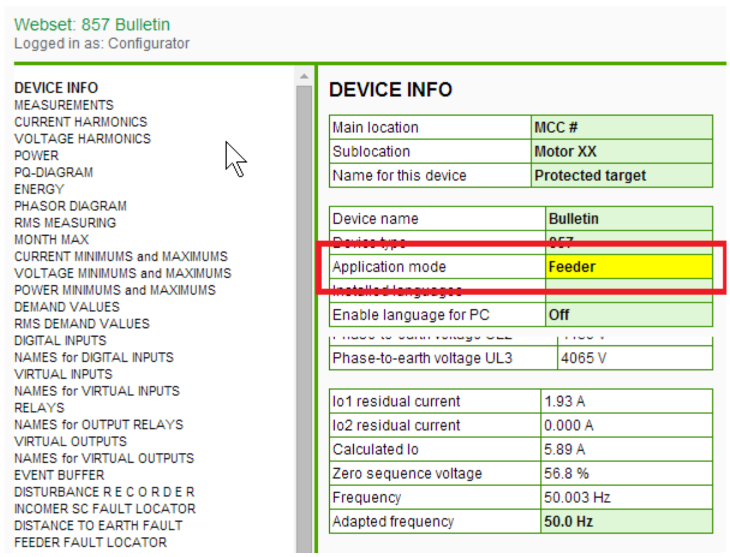
Figure 28 - Editing the Parameters



If a change is made to a given parameter, which affects other values on the page, these other values do not automatically update. Refresh the content or enable the Auto-refresh function. This aspect depends on type of change being made. Updating the page with the browser refresh function is also an option, but can provide a slower response time than the Webset refresh functionality.

For some parameter changes, the editing of a value requires the 857 Protection System to restart. In this case, the edited field will turn yellow after the submit button has been clicked to indicate that a restart is required. The Protection System protective mode has been changed to Feeder Protection Mode from Motor Protection Mode. The yellow color (Figure 29) signifies that a restart of the Protection System is required to initialize this change.

Figure 29 - Parameter Change Requiring Restart



To restart the protection system follow these steps.

1. Click the Restart Device button on the Webset page
2. Click OK.
3. Refresh to make sure that the views are updated.

Notes:

Protection Functions

Each protection stage can independently be enabled or disabled according to the requirements of the intended application.

Maximum Number of Protection Stages in One Application

The device limits the maximum number of enabled stages to about 30, depending on the type of the stages. For more information, see Configuration and Parameter Setting on page 43.

Protection Functions

Table 5 - List of Protection Functions

IEEE/ANSI Code	IEC Symbol	Function Name	Page
25	df/dv	Synchrocheck	138
14	U< U<< U<<<	Speed switch input	128
27		Undervoltage protection	
32	P< P<<	Reverse and underpower protection	131
37	I<	Undercurrent protection	93
38	I_2>	RTDs	81, 82
46(1) (2)		Current unbalance protection	
46(1) (2)	I_2>>	Phase reversal / incorrect phase sequence protection	85
48(1)	I_{st}>	Stall protection	86
49	T>	Thermal overload protection	121
50/51	I> I>> I>>>	Overcurrent protection	70
50ARC	ArcI>	Optional arc overcurrent protection	151
50BF	CBFP	Circuit-breaker failure protection	147
50N/51N 50G/51G 50GS/51GS	I_0> I_0>> I_0>>> I_0>>>>	Earth-fault protection	104
50NARC	ArcI_{01}> ArcI_{02}>	Optional earth-fault protection	151
50NC/51NC		Capacitor-bank unbalance protection	114
55PF		Power Factor Relay	

Table 5 - List of Protection Functions (Continued)

IEEE/ANSI Code	IEC Symbol	Function Name	Page
59N	$U_0>$ $U_0>>$	Zero sequence voltage protection	118
59	U> U>> U>>>	Overvoltage protection	125
66(1)	N>	Frequent start protection	90
67	$I_{\varphi}>$ $I_{\varphi}>>$ $I_{\varphi}>>>$ $I_{\varphi}>>>>$	Directional overcurrent protection	75
67N	$I_{0\varphi}>$ $I_{0\varphi}>>$	Directional earth-fault protection	93
67NI	I_{0int}	Directional transient intermittent earth-fault protection	109
68F2	$I_{f2}>$	Second harmonic overcurrent protection	146
68F5	$I_{f5}>$	Fifth Harmonic Overcurrent Stage	147
81, 81H, 81L	f>< f>><<	Frequency protection	132
79	AR	Reclose	132
81L	f< f<<	Underfrequency protection	
81R	df/dt	Rate of change of frequency (ROCOF) protection	134
86		Selective lockout	
99	Prg1…8	Programmable stages	148

(1) Some stages vary between feeder or motor protective modes.

(2) Voltage phase reversal / incorrect phase sequence indication is provided through various parameters. See Appendix A.

General Features of Protection Stages

Setting Groups

The setting groups are controlled by using digital inputs or other assigned inputs. Up to four setting groups can be available depending on the version of the Protection System firmware. When none of the assigned input/inputs is/are not active, the parameter 'SetGrp no control state' defines the active setting group. When controlled input activates, the corresponding setting group is activated as well. If multiple inputs are active simultaneously, 'SetGrp priority' defines the active setting group. By using virtual I/O, the active setting group can be controlled. Also by using the local panel display, any communication protocol, or the built-in programmable logic functions. The status of a protection stage can be any of the following list:

OK = '–'	Stage is not detecting any fault.
Blocked	Stage is detecting a fault but is blocked for some reason.
Start (Alarm)	Stage has begun counting the operation delay and is an Alarm state.
Trip	Stage has tripped and the fault is still active.

IMPORTANT Since the 857 relay is designed to be applied in any global location, the term 'Start' is used universally throughout the product to indicate that protective element or condition is in an alarm state or condition. This term is used throughout the product and this document.

The status of a protective stage can show Blocked. The block can be due to an active signal through the block matrix from other stages, the programmable logic, or any digital input. Some stages also have built-in logic for blocking. For example, an under frequency stage is blocked if the voltage is too low. For more details about block matrix, see Measurement Functions on page 213.

Forcing a Start or Trip Condition for Testing

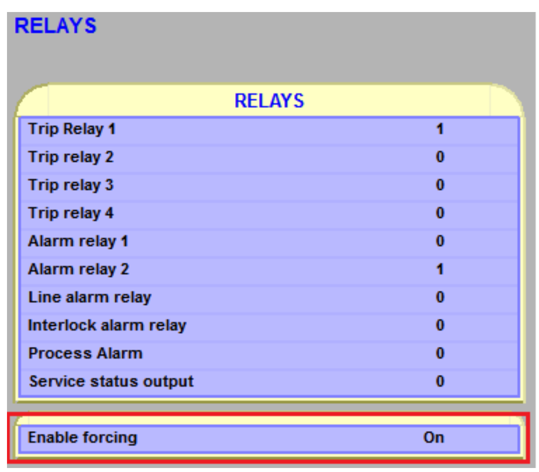
The "Force flag" parameter forces the status of any protection stage to be "start" or "trip" for a half second. By using the parameter, no current or voltage injection to the Protection System is required check the following:

- The output matrix configuration.
- The wiring from the output relays to the circuit breaker or contactor.
- The communication protocols are correctly transferring event information to a remote system.

After testing, the force flag automatically resets 5 minutes after the last local panel push button activity.

The force flag also enables the forcing of the output relays and the forcing of the optional mA outputs. Force Flag is found in the Relays menu.

Figure 30 - Force Flag



Start and Trip Signals

Every protection stage has two internal binary-output signals, start and trip. The start signal is issued when a fault is detected (Alarm condition). The trip signal is issued after the configured operation delay, unless the fault disappears before the end of the delay time. These conditions can be configured to Trip or Alarm relays or virtual outputs.

Output Matrix

The output matrix is used to connect the internal start and trip signals to the output relays and indicators, see Control Functions on page 231.

Blocking

Any protection function, except arc protection, can be blocked with internal and external signals when the block matrix is used. See Measurement Functions on page 213). For example, internal signals are logic outputs and start and trip signals from other stages and external signals are digital and virtual inputs.

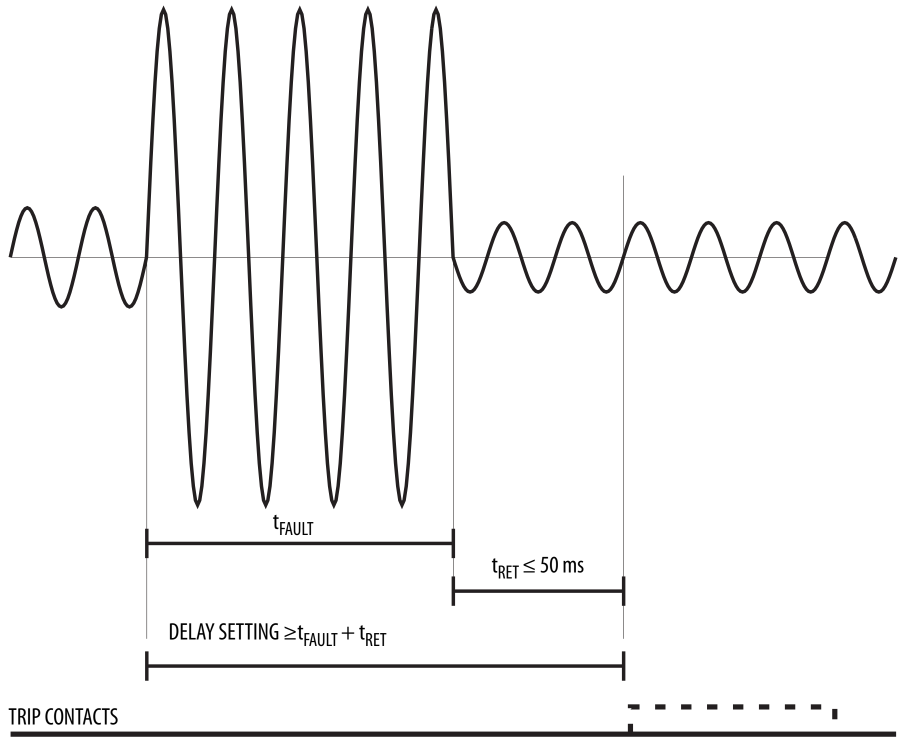
Some protection stages have the blocking functions built-in. For example, under-frequency protection has the blocking for undervoltage built-in to avoid tripping when the voltage is off.

When a protection stage is blocked, it does not pick up if a fault condition is detected. If the blocking is activated during the operation delay, the delay counting is frozen until the blocking goes off or the pick-up reason. If the stage is tripping, the blocking has no effect.

Retardation Time

Retardation time is a protection the Protection System requires to notice that a fault has been cleared during the operation time delay. This parameter is important when grading the operation time-delay settings between Protection Systems. If the delay setting was slightly shorter, an unselective trip can occur (the dash line pulse).

Figure 31 - Retardation Time



For example, when there is a large fault in an outgoing feeder, it can start (that is pick-up both the incoming and outgoing feeder Protection System). Clear the fault by the outgoing feeder relay. The incoming feeder relay must not trip. Set the operating delay of the incoming feeder so that it is greater than at the outgoing feeder. The incoming feeder can still trip if the operation time difference is inadequate. The difference must be more than the retardation time of the incoming feeder relay, plus the operating time of the outgoing feeder circuit breaker.

Figure 31 shows an overcurrent fault as seen by the incoming feeder, when the outgoing feeder does clear the fault. An unselective trip can happen (the dashed 40-ms pulse in the figure) if either the following occurs:

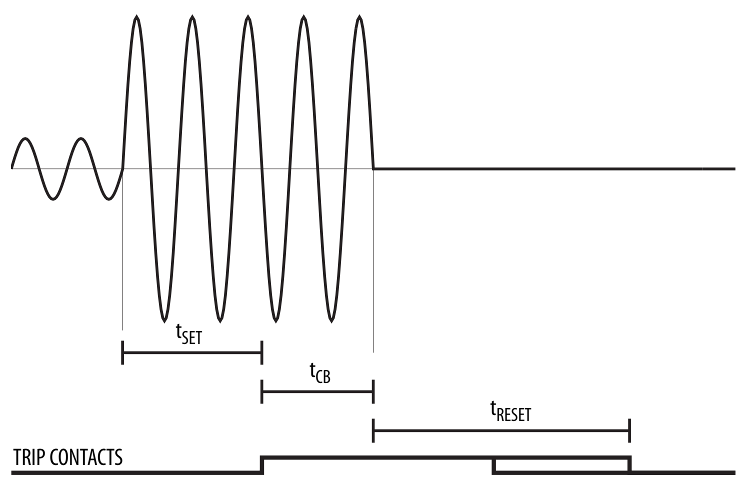
- The operation delay setting is slightly shorter.
- The fault duration is slightly longer than in the figure.

The 857 Protection System retardation time is less than 50 ms.

Reset Time (Release Time)

Figure 32 shows an example of reset time (release delay) when the Protection System is clearing an overcurrent fault. When the protection system trip contacts are closed, the circuit breaker (CB) starts to open. After the CB contacts are open, the fault current still flows through an arc between the opened contacts. The current is finally cut when the arc extinguishes at the next zero -crossing of the current (the start moment of the reset delay). After the reset delay, the trip contacts and start contact are opened unless the latching is configured. The reset time varies from fault to fault depending on the fault size. After a significant fault, the time is longer. The reset time also depends on the specific protection stage. The maximum reset time for each stage is specified in Chapter 10. For most stages, it is less than 95 ms.

Figure 32 - Reset Time

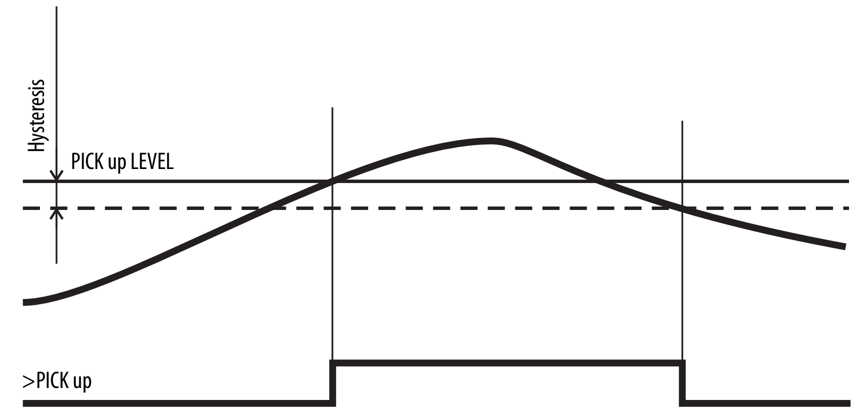


Hysteresis or Deadband

When comparing a measured value against a pick-up value, some amount of hysteresis is required to avoid oscillation near any equilibrium situation. With zero hysteresis, any noise in the measured signal or any noise in the measurement itself would cause unwanted oscillation between a fault-on and fault-off situation.

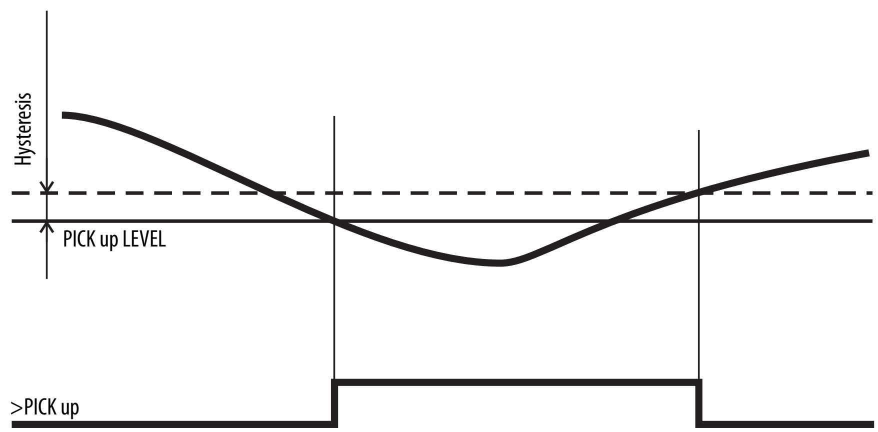
In overcurrent and overvoltage stages, the hysteresis (deadband) acts according to this figure

Figure 33 - Behavior of a Greater Than Comparator



In undercurrent and under frequency stages, the hysteresis (deadband) acts according to this figure

Figure 34 - Behavior of a Less Than Comparator



Function Dependencies

Application Modes

There are two application modes available within the protection system the feeder protective mode and the motor protective mode. In feeder protective mode, all current-dependent protection functions are relative to nominal current I_n derived by CT ratios. The motor protection functions are unavailable in the feeder protective mode. In the motor protective mode, all current-dependent protection functions are relative to the nominal current I_{mot} of the motor. The motor protective mode enables motor protection functions. All functions that are available in the feeder protective mode are also available in the motor protective mode.

The application mode can be changed with the SetPointPS software or from CONF menu in the device. To change the application mode, it requires the configurator password, and a restart of the protection system.

Current Protection Function Dependencies

The current based protection functions are relative to I_{MODE}, which is dependent on the application mode. In motor protective mode, all current based functions are relative to I_{MOT}, and in the feeder protective mode to I_n, with the following exceptions.

I_2> (46), I_2>> (46), I_{st}> (48), and N> (66) are dependent on I_{MOT} and are only available when the application mode is motor protection.

Overcurrent Stage I> (50/51)

Overcurrent protection is used against short circuit faults and heavy overloads.

The overcurrent function measures the fundamental frequency component of the phase currents. The protection is sensitive for the highest of the three phase currents. Whenever this value exceeds the pick-up setting of a particular stage, this stage picks up and a start signal is issued. If the fault situation remains longer than the operation delay setting, a trip signal is issued.

IMPORTANT	When the 857 is used for control and protection of fuse and contactor based configuration (E2), 50/51 protection elements should only be used for alternative functions or used to block the tripping of the switching device for currents greater than the switching device's interrupting rating.

Three Independent Stages

There are three adjustable overcurrent stages I>, I>>, and I>>>. The first stage I> can be configured for definite time (DT) or inverse time operation characteristic (IDMT). The stages I>> and I>>> have DT operation characteristic. By using the definite delay type and setting the delay to its minimum, an instantaneous (ANSI 50) operation is obtained.

Figure 35 shows a functional block diagram of the I> overcurrent stage with DT and inverse time operation time. Figure 36 shows a functional block diagram of the I>> and I>>> overcurrent stages with DT operation delay.

Inverse Operation Time

Inverse delay means that the operation time depends on the amount the measured current exceeds the pick-up setting. The bigger the fault current, the faster the operation. Accomplished inverse delays are available for the I> stage. The inverse delay types are described in Inverse Time Operation on page 154. The device shows the currently used inverse delay curve-graph on the local panel display.

Inverse Time Limitation

The maximum measured secondary current is 50 x I_N, which limits the scope of inverse curves with high pick-up settings. See Inverse Time Operation on page 154.

Cold Load and Inrush Current Handling

See Cold Load Pick-up and Inrush Current Detection on page 178.

Setting Groups

There are four settings groups available for each stage. Use digital inputs, virtual inputs (mimic display, communication, logic), and manual control to switch between setting groups.

Figure 35 - Block Diagram of the Three-phase Overcurrent Stage I> and I'>

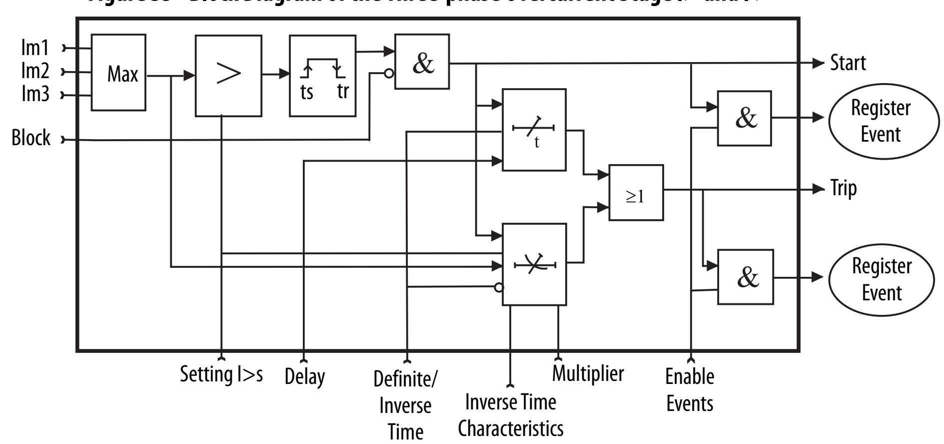


Figure 36 - Block Diagram of the Three-phase Overcurrent Stage I>> and I>>>

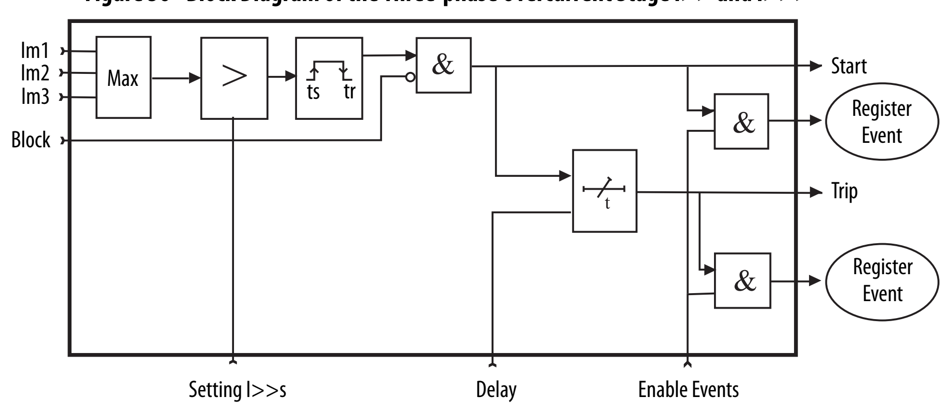


Table 6 - Parameters of the Overcurrent Stage I> (50/51)

Parameter	Value	Unit	Description	Note
Status	- Blocked Start Trip		Status of the stage	 F[1] F[1]
TripTime		s	Estimated time to trip	
SCntr			Cumulative start counter	C[2]
TCntr			Cumulative trip counter	C[2]
SetGrp	1…4		Active setting group	Set[3]
SGrpDI	 - DIx VIx LEDx VOx		Digital signal to select the active setting group: None Digital input Virtual input Status indicator signal Virtual output	Set[3]
Force	Off On		Force flag for status, forcing for test purposes. A common flag for all stages and output relays, too. This flag is automatically reset 5 minutes after the front panel button are last used.	Set[3]
ILmax		A	The supervised value. Max. of IL1, IL2, and IL3	
I>		A	Pick-up value that is scaled to primary value	
I>		xImode	Pick-up setting	Set[3]
Curve	 DT IEC IEEE IEEE2 RI PrgN		Delay curve family Definite time Inverse time. See Inverse Time Operation on page 154. Pre 1996	Set[3]
Type	 DT NI VI EI LTI Parameters		Delay type Definite time Inverse time. See Inverse Time Operation on page 154. Inverse Inverse Long Time Inverse	Set[3]
t>		s	Definite operation time (for Definite Time only)	Set[3]
k>			Inverse delay multiplier (for inverse time only)	Set[3]
Dly20x		s	Delay at 20xIset	
Dly4x		s	Delay at 4xIset	
Dly2x		s	Delay at 2xIset	
Dly1x		s	Delay at 1xIset	
IncHarm	On / Off		Include Harmonics	
Delay curves			Graphic delay curve picture (only local display)	
A, B, C, D, E			User constants for standard equations. Type = parameters. See Inverse Time Operation on page 154.	Set[3]

(1) F = Editable when force flag is on
(2) C = Can be cleared to zero.
(3) Set = An editable parameter (password required).

Missing Recorded Value

Table 7 - Recorded Values

LOG1		Date and time of trip
Type		Fault type
Flt	xIMODE	Fault current
Load	xIMODE	Pre-fault current
Edly	%	Elapsed delay time
SetGrp		Active set group during default

Table 8 - Parameters of the Overcurrent Stages I>>, I>>> (50/51)

For details on setting ranges, see Protection Stages on page 351.

Parameter	Value	Unit	Description	Note
Status	- Blocked Start Trip		Status of the stage	 F[1] F[1]
SCntr			Cumulative start counter	C[2]
TCntr			Cumulative trip counter	C[2]
SetGrp	1 …4		Active setting group	Set[3]
SGrpDI	 - DIx VIx LEDx VOx		Digital signal to select the active setting group None Digital input Virtual input Status indicator signal Virtual output	Set[3]
Force	Off On		Force flag for status, forcing for test purposes. A common flag for all stages and output relays, too. Automatically reset by a 5-minute timeout.	Set[3]
ILmax		A	The supervised value. Max. of IL1, IL2, and IL3	
I>> I>>>		A	Pick-up value that is scaled to primary value	
I>> I>>>		xImode	Pick-up setting	Set[3]
t>> t>>>		s	Definite operation time	Set[3]
IncHarm	On Off		Include harmonics	Set

(1) F = Editable when force flag is on.
(2) C = Can be cleared to zero.
(3) Set = An editable parameter (password required).

Recorded Values of the Latest Eight Faults

Detailed information is available on the eight latest faults: Time stamp, fault type, fault current, load current before the fault, elapsed delay, and setting group.

Table 9 - Recorded Values of Overcurrent Stages (Eight Latest Faults) I>, I>>, I>>> (50/51)

Parameter	Value	Unit	Description
	yyyy-mm-dd		Time stamp of the recording, date
	hh : mm: ss: ms		Time stamp, time of day
Type	 1-N 2-N 3-N 1-2 2-3 3-1 1,2,3		Fault type: Ground fault Ground fault Ground fault Two-phase fault Two-phase fault Two-phase fault Three-phase fault
Flt		xImode	Maximum fault current
Load		xImode	1-s average phase currents before the fault
EDly		%	Elapsed time of the operating time setting. 100% = trip
SetGrp	1…4		Active setting group during fault

Remote Controlled Overcurrent Scaling

Pick-up setting of the three overcurrent stages can also be controlled remotely. In this case, only two coefficients for scaling are possible100% (the scaling is inactive) and any configured value between 10...200% (the scaling is active). When scaling is enabled, all settings of group one are copied to group two. But the pick-up value of group two is changed, according to the given value (10...200%).

- This feature is enabled/disabled through SetPointPS or by using the local panel. When using SetPointPS, the scaling can be activated and adjusted in the “protection stage status 2” –menu. The local panel has similar settings that are found in the “prot” -menu.
- It is also possible to change the scaling factor remotely by using the Modbus TCP –protocol. When changing the scaling factor remotely, the value of 1% is equal to 1. Check the correct Modbus address for this application from the SetPointPS or from the communication parameter list.

Figure 37 - Example of Remote Scaling

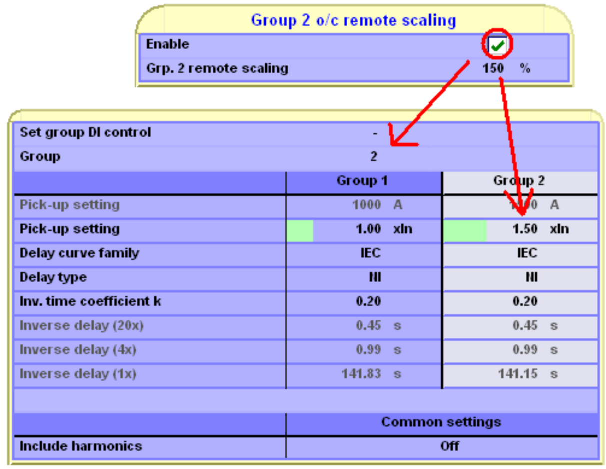


Figure 37 shows the effect of remote scaling. After enabling, group is changed from group one to group two and all settings from group one are copied to group two. The difference is that group two uses scaled pick-up settings.

IMPORTANT	When the remote scaling function is used, all settings of group 2, 3, and 4 are placed. This function cannot be used simultaneously with normal group changes.

Directional Overcurrent Protection I_{φ}> (67)

The directional overcurrent protection can be used for directional short circuit protection. Typical applications are the following:

- Short circuit protection of two parallel cables or overhead lines in a radial network.
- Short circuit protection of a looped network with one feeding point.
- Short circuit protection of a two-way feeder, which usually supplies loads but is used in special cases as an incoming feeder.
- Directional earth-fault protection in low impedance earthed networks. In this case, the device must be connected to line-to-neutral voltages instead of line-to-line voltages. The voltage measurement mode must be “3LN” (see Voltage Measurement Mode on page 217).

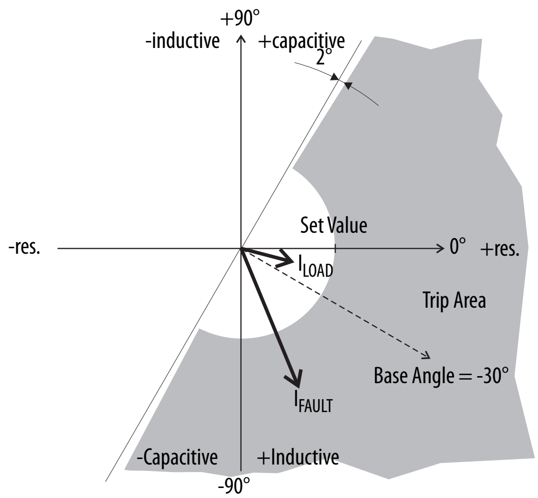
The stages are sensitive to the amplitude of the highest fundamental frequency current of the three measured phase currents. The phase angle is based on the phase angle of the three-phase power phasor. For details of power direction, see Direction of Power and Current on page 220. A typical characteristic is shown in Figure 38. The base angle setting is –30°. The stage picks up, if the tip of the three-phase current phasor gets into the gray area.

TIP To connect for the right direction for earth-faults:

If the maximum earth-fault current is greater than the most sensitive directional overcurrent setting, connect the device to the line to neutral voltages.

For networks having the maximum possible earth-fault current less than the overcurrent setting, use 67N, the directional earth-fault stages.

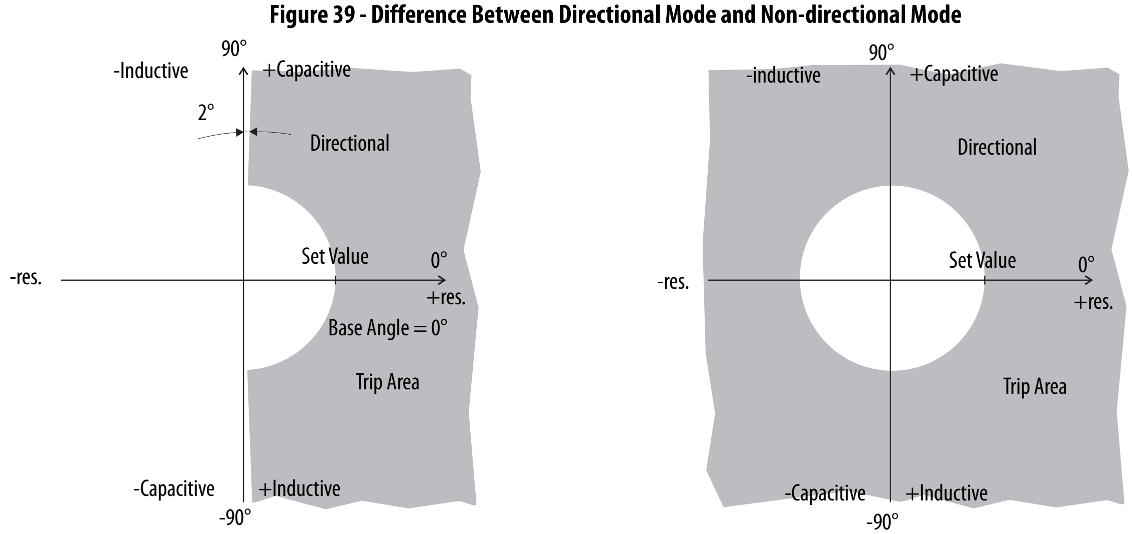
Figure 38 - Example of Protection Area of the Directional Overcurrent Function



Three modes are available: directional, ,non-directional and directional + back-up Figure 39. In the non-directional mode, the stage is acting just like an ordinary overcurrent 50/51 stage.

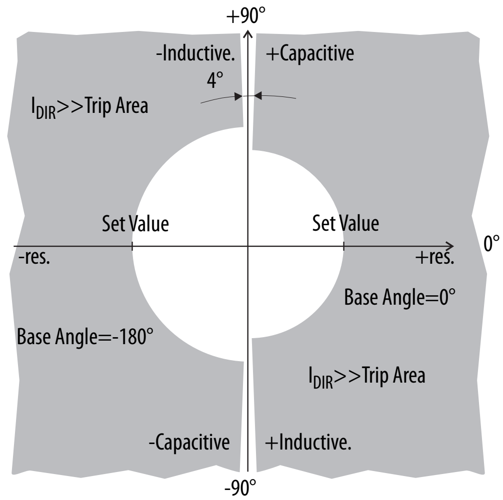
Directional+back-up mode works the same way as directional mode but it has undirectional back-up protection in case a close-up fault forces all voltages to about zero. After the angle memory hold time, the direction would be lost. Basically the directional+backup mode is required when operation time is set longer than voltage memory setting and no other undirectional back-up protection is in use.

Figure 39 - Difference Between Directional Mode and Non-directional Mode



An example of bi-directional operation characteristic is shown in Figure 40. The right side stage in this example is the stage $I_φ$> and the left side is $I_φ$>>. The base angle setting of the $I_φ$> is 0° and the base angle of $I_φ$>> is set to –180°.

Figure 40 - Bi-directional Application with Two Stages $I_φ$> and $I_φ$>>



The stage picks up and issues a start signal when any of the three phase currents:

- Exceeds the setting value.
- Is in directional mode and has a phase angle including the base angle within the active ± 88° wide sector.

If this fault situation remains on longer than the delay setting, a trip signal is issued.

Four Independent Stages

There are four separately adjustable stages available: $I_φ$>, $I_φ$>>, $I_φ$>>>, and $I_φ$>>>>.

Inverse Operation Time

Stages $I_φ$> and $I_φ$>> are configured for Definite Time (DT) or inverse time characteristic. See Inverse Time Operation on page 154 for available inverse delays. Stages $I_φ$>>> and $I_φ$>>>> have DT operation delay. The device shows a scalable graph of the configured delay on the local panel display.

Inverse Time Limitation

The maximum measured secondary current is 50 x I_N. This maximum limits the scope of inverse curves with high pick-up settings. See Inverse Time Operation on page 154.

Cold Load and Inrush Current Handling

See Cold Load Pick-up and Inrush Current Detection on page 178.

Setting Groups

There are four settings groups available for each stage. Use digital inputs, virtual inputs (mimic display, communication, logic), and manual control to switch between setting groups. For details on setting ranges, seeProtection Stages on page 351.

Figure 41 shows the functional block of the $I_{\varphi}>$ stage.

Figure 41 - Block Diagram of the Three-phase Overcurrent Stage $I_{\varphi}>$

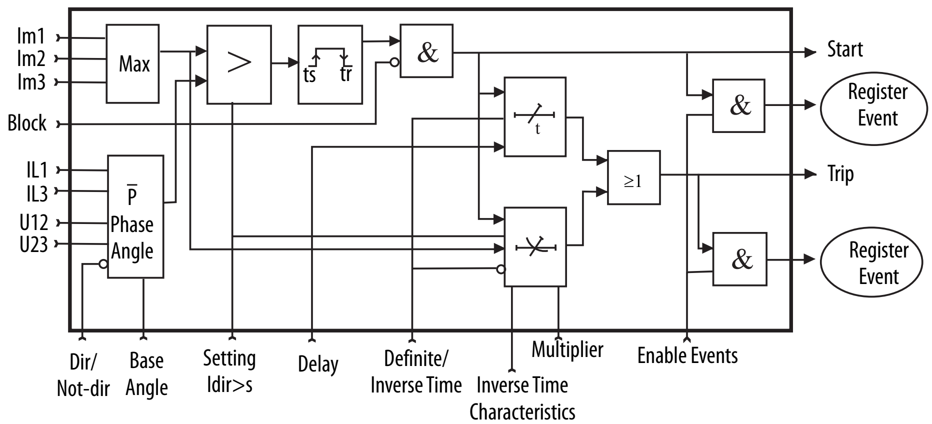


Table 10 - Parameters of the Directional Overcurrent Stages $I_{\varphi}>$, $I_{\varphi}>>$ (67)

Parameter	Value	Unit	Description	Note
Status	- Blocked Start Trip		Status of the stage	 F(1) F(1)
Trip Time		S	Estimated time to trip	
SCntr			Cumulative start counter	C(2)
TCntr			Cumulative trip counter	C(2)
SetGrp	1…4		Active setting group	Set(3)
SGrpDI	 - DIx VIx LEDx VOx		Digital signal to select the active setting group: None Digital input Virtual input Status indicator signal Virtual output	Set(3)
Force	Off On		Force flag for status forcing for test purposes. A common flag for all stages and output relays, too. Automatically reset by a 5-minute timeout.	Set(3)
ILmax		A	The supervised value. Max. of IL1, IL2, and IL3	
$I_{\varphi}>$ $I_{\varphi}>>$		A	Pick-up value that is scaled to primary value	

Table 10 - Parameters of the Directional Overcurrent Stages $I_φ$>, $I_φ$>> (67) (Continued)

Parameter	Value	Unit	Description	Note
$I_φ$> $I_φ$>>		xImode	Pick-up setting	Set(3)
Curve	 DT IEC IEEE IEEE2 RI PrgN		Delay curve family: Definite time Inverse time. See Inverse Time Operation on page 154.	Set (3)
Type	 DT NI VI EI LTI Parameters		Delay type: Definite time Inverse time Very Inverse Extremely Inverse Long Time Inverse	Set(3)
t>		s	Definite operation time (for Definite Time only)	Set(3)
k>			Inverse delay multiplier (for inverse time only)	Set(3)
Dly20x		s	Delay at 20 I_{MODE}	
Dly4x		s	Delay at 4 I_{mode}	
Dly2x		s	Delay at 2 I_{MODE}	
Dly1x		s	Delay at 1xI_{MODE}	
Mode	Dir Undir		Directional mode (67) Undirectional (50/51)	Set(3)
Offset		?	Angle offset in degrees	Set(3)
φ		?	Measured power angle	
U1		%Un	Measured positive sequence voltage	
A, B, C, D, E			User constants for standard equations. Type = Parameters. See Inverse Time Operation on page 154.	Set(3)

(1) F = Editable when force flag is on
(2) C = Can be cleared to zero
(3) Set = An editable parameter (password required)

Table 11 - Parameters of the Directional Overcurrent Stages $I_φ$>>>, $I_φ$>>>> (67)

Parameter	Value	Unit	Description	Note
Status	- Blocked Start Trip		Status of the stage	 F(1) F(1)
SCntr			Cumulative start counter	C(2)
TCntr			Cumulative trip counter	C(2)
SetGrp	1…4		Active setting group	Set(3)
SGrpDI	 - DIx VIx LEDx VOx		Digital signal to select the active setting group: None Digital input Virtual input Status indicator signal Virtual output	Set(3)
Force	Off On		Force flag for status forcing for test purposes. Force is a common flag for all stages and output relays. Automatically reset by a 5-minute timeout.	Set(3)
ILmax		A	The supervised value. Max. of IL1, IL2, and IL3	
$I_φ$>>> $I_φ$>>>>		A	Pick-up value that is scaled to primary value	
$I_φ$>>> $I_φ$>>>>		xImode	Pick-up setting	Set(3)
t>>> t>>>>		s	Definite operation time (for Definite Time only)	Set(3)
Mode	Dir Undir		Directional mode (67) Undirectional (50/51)	Set(3)
Offset		?	Angle offset in degrees	Set(3)
φ		?	Measured power angle	
U1		%Un	Measured positive sequence voltage	

(1) F = Editable when force flag is on.
(2) C = Can be cleared to zero.
(3) Set = An editable parameter (password required).

For details on setting ranges, see Protection Stages on page 351.

Recorded Values of the Latest Eight Faults

Detailed information is available on the eight latest faults: Time stamp, fault type, fault current, load current before the fault, which is elapsed delay, and setting group.

Table 12 - Recorded Values of the Directional Overcurrent Stages (8 Latest Faults) I_φ>, I_φ>>, I_φ>>>, I_φ>>>> (67)

Parameter	Value	Unit	Description
	yyyy-mm-dd		Time stamp of the recording, date
	hh:mm:ss:ms		Time stamp, time of day
Type	 1-N 2-N 3-N 1-2 2-3 3-1 1-2-3		Fault type: Ground fault Ground fault Ground fault Two-phase fault Two-phase fault Two-phase fault Three-phase fault
Flt		xIn	Maximum fault current
Load		xIn	1-s average phase currents before the fault
EDly		%	Elapsed time of the operating time setting. 100% = trip
Angle		?	Fault angle in degrees
U1		xUn	Positive sequence voltage during fault
SetGrp	1…4		Active setting group during fault

Current Unbalance Stage I_2> (46) in Feeder Protection Mode

The unbalance stage detects unbalanced load conditions. For example, a broken conductor or a heavy loaded overhead line if there is no earth-fault.

The operation of the unbalanced load function is based on the negative-phase-sequence component I_2 related to the positive-phase sequence component I_1. This function is calculated from the phase currents with the method of symmetrical components. The function requires that the measuring inputs are connected correctly so that the rotation directions of the phase currents are as in Chapter 9. The unbalance protection has DT operation characteristic.

$$K2 = \frac{I_2}{I_1}, \text{ where}$$

$$I1 = I_{L1} + aI_{L2} + a^2I_{L3}$$

$$I2 = I_{L1} + a^2I_{L2} + aI_{L3}$$

$$\underline{a} = 1\angle 120^\circ = -\frac{1}{2} + j\frac{\sqrt{3}}{2}, \text{ a phasor rotating constant.}$$

Setting Parameters of Current Unbalance Stage I_2> (46)

Table 13 - Parameter Value Unit-default Description

Parameter	Value	Unit	Default	Description
I_2/I_1	2…70	%	20	Setting value, I_2/I_1
t>	1.0…600.0	s	10.0	Definite Operating Time
Type	DT INV	—	DT	The selection of time characteristics
S_On	Enabled/Disabled	—	Enabled	Start on event
S_Off	Enabled/Disabled	—	Enabled	Start off event
T_On	Enabled/Disabled	—	Enabled	Trip on event
T_Off	Enabled/Disabled	—	Enabled	Trip off event

Measured and Recorded Values of Current Unbalance Stage I_2> (46)

Table 14 - Parameter Value Unit-default Description

	Parameter	Value	Unit	Description
Measured Value	I_2/I_1		%	Relative negative-sequence component
Recorded Values	SCntr			Cumulative start counter
	TCntr			Cumulative start counter
	Flt		%	Maximum I_2/I_1 fault component
	EDly		%	Elapsed time as compared to the set operating time, 100% = tripping

Current Unbalance Protection I_2> (46) in Motor Protection Mode

Current unbalance in a motor causes double frequency currents in the rotor. This unbalance warms up the surface of the rotor. The available thermal capacity of the rotor is much less than the thermal capacity of the whole motor. An rms only current based overload protection (see Thermal Overload Protection T> (49) on page 121) cannot prevent a motor from a current unbalance.

The current unbalance protection is based on the negative sequence of the base frequency phase-currents. Both definite and inverse time characteristics are available. Incorrect current phase sequencing to the 857 can result in abnormal and extreme unbalanced values.

Inverse Delay

Equation 3.1

The inverse delay is based on this equation.

$$T = \frac{K_1}{\left(\frac{I_2}{I_{MOT}}\right)^2 - K_2^2}, \text{ where}$$

T	=	Operation time (in seconds).
K_1	=	Delay multiplier.
I_2	=	Measured and calculated negative sequence phase current of fundamental frequency.
I_{MOT}	=	Nominal current of the motor.
K_2	=	Pick-up setting I_2> in pu. The maximum allowed degree of unbalance.

Example:

K_1	=	15 s
I_2	=	22.9% = 0.229 x I_{MOT}
K_2	=	5% = 0.05 x I_{MOT}

$$t = \frac{15}{\left(\frac{0.229}{1}\right)^2 - 0.05^2} = 300.4 \text{ seconds}$$

The operation time in this example is 5 minutes.

More Stages (DT Delay Only)

If multiple DT delay stages are needed for current unbalance protection, the freely programmable stages (99) can be used (see Programmable Stages (99) on page 148).

Setting Groups

There are four settings groups available for each stage. Use digital inputs, virtual inputs (mimic display, communication, logic), and manual control to switch between setting groups.

Figure 42 - Inverse Operation Delay of Current Unbalance Stage I_2>

The longest delay is limited to 1000 seconds (16 Min 40s).

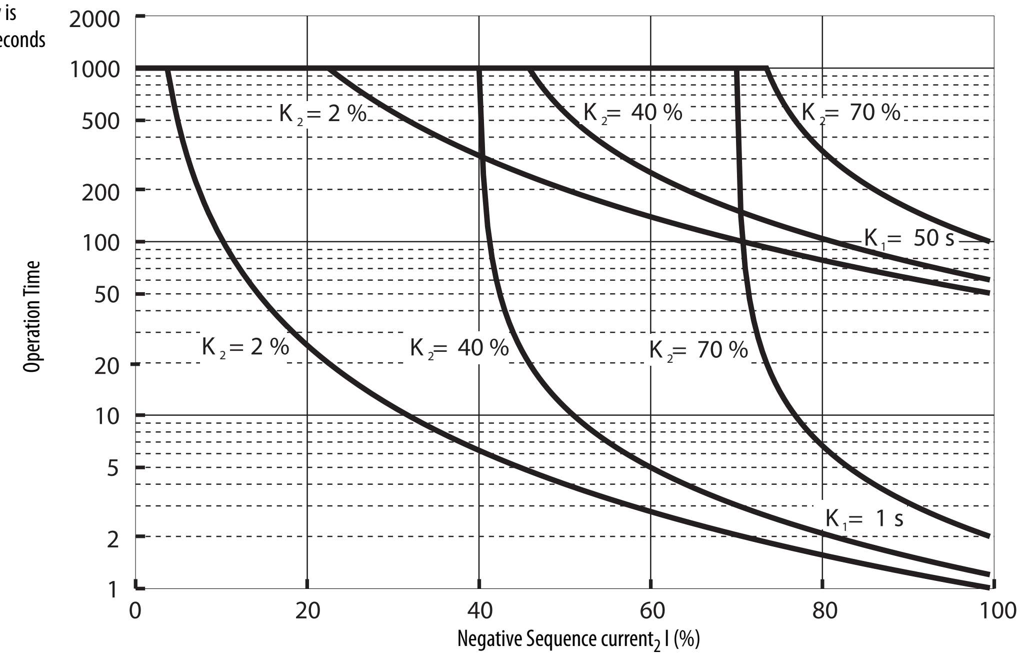


Table 15 - Parameters of the Current Unbalance Stage I_2> (46)

For details on setting ranges, see Protection Stages on page 351.

Parameter	Value	Unit	Description	Note
Status	- Blocked Start Trip		Status of the stage	 F(1) F(1)
SCntr			Cumulative start counter	C(2)
TCntr			Cumulative trip counter	C(2)
SetGrp	1…4		Active setting group	Set(3)
SGrpDI	 - DIx VIx LEDx VOx		Digital signal to select the active setting group: None Digital input Virtual input Status indicator signal Virtual output	Set(3)
Force	Off On		Force flag for status forcing for test purposes. A common flag for all stages and output relays, too. Automatically reset by a 5-minute timeout.	Set(3)
I_2/I_{mot}		%Imot	The supervised value.	
I_2>		%Imot	Pick-up setting	Set(3)
t>		s	Definite operation time (Type=DT)	Set(3)
Type	DT INV		Definite time Inverse time (See Equation 3.1)	Set(3)
K1		s	Delay multiplier (Type =INV)	Set(3)

(1) F = Editable when force flag is on.
(2) C = Can be cleared to zero.
(3) Set = An editable parameter (password required).

Recorded Values of the Latest Eight Faults

Detailed information is available on the eight latest faults: Time stamp, unbalance current, elapsed delay, and setting group.

Table 16 - Recorded Values of the Current Unbalance Stage (8 Latest Faults) I_2> (46) in Motor Protection Mode

Parameter	Value	Unit	Description
	yyyy-mm-dd		Time stamp of the recording, date
	hh:mm:ss:ms		Time stamp, time of day
Flt		%Imot	Maximum unbalance current
EDly		%	Elapsed time of the operating time setting. 100% = trip
SetGrp	12		Active setting group during the fault

Incorrect Phase Sequence Protection I_2>> (46)

The phase sequence stage helps prevent the motor from running in the wrong direction. When the ratio between negative and positive sequence current exceeds 80%, the phase sequence stage starts and trips after 100 ms. Visual indication of correct voltage and current phase sequencing is provided through the relay measurement functions.

Table 17 - Parameters of the Incorrect Phase Sequence Stage: I_2>> (46)

	Parameter	Value/unit	Description
Measured value	I2/I1	%	Negative phase sequence current/positive phase sequence current
Recorded values	SCntr		Start counter (Start) reading
	TCntr		Trip counter (Trip) reading
	Flt	%	Max. value of fault current
	EDly	%	Elapsed time as compared to the set operate time, 100% = tripping

Incorrect Phase Sequence (Voltage Based)

A 857 relay also provides functional feedback related to desired phase sequence requirements based on three phase voltage references voltage, similar to IEEE device 47. The 857 relay provides voltage phase sequence verification via several parameters within the Ethernet/IP™, Modbus, and IEC 61850 protocol stacks as well as on the front display of the relay. These indicators include values for:

- Positive Sequence Voltage
- Negative Sequence Voltage
- Percentage of Negative Sequence Voltage to Positive Sequence Voltage
- Voltage Phase Sequence condition indication (OK, Reversed, or Unknown).

Refer to the Parameter Listing in Appendix A.

Stall Protection I_{st}> (48)

The stall protection (unit I_{st}>) measures the fundamental frequency component of the phase currents.

Protection (stage I_{st}>) can be configured for definite time or inverse time operation characteristic.

The stall protection stage helps protect the motor against prolonged full voltage starts caused by a stalled rotor. The pickup setting I_{st}> is the current detection level for a motor start, too high of load inertia, or too low of system voltage. This protection stage is sensitive to the fundamental frequency component of the phase currents. The I_{st}> stage can be configured for definite operation time or inverse-time operation characteristics. For a weak power system voltage, the inverse characteristic is useful. This characteristic allows more start time when the voltage drop decreases the starting current, and increases the starting time. Figure 43 shows an example of the inverse characteristics.

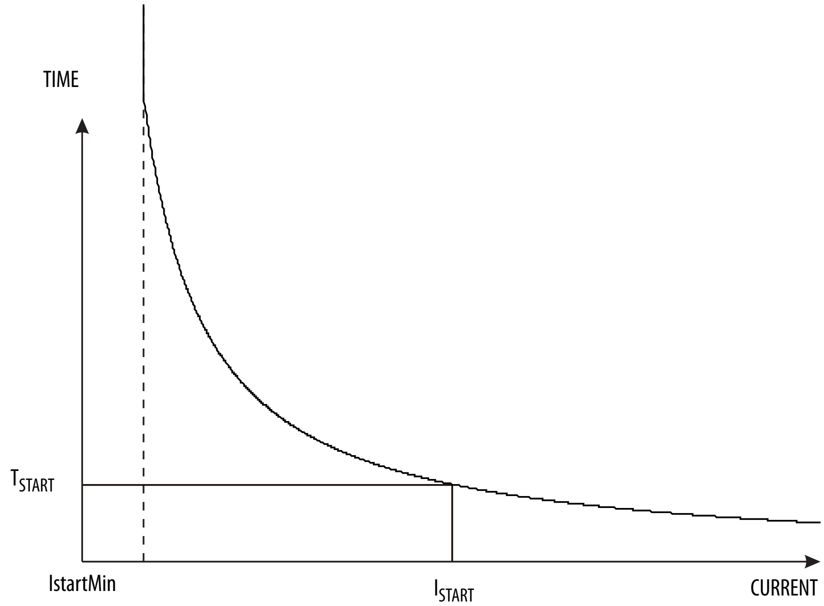
If the measured current is less than the specified start current (I_{START}), the operation time is longer than the specified start time (T_{START}) and vice versa. While the current has been under 10% of I_{MOT}, and I_{Start} is exceeded by 200 milliseconds. The stall protection stage starts to count the operation time T_{START} according to Equation 3.2 . The equation is also drawn in Figure 43. When current drops below 120% x I_{MOT}, the stall protection stage releases. Stall protection is active only during the start of the motor.

Equation 3.2

$$T = \left(\frac{I_{START}}{I_{MEAS}}\right)^2 T_{START} \quad \text{, where}$$

T	=	Operation time in seconds
I_{START}	=	Start current of the motor. Default 6.00 x I_{MOT}
I_{MEAS}	=	Measured current during start
T_{START}	=	Maximum allowed start time for the motor

Figure 43 - Operation Time Delay of the Stall Protection Stage I_{st}>



If the measured current is less than the specified start current I_{START}, the operation time is longer than the specified start time T_{START} and vice versa.

Figure 44 - Block Diagram of the Stall Protection Stage I_{st}>

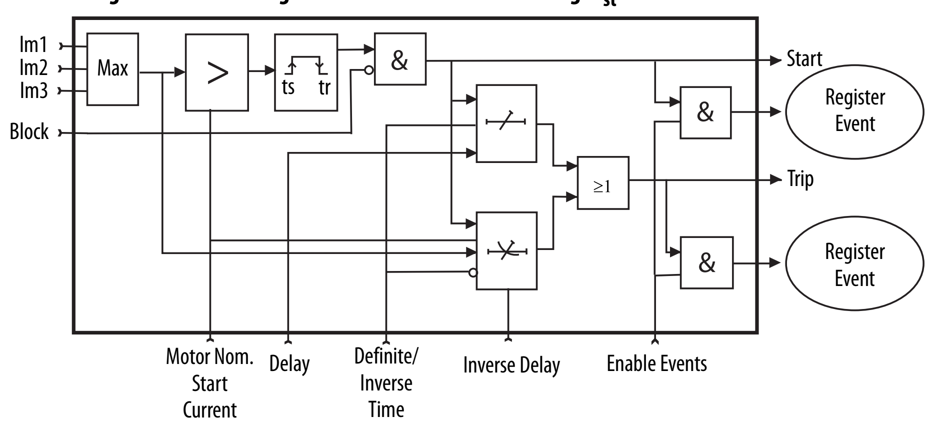


Table 18 - Parameters of the Stall Protection Stage: I_{st}> (48)

	Parameter	Value/unit	Description
Setting values	ImotSt	xImot	Nom motor starting current
	Ist>	%Imot	Motor start detection current. Must be less than initial motor starting current.
	Type	DT	Operation characteristic /definite time
		Inv	Operation characteristic/ inverse time
	tDT>	s	Operation time [s]
	tInv>	s	Time multiplier at inverse time

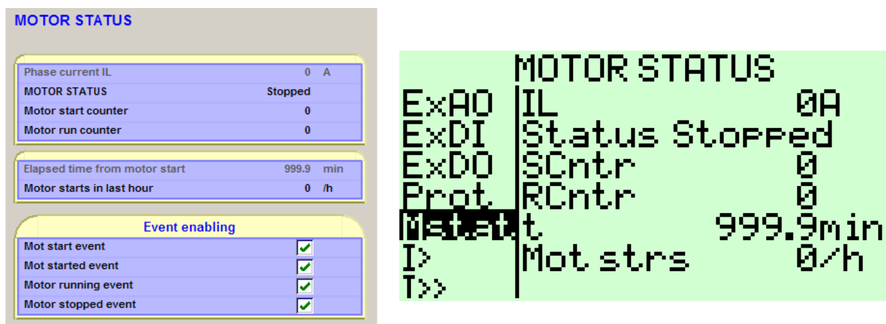
	Parameter	Value/unit	Description
Recorded values	SCntr		Start counter (Start) reading
	TCntr		Trip counter (Trip) reading
	Flt	xImot	Max. value of fault.
	EDly	%	Elapsed time as compared to the set operate time, 100% = tripping

Motor Status

Motor status is defined internally as Stopped, Starting, or Running.

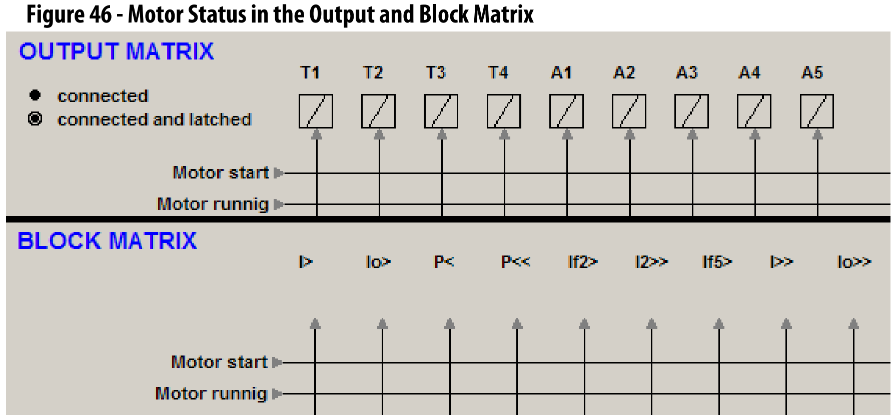
Motor Stopped	The average current for the motor is less than 10% of the Nom current, I_{MOT}.
Motor Starting	To achieve this status condition, the motor must be in the Motor Stopped status for at least 500 ms before starting. The motor average current must increase above the setting for start detection current within 200 ms. This status continues to be reported until the conditions for the running state are reached.
Motor Running	The running status is achieved from the stop or start condition. The low limit for Motor Running is 20% of the motor nominal current, I_{MOT}. The high limit for Motor Running is 120% of the motor nominal current, I_{MOT}.

Figure 45 - Motor Status in SetPointPS Displayed on the Local Panel of the Protection System



The status of the motor can be viewed through the SetPointPS software or by the M_{STAT} status display on the Protection System. These motor status conditions are also found in the Output and Block Matrix. These status signals can be used for tripping, indication, or for purpose of protection blocking.

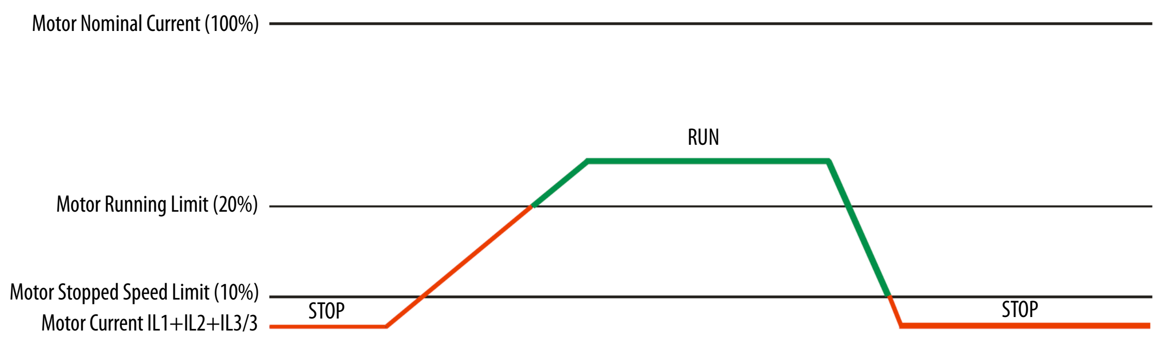
Figure 46 - Motor Status in the Output and Block Matrix



Soft Starting

Frequency converter drives and voltage-based soft starters do not initiate the Motor Starting status due to the lower currents during the starting of the motor. The motor status changes directly from the Motor Stopped to Motor Running position when the current increases to a certain level.

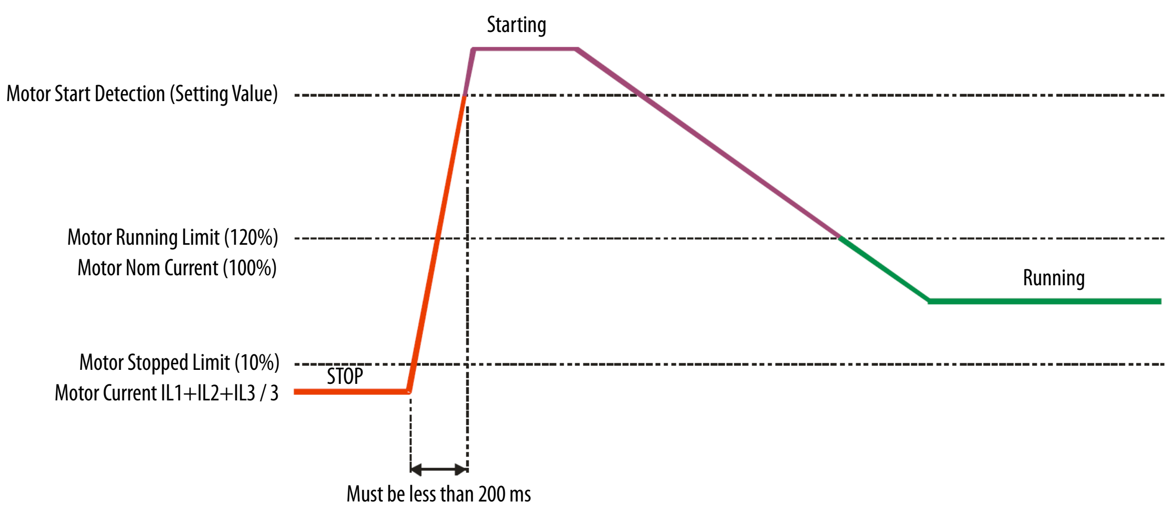
Figure 47 - Impact of a Soft Starting Profile



Normal Starting Sequence

The default value for Start Detection is a value of six times the motor Nom current (6 x I_{MOT}).

Figure 48 - Normal Start Sequence



The problem with various soft starting methods is the impact to the traditional full voltage motor starting current profile. This will generally cause the 857 not to engage the Motor Starting status indication.

As well, the protection settings tend to be done related to a full voltage start and a normal running level of protection. Thus, an alternative signal is required to accomplish the blocking during starting.

The most straightforward way is to provide an externally wetted (120…240V sourced) contact to one of the digital inputs (DI7 through DI18). An Up to Speed or bypass contactor status contact must be fed to a digital input on the 857. This can be used augment the motor start detection characteristics within the 857.

In most cases, the soft starters and adjustable speed drives are already providing good levels of start protection that is based on specific protection algorithms in their control firmware. In most of these types of applications, the 857 is providing a level of redundant start protection. However, the 857 can accommodate these types of applications in several different ways. Many of the 857 protection elements can be adjusted to have multiple programmed protective conditions if the customer so desires. The user can select from Group 1 (default) through Group 4 setting by using any one of the digital inputs as a switching command.

The most effective method is to use one or more control signals to Block select protection elements during a given condition or state. In this case, a reduce voltage or variable frequency start.

This is accomplished by using the Block Matrix feature. Any protection function, except arc protection elements, can be blocked with internal control and/or status signals or via external control signals. Internal and external elements, conditions or status from items like logic outputs, protective elements, start and trip signals and external digital and virtual inputs are constantly monitored by the 857.

Frequent Start Protection N> (66)

The most common way to start an asynchronous motor is to switch the stator windings to the supply voltages. Each start heats up the motor considerably because the initial currents are higher than the rated current.

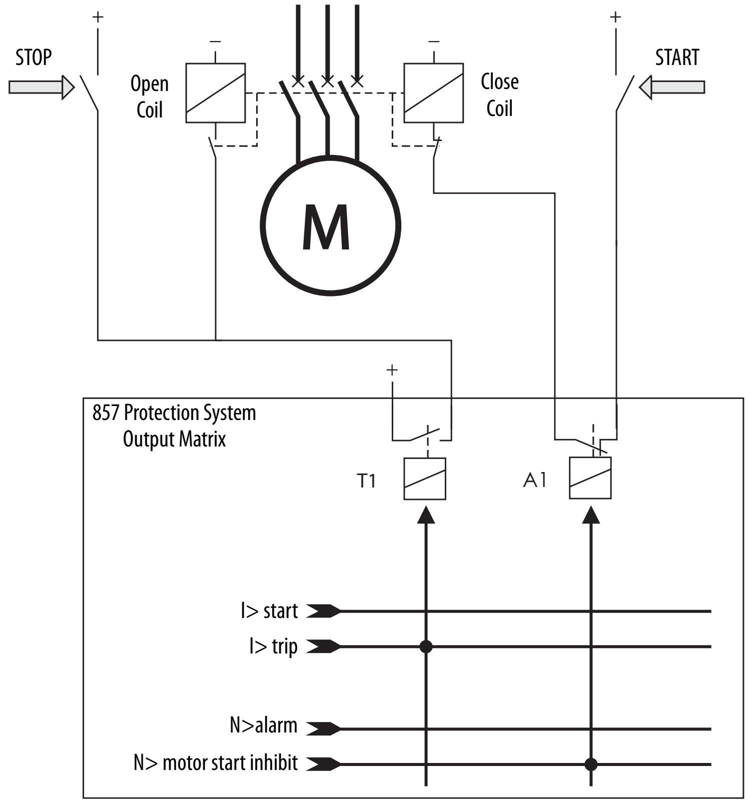
If the motor manufacturer defines the maximum number of starts within 1 hour and/or the minimum time between two consecutive starts, this stage helps prevent frequent starts.

When the motor current has been less than 10% of I_{MOT} and then exceeds I_{ST}>, the situation is recognized as a Start. When the current is less than 10% x I_{MOT}, the motor is regarded as stopped. See Motor Status on page 88 for additional details.

This stage produces a signal when the second last start has been completed. A trip signal is normally activated and released when there are no starts left. Figure 49 shows an application.

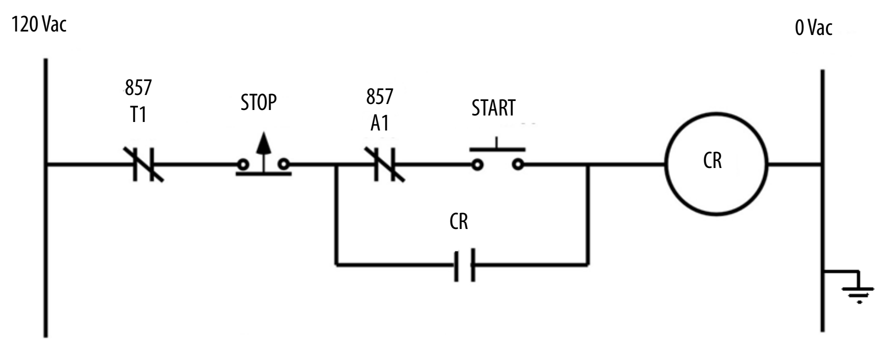
The A1 relay has been configured to Normally Closed (NC) and controlled by the N> motor start inhibit signal. Whenever N> motor start becomes activated, it stops the circuit breaker from closing.

Figure 49 - Application to Prevent Frequent Starts, Using N> Stage - Breaker Control



The Frequent Start Protection must be adapted for use with electrically held breakers or contactors. This adaption is due to the initiation or trigger point that is used within the firmware. See Figure 50.

Figure 50 - Application to Prevent Frequent Starts, Using the N> Stage - Contactor Control



The A1 contact, which is shown in Figure 50, is used to block subsequent starts after the last programmed available start. The A1 contact is mapped to the "N>motor start inhibition" status signal in the output matrix.

Table 19 - Parameters of the Frequent Start Protection: N> (66)

	Parameter	Value/unit	Description
Measured value	Mot strs		Motor starts in last hour
	T	Min	Elapsed time from motor start
Setting values	Sts/h		Max. starts in 1 hour
	Interval	Min	Min. interval between two consecutive starts
Recorded values	SCntr		Start counter (Start) reading
	TCntr		Trip counter (Trip) reading
	Descr	1StartLeft	One start that is left, activates the N> start signal
		MaxStarts	Max. start trip, activates the N> trip signal
		Interval	Min. interval between two consecutive starts has not yet been elapsed, activates the N> trip signal
	Tot Mot Strs		Number of total motor starts
	Mot Strs/h		Number of motor starts in last hour
	El. Time from mot Strt	Min	Elapsed time from the last motor start

Undercurrent Protection I< (37)

The undercurrent unit measures the fundamental frequency component of the phase currents.

The stage I< can be configured for DT characteristic.

The undercurrent stage helps protect the motor driven device, for example a submersible pump, rather than the motor itself.

Table 20 - Parameters of the Undercurrent Stage: I< (37)

	Parameter	Value/unit	Description
Measured value	ILmin	A	Min. value of phase currents IL1…IL3 in primary value
Setting values	I<	xImode	Setting value as per times Imot
	t<	S	Operation time [s]
Recorded values	SCntr		Start counter (Start) reading
	TCntr		Trip counter (Trip) reading
	Type	1-N 2-N 3-N	Fault type/single-phase fault, for example, 1-N = fault on phase L1
		1-2 2-3 1-3	Fault type/two-phase fault, for example: 2-3 = fault between L2 and L3
		1-2-3	Fault type/three-phase fault
	Flt	%	Min. value of fault current as per times I_{mot}
	Load	%	1s is the mean value of pre-fault currents IL1—IL3
	EDly	%	Elapsed time as compared to the set operate time, 100% = tripping

Directional Earth-fault Protection $I_{0\varphi}$> (67N)

The directional earth-fault-protection is used for earth-faults. This protection is used in networks or motors where a selective and sensitive earth-fault-protection is needed in applications with network structures and lengths that vary.

The device consists of versatile protection functions for earth-fault-protection in various network types.

The function is sensitive to the fundamental frequency component of the residual current and zero sequence voltage, and the phase angle between them. The attenuation of the third harmonic is more than 60 dB. When the I_0 and U_0 size and the phase angle between I_0 and $-U_0$ fulfills the pick-up criteria: the stage picks up and a start signal is issued. If the fault situation remains on longer than the setting for operation time delay, a trip signal is issued.

Polarization

The negative zero sequence voltage $-U_0$ is used for polarization, which is the angle reference for I_0. The$-U_0$ voltage can be measured in two ways, by the energizing input U_0 or calculated from the phase voltages internally. The measurement mode depends on the selected voltage measurement mode (see Voltage Measurement Mode on page 217):

- LN: the zero sequence voltage is calculated from the phase voltages so separate zero sequence voltage transformers are not needed. The setting values are relative to the configured voltage transformer (VT) voltage/ √3.

- $LL+U_0$: The zero sequence voltage is measured with voltage transformer, for example, fault-protection that uses a broken (open) delta connection. The setting values are relative to the VT_0 secondary voltage that is defined in the configuration settings.

TIP The U_0 signal (X1-17 and X1-18) must be connected according to the connection diagram (Figure 188 on page 341) to get a correct polarization. The negative U_0, $-U_0$, is connected to the device.

Modes for Different Network Types

The available modes are the following:

- ResCap
  This mode consists of two sub modes, Res and Cap. A digital signal can be used to switch dynamically between these two sub modes. This feature can be used with compensated networks, when the use of a Petersen coil or other system is temporarily switched off.
  - Res
    The stage is sensitive to the resistive component of the selected I_0 signal. This mode is used with compensated networks (resonant grounding) and networks that are earthed with a high resistance. In this context, “high resistance” means that the earth-fault current is limited to be less than the rated phase current. Compensation is done with a Petersen coil or grounded resistor between the neutral point of the main transformer and earth. The trip area is a half plane as shown in Figure 52. The base angle is set to zero degrees.
  - Cap
    The stage is sensitive to the capacitive component of the selected I_0 signal. This mode is used with unearthed/ungrounded networks. The trip area is a half plane as shown in Figure 52. The base angle is set to zero degrees.

- Sector
  This mode is used with networks that are earthed with a small/low resistance. In this context “small” means that the earth-fault current can be more than the rated phase currents. The trip area has a shape of a sector as shown in Figure 53. The base angle is set to zero degrees or slightly on the lagging inductive side (that is negative angle).
- Undir
  This mode makes the stage equal to the undirectional stage I_0>. The phase angle and U_0 amplitude setting are discarded. Only the amplitude of the selected I_0 input is supervised.

Input Signal Selection

Each stage can be connected to supervise any of these inputs and signals:

- Input I_{01} for all networks other than rigidly earthed.
- Input I_{02} for all networks other than rigidly earthed.
- Calculated signal I_{0Calc} for rigidly and low impedance earthed networks. $I_{0Calc} = I_{L1} + I_{L2} + I_{L3} = 3I_0$.

Intermittent Earth-fault Detection

Intermittent earth-faults make the protection to “start” (to pick up), but does not cause a trip. Here an intermittent fault means one cycle or more. For shorter than 1-ms transient type of intermittent earth-faults in compensated networks, there is a dedicated stage I_{0int}> 67NI. When starting happens with enough frequency, such intermittent faults can be cleared using the intermittent time setting. When a new “start” happens within the set intermittent time, the operation delay counter is not cleared between adjacent faults and finally the stage trips.

Two Independent Stages

There are two separately adjustable stages: I_φ> and I_φ>>. Both the stages can be configured for definite time (DT) delay or inverse time delay operation.

Inverse Operation Time

Inverse delay means that the operation time depends on the amount the measured current exceeds the pick-up setting. The bigger the fault current is the faster the operation. Accomplished inverse delays are available for both stages $I_{0\varphi}$> and $I_{0\varphi}$>>. The inverse delay types are described in Inverse Time Operation on page 154. The device shows a scalable graph of the configured delay on the local panel display.

Inverse Time Limitation

The maximum measured secondary residual current is 10 x I_{0N} and maximum measured phase current is 50 x I_N. This setting limits the scope of inverse curves with high pick-up settings. See Inverse Time Operation on page 154 for more information.

Setting Groups

There are two settings groups available for each stage. Use digital inputs, virtual inputs (mimic display, communication, logic), and manual control to switch between setting groups.

Figure 51 - Block Diagram of the Directional Earth-fault Stages $I_{0\varphi}$> and $I_{0\varphi}$>>

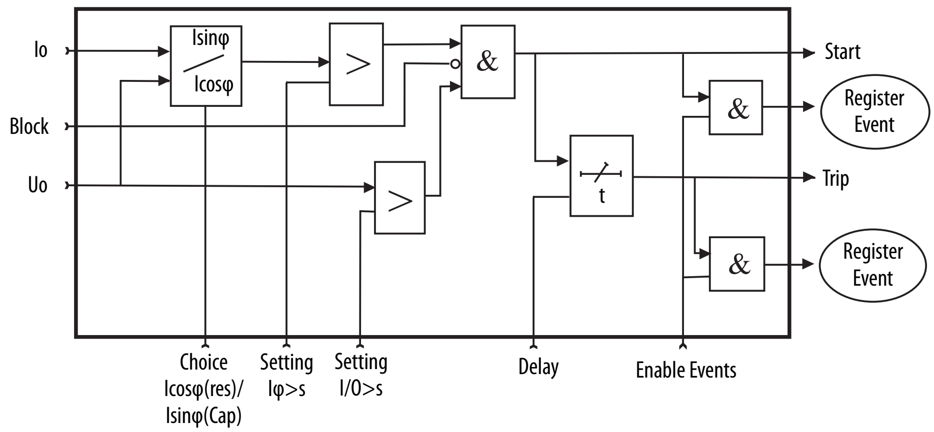


Figure 52 - Operation Characteristic of the Directional Earth-fault-protection in Res or Cap Mode

Res mode can be used with compensated networks and Cap mode is used with ungrounded networks.

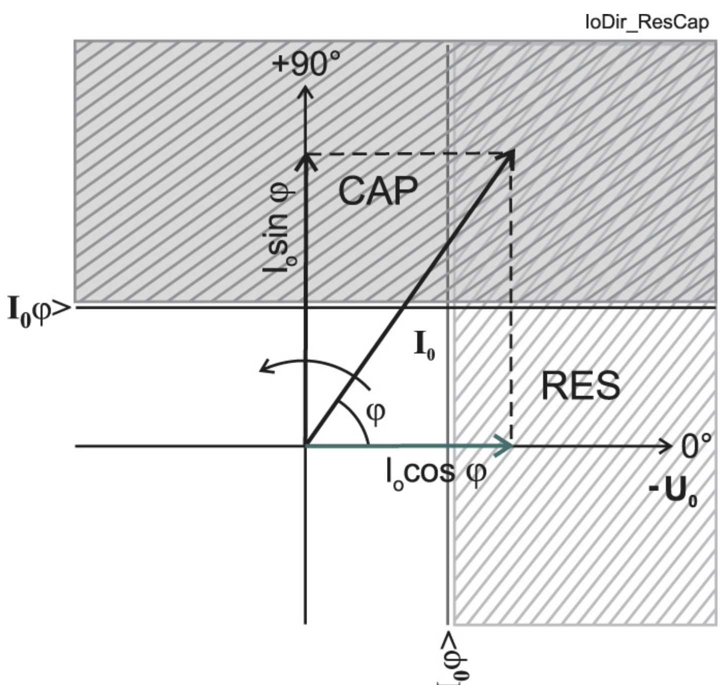
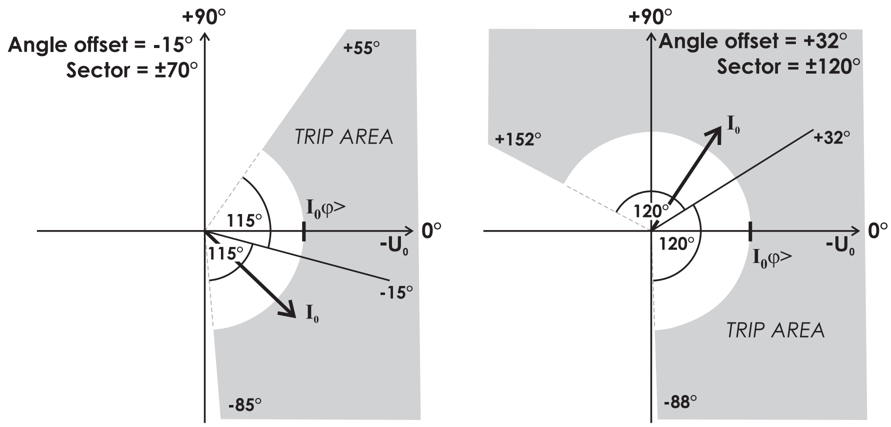


Figure 53 - Examples of Operation Characteristics of the Directional Earth-fault Stages in Sector Mode



TIP The drawn I_0 phasor in both figures is inside the trip area.
The angle offset and half sector size are parameters that are user-defined.

Table 21 - Parameters of the Directional Earth-fault Stages $I_{0\varphi}$>, $I_{0\varphi}$>> (67N)

Parameter	Value	Unit	Description	Note
Status	- Blocked Start Trip		Status of the stage	 F(1) F(1)
TripTime		s	Estimated time to trip	
SCntr			Cumulative start counter	C(2)
TCntr			Cumulative trip counter	C(2)
SetGrp	1…4		Active setting group	Set(3)
SGrpDI	 - DIx VIx LEDx VOx		Digital signal to select the active setting group: None Digital input Virtual input Status indicator signal Virtual output	Set(3)
Force	Off On		Force flag for status forcing for test purposes. A common flag for all stages and output relays, too. Automatically reset by a 5-minute timeout.	Set(3)
Io Io2 IoCalc IoPeak Io2Peak		pu	The supervised value according to the parameter “Input”. ($I_{0\varphi}$> only) ($I_{0\varphi}$> only)	
IoRes		pu	Resistive part of I_0 (only when “InUse”=Res)	
IoCap		pu	Capacitive part of I_0 (only when “InUse”=Cap)	
$I_{0\varphi}$>		A	Pick-up value that is scaled to primary value	
$I_{0\varphi}$>		pu	Pick-up setting relative to the parameter “Input” and the corresponding CT value	Set(3)
Uo>		%	Pick-up setting for U_0	Set(3)
Uo		%	Measured U_0	

Table 21 - Parameters of the Directional Earth-fault Stages $I_{0\varphi}>$, $I_{0\varphi}>>$ (67N) (Continued)

Parameter	Value	Unit	Description	Note
Curve	 DT IEC IEEE IEEE2 RI PrgN		Delay curve family: Definite time Inverse time. See Inverse Time Operation on page 154.	Set[3]
Type	 DT NI VI EI LTI Parameters		Delay type: Definite time Inverse time. See Inverse Time Operation on page 154.	Set[3]
t>		s	Definite operation time (for Definite Time only)	Set[3]
k>			Inverse delay multiplier (for inverse time only)	Set[3]
Mode	ResCap Sector Undir		High impedance earthed nets Low impedance earthed nets Undirectional mode	Set[3]
Offset		?	Angle offset (MTA) for RecCap and Sector modes	Set[3]
Sector	Default = 88	±°	Half sector size of the trip area on both sides of the offset angle	Set[3]
ChCtrl	 Res Cap DI1…32 VI1…4		Res/Cap control in mode ResCap: Fixed to Resistive characteristic Fixed to Capacitive characteristic Controlled by digital input Controlled by virtual input	Set[3]
InUse	 - Res Cap		Selected submode in mode ResCap: Mode is not ResCap Submode = resistive Submode = capacitive	
Input	Io1 Io2 IoCalc Io1Peak Io2Peak		X6-7, 8, 9.X1-7 and 8. See Applications on page 307. X6-10, 11, 12 IL1 + IL2 + IL3 X6-7, 8, 9 peak mode ($I_{0\varphi}>$ only) X6-10, 11, 12 peak mode ($I_{0\varphi}>$ only)	Set[3]
Intrmt		s	Intermittent time	Set[3]
Dly20x		s	Delay at 20xIoset	
Dly4x		s	Delay at 4xIoset	
Dly2x		s	Delay at 2xIoset	
Dly1x		s	Delay at 1xIoset	
A, B, C, D, E			User-defined constants for standard equations. Type = parameters. See Inverse Time Operation on page 154.	Set[3]

(1) F = Editable when force flag is on.
(2) C = Can be cleared to zero.
(3) Set = An editable parameter (password required).

For details on setting ranges, see Protection Stages on page 351.

Recorded Values of the Latest Eight Faults

There is detailed information available of the eight latest earth-faults: Time stamp, fault current, elapsed delay, and setting group.

Table 22 - Recorded Values of Directional Earth-fault Stages (Eight Latest Faults) $I_{0\varphi}$>, $I_{0\varphi}$>> (67N)

Parameter	Value	Unit	Description
	yyyy-mm-dd		Time stamp of the recording, date
	hh:mm:ss:ms		Time stamp, time of day
Flt		pu	Maximum earth-fault current
EDly		%	Elapsed time of the operating time setting. 100% = trip
Angle	?		Fault angle of I_0. $-U_0 = 0°$
Uo		%	Max. U_0 voltage during the fault
SetGrp	1…4		Active setting group during fault

Table 23 - Directional Phase Overcurrent Iφ> (67)

Parameter	Value	Unit	Description	Note
Iφ>, Iφ>>		xImode	Pick-up value that is scaled to primary value	
Iφ>, Iφ>>			Pick-up setting	Set(1)
Curve	 DT IEC, IEEE, IEEE2, RI, PrgN		Delay curve family: Definite time Inverse time. See Inverse Time Operation on page 154.	Set(1)
Type	 DT NI, VI, EI, LTI, Parameters		Delay type Definite time Inverse time. See Inverse Time Operation on page 154.	Set(1)
t> k>		s	Definite operation time (for Definite Time only)	Set(1)
Dly20x			Inverse delay multiplier (for inverse time only)	Set(1)
Dly4x		s	Delay at 20xImode	
Dly2x		s	Delay at 4xImode	
Dly1x		s	Delay at 2xImode	
Mode		s	Delay at 1xImode	
	Dir Undir Dir+back-up		Directional mode (67) Undirectional (50/51) Directional and undirectional back-up	Set(1)
Offset			Angle offset in degrees	
U/I angle			Measured U1/I1 angle	
U1			Measured positive sequence voltage	
A, B, C, D, E			User-defined constants for standard equations. Type=Parameters. See Inverse Time Operation on page 154.	Set(1)

(1) Set = An editable parameter (password required).

Table 24 - Parameters of the Directional Overcurrent Stages Iφ>>>, Iφ>>>> (67)

Parameter	Value	Unit	Description	Note
Status			Status of the stage	
	Blocked			
	Start			F(1)
	Trip			F(1)
SCntr			Cumulative start counter	C(2)
TCntr			Cumulative trip counter	C(2)
SetGrp	1…4		Active setting group	Set(3)
SgrpDI			Digital signal to select the active setting group	Set(3)
	-Dix		None	
	Vix		Digital input	
	LEDx		Virtual input	
	Vox		Status Indicator indicator signal	
	Off		Virtual output	
Force	On		Force flag for status forcing for test purposes. A common flag for all stages and output relays, too. Automatically reset by a 5-minute timeout.	Set(3)
ILmax		A	The supervised value. Max. of IL1, IL2, and IL3	
Iφ>>>> Iφ>>>>		A	Pick-up value that is scaled to primary value	
Iφ>>>> Iφ>>>>		xImode	Pick-up setting	Set(3)
t>>> t>>>	 Dir	s	Definite operation time (for Definite Time only	Set(3)
Mode	 Undir Dir+back-up		Directional (67) Undirectional (50/51) Directional and undirectional back-up	Set(3)
Offset		°	Angle offset in degrees	Set(3)
U/I angle		°	Measured U1/I1 angle	
U1		% Un	Measured positive sequence voltage	

(1) F = Editable when force flag is on. For details of setting ranges, see Chapter 12.3 Protection functions.

(2) C = Can be cleared to zero.

(3) Set = An editable parameter (password required).

Recorded Values of the Latest Eight Faults

There is detailed information available of the eight latest faults: Time stamp, fault type, fault current, load current before the fault, elapsed delay, and setting group.

Table 25 - Recorded Values of the Directional Overcurrent Stages (8 Latest Faults) Iφ>, Iφ>>, Iφ>>>, Iφ>>>> (67)

Parameter	Value	Unit	Description
	yyyy-mm-dd		Time stamp of the recording, date
	hh:mm:ss:ms		Time stamp, time of day
Type			Fault type
	1-N		Ground fault
	2-N		Ground fault
	3-N		Ground fault
	1-2		Two-phase fault
	2-3		Two-phase fault
	3-1		Two-phase fault
	1-2-3		Three-phase fault
	1-2-N		Two-phase fault with earth contact
	2-3-N		Two-phase fault with earth contact
	3-1-N		Two-phase fault with earth contact
	1-2-3-N		Three-phase fault with earth contact
Flt		xIn	Maximum fault current
Load		xIn	1-s average phase currents before the fault
EDly		%	Elapsed time of the operating time setting. 100% = trip
Angle		°	Fault angle in degrees
U1		xUn	Positive sequence voltage during fault
SetGrp	1…4		Active setting group during fault
Direction mode			Dir, undir, and dir+back-up

Earth-fault Phase Detection Algorithm

A faulty phase is initially recognized when a zero sequence overcurrent is detected. The faulted phase or phases are detected in a two stage system:

1. Algorithm is using delta principle to detect the faulty phase/phases.
2. Algorithm confirms the faulty phase with neutral current angle comparison to the suspected faulted phase.

On an Ideal Grounded Network

If there is a forward earth-fault in phase L1, its current increases to create calculated or measured zero sequence current at phase angle of 0°. If there is reverse earth-fault in phase L1, its current decreases to create calculated or measured zero sequence current at a phase angle of 180°.

If there is forward earth-fault in phase L2, its current increases to create calculated or measured zero sequence current at phase angle of -120°. If there is reverse earth-fault in phase L2, its current decreases to create calculated or measured zero sequence current at a phase angle of 60°.

If there is a forward earth-fault in phase L3, its current increases to create calculated or measured zero sequence current. In phase current decreases to create calculated or measured zero sequence current at a phase angle of -60°.

Implementation

When a faulty phase is recognized, it is recorded in the 50-N protection element fault log (also in event list and alarm screen). To enable or disable the faulted phase and the direction record function, use the Io>>, Io>>>, and Io>>>> protection stage settings.

For compensated ground networks, the results of this algorithm are not accurate or reliable. The algorithm depends on the network compensation degree. For compensated networks, turn off this feature to avoid confusion or false indications.

For high impedance earthed networks, the protection element includes a pull-down menu in both setting groups. To permit the selection of grounding network between *RES* or *CAP*. The *RES* selection is default selection and it is for earthed networks. When the *CAP* selection is used, the I/O angle will be corrected to the inductive direction of90°. After that, the faulty phase detection is made.

The possible detection, identification, and associated details for each condition are listed in Table 26.

Table 26 - Earth-fault Phase Conditions

Condition	Identification and Associated Details
FWD L1	Phase L1 increases above the set limit and two other phases remain inside the set (delta) limit. The I/O current angle is +/- 60° from L1 phase angle.
FDW L2	Phase L2 increases above the set limit and two other phases remain inside the set (delta) limit. The I/O current angle is +/- 60° from L2 phase angle.
FDW L3	Phase L3 increases above the set limit and two other phases remain inside the set (delta) limit. The I/O current angle is +/- 60° from L3 phase angle.
FWD L1-L2	Phase L1 and L2 increase above the set limit and phase L3 remains inside the set (delta) limit. The I/O current angle is between L1 and L2 phase angles.
FWD L2-L3	Phase L2 and L3 increase above the set limit and phase L1 remains inside the set (delta) limit. The I/O current angle is between L2 and L3 phase angles.
FWD L3-L1	Phase L3 and L1 increase above the set limit and phase L2 remains inside the set (delta) limit. The I/O current angle is between L3 and L3 phase angles.
FWD L1-L2-L3	All three phase currents increase above the set delta limit.
REV 1 (any one phase)	One phase decreases below the set delta limit and other two phases remain inside the delta limit.
REV 2 (any two phases)	Two phases decrease below the set delta limit and third phase remains inside the delta limit.
REV 3 (all three phases)	All three phase currents decrease below the set delta limit.

Figure 54 ... Figure 56 illustrates three simulated fault scenarios.

Figure 54 - Phase L1 Forward

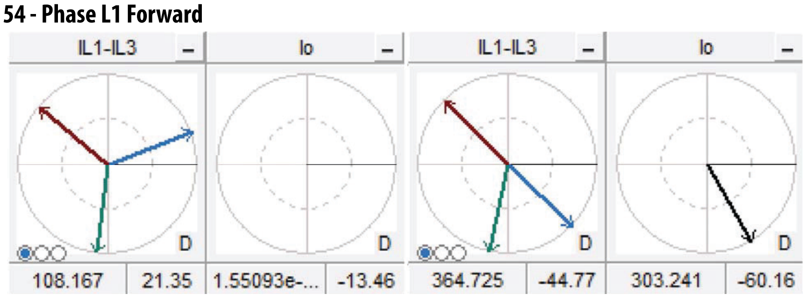


Figure 55 - Phase L2 Forward

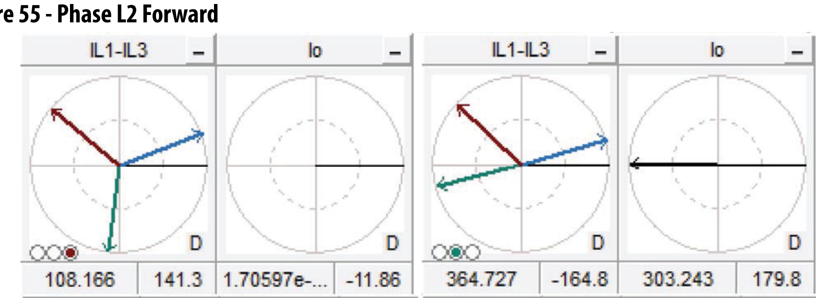
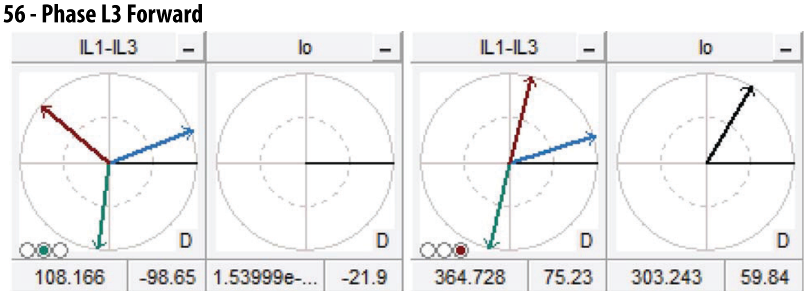


Figure 56 - Phase L3 Forward



Earth-fault-protection I_0> (50N/51N),(50G/51G), (50GS/51GS)

Undirectional earth-fault-protection is used to detect earth-faults in low impedance earthed networks. In high impedance earthed networks, compensated networks, and isolated networks, undirectional earth-fault can be used as back-up protection.

The undirectional earth-fault function is sensitive to the fundamental frequency component of the residual current $3I_0$. The attenuation of the third harmonic is more than 60 dB. Whenever this fundamental value exceeds the pick-up setting of a particular stage, this stage picks up and a start signal is issued. If the fault situation remains longer than the operation time-delay setting, a trip signal is issued.

Figure 57 - Block Diagram of the Earth-fault Stage I_0>

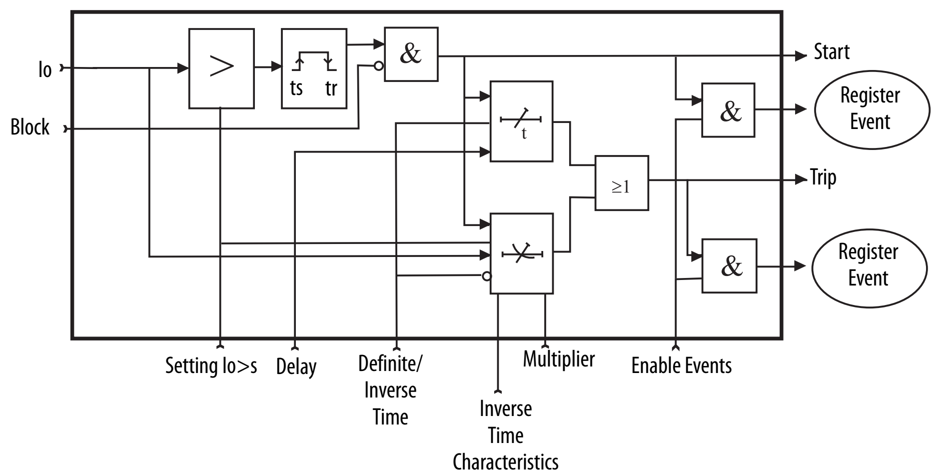


Figure 58 - Block Diagram of the Earth-fault Stages I_0>>, I_0>>>, and I_0>>>>

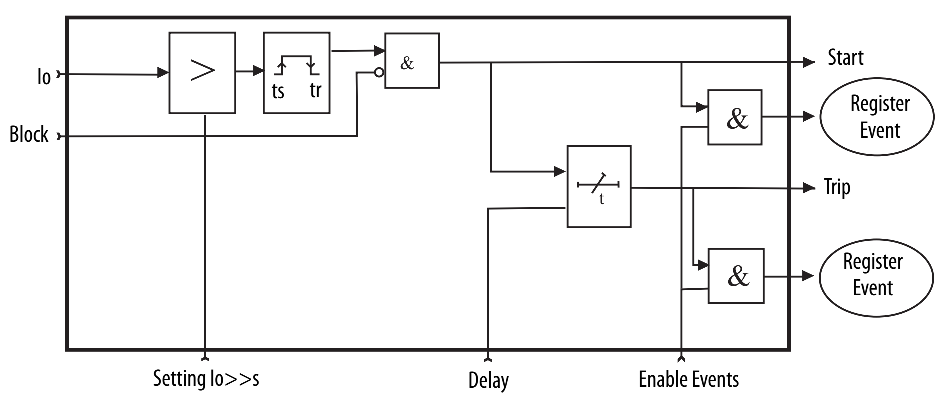


Figure 57 shows a functional block diagram of the I_0> earth overcurrent stage with definite and inverse time operation. Figure 58 shows a functional block diagram of the I_0>>, I_0>>>, and I_0>>>> earth-fault stages with Definite Time operation delay. This element can be configured to provide 50/51 G, GS and N protection, depending on configuration.

Input Signal Selection

Each stage can be connected to supervise any of these inputs and signals:

- Input I_{01} for all networks other than rigidly earthed.
- Input I_{02} for all networks other than rigidly earthed.
- Calculated signal I_{0Calc} for rigidly and low impedance earthed networks $I_{0Calc} = I_{L1} + I_{L2} + I_{L3}$.

Intermittent Earth-fault Detection

Intermittent earth-faults cause protection to start, but does not cause a trip. Here, a short fault means one cycle or more. For transient types of intermittent earth-faults (shorter than 1 ms) in compensated networks, use a dedicated stage I_{ot}> 67NT. When engagement happens enough times, such intermittent faults can be cleared using the intermittent time setting. When a new engagement happens within the set intermittent time, the operation delay counter is not cleared between adjacent faults and finally the stage trips.

By using I_{01} peak OR I_{02} peak, a 1-ms current peak is enough to start the stage and increase the delay counter by 20 ms. For example, if the operating time is 120 ms. And the time between two peaks does not exceed the intermittent time setting, the six peaks would initiate a trip.

Four or Six Independent Undirectional Earth-fault Overcurrent Stages

There are four separately adjustable earth-fault stages: I_0>, I_0>>, I_0>>>, and I_0>>>>. The first stage I_0> can be configured for Definite Time (DT) or inverse-time operation characteristic (IDMT). The other stages have DT operation characteristic. By using the definite delay type and setting the delay to its minimum, an instantaneous (ANSI 50) operation is obtained.

When using the directional earth-fault stages (Chapter 10) in undirectional mode, two or more stages with inverse-time operation delay are available for undirectional earth-fault-protection.

Inverse Operation Time (I_0> Stage only)

Inverse delay means that the operation time depends on the amount the measured current exceeds the pick-up setting. The bigger the fault current is, the faster the operation. Accomplished inverse delays are available for the I_0> stage. The inverse delay types are described under Inverse Time Operation on page 154. The Protection System shows a scalable graph of the configured delay on the local panel display.

Inverse Time Limitation

The scope of inverse curves with high pick-up settings is limited by:

- The maximum the measured secondary residual current 10 x I_{0N}, and
- The maximum measured phase current 50 x I_N

See Inverse Time Operation on page 154 for more information.

Setting Groups

There are two settings groups available for each stage. Use digital inputs, virtual inputs (mimic display, communication, logic), and manual control to switch between setting groups.

Table 27 - Parameters of the Undirectional Earth-fault Stage I_0> (50N/51N)(1)

Parameter	Value	Unit	Description	Note
Status	- Blocked Start Trip		Status of the stage	 F(2) F(2)
TripTime		s	Estimated time to trip	
SCntr			Cumulative start counter	C(3)
TCntr			Cumulative trip counter	C(3)
SetGrp	1…4		Active setting group	Set(4)
Set				
SGrpDI	 - DIx VIx LEDx VOx		Digital signal to select the active setting group: None Digital input Virtual input Status indicator signal Virtual output	Set(4)
Force	Off On		Force flag for status for test purposes. A common flag for all stages and output relays. Automatically reset by a 5-minute timeout.	Set(4)
Io Io2 IoCalc IoPeak Io2Peak I'oCalc		pu	The supervised value according to the parameter "Input".	
Io>		A	Pick-up value that is scaled to primary value	
Io>		pu	Pick-up setting relative to the parameter "Input" and the corresponding CT value	Set(4)

Table 27 - Parameters of the Undirectional Earth-fault Stage I_0> (50N/51N)[1] (Continued)

Parameter	Value	Unit	Description	Note
Curve	 DT IEC IEEE IEEE2 RI PrgN		Delay curve family: Definite time Inverse time. See Local Panel User Interface on page 23.	Set [4]
Type	 DT NI VI EI LTI Paramete rs		Delay type: Definite time Inverse time. See Local Panel User Interface on page 23.	Set[4]
t>		s	Definite operation time (for Definite Time only)	Set[4]
k>			Inverse delay multiplier (for inverse time only)	Set[4]
Input	Io1 Io2 IoCalc Io1Peak Io2Peak I'oCalc		X1-7 and 8. See Applications on page 307. X1-9 and 10 IL1 + IL2 + IL3 X1-7 and 8 peak mode X1-9 and 10 peak mode I'L1 + I'L2 + I'L3	Set[4]
Intrmt		s	Intermittent time	Set[4]
Dly20x		s	Delay at 20xIset	
Dly4x		s	Delay at 4xIset	
Dly2x		s	Delay at 2xIset	
Dly1x		s	Delay at 1xIset	
A, B, C, D, E			User-defined constants for standard equations. Type = parameters. See Local Panel User Interface on page 23.	Set[4]

(1) Provides 50/51 G, GS, and N protection depending on configuration
(2) F = Editable when force flag is on
(3) C = Can be cleared to zero.
(4) Set = An editable parameter (password required).

For details on setting ranges, see Connections on page 321.

Table 28 - Parameters of the Undirectional Earth-fault Stage I_0>>, I_0>>>, I_0>>>> (50N/51N)[1]

Parameter	Value	Unit	Description	Note
Status	- Blocked Start Trip		Status of the stage	 F[2] F[2]
TripTime		s	Estimated time to trip	
SCntr			Cumulative start counter	C[3]
TCntr			Cumulative trip counter	C[3]

Table 28 - Parameters of the Undirectional Earth-fault Stage I_0>>, I_0>>>, I_0>>>> (50N/51N)[1] (Continued)

Parameter	Value	Unit	Description	Note
SetGrp	1…4		Active setting group	Set[4]
Set				
SGrpDI	 - DIx VIx LEDx VOx		Digital signal to select the active setting group: None Digital input Virtual input Status indicator signal Virtual output	Set[3]
Force	Off On		Force flag for status forcing for test purposes. A common flag for all stages and output relays, too. Automatically reset by a 5-minute timeout.	Set[3]
Io Io2 IoCalc		pu	The supervised value according to the parameter "Input".	
Io>> Io>>> Io>>>>		A	Pick-up value that is scaled to primary value	
Io>> Io>>> Io>>>>		pu	Pick-up setting relative to the parameter "Input" and the corresponding CT value	Set[3]
t>		s	Definite operation time (for Definite Time only)	Set[3]
Input	Io1 Io2 IoCalc I'oCalc		X1-7 and 8. See Connections on page 321. X1-9 and 10 IL1 + IL2 + IL3 I'L1 + I'L2 + I'L3	Set [3]

(1) Provides 50/51 G, GS, and N protection depending on configuration
(2) F = Editable when force flag is on
(3) C = Can be cleared to zero.
(4) Set = An editable parameter (password required).

For details on setting ranges, see Protection Stages on page 351.

Recorded Values of the Latest Eight Faults

Detailed information is available on the eight latest earth-faults: Time stamp, fault current, elapsed delay, and setting group.

Table 29 - Parameters of the Undirectional Earth-fault Stages (Eight Latest Faults) I_0>, I_0>>, I_0>>>, I_0>>>> (50N/51N)

Parameter	Value	Unit	Description
	yyyy-mm-dd		Time stamp of the recording, date
	hh:mm:ss:ms		Time stamp, time of day
Flt		pu	Maximum earth-fault current
EDly		%	Elapsed time of the operating time setting. 100% = trip
SetGrp	1…4		Active setting group during the fault

Directional Transient Intermittent Earth-fault-protection I_{0int}> (67NI)

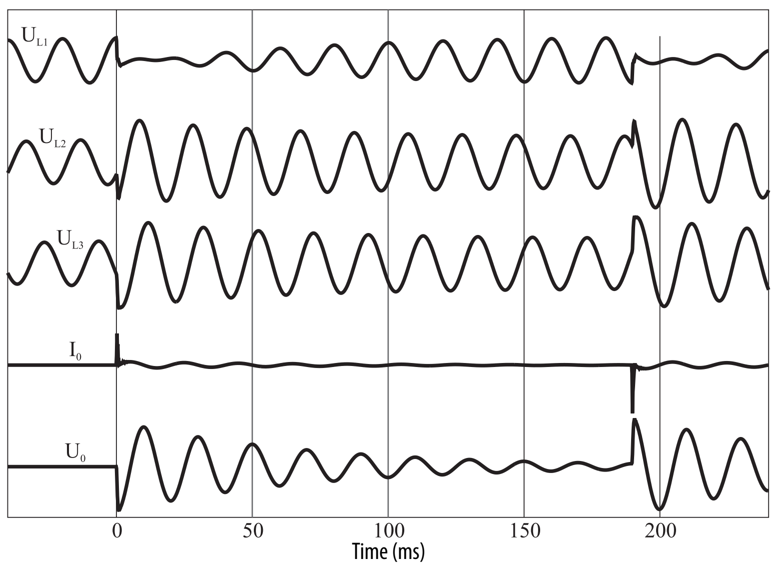
TIP This function is available only in voltage measurement modes. The modes include direct -U_0 measurement, for example, $2U_{LL}+U_0$, but not, for example, in mode $3U_{LN}$. See Voltage Measurement Mode on page 217.

The directional intermittent transient earth-fault-protection is used to detect short intermittent transient faults in compensated cable networks. The transient faults are self-extinguished at some zero crossing of the transient part of the fault current I_{Fault}. The fault duration is typically only 0.1…1 ms. Normal directional earth-fault function, by using only the fundamental frequency components of I_0 and U_0, cannot recognize such short duration faults.

Although a transient fault usually self-extinguishes within less than 1 ms, in most cases a new fault happens when the phase-to-earth voltage of the faulty phase has recovered (Figure 59).

Figure 59 - Typical Phase to Earth Voltages

Residual current of the faulty feeder and the zero sequence voltage U0 during two transient earth-faults in phase L1. In this case, the network is compensated.



Direction Algorithm

The function is sensitive to the instantaneous sampled values of the residual current and residual voltage. The selected voltage measurement mode must include a direct –U_0 measurement.

I_0 Pick-up Sensitivity

The sampling time interval of the relay is 625 μs at 50 Hz/520 μs at 60 Hz (32 samples/cycle). The I_0 current spikes can be short compared to this sampling interval. Fortunately, the current spikes in cable networks are high.

While the anti-alias filter of the relay attenuates the amplitude, the filter also makes the pulses wider. When the current pulses are high enough, it is possible to detect pulses, which have duration of >20% of the sampling interval. Although the measured amplitude can be only a fraction of the actual peak amplitude. It does not disturb the direction detection. The algorithm is more sensitive to the sign and the timing of the I_0 transient than sensitive to the absolute amplitude of the transient. Thus a fixed value is used as a pickup level for the I_0.

Co-ordination with U_0> Backup Protection

In a fully compensated situation, the zero sequence voltage back up protection stage U_0> for the bus cannot release between consecutive faults. The U_0> can do an unselective trip if the intermittent transient stage I_{0INT}> doesn't operate fast enough. The actual operation time of the I_{0INT}> stage is dependent on the behavior of the fault and the intermittent time setting. The co-ordination between U_0> and I_{0INT}> is simple. The start signal of the transient stage I_{0INT}> in an outgoing feeder can be used to block the U_0> backup protection.

Co-ordination with the Normal Directional Earth-fault-protection

Based on Fundamental Frequency Signals, the intermittent transient earth-fault-protection stage I0INT> must be used together with the normal directional earth-fault-protection stages $I\phi$>, $I\phi$>>. The transient stage I0INT> can (in worst case) detect the start of a steady earth-fault in the wrong direction, but will not trip. The peak value of a steady state sine-wave I0 signal must also exceed the corresponding base frequency component peak-value to make the I0INT> trip.

The operation time of the transient stage I_{0INT}> must be lower than the settings of any directional earth-fault-stage. This setting avoids any unnecessary trip from the I_φ>, I_φ>> stages. The start signals from the I_{0INT}> stage can also be used to block I_φ>, I_φ>> stages of parallel functions.

Auto Reclosing

The start signal of any I_φ> stage initiating auto-reclosing (AR) can be used to block the I_{0INT}> stage. This AR avoids the I_{0INT}> stage with a long intermittent setting, from interfering with the AR cycle in the middle of discrimination time.

Usually the I_{0INT}> stage itself is not used to initiate any AR. For transient faults, the AR does not help because the fault phenomenon includes repeated self-extinguishing.

Intermittent Time

Single transient-faults make the protection pick up, but does not cause a trip if the stage has time to release between to successive faults. When starting happens enough times, such intermittent faults can be cleared using the intermittent time setting.

When a new fault happens within the set intermittent time, the operation delay counter is not cleared between adjacent faults and finally the stage trips. One transient fault is enough to start the stage and increase the delay counter by 20 ms. For example, if operating time is 140 ms. And the intermittent time setting between two peaks is not exceeded, then the seventh peak (in a 50-Hz system) causes a trip (Figure 63).

Peak Amount Counter, Operation Time, and Intermittent Time Coordination

Algorithm has three independently settable parameters: operation delay, required amount of peaks and intermittent time. All requirements must be satisfied before the stage issues a trip signal. There is a settable reset delay that makes sure the stage does not release before the circuit breaker has operated. The setting range for the required number of peaks is 1…20 and for operational delay is 0.04…300 s. Reset delay setting range is 0.06…300 s. Intermittent time setting is 0.00…300 s.

If the setting for the following has the:

- Peak is set to 2.
- Operation delay is set to 160 ms.
- Intermittent time is set to 200 ms.

The function starts operation delay calculation from the first peak. After the second peak, in 80 ms the peak amount criteria is satisfied. At 160 ms, full-operation time criteria is satisfied and the stage issues trip (Figure 60).

If the second peak does not come before the operational delay becomes full, the stage is released after intermittent time has come full. But if the second peak comes after operation time has come full but still inside intermittent time then a trip is issued instantly (Figure 61).

If intermittent time comes full before operation delay comes full, the stage is released (Figure 62). There are limitations to avoid incorrect settings. The Algorithm assumes that peaks cannot come more often than 10 ms. If peak amount is set to 10, then operation delay does not accept value less than 100 ms. If operational delay is set to 40 ms, it is not possible to set a higher peak amount setting than 4. This setting prohibits the usage of settings that can never be satisfied.

Figure 60 - Stage Issues a Trip.

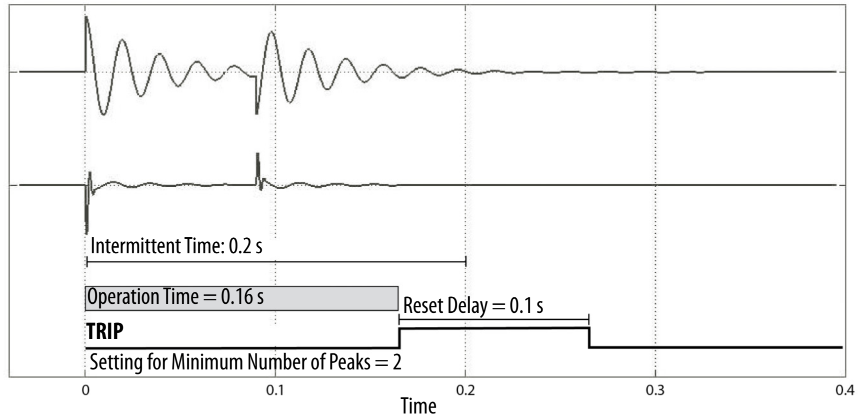


Figure 61 - Stage Issues Instant Trip

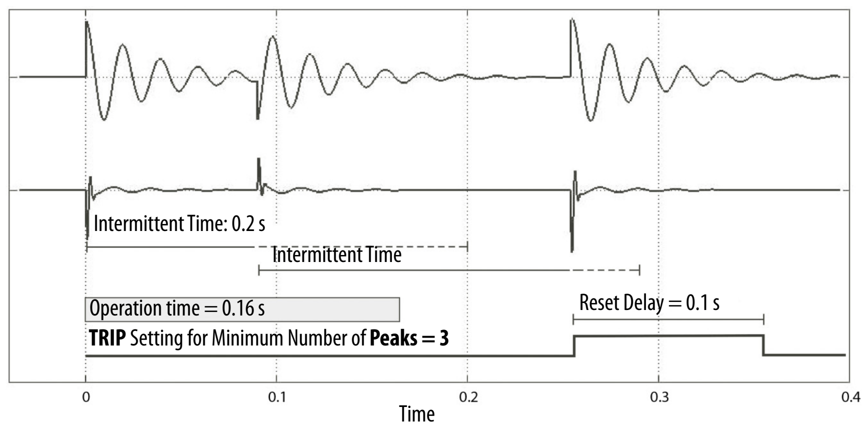
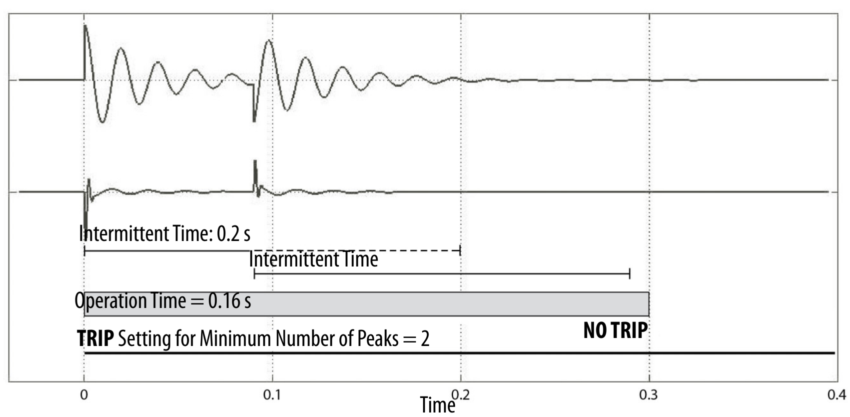


Figure 62 - Stage Is Released



Setting Groups

There are two settings groups available for each stage. Use digital inputs, virtual inputs (mimic display, communication, logic), and manual control to switch between setting groups.

Figure 63 - Block Diagram of the Directional Intermittent Transient Earth-fault Stage I_{0int}>

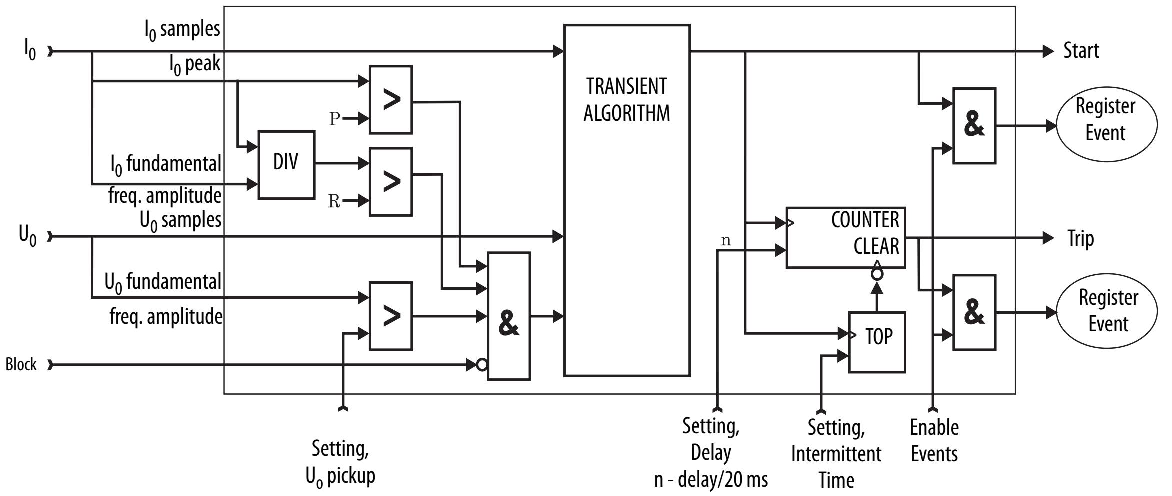


Table 30 - Parameters of Directional Intermittent Transient Earth Fault Stage I_{0int}> (67NI)

Parameter	Value	Unit	Description	Note
Status	- Blocked Start Trip		Status of the stage	 F(1) F(1)
SCntr			Cumulative start counter	C(2)
TCntr			Cumulative trip counter	C(2)
SetGrp	1…4		Active setting group	Set(3)
SGrpDI	 - DIx VIx LEDx VOx		Digital signal to select the active setting group: None Digital input Virtual input Status indicator signal Virtual output	Set(3)
Force	Off On		Force flag for status forcing for test purposes. A common flag for all stages and output relays, too. Automatically reset after a 5-minute timeout.	Set(3)
Io1 Io2		pu	The detected I0 value according to the parameter "Input".	
Uo		%	The measured U_0 value. U_{0N} = 100%	
Uo>		%	U_0 pickup level. U_{0N} = 100%	Set(3)

Table 30 - Parameters of Directional Intermittent Transient Earth Fault Stage I_{0int}> (67NI)

Parameter	Value	Unit	Description	Note
t>		s	Operation time. Actually the number of cycles including faults x 20 ms. When the time between faults exceeds 20 ms, the actual operation time is longer.	Set(3)
Io input	Io1Peak Io2Peak		I_{01} Connectors X1-7 and 8 I_{02} Connectors X1-9 and 10	Set(3)
Intrmt		s	Intermittent time. When the next fault occurs within this time, the delay counting continues from the previous value.	Set(3)

(1) F = Editable when force flag is on.
(2) C = Can be cleared to zero.
(3) Set =An editable parameter (password required).

For details on setting ranges, see Protection Stages on page 351.

Recorded Values of the Latest Eight Faults

There is detailed information available of the eight latest detected faults: Time stamp, U_0 voltage, elapsed delay, and setting group.

Table 31 - Recorded Values of the Directional Intermittent Transient Earth-fault Stage (Eight Latest Faults) I_{0int}> (67NI)

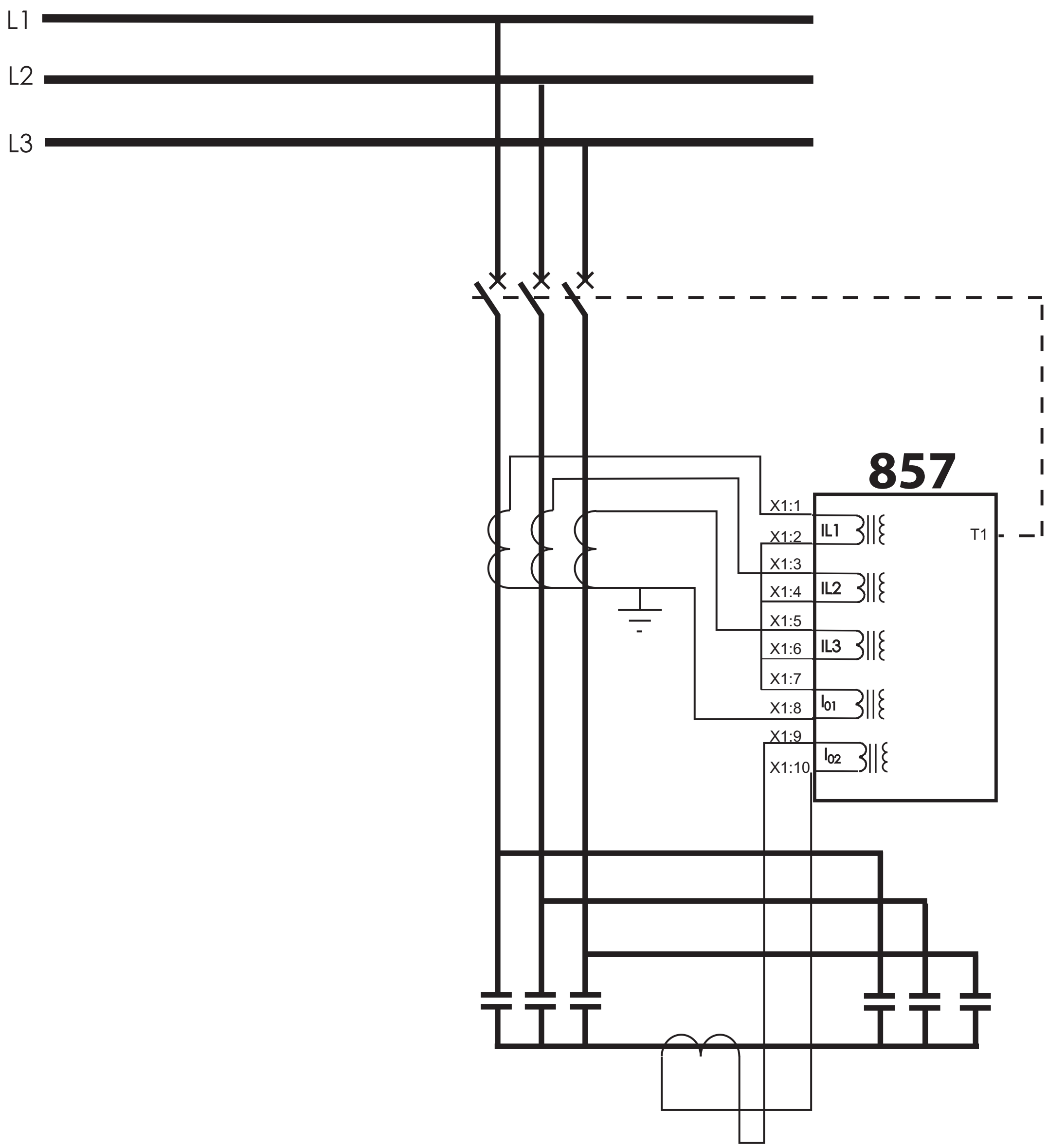
Parameter	Value	Unit	Description
	yyyy-mm-dd		Time stamp of the recording, date
	hh:mm:ss:ms		Time stamp, time of day
Flt		pu	Maximum detected earth-fault current
EDly		%	Elapsed time of the operating time setting. 100% = trip
Uo		%	Max. U_0 voltage during the fault
SetGrp	1…4		Active setting group during fault

Capacitor Bank Unbalance Protection (50NC/51NC)

The versatile capacitor, filter, and reactor bank protection can be enabled with five current measurement inputs. The fifth input is useful for unbalance current measurement of a double wye connected unearthed bank. The unbalance protection is highly sensitive to internal faults of a bank because of the natural unbalance compensation. The location method gives the protection a new dimension and enables easy maintenance monitoring for a bank.

This protection scheme is used in double wye connected capacitor banks. The unbalance current is measured with a dedicated current transformer (could be like 5A/5A) between two startpoints of the bank. System unbalance does not affect the unbalance current. However, due to manufactured tolerances, some amount of natural unbalance current exists between the startpoints. This natural unbalance current affects the settings, so the setting must be increased.

Figure 64 - Typical, Capacitor Bank Protection Application with the 857 Protection System



Compensation Method

The method for unbalance protection is to compensate the natural unbalance current. The compensation is triggered manually when commissioning. The phasors of the unbalance current and one phase current are recorded, because one polarizing measurement is needed. When the phasor of the unbalance current is related to I_{L1}, the frequency changes or deviations have no effect on the protection.

After recording, the measured unbalance current corresponds the zero-level so the setting of the stage can be sensitive.

Compensation and Location

The most sophisticated method is to use the same compensation method as previously mentioned. The add-on feature is to locate the branch of each broken fuse.

This feature is implemented to the stage I_0>>>>, while the other stage I_0>>> can still function as a normal unbalance protection-stage with compensation method. Normally, the I_0>>>> could be set as an alarming stage while stage I_0>>> trips the circuit-breaker.

Set the stage I_0>>>> based on the calculated unbalance current change of one faulty element. The calculated setting must be approximately 10% smaller than the calculated value. There are tolerances in the primary equipment and in the Protection System measurement circuit. The time setting of I_0>>>> is not used for tripping. The time setting specifies, how long the device must wait until it is certain that there is a faulty element in the bank. After this time has elapsed, the stage I_0>>>> makes a new compensation automatically, and the measured unbalance current for this stage is now zero.

IMPORTANT	The automatic compensation does not effect on the measured unbalance current of stage I_0>>>.

When an element failure in the bank occurs, the algorithm checks the phase angle of the unbalance current. This check is related to the phase angle of the phase current I_{L1}. Based on this angle, the algorithm can increase the corresponding faulty elements counter (there are six counters).

Set for the stage I_0>>>> to the allowed number of faulty elements. For example if set to three elements, the fourth fault element issues the trip signal.

The fault location is used with internal fused capacitor and filter banks. There is no need to use it with fuseless or external fused capacitor and filter banks, nor with the reactor banks.

Table 32 - Setting Parameters of Capacitor Bank Unbalance Protection: I_0>>>, I_0>>>> (50N/51N)

Parameter	Value	Unit	Default	Description
Input	Io1 Io2 IoCalc	-	Io2	Current measurement input. Do not use the calculated value, which is only for earth-fault-protection purposes
Io>>>	0.01…8.00 (Input Io1, Io2)		0.10 (Io>>>)	Setting value
Io>>>>	0.01…20.0 (Input IoCalc)	pu	0.20 (Io>>>>)	
t>	0.08…300.00	s	0.50 (Io>>>) 1.00 (Io>>>>)	Definite operating time
CMode	Off; On (Io>>>) Off; Normal Location (Io>>>>)	-	Off	Compensation selection
SaveBa	- Get	-	-	Trig the phasor recording
SetBal	0.010…3.000	pu	0.050	Compensation level
S_On	On Off	-	On	Start on event
S_Off	On Off	-	On	Start off event
T_On	On Off	-	On	Trip on event
T_Off	On Off	-	On	Trip off event
DIoSav	On Off	-	Off	Recording triggered event
DIoSav	On Off	-	Off	Recording ended event

Table 33 - Measured and Recorded Values of Capacitor Bank Unbalance Protection: I02>, I02>> (50N/51N)

Parameter	Value	Unit	Default	Description
Measured values	Io		Pu	Unbalance current (including the natural unbalance current)
	dIo		A	Compensated unbalance current
Display	Io>>> Io>>>>		A	Setting value
Recorded values	SCntr		-	Cumulative start counter
	TCntr		-	Cumulative trip counter
	Flt		pu	The max. fault value
	EDly		%	Elapsed time as compared to the set operating time; 100% = tripping
	Isaved		A	Recorded natural unbalance current
	SavedA		deg	Recorded phase angle of natural unbalance current

Table 33 - Measured and Recorded Values of Capacitor Bank Unbalance Protection: I02>, I02>> (50N/51N) (Continued)

Parameter	Value	Unit	Default	Description
Recorded values	Faults (Io>>>> only)		-	Allowed number of element failures
	Total (Io>>>> only)		-	Actual number of element failures in the bank
	Clear (Io>>>> only)	- Clear	-	Clear the element counters
	L1-B1 (Io>>>> only)		-	Number of element failures in phase L1 in branch 1 (left side)
	L1-B2 (Io>>>> only)		-	Number of element failures in phase L1 in branch 2 (right side)
	L2-B1 (Io>>>> only)		-	Number of element failures in phase L2 in branch 1 (left side)
	L2-B2 (Io>>>> only)		-	Number of element failures in phase L2 in branch 2 (right side)
	L3-B1 (Io>>>> only)		-	Number of element failures in phase L3 in branch 1 (left side)
	L3-B2 (Io>>>> only)		-	Number of element failures in phase L3 in branch 2 (right side)
	Locat (Io>>>> only)		-	Changed unbalance current (after automatic compensation)
	LocAng (Io>>>> only)		-	Changed phase angle of the unbalance current (after automatic compensation)

Zero Sequence Voltage Protection U_0>, U_0>>(59N)

The zero sequence voltage protection is used as unselective backup for earth-faults. And for selective earth-fault-protections for motors having a unit transformer between the motor and the busbar.

This function is sensitive to the fundamental frequency component of the zero sequence voltage. The attenuation of the third harmonic is more than 60 dB. 3n harmonics exist between the neutral point and earth also when there is no earth-fault.

When the measured value exceeds the pick-up setting of a particular stage, this stage picks up and a start signal is issued. If the fault situation remains on longer than the setting for the operation time delay, a trip signal is issued.

Measure Residual Voltage

The zero sequence voltage can be measured with three voltage transformers, one voltage transformer between the neutral point of the motor and earth. Or calculated from the measured phase-to-neutral voltages according to the selected voltage measurement mode (see Voltage Measurement Mode on page 217):

- Phase: the zero sequence voltage is calculated from the phase voltages a separate zero sequence voltage transformer is not needed. The setting values are relative to the configured voltage transformer (VT) voltage/ √3.
- Line + U_0: The zero sequence voltage is measured with voltage transformer, for example with a broken delta connection. The setting values are relative to the VT0 secondary voltage defined in configuration.

TIP The U_0 signal must be connected according to the connection diagram (Figure 188 on page 341) to get a correct polarization. Connect $-U_0$ to the device.

Two Independent Stages

There are two separately adjustable stages: U_0> and U_0>>. Both stages can be configured for Definite Time operation characteristic. The zero sequence voltage function comprises two separately adjustable zero sequence voltage stages (stage U_0> and U_0>>).

Setting Groups

Each stage has four settings groups. Use digital and virtual inputs (mimic display, communication, logic), and manual control to switch between setting groups.

Figure 65 - Block Diagram of the Zero Sequence Voltage Stages U_0> and U_0>>

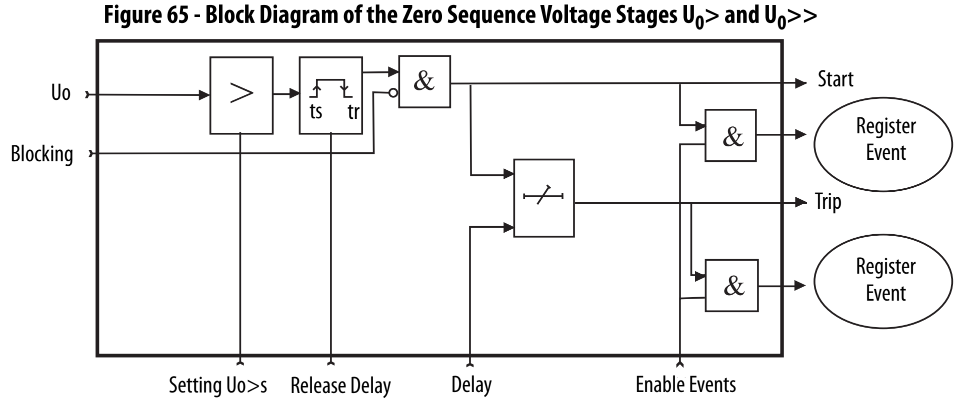


Table 34 - Parameters of the Residual Overvoltage Stages U_0>, U_0>> (59N)

Parameter	Value	Unit	Description	Note
Status	- Blocked Start Trip		Status of the stage	 F(1) F(1)
SCntr			Cumulative start counter	C(2)
TCntr			Cumulative trip counter	C(2)
SetGrp	1…4		Active setting group	Set(3)
SGrpDI	 - DIx VIx LEDx VOx		Digital signal to select the active setting group: None Digital input Virtual input Status indicator signal Virtual output	Set(3)
Force	Off On		Force flag for status forcing for test purposes. A common flag for all stages and output relays. Automatically reset by a 5-minute timeout.	Set(3)
Uo		%	The supervised value relative to Un/√ 3	
Uo> Uo>>		%	Pick-up value relative to Un/√ 3	Set(3)
t> t>>		s	Definite operation time	Set(3)

(1) F = Editable when force flag is on.
(2) C = Can be cleared to zero.
(3) Set = An editable parameter (password required).

For details on setting ranges, see Protection Stages on page 351.

Recorded Values of the Latest Eight Faults

Detailed information is available on the eight latest faults: Time stamp, fault voltage, elapsed delay, and setting group.

Table 35 - Recorded Values of the Residual Overvoltage Stages U_0>, U_0>> (59N)

Parameter	Value	Unit	Description
	yyyy-mm-dd		Time stamp of the recording, date
	hh:mm:ss:ms		Time stamp, time of day
Flt		%	Fault voltage relative to Un/√ 3
EDly		%	Elapsed time of the operating time setting. 100% = trip

Thermal Overload Protection T> (49)

The thermal overload function helps protects the motor in the motor mode or cables in the feeder mode against excessive heating.

Thermal Model

The temperature is calculated using rms values of phase currents and a thermal model according to IEC 60255-8. The rms value is calculated using harmonic components up to the 15th.

Trip time: $$t = \tau \bullet \ln \frac{I^2 - I_P^2}{I^2 - a^2}$$

Alarm: $$a = k \bullet k_\Theta \bullet I_{mode} \bullet \sqrt{alarm} \text{ (Alarm 60\% = 0.6)}$$

Trip: $$a = k \bullet k_\Theta \bullet I_{mode}$$

Release time: $$t = \tau \bullet C_\tau \bullet \left(\ln \frac{I_P^2}{a^2 - I^2} \right)$$

Trip release: $$a = \sqrt{0.95} \bullet k_\Theta \bullet I_{mode}$$

Start release: $$a = \sqrt{0.95} \bullet k_\Theta \bullet I_{mode} \bullet \sqrt{alarm} \text{ (Alarm 60\% = 0.6)}$$

T	=	Operation time.
τ	=	Thermal time constant tau (setting value).
ln	=	Natural logarithm function.
I	=	Measured rms phase current (max. value of three phase currents).
Ip	=	Preload current, $I_P = \sqrt{\theta} \bullet k_\Theta \bullet I_n$ (If temperature rise is 120%→ θ=1.2). This parameter is the memory of the algorithm and corresponds to the actual temperature rise.
k	=	Overload factor (Maximum continuous current), which is service factor (setting value).
k_Θ	=	Ambient temperature factor (permitted current due to tamb). See Figure 66.
I_{MODE}	=	The rated current (I_N or I_{MOT}).
C_τ	=	Protection System constant for time to cool (constant = C_τ x τ).

Time Constant for Cooling Situation

If the fan motor is stopped, the cooling is slower than with an active fan. Therefore there is a coefficient C_τ for thermal constant available. The coefficient to be used as a cooling time constant, when current is less than 0.3 x I_{MOT}.

Heat Capacitance, Service Factor, and Ambient Temperature

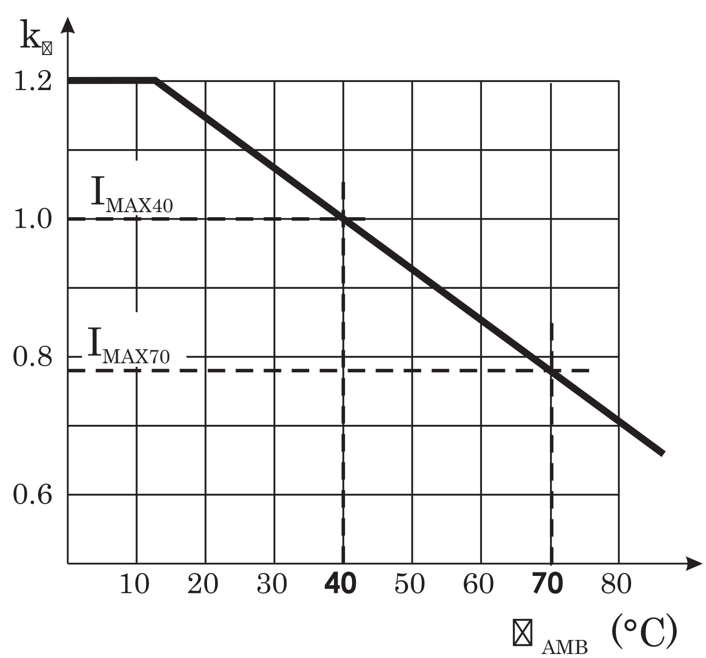
The maximum allowed continuous current I_{MAX} determines the trip level. The trip level corresponds to the 100% temperature rise Θ_{TRIP} that is the heat capacitance of the transformer. I_{MAX} depends on the given service factor k and ambient temperature Θ_{AMB} and settings I_{MAX40} and I_{MAX70} according to the equation:

$$I_{MAX} = k \bullet k_\theta \bullet I_{MODE}$$

The value of the ambient temperature compensation-factor kΘ depends on the ambient temperature Θ_{AMB} and settings I_{MAX40} and I_{MAX70} (Figure 66). Ambient temperature is not in use when kΘ = 1. This factor is true when:

- I_{MAX40} is 1.0.
- Samb is “N/A” (no ambient temperature sensor used).
- T_{AMB} is 40 °C (104 °F).

Figure 66 - Ambient Temperature Correction of the Overload Stage T>



Example of a Behavior of the Thermal Model

Figure 67 shows an example of the thermal model behavior. In this example τ = 30 minutes, k = 1.06, and kΘ = 1. The current has been zero for a long time and thus the initial temperature rise is 0%. At time = 50 minutes, the current changes to $0.85xI_{MODE}$. The temperature rise starts to approach value $(0.85/1.06)^2$ = 64% according to the time constant. At time = 300 min., the temperature is stable, and the current increases to 5% over the maximum. The rated current and the service factor k define the maximum. The temperature rise starts to approach value 110%. At about 340 minutes, the temperature rise is 100% and a trip follows.

Initial Temperature Rise After Restart

When the Protection System is switched on, an initial temperature rise of 70% is used. Depending on the actual current, the calculated temperature rise then starts to approach the final value.

Alarm Function

The thermal overload stage contains a separately settable alarm function. When the alarm limit is reached, the stage activates its start signal.

Figure 67 - Example of the Thermal Model Behavior

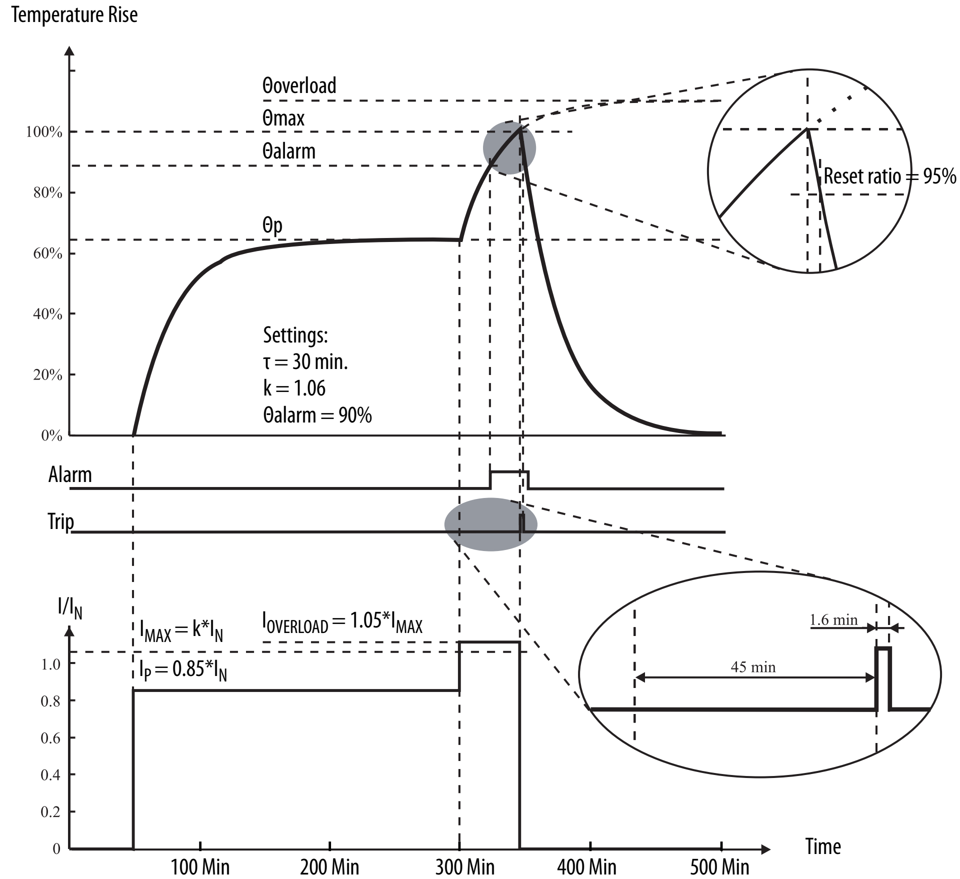


Table 36 - Parameters of the Thermal Overload Stage T> (49)

Parameter	Value	Unit	Description	Note
Status	- Blocked Start Trip		Status of the stage	 F(1) F(1)
Time	Hour (hh) Minute (mm) Second (SS)		Estimated time to trip	
SCntr			Cumulative start counter	C(2)
TCntr			Cumulative trip counter	C(2)
Force	Off On		Force flag for status forcing for test purposes. A common flag for all stages and output relays, too. Automatically reset by a 5-minute timeout.	Set(3)
T		%	Calculated temperature rise. Trip limit is 100%.	F(1)
MaxRMS		A rms	Measured current. Highest of the three phases.	
Imax		A	kxIgn. Current corresponding to the 100% temperature rise.	
k>		xIn	Allowed overload (service factor)	Set(3)
Alarm		%	Alarm level	Set(3)
tau		min	Thermal time constant	Set(3)
ctau		xtau	Coefficient for the cooling time constant. Default = 1.0	Set(3)

Table 36 - Parameters of the Thermal Overload Stage T> (49) (Continued)

Parameter	Value	Unit	Description	Note
kTamb		xIn	Ambient temperature corrected max. allowed continuous current	
Imax40		%In	Allowed load at Tamb 40°C. Default = 100%.	Set(3)
Imax70		%In	Allowed load at Tamb 70°C.	Set(3)
Tamb		°C	Ambient temperature. Editable Samb=n/a. Default = 40°C	Set(3)
Samb 	 n/a ExtAI1…16		Sensor for ambient temperature: No sensor in use for Tamb External analog input 1…16	Set(3)

(1) F = Editable when force flag is on.
(2) C = Can be cleared to zero.
(3) Set = An editable parameter (password required).

For details on setting ranges, see Protection Stages on page 351.

Overvoltage Protection U> (59)

The overvoltage function measures the fundamental frequency component of the line-to-line voltages regardless of the voltage measurement mode (see Voltage Measurement Mode on page 217). By using line-to-line voltages, any phase-to-ground overvoltages during earth-faults have no effect (the earth-fault-protection functions take care of earth-faults). Whenever any of these three line-to-line voltages exceeds the pick-up setting of a particular stage, this stage picks up and a start signal is issued. If the fault situation remains on longer than the operation-time delay setting, a trip signal is issued.

In solidly earthed 4-wire networks, with loads between phase and neutral, overvoltage protection can be needed for phase-to-ground voltages, too. In these applications, the programmable stages can be used. See Programmable Stages (99) on page 148.

Three Independent Stages

There are three separately adjustable stages: U>, U>>, and U>>>. All stages can be configured for Definite Time operation characteristic.

Configurable Release Delay

The U> stage has a settable release delay that enables the detection of intermittent faults. The time counter of the protection function does not reset immediately after the fault is cleared, but resets after the release delay has elapsed. If the fault appears again before the release delay time has elapsed, the delay counter continues from the previous value. The function trips if faults occur frequently.

Configurable Hysteresis

The deadband is 3% by default. An overvoltage fault is regarded as a fault until the voltage drops below 97% of the pickup setting. In a sensitive alarm application, a smaller hysteresis is needed. If the pickup setting is about only 2% above the normal voltage level, hysteresis must be less than 2%. Otherwise the stage will not release after fault.

Setting Groups

There are two settings groups available for each stage. Use digital inputs, virtual inputs (mimic display, communication, logic), and manual control to switch between setting groups.

Figure 68 shows the functional block diagram of the overvoltage function stages U>, U>> and U>>>.

Figure 68 - Block Diagram of the Three-phase Overvoltage Stages U>, U>>, and U>>>

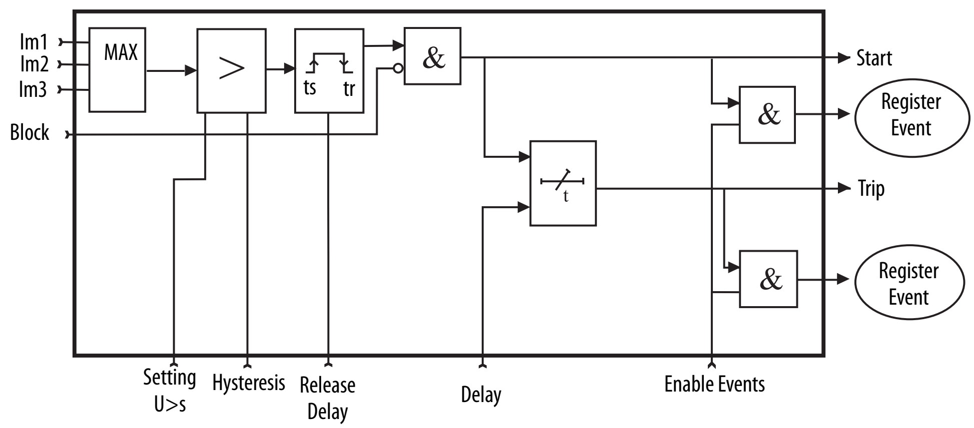


Table 37 - Parameters of the Overvoltage Stages U>, U>>, U>>> (59)

Parameter	Value	Unit	Description	Note
Status	- Blocked Start Trip		Status of the stage	 F(1) F(1)
SCntr			Cumulative start counter	C(2)
TCntr			Cumulative trip counter	C(2)
SetGrp	1…4		Active setting group	Set(3)
SGrpDI	 - DIx VIx LEDx VOx		Digital signal to select the active setting group: None Digital input Virtual input Status indicator signal Virtual output	Set(3)
Force	Off On		Force flag for status forcing for test purposes. A common flag for all stages and output relays, too. Automatically reset by a 5-minute timeout.	Set(3)

Table 37 - Parameters of the Overvoltage Stages U>, U>>, U>>> (59) (Continued)

Parameter	Value	Unit	Description	Note
Umax		V	The supervised value. Max. of U12, U23, and U31	
U> U>> U>>>		V	Pick-up value that is scaled to primary value	
U> U>> U>>>		%Un	Pick-up setting relative to UN	Set[3]
t> t>> t>>>		s	Definite operation time	Set[3]
RlsDly		s	Release delay (U> stage only)	Set[3]
Hyster	3 (default)	%	Deadband size that is hysteresis	Set[3]

(1) F = Editable when force flag is on.
(2) C = Can be cleared to zero.
(3) Set = An editable parameter (password required).

For details on setting ranges, see Protection Stages on page 351.

Recorded Values of the Latest Eight Faults

Detailed information is available on the eight latest faults: Time stamp, fault voltage, elapsed delay, and setting group.

Table 38 - Recorded Values of the Overvoltage Stages (8 Latest Faults) U>, U>>, U>>> (59)

Parameter	Value	Unit	Description
	yyyy-mm-dd		Time stamp of the recording, date
	hh:mm:ss:ms		Time stamp, time of day
Flt		%Un	Maximum fault voltage
EDly		%	Elapsed time of the operating time setting. 100% = trip
SetGrp	1…4		Active setting group during fault

Undervoltage Protection U< (27)

A basic undervoltage protection. The function measures the three line-to-line voltages. Whenever the smallest of them drops below the pick-up setting of a particular stage, this stage picks up and a start signal is issued. If the fault situation remains on longer than the operation-time delay setting, a trip signal is issued.

Blocking During VT/PT Fuse Failure

As with all protection stages, the undervoltage function can be blocked with any internal or external signal by using the block matrix. For example, if the secondary voltage of one of the measuring transformers disappears because of a fuse failure (see Voltage Transformer Supervision on page 183). The blocking signal can also be a signal from the user logic (see Logic Functions on page 247).

Self-blocking at Very Low Voltage

The stages can be blocked with a separate, low limit setting. With this setting, the particular stage is blocked when the biggest of the three line-to-line voltages drop below the given limit. The idea is to avoid tripping when the voltage is switched off. If the operating time is less than 0.08 s, set the blocking level to exceed 15% for the blocking action to be fast enough. The self-blocking can be disabled by setting the low-voltage block limit equal to zero.

Figure 69 shows an example of low voltage self-blocking.

(A) The maximum of the three line-to-line voltages U_{LLmax} is below the block limit. Not regarded as an under voltage situation.

(B) The voltage U_{LLmin} is above the block limit but below the pick-up level. An undervoltage situation.

(C) Voltage is OK, because it is above the pick-up limit.

(D) An under voltage situation.

(E) Voltage is OK.

(F) An under voltage situation.

(G) The voltage U_{LLmin} is under block limit and is not regarded as an under voltage situation.

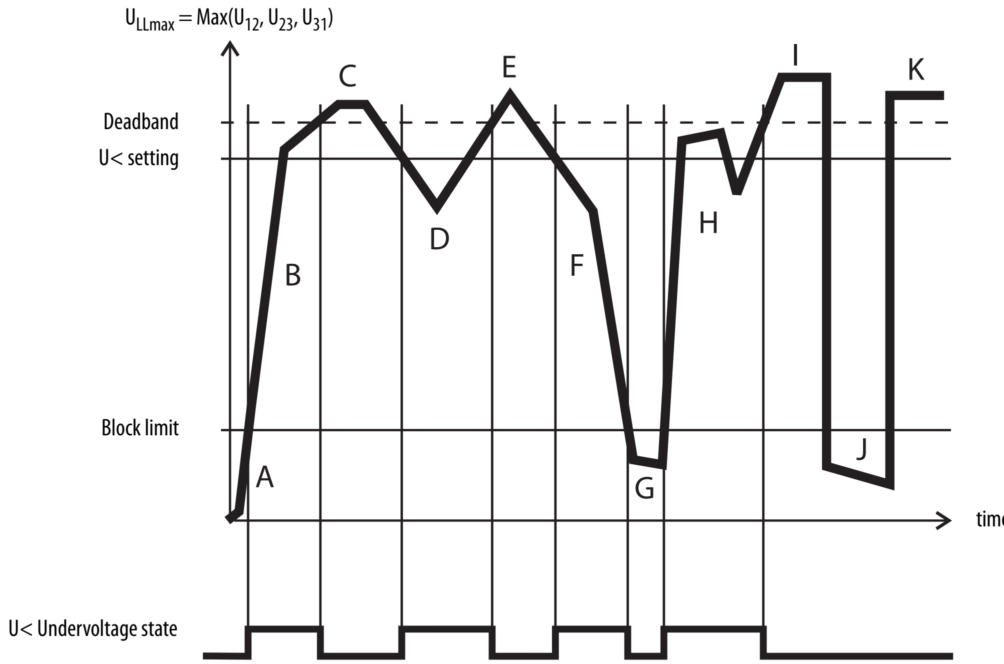
(H) An under voltage situation.

(I) Voltage is OK.

(J) Same as G.

(K) Voltage is OK.

Figure 69 - Undervoltage State and Block Limit



Three Independent Stages

There are three separately adjustable stages: U<, U<<, and U<<<. They can be configured for Definite Time (DT) operation characteristic.

Setting Groups

There are two settings groups available for each stage. Use digital inputs, virtual inputs (mimic display, communication, logic), and manual control to switch between setting groups.

Table 39 - Parameters of the Undervoltage Stages U<, U<<, U<<< (27)

Parameter	Value	Unit	Description	Note
Status	- Blocked Start Trip		Status of the stage	 F(1) F(1)
SCntr			Cumulative start counter	C(2)
TCntr			Cumulative trip counter	C(2)
SetGrp	1…4		Active setting group	Set(3)
SGrpDI	 - DIx VIx LEDx VOx		Digital signal to select the active setting group: None Digital input Virtual input Status indicator signal Virtual output	Set(3)

Table 39 - Parameters of the Undervoltage Stages U<, U<<, U<<< (27) (Continued)

Parameter	Value	Unit	Description	Note
Force	Off On		Force flag for status forcing for test purposes. A common flag for all stages and output relays, too. Automatically reset by a 5-minute timeout.	Set(3)
MinU		V	The supervised minimum of line-to-line voltages in primary volts	
U< U<< U<<<		V	Pick-up value that is scaled to primary value	
U< U<< U<<<		%Un	Pick-up setting	Set(3)
t< t<< t<<<		S	Definite operation time	Set(3)
LVBlk		%Un	Low limit for self-blocking	Set(3)
RlsDly		S	Release delay (U< stage only)	Set(3)
Hyster	Default 3.0%	%	Deadband setting	Set(3)

(1) F = Editable when force flag is on.
(2) C = Can be cleared to zero.
(3) Set = An editable parameter (password required).

For details on setting ranges, see Protection Stages on page 351.

Recorded Values of the Latest Eight Faults

Detailed information is available on the eight latest faults for each of the stages: Time stamp, fault voltage, elapsed delay, voltage before the fault and setting group.

Table 40 - Recorded Values of the Undervoltage Stages (8 Latest Faults) U<, U<<, U<<< (27)

Parameter	Value	Unit	Description
	yyyy-mm-dd		Time stamp of the recording, date
	hh:mm:ss:ms		Time stamp, time of day
Flt		%Un	Minimum fault voltage
EDly		%	Elapsed time of the operating time setting. 100% = trip
PreFlt		%Un	Supervised value before fault, 1-s average value.
SetGrp	1…4		Active setting group during fault

Reverse Power and Underpower Protection P<, P<<(32)

Reverse power function can disconnect a motor if the supply voltage is lost and helps prevent power generation by the motor. Underpower function can detect the loss of load of a motor.

Reverse power and underpower function is sensitive to active power. For reverse power function, the pick-up value is negative. For underpower function, a positive pick-up value is used. Whenever the active power goes under the pick-up value, the stage picks up and issues a start signal. If the fault situation stays on longer than the delay setting, a trip signal is issued.

The pick-up setting range is from -200…200% of the Nom apparent power Sn. The configured voltage and current transformer values determine the Nom apparent power.

Equation 3.3

$$S_n = (VT_{RatedPrimary} \bullet CT_{RatedPrimary}) \bullet \sqrt{3}$$

There are two identical stages available with independent setting parameters.

Table 41 - Setting Parameters of P< and P<< Stages

Parameter	Value	Unit	Default	Description
P< P<<	-200.0…200.0	%Sn	-4.0 (P<) -20.0(P<<)	P<,P<< pick-up setting
T<	0.3…300.0	S	1.0	P<, P<< operational delay
S_On	Enabled Disabled	-	Enabled	Start on event
S_Off	Enabled Disabled	-	Enabled	Start off event
T_On	Enabled Disabled	-	Enabled	Trip on event
T_Off	Enabled Disabled	-	Enabled	Trip off event

Table 42 - Measured and Recorded Values of P< and P<< Stages

	Parameter	Value	Unit	Description
Measured value	P		kW	Active power
Recorded values	SCntr		-	Start counter (Start) reading
	TCntr		-	Trip counter (Trip) reading
	Flt		%Sn	Maximum value of fault
	EDly		%	Elapsed time as compared to the set operating time, 100% = tripping

Overfrequency and Underfrequency Protection f><, f>><< (81), (81H/81L)

Frequency protection is used for load sharing, loss of mains detection, and as a backup protection for over-speeding.

The frequency function measures the frequency from the two first voltage inputs. At least one of these two inputs must have a voltage that is connected to be able to measure the frequency. Whenever the frequency crosses the pick-up setting of a particular stage, this stage picks up and a start signal is issued. If the fault situation remains on longer than the operation delay setting, a trip signal is issued. For situations where no voltage is present, an adapted frequency is used.

Protection Mode for f>< and f>><< Stages

These two stages can be configured for overfrequency or underfrequency.

Undervoltage Self-blocking of Underfrequency Stages

The underfrequency stages are blocked when biggest of the three line-to-line voltages are below the low-voltage block limit setting. With this common setting (LVBlk), all stages in underfrequency mode are blocked when the voltage drops below the given limit. The idea is to avoid purposeless alarms when the voltage is off.

Initial Self-blocking of Underfrequency Stages

When the biggest of the three line-to-line voltages have been below the block limit, the underfrequency stages are blocked until the pick-up setting is reached.

Four Independent Frequency Stages

There are four separately adjustable frequency stages: f><, f><><, f<, f<<. The two first stages can be configured for overfrequency or underfrequency usage. So totally four underfrequency stages can be in use simultaneously. The use of programmable stages even more can be implemented (see Programmable Stages (99) on page 148). All stages have definite operation-time delay (DT).

Setting Groups

There are four settings groups available for each stage. Use digital inputs, virtual inputs (mimic display, communication, logic), and manual control to switch between setting groups.

Table 43 - Parameters of the Over and Underfrequency Stages f><, f><><, f<, f<< (81H/81L)

Parameter	Value	Unit	Description	Note
Status	- Blocked Start Trip		Status of the stage	 F[1] F[1]
SCntr			Cumulative start counter	C[2]
TCntr			Cumulative trip counter	C[2]
SetGrp	1…4		Active setting group	Set[3]
SGrpDI	 - DIx VIx LEDx VOx		Digital signal to select the active setting group: None Digital input Virtual input Status indicator signal Virtual output	Set[3]
Force	Off On		Force flag for status forcing for test purposes. A common flag for all stages and output relays, too. Automatically reset by a 5-minute timeout.	Set[3]
f		Hz	The supervised value.	
 fx fXX f< f<<		Hz	Pick-up value: Over/under stage f><. See Mode. Over/under stage f><>< Under stage f< Under stage f<<	Set[3]
 tX tXX t< t<<		s	Definite operation time: f>< stage f><>< stage f< stage f<< stage	Set[3]
Mode	 > <		Operation mode. (only for f>< and f><><): Overfrequency mode Underfrequency mode	Set[3]
LVblck		%Un	Low limit for self-blocking. A common setting for all four stages.	Set[3]

(1) F = Editable when force flag is on.
(2) C = Can be cleared to zero.
(3) Set = An editable parameter (password required).

For details on setting ranges, see Protection Stages on page 351.

Recorded Values of the Latest Eight Faults

Detailed information is available on the eight latest faults: Time stamp, frequency during fault, elapsed delay, and setting group.

Table 44 - Recorded Values of the Over and Under Frequency Stages (Eight Latest Faults) f><, f><><, f<, f<< (81H/81L)

Parameter	Value	Unit	Description
	yyyy-mm-dd		Time stamp of the recording, date
	hh:mm:ss:ms		Time stamp, time of day
Flt		Hz	Faulty frequency
EDly		%	Elapsed time of the operating time setting. 100% = trip
SetGrp	1…4		Active setting group during fault

Rate of Change of Frequency (ROCOF) Protection df/dt (81R)

Rate of change of frequency (ROCOF or df/dt) function is for fast Load-shedding. The function is used to speed up operation time in over- and under-frequency situations and to detect loss of grid. For example, a centralized dedicated relay to shed load can be omitted and replaced with distributed Load-shedding, if all outgoing feeders are equipped with 857 Protection Systems.

A special application for ROCOF is to detect loss of grid (loss of mains, islanding). The more the remaining load differs from the load before the loss of grid, the better the ROCOF function detects the situation.

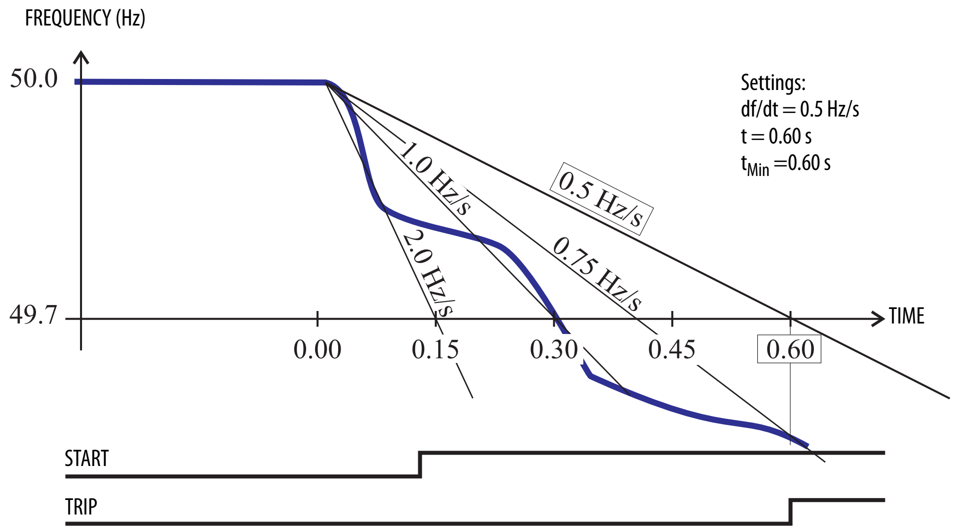
Frequency Behavior During Load Switching

Load switching and fault situations can generate a change in frequency. A load drop can increase the frequency and increase in load can decrease the frequency, for a while. The frequency can also oscillate after the initial change. Over time, the control system of any local generator can drive the frequency back to the original value. If there is a heavy short circuit fault or in case the new load exceeds the generating capacity, the average frequency decreases.

In Figure 70, is an example. At 0.6 s, which is the programmed delay setting, the average slope exceeds the 0.5 Hz/s setting and a trip signal would be generated.

At 0.6 s, which is the delay setting, the average slope exceeds the setting 0.5 Hz/s and a trip signal is generated

Figure 70 - Example of Definite Time df/dt Operation Time



Settings Groups

There are four settings available and can be switched by using a digital input, a virtual input, or manually.

ROCOF Implementation

The ROCOF function is sensitive to the absolute average value of the time derivate of the measured frequency |df/dt|. Whenever the measured frequency slope |df/dt| exceeds the setting value for 80-ms time a start signal is issued. The ROCOF stage picks up and issues the start signal only after an additional 60-ms delay. If the average |df/dt|, since the pick-up moment, still exceeds the setting, when the operation delay time has elapsed, a trip signal is issued. In this Definite Time mode, the second delay parameter “minimum delay, t_{Min}” must be equal to the operation delay parameter “t”.

If the frequency is stable for about 80 ms without a trip, the stage releases.

ROCOF and Frequency Over and Under Stages

One difference between over-/under-frequency and df/dt function is the speed. In many cases, a df/dt function can predict an overfrequency or underfrequency situation and is thus faster than a simple overfrequency or underfrequency function. In most cases, standard overfrequency and underfrequency stages must be used together with ROCOF. This association makes sure that there is tripping in case the frequency drift is slower than the slope setting of ROCOF.

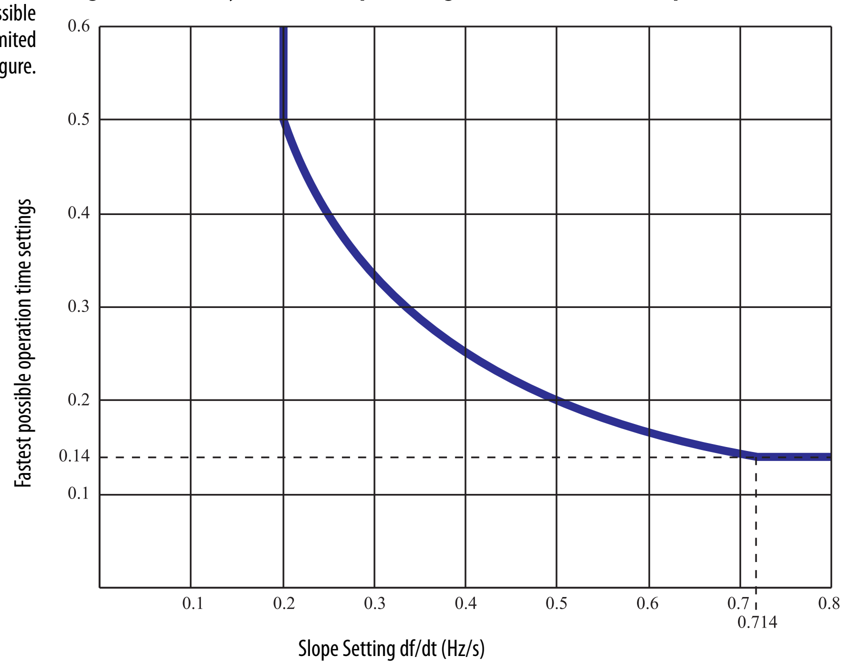
Definite Operation-time Characteristics

Figure 70 shows an example where the df/dt pick-up value is 0.5 Hz/s and the delay settings are t=0.60 s and t_{Min}=0.60 s. Equal times t = t_{Min} gives DT delay characteristics. Although the frequency slope fluctuates, the stage does not release but continues to calculate the average slope since the initial pick-up. At the defined operation time, t = 0.6 s, the average slope is 0.75 Hz/s. This value exceeds the setting, and the stage trips.

At slope settings less than 0.7 Hz/s, the fastest possible operation time is limited (Figure 71).

Figure 71 - At Very Sensitive Slope Settings, the Fastest Possible Operation Time Is Limited

The fastest possible operation time is limited according to this figure.



Inverse Operation-time Characteristics

By setting the second delay parameter t_{Min} smaller than the operational delay t, an inverse type of operation time characteristics is achieved (Figure 72).

Figure 73 shows an example, where the frequency behavior is the same as in the first figure. But the t_{Min} setting is 0.15 s instead of being equal with t. The operation time depends on the measured average slope according to this equation.

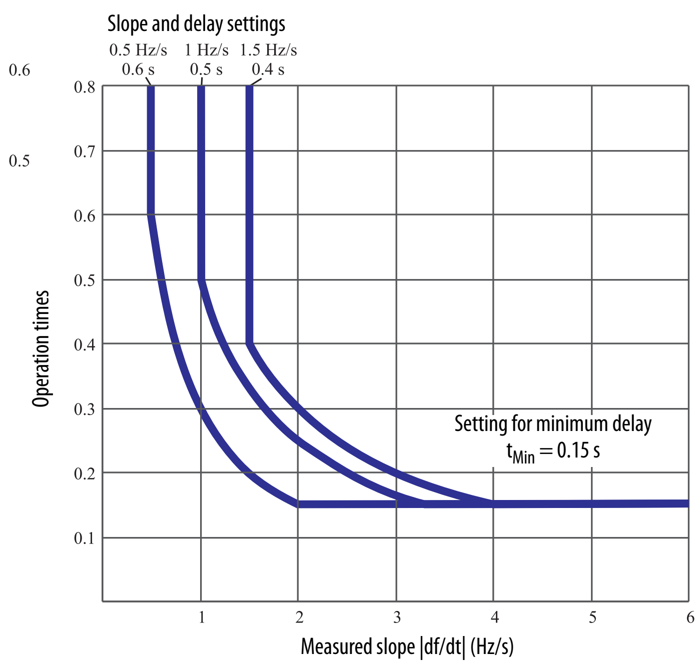
$$t_{TRIP} = \frac{s_{SET} \bullet t_{SET}}{|s|} \text{ where,}$$

t_{TRIP}	=	The resulting operation times.
s_{SET}	=	df/dt that is slope setting (Hz/s).
t_{SET}	=	Operation time setting t (s).
s	=	Measured average frequency slope (hz/s).

The minimum operation time is limited by the setting parameter t_{Min}. In the example of the fastest operation time, 0.15 s, is achieved when the slope is 2 Hz/s or more. The leftmost curve in Figure 72 shows the inverse characteristics with the same settings as in Figure 73.

The slope and operation delay settings define the knee points to the left. A common setting for t_{Min} has been used in these three examples. The minimum delay parameter defines the knee point positions on the right.

Figure 72 - Three Examples of Possible Inverse df/dt Operation Time Characteristics



The time to trip is 0.3.s, although the setting is 0.6 s. Because the average slope 1 Hz/s is steeper than the setting value 0.5 Hz/s.

Figure 73 - Example of Inverse df/dt Operation Time

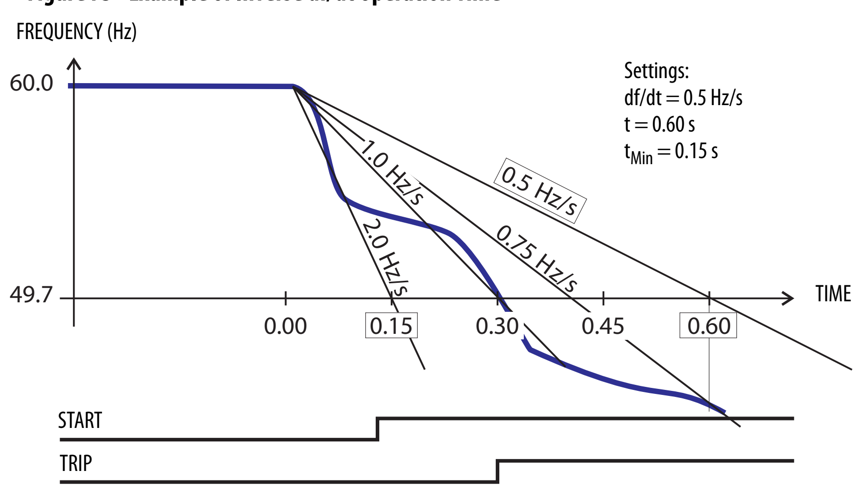


Table 45 - Setting Parameters of df/dt Stage

Parameter	Value	Unit	Default	Description
df/dt	0.2…10.0	Hz/s	5.0	df/dt pick-up setting
t>	0.14…10.0	s	0.50	df/dt operational delay
tMin>	0.14…10.0	s	0.50	df/dt minimum delay
S_On	Enabled Disabled	-	Enabled	Start on event
S_Off	Enabled Disabled	-	Enabled	Start off event
T_On	Enabled Disabled	-	Enabled	Trip on event
T_Off	Enabled Disabled	-	Enabled	Trip off event

Table 46 - Measured and Recorded Values of df/dt Stage

	Parameter	Value	Unit	Description
Measured value	f		Hz	Frequency
	df/dt		Hz/s	Frequency rate of change
Recorded values	SCntr		-	Start counter (Start) reading
	TCntr		-	Trip counter (Trip) reading
	Flt		%Hz/s	Maximum rate of change fault value
	EDly		%	Elapsed time as compared to the set operating time, 100% = tripping

Synchrocheck Protection (25)

A function that checks synchronism when the circuit-breaker or contactor is closed. The function monitors voltage amplitude, frequency, and phase angle difference between two voltages. Since there are two stages available, it is possible to monitor three voltages. The voltages can be busbar and line or busbar and busbar (bus coupler).

The Synchrocheck protection element disqualifies the use of the normal measuring modes. Therefore, “2LL/LLy”, “1LL+U_0/LLy” or “LL/LLy/LLz” voltage-measuring mode must be selected to enable Synchrocheck function. If “2LL/LLy”- or “1LL+U_0/LLy”-mode is selected, one stage is available. The “LL/LLy/LLz”-mode enables the use of two stages.

The voltage that is used to Synchrocheck is phase-to-phase voltage U_{12}. The Synchrocheck stage 1 compares U_{12} with U_{12y}. The compared voltages for the stage 2 can be selected.

Table 47 - Setting Parameters of Synchrocheck Stages SyC1, SyC2 (25)

Parameter	Values	Unit	Default	Description
Side	U12/U12y U12/U12z U12y/U12z	-	U12/ U12z	Voltage selection. The stage 1 has fixed voltages U12/ U12y.
CBObj	Obj1…6	-	Obj1	The selected object for CB control. The Synchrocheck closing command uses the closing command of the selected object. The stage 1 uses the object 1. The stage 2 can use objects 2…6.
SMode	Async Sync Off	-	Sync	Synchrocheck mode. Off = only voltage check Async = the function checks dU, df and dangle. The frequency slip, df, determines the remaining time for closing. This time must be longer than “CB time”. Sync mode = Synchronization is tried to make exactly when angle difference is zero. In this mode, the Measured frequency difference (df) setting must be enough small (<0.3 Hz).
UMode	- DD DL LD DD/DL DD/LD DL/LD DD/DL/LD	-	-	Voltage check mode: The first letter refers to the reference voltage and the second letter refers to the comparison voltage. D means that the side must be “dead” when closing (dead = The voltage below the dead-voltage limit setting) L means that the side must be “live” when closing (live = The voltage higher than the live voltage limit setting). Example: DL mode for stage 1: The U12 side must be “dead” and the U12y side must be “live”.
CBtime	0.04…0.6	s	0.1	Typical closing-time of the circuit-breaker.
DIbypass	Digital inputs	-	-	Bypass input. If the input is active, the function is bypassed.
Bypass	0 1	-	0	The bypass status. “1” means that the function is bypassed. This parameter can also be used for manual bypass.
CBCtrl	Open Close	-	-	Circuit-breaker control.
ShowInfo	Off On	-	On	Additional information display about the Synchrocheck status to the mimic.
SGrpDI	Digital inputs	-	-	The input for changing the setting group.
SetGrp	1…4	-	1	The active setting group.

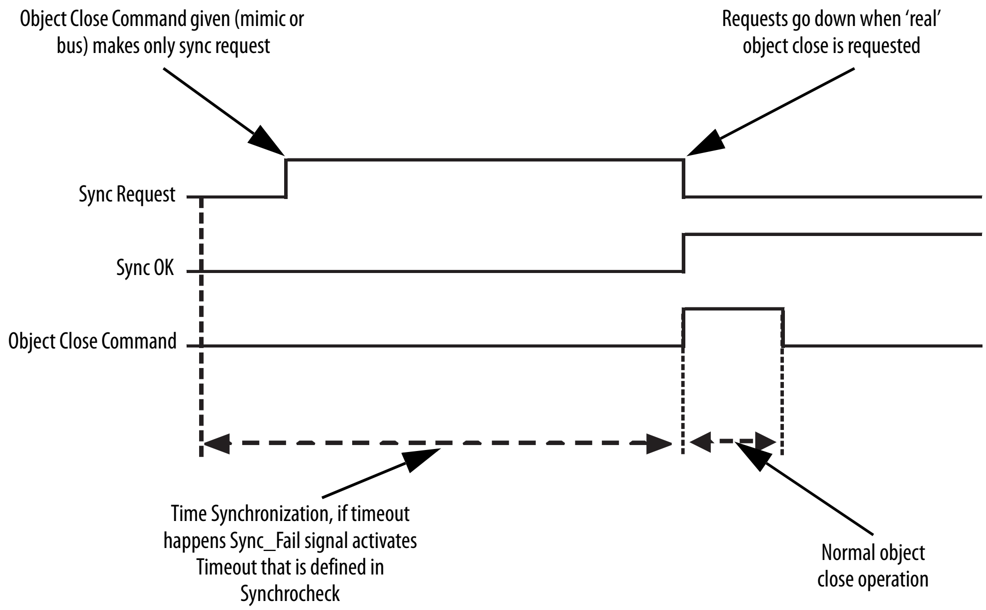
Table 48 - Measured and Recorded Values of Synchrocheck Stages SyC1, SyC2 (25)

	Parameter	Values	Unit	Description
Measured Values	df	-	Hz	Measured frequency difference
	dU	-	% Un / deg	Measured voltage amplitude and phase angle difference
	UState	-	-	Voltage status (for example DD)
	SState	-	-	Synchrocheck status
	ReqTime	-	-	Request time status
	f (1)	-	Hz	Measured frequency (reference side)
	fy (1)	-	Hz	Measured frequency (comparison side)
	U12(1)	-	% Un	Measured voltage (reference side)
	U12y(1)	-	% Un	Measured voltage (comparison side)
Recorded Values	ReqCntr	-	-	Request counter
	SyncCntr	-	-	Synchronizing counter
	FailCntr	-	-	Fail counter
	f (1)	-	Hz	Recorded frequency (reference side)
	fy (1)	-	Hz	Recorded frequency (comparison side)
	U12 (1)	-	% Un	Recorded voltage (reference side)
	U12y (1)	-	% Un	Recorded voltage (comparison side)
	dAng	-	Deg	Recorded phase angle difference, when close command is given from the function
	dAngC	-	Deg	Recorded phase angle difference, when the circuit-breaker actually closes.
	EDly	-	%	The elapsed time that is compared to the set request timeout setting, 100% = timeout

(1) The labels (parameter names) change according to the voltage selection.

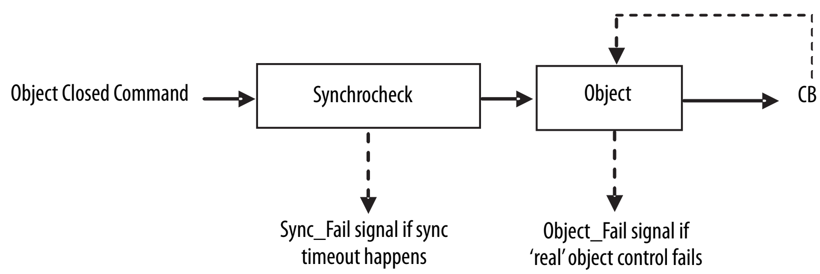
The signals of both the stages are available in the output matrix and the logic: “Request”, “OK” and “Fail”. The “request” signal is active when a request has received but the breaker is not yet closed. The “OK” signal is active when the synchronizing conditions are met or the voltage check criterion is met. The “fail”-signal is activated if the function fails to close the breaker or contactor within the request timeout setting (Figure 74).

Figure 74 - Principle of the Synchrocheck Function



IMPORTANT	The control pulse of the selected object must be long enough. For example, if the voltages are in opposite direction, the synchronizing conditions are met after several seconds.

Figure 75 - Block Diagram of the Synchrocheck and the Controlling Object



Time Settings:
Synchrocheck: Max Synchronize Time (~seconds)
Object: Max Object Control Pulse len (~200 ms)

The wiring of the secondary circuits of voltage transformers to the device terminal depends on the selected voltage-measuring mode.

Table 49 - Voltage Measurement Modes for Synchrocheck Function

Voltage Input	Terminals	Signals in Mode "1LL+U_0/LLy"	Signals in Mode "2LL/LLy"	Signals in Mode "LL/LLy/LLz"
U_a	X1:11, 12	U_{12}	U_{12}	U_{12}
U_b	X1:13, 14	U_{12y}	U_{23}	U_{12y}
U_c	X1:17, 18	U_0	U_{12y}	U_{23z}
Number of Synchrocheck Stages		1	1	2
Availability of U_0 and directional I_0 stages		Yes	No	No
Power Measurement		1-phase power, symmetrical loads	3-phase power, unsymmetrical loads	1-phase power, symmetrical loads

The application examples show the correct connection of the voltage inputs. In Figure 76 and Figure 77, the applications require only one stage (voltage-measuring modes are "1LL+U_0/LLy" and "2LL/LLy"). Two stages are needed for the application that is presented in Figure 78 (voltage-measuring mode is "LL/LLy/LLz").

Figure 76 - One Synchrocheck Stage Is Needed with “1LL+U_o/LLy”-mode

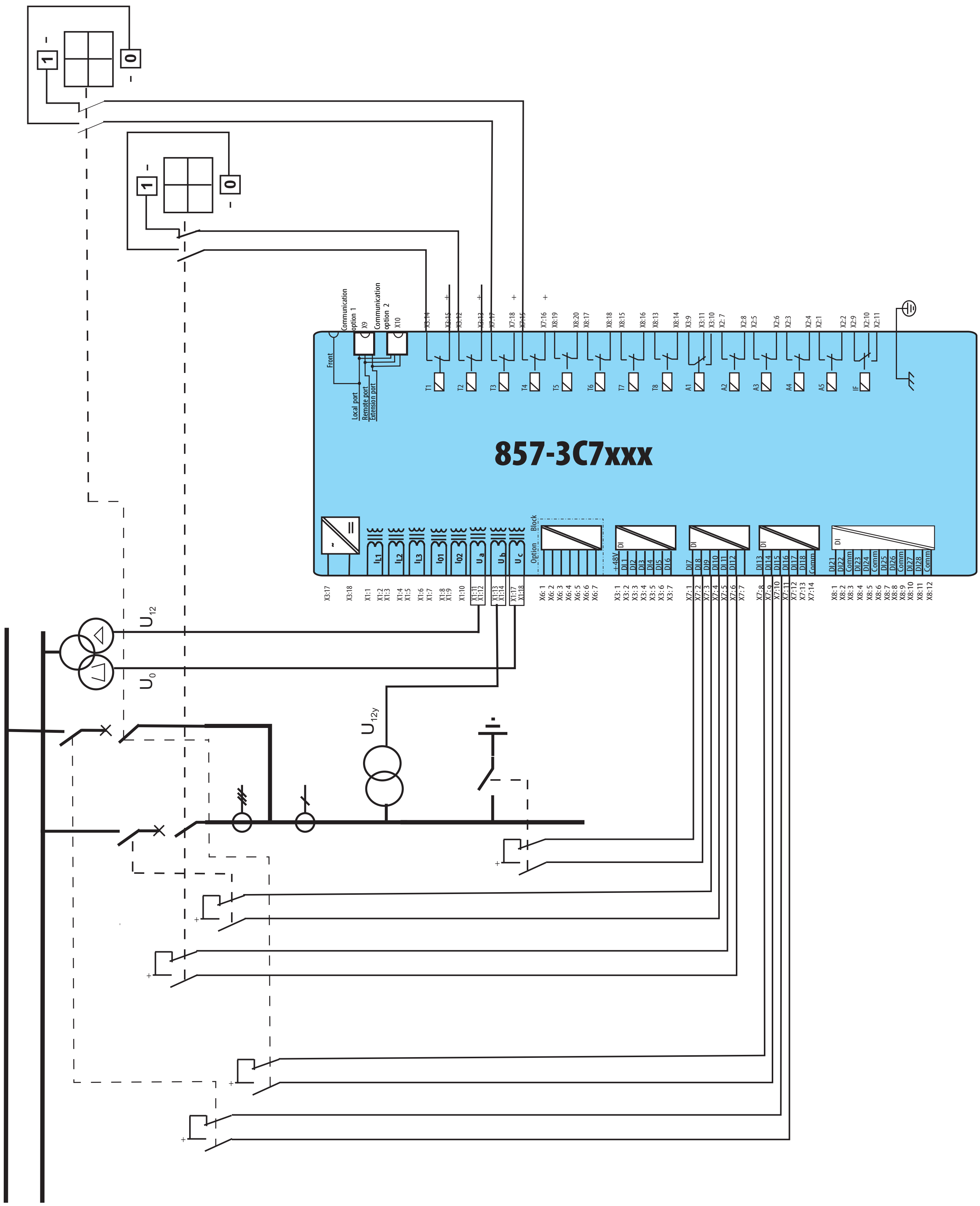


Figure 77 - One Synchrocheck Stage Is Needed with "2L/LLy"-mode

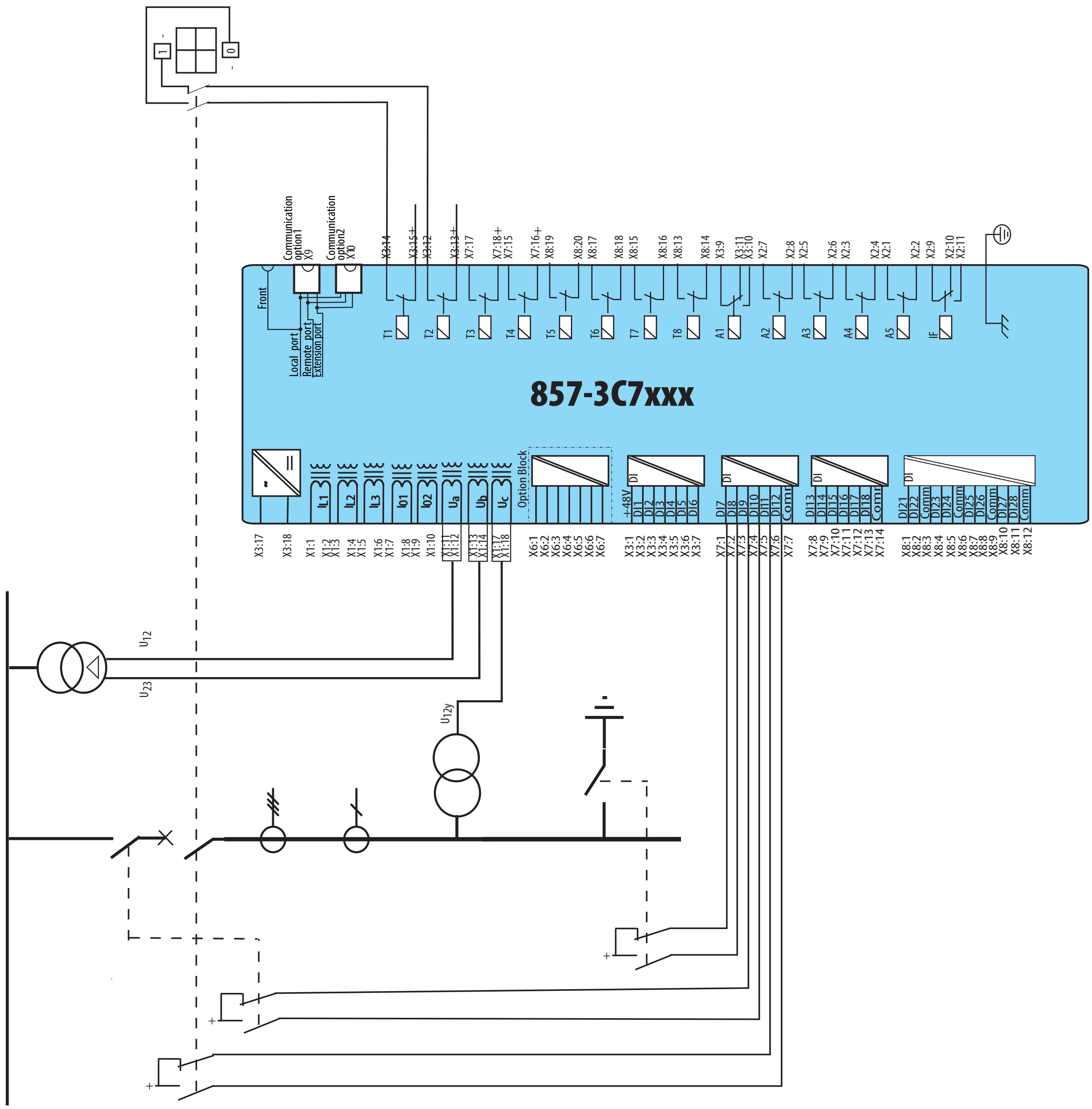
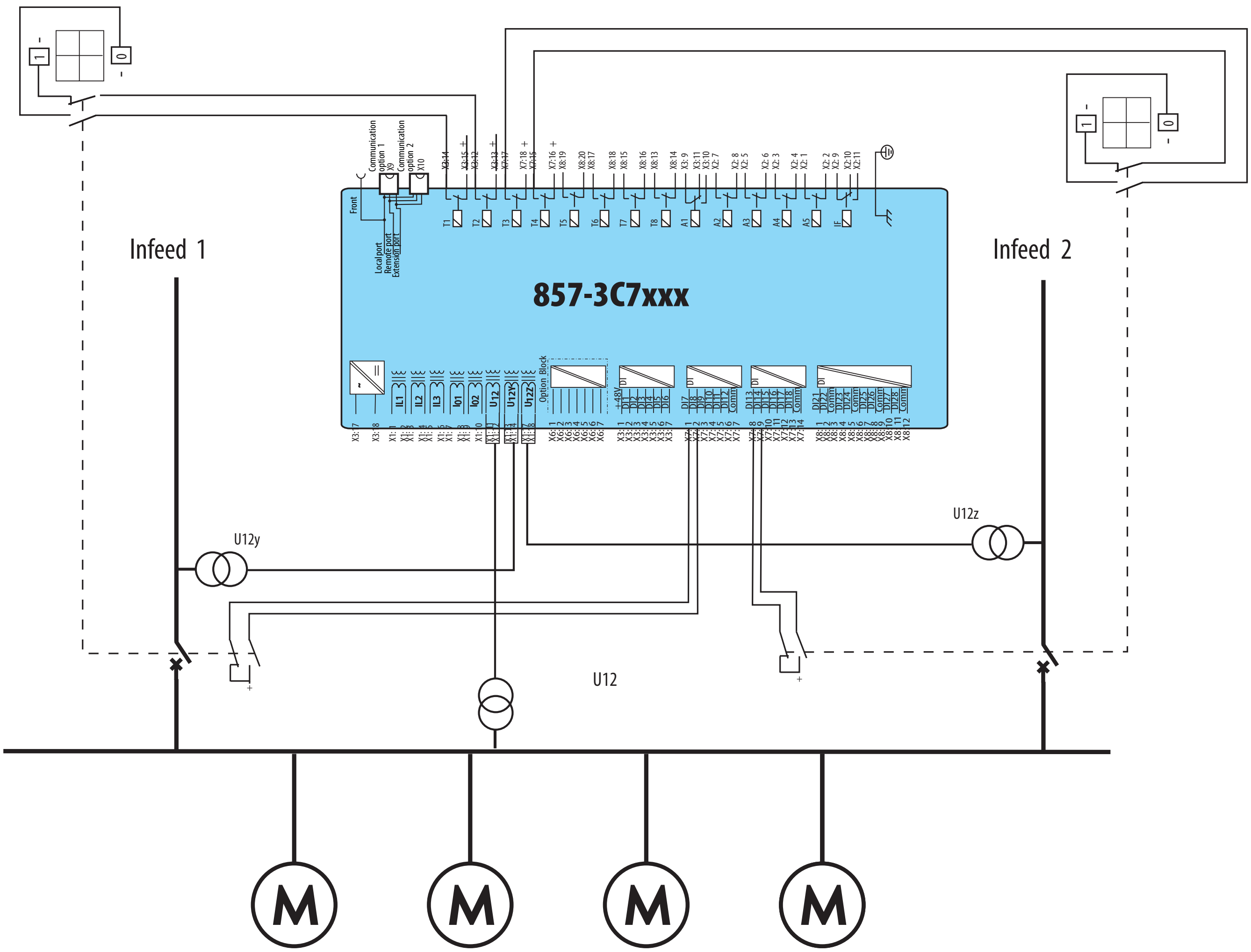


Figure 78 - Two Synchrocheck Stages Are Needed with “LL/LLy/LLz”-mode



Magnetizing Inrush Second Harmonic O/C Stage I_{f2}>(68F2)

This stage is used to block other stages. The ratio between the second harmonic component and the fundamental frequency component is measured on all phase currents. When the ratio in any phase exceeds the setting value, the stage gives a start signal. After a settable delay, the stage gives a trip signal.

The start and trip signals can be used for blocking the other stages. The trip delay is irrelevant if only the start signal is used for blocking. The trip delay of the stages to be blocked must be more than 60 ms to make sure of a proper block.

Figure 79 - Block Diagram of the Second Harmonic Stage

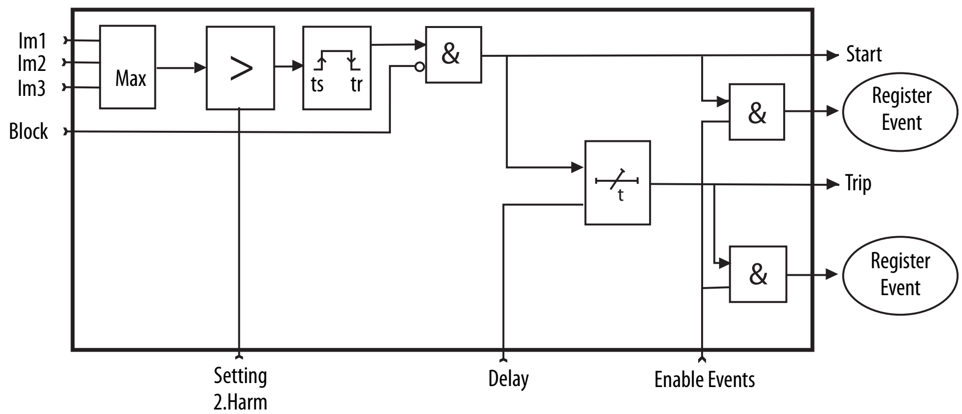


Table 50 - Setting Parameters of Second Harmonic Blocking I_{f2}> (68F2)

Parameter	Value	Unit	Default	Description
If2>	10…100	%	10	Setting value I_{f5}/Ifund
t_f2	0.03…300.0	s	2.00	Definite operating time
S_On	Enabled; Disabled	—	Enabled	Start on event
S_Off	Enabled; Disabled	—	Enabled	Start off event
T_On	Enabled; Disabled	—	Enabled	Trip on event
T_Off	Enabled; Disabled	—	Enabled	Trip off event

Table 51 - Measured and Recorded Values of Second Harmonic Blocking I_{f2}> (68F2)

	Parameter	Value	Unit	Description
Measured Values	IL1H2		%	2. Harmonic of IL1, proportional to the fundamental value of IL1
	IL2H2		%	2. Harmonic of IL2
	IL3H2		%	2. Harmonic of IL3
Recorded Values	Flt		%	The max. fault value
	EDly		%	Elapsed time as compared to the set operating time; 100% = tripping

Fifth Harmonic O/C Stage I_{f5}> (68F5)

Overexcitation of a transformer creates odd harmonics. This fifth harmonic overcurrent stage can detect overexcitation and block some other stages.

The ratio between the fifth harmonic component and the fundamental frequency component is measured on all phase currents. When the ratio in any phase exceeds the setting value, the stage gives a start signal. After a settable delay, the stage gives a trip signal.

The trip delay of the stages to be blocked must be more than 60 ms to make sure of proper block.

Table 52 - Setting Parameters of Second Harmonic Blocking I_{f5}> (68F5)

Parameter	Value	Unit	Default	Description
If5>	10…100	%	10	Setting value If2/Ifund
t_f5	0.03…300.0	s	0.03home?	Definite operating time
S_On	Enabled; Disabled	—	Enabled	Start on event
S_Off	Enabled; Disabled	—	Enabled	Start off event
T_On	Enabled; Disabled	—	Enabled	Trip on event
T_Off	Enabled; Disabled	—	Enabled	Trip off event

Circuit Breaker Failure Protection CBFP (50BF)

The (CBFP) feature is used to trip any upstream circuit breaker (CB). The trip occurs if the fault does not disappear within a given time after the initial trip command. Another output contact from the relay must be used for this backup trip.

The operation of the CBFP is based on two criteria. The supervision of the signal to the selected trip relay and the time the fault remains on after the trip command.

If this time is longer than the operating time of the CBFP stage, the CBFP stage activates another output relay. This output relay remains activated until the primary trip relay is reset.

The CBFP stage is supervising all protection stages with the same selected trip relay, since it supervises the control signal of this relay. See Output Matrix on page 234 for details about the Output Matrix and the trip relays.

Table 53 - Parameters of the Circuit Breaker Failure Stage (50BF)

Parameter	Value	Unit	Description	Note
Status	- Blocked Start Trip		Status of the stage	 F(2) F(2)
SCntr			Cumulative start counter	C(3)
TCntr			Cumulative trip counter	C(3)

Table 53 - Parameters of the Circuit Breaker Failure Stage (50BF) (Continued)

Parameter	Value	Unit	Description	Note
Force	Off On		Force flag for status forcing for test purposes. A common flag for all stages and output relays, too. Automatically reset by a 5-minute timeout.	Set(4)
CBrelay	1…14		The supervised output relay(1) Relay T1 – T14 (depending on the ordering code)	Set(4)
t>		s	Definite operation time	Set(4)

(1) This setting is also used for circuit breaker condition monitoring. See Circuit Breaker Condition Monitoring on page 183.
(2) #F = Editable when force flag is on.
(3) #C = Can be cleared to zero.
(4) #Set = An editable parameter (password required).

For details on setting ranges, see Protection Stages on page 351.

Recorded Values of the Latest Eight Faults

Detailed information is available on the eight latest faults: Time stamp and elapsed delay.

Table 54 - Recorded Values of the Circuit Breaker Failure Stage (Eight Latest Faults) CBFP (50BF)

Parameter	Value	Unit	Description
	yyyy-mm-dd		Time stamp of the recording, date
	hh:mm:ss:ms		Time stamp, time of day
EDly		%	Elapsed time of the operating time setting. 100% = trip

Programmable Stages (99)

For special applications, customized protection stages can be built by selecting the supervised signal and the comparison mode.

These parameters are available:

- **Priority:** for operation times under 1 second but greater than 60 ms, 20 ms is recommended. If operation times less than 60 ms are needed, select 10 ms. For longer operation times and THD signals, 100 ms is recommended.
- **Coupling A**: the name of the supervised signal in “>” and “<” modes (see Table 55). Also the name of the supervised signal 1 in “Diff” and “AbsDiff” modes.
- **Coupling B**: the name of the supervised signal 2 in “Diff” and “AbsDiff” modes.
- **Link:** The name of the supervised signal (see Table 55).
- **Compare Condition:** Compare mode. ‘>’ for over or ‘<’ for under comparison. “Diff” and “AbsDiff” for Coupling A and Coupling B comparison.
- **Pick-up:** Limit of the stage. The available setting range and the unit depend on the selected signal.

- **Operation Delay:** Definite time operation delay.
- **Hysteresis:** Deadband (hysteresis).
- **No Compare Limit for <:** Only used with compare mode under (‘<’) as the limit to start the comparison. Signal values under NoCmp are not regarded as fault.

Table 55 - Available Signals Supervised by the Programmable Stages

IL1, IL2, IL3	Phase currents
Io1	Residual current input $_{I01}$
Io2	Residual current input I_{02}
U12, U23, U31	Line-to-line voltages
UL1, UL2, UL3	Phase-to-ground voltages
Uo	Zero-sequence voltage
f	Frequency
P	Active power
Q	Reactive power
S	Apparent power
Cos Phi	Cosine φ
IoCalc	Phasor sum $I_{L1} + I_{L2} + I_{L3}$
I1	Positive sequence current
I2	Negative sequence current
I2/I1	Relative negative sequence current
I2/In	Negative sequence current in pu
U1	Positive sequence voltage
U2	Negative sequence voltage
U2/U1	Relative negative sequence voltage
IL	Average $(I_{L1} + I_{L2} + I_{L3})/3$
Uphase (U_{LN})	Average $(U_{L1} + U_{L2} + U_{L3})/3$
Uline (U_{LL})	Average $(U_{12} + U_{23} + U_{31})/3$
TanFii	Tangent φ [=tan(arccos φ)]
Prms	Active power rms value
Qrms	Reactive power rms value
Srms	Apparent power rms value
THDIL1	Total harmonic distortion of I_{L1}
THDIL2	Total harmonic distortion of I_{L2}
THDIL3	Total harmonic distortion of I_{L3}
THDUa	Total harmonic distortion of input U_a
THDUb	Total harmonic distortion of input U_b
THDUc	Total harmonic distortion of input U_c
fy	Frequency behind circuit breaker
fz	Frequency behind second circuit breaker
IL1rms	IL1 rms for average sampling

Table 55 - Available Signals Supervised by the Programmable Stages (Continued)

IL2rms	IL2 rms for average sampling
IL3rms	IL3 rms for average sampling
U12y	Voltage behind circuit breaker
U12z	Voltage behind second circuit breaker
ILmin, ILmax	Minimum and maximum of phase currents
ULLmin, ULLmax	Minimum and maximum of line voltages
ULNmin, ULNmax	Minimum and maximum of phase voltages

Eight Independent Stages

The Protection System has eight independent programmable stages. Each programmable stage can be enabled or disabled to fit the intended application.

Setting Groups

There are four settings groups available for each stage. Use digital inputs, virtual inputs (mimic display, communication, logic), and manual control to switch between setting groups.

There are two identical stages available with independent setting parameters.

Table 56 - Parameters of the Programmable Stages PrgN (99)

Parameter	Value	Unit	Description	Note
Status	- Blocked Start Trip		Status of the stage	 F F
SCntr			Cumulative start counter	C
TCntr			Cumulative trip counter	C
SetGrp	1…4		Active setting group	Set
SGrpDI	 - DIx VIx LEDx VOx		Digital signal to select the active setting group: None Digital input Virtual input Status indicator signal Virtual output	Set
Force	Off On		Force flag for status, forcing for test purposes. A common flag for all stages and output relays, too. Automatically reset by a 5-minute timeout.	Set
Link	(See Table •)		Name for the supervised signal	Set
	(See Table •)		Value of the supervised signal	
Cmp	 > <		Mode of comparison: Over protection Under protection	Set
Pickup			Pick up value is scaled to primary level	
Pickup		pu	Pick up setting in pu	Set

Table 56 - Parameters of the Programmable Stages PrgN (99) (Continued)

Parameter	Value	Unit	Description	Note
t		s	Definite operation time	Set
Hyster		%	Deadband setting	Set
NoCmp		pu	Minimum value to start under comparison. (Mode='<')	Set

Set = An editable parameter (password required).
C = Can be cleared to zero.
F = Editable when force flag is on.

Recorded Values of the Latest Eight Faults

Time stamp, fault value, and elapsed delay information for the eight latest faults.

Table 57 - Recorded Values of the Programmable Stages PrgN (99)

Parameter	Value	Unit	Description
	yyyy-mm-dd		Time stamp of the recording, date
	hh:mm:ss:ms		Time stamp, time of day
Flt		pu	Fault value
EDly		%	Elapsed time of the operating time setting. 100% = trip
SetGrp	1…4		Active setting group during fault

Arc Fault Protection (50ARC/ 50NARC) (Optional)

TIP This protection function needs optional hardware in slot X6. See Optional Two-channel Arc Protection Card on page 335 (Chapter 9) and Arc Fault-protection Stages (Option) on page 362 (Chapter 10).

Arc protection is for fast arc protection and elimination that is based on simultaneous light and current measurement. Special arc sensors measure the light of an arc.

Three Stages for Arc Faults

There are three separate stages for the various current inputs:

- ArcI> For phase-to-phase arc faults. Current inputs IL1, IL2, IL3 are used.
- ArcI$_{01}$> For phase-to-earth arc faults. Current input I_{01} is used.
- ArcI$_{02}$> For phase-to-earth arc faults. Current input I_{02} is used.

Light Channel Selection

The light information source to the stages can be selected from this list.

- – No sensor is selected. The stage does not work.
- S1 Light sensor S1.
- S2 Light sensor S2.
- S1/S2 One of the light sensors S1 or S2.
- BI Binary input of the arc card. 48 Vdc.
- S1/BI Light sensor S1 or the binary input.
- S2/BI Light sensor S2 or the binary input.
- S1/S2/BI Light sensor S1 or S2 or the binary input.

Binary Input

The binary input (BI) on the arc option card can be used to get the light indication from another Protection System to build selective arc protection systems. See Optional Two-channel Arc Protection Card on page 335 for more information.

The BI signal can also be connected to any of the output relays, BO, indicators, and so on, offered by the output matrix (see Output Matrix on page 234). BI is a dry input for 48-Vdc signal from binary outputs of other 857 Protection Systems or dedicated compatible arc protection devices that are supplied by Allen-Bradley®.

Binary Output

The binary output (BO) on the arc option card is used to give the light indication signal or any other signal to another Protection System binary input. The signal is used to build selective arc protection systems. See Optional Two-channel Arc Protection Card on page 335 and Optional Digital I/O Card (DI19/DI20) on page 336 (Chapter 9) for more details.

Selection of the BO connected signal is done with the output matrix (see Measurement Functions on page 213). BO is an internally wetted 48V DC signal for BI to other 857 Protection Systems or compatible dedicated arc protection devices that are supplied by Allen-Bradley®.

Delayed Light Indication Signal

The relay output matrix has a delayed light indication output signal (Delayed ArcL>) available for building selective arc protection systems. Any light source combination and a programmed delay can be configured starting from 0.01…0.15 s. The resulting signal is available in the output matrix to be connected to any BO, output relays, and so on.

Pick-up Scaling

The per unit (pu) values for pickup setting are based on the current transformer values.

- ArcI>: 1 pu = 1 x I_N = rated phase current CT value
- ArcI_{01}>: 1 pu = 1 x I_{01N} = rated residual current CT value for input I_{01}
- ArcI_{02}>: 1 pu = 1 x I_{02N} = rated residual current CT value for input I_{02}

Table 58 - Parameters of Arc Protection Stages ArcI>, ArcI$_{01}$>, ArcI$_{02}$> (50 ARC / 50N ARC)

Parameter	Value	Unit	Description	Note
Status	– Start Trip		Status of the stage Light is detected according to ArcIn Light and overcurrent is detected	 F F
LCntr			Cumulative light indications counter. S1, S2, or BI.	C
SCntr			Cumulative light indication counter for the selected inputs according to parameter ArcIn	C
TCntr			Cumulative trip counter	C
Force	Off On		Force flag for status, forcing for test purposes. A common flag for all stages and output relays, too. Automatically reset by a 5-minute timeout.	Set
 ILmax Io1 Io2			Value of the supervised signal: Stage ArcI> Stage Arc$_{I01}$> Stage Arc$_{I02}$>	
ArcI> ArcIo1> ArcIo2>		pu pu pu	Pick up setting x_{IN} Pick up setting xI_{01N} Pick up setting xI_{02N}	Set
ArcIn	 – S1 S2 S1/S2 BI S1/BI S2/BI S1/S2/BI		Light indication source selection: No sensor that is selected Sensor 1 at terminals X6:4…5 Sensor 2 at terminals X6:6…7 Terminals X6:1…3	Set

Table 58 - Parameters of Arc Protection Stages ArcI>, $ArcI_{01}$>, $ArcI_{02}$> (50 ARC / 50N ARC)

Parameter	Value	Unit	Description	Note
Delayed light signal output				
Ldly		s	Delay for delayed light output signal	Set
LdlyCn	 – S1 S2 S1/S2 BI S1/BI S2/BI S1/S2/BI		Light indication source selection: No sensor that is selected Sensor 1 at terminals X6:4…5 Sensor 2 at terminals X6:6…7 Terminals X6:1…3	Set

For details on setting ranges, see Protection Stages on page 351.
Set = An editable parameter (password required).
C = Can be cleared to zero.
F = Editable when force flag is on.

Recorded Values of the Latest Eight Faults

Detailed information is available on the eight latest faults: Time stamp, fault type, fault value, load current before the fault and elapsed delay.

Table 59 - Recorded Values of the Arc Protection Stages ArcI>, $ArcI_{01}$>, $ArcI_{02}$> (50 ARC / 50N ARC)

Parameter	Value	Unit	Description
	yyyy-mm-dd		Time stamp of the recording, date
	hh:mm:ss:ms		Time stamp, time of day
Type		pu	Fault type value. Only for ArcI> stage.
Flt		pu	Fault value
Load		pu	Pre fault current. Only for ArcI> stage.
EDly		%	Elapsed time of the operating time setting. 100% = trip

Inverse Time Operation

The inverse-time operation, inverse delay minimum-time (IDMT), is available for several protection functions. The common principle, formula, and graphic representations of the available inverse delay types are described in this section.

Inverse delay means that the operation time depends on the measured real-time process values during a fault. For example, with an overcurrent stage that uses inverse delay a bigger fault current gives faster operation. The alternative to inverse delay is definite delay. With definite delay, a preset time is used and the operation time does not depend on the size of a fault.

Stage Specific Inverse Delay

Some protection functions have their own specific type of inverse delay. Details of these dedicated inverse delays are described with the protection function.

Operation Modes

There are three operation modes to use the inverse time characteristics.

Standards delays	Use standard delay characteristics by selecting a curve family (IEC, IEEE, IEEE2, RI) and a delay type (Normal Inverse, Very Inverse, and so on).
Standard delay formula with free parameters	Select a curve family (IEC, IEEE, IEEE2) and define your own parameters for the selected delay formula. This mode is activated by setting delay type to 'Parameters', and change the delay function parameters from A to E. See Free Parameter Settings with IEC, IEEE, and IEEE2 Equations on page 167.
Fully programmable inverse delay characteristics	Build the characteristics by setting 16 [current, time] points. The Protection System interpolates the values between given points with second degree polynomials. This mode is activated by setting curve family to "PrgN". There are a maximum of three different programmable curves available simultaneously. Each programmed curve is used by any number of protection stages. See Programmable Inverse-time Curves on page 168.

Local Panel Graph

The Protection System shows a graph of the currently used inverse delay on the local panel display. Up and down keys can be used for zooming. Also the delays at $20xI_{SET}$, $4xI_{SET}$, and $2xI_{SET}$ are shown.

Inverse Time Setting Error Signal

If there are any errors in the inverse delay configuration, the protection stage uses DT delay.

There is a signal "Setting Error" available in output matrix, which indicates three different situations:

- Settings are currently changed with SetPointPS or the local panel and there is temporarily an illegal combination of curve/delay/points. For example, if curve family settings are IEC/NI and then changed to IEEE. The setting error is active, because there is no NI type available for IEEE curves. After changing the valid delay type for IEEE mode (for example MI), the "Setting Error" signal will release.

- There are errors in formula parameters A to E, and the device cannot build the delay curve.

- There are errors in the programmable curve configuration and the device cannot interpolate values between the given points.

Limitation

The maximum measured phase current is $50xI_N$ and the maximum directly measured earth-fault current is $5xI_{0N}$. The full scope of inverse delay curves goes up to 20 times the setting. At high setting, the maximum measurement capability limits the scope of inverse curves according to Table 60.

Table 60 - Maximum Secondary Current

Current Input	Maximum Measured Secondary Current	Maximum Secondary Scaled Setting Enabling Inverse-delay Times up to Full 20x Setting
I_{L1}, I_{L2}, I_{L3}, and I_{0Calc}	250 A	12.5 A
I_{0N} = 5 A (1)	50 A	2.5 A
I_{0N} = 1 A (1)	10 A	0.5 A
I_{0N} = 0.2 A(1)	2 A	0.1 A

(1) The available I_{0N} values depend on the order code. The Allen-Bradley® 857-3C6*XXX* has 1A and 5 A I_0 inputs while the Allen-Bradley® 857-3D6*XXX* has 0.2 A and 1 A I_0 inputs.

Example 1 of Limitations:

Application mode is Feeder.

CT = 750/5.
CT_0= 100/1 (cable CT is used for residual current).

The cable CT is connected to the 1 A terminal of the available I_0 inputs.

For overcurrent stage I>, Table 60 gives 12.5 A. The maximum setting for I> stage that gives full inverse-delay range is 12.5 A / 5 A = 2.5 x I_N = 1875 $A_{Primary}$.

For earth-fault stage I_0>, Table 60 gives 0.5 A. The maximum setting for I_0> stage that gives full inverse-delay range is 0.5 A / 1 A = 0.5 x I_{0N} = 50 $A_{Primary}$.

Example 2 of Limitations:

Application mode is Motor.

CT = 750/5.

Rated current of the motor = 600 A.

I_{0Calc} (= I_{L1} +I_{L2} +I_{L3}) is used for residual current.

At the secondary level, the rated motor current is 600 / 750 ∗ 5 = 4 A.

For overcurrent stage I>, Table 60 gives 12.5 A. The maximum setting that gives full inverse delay range, is 12.5 A / 4 A = 3.13 xI_{MOT} = 1875 $A_{Primary}$.

For earth-fault stage I_0>, Table 60 gives 12.5 A. Thus the maximum setting for I_0> the stage that gives the full inverse delay range is 12.5 A / 5 A = 2.5 xI_{0N} = 1875 $A_{Primary}$.

Standard Inverse Delays IEC, IEEE, IEEE2, RI

The available standard inverse delays are divided in four categories IEC, IEEE, IEEE2, and RI called delay curve families. Each category of family contains a set of different delay types according to Table 61.

Inverse -time Setting Error Signal

The inverse-time setting error signal is activated, if the delay category is changed and the old delay type does not exist in the new category. See Table 61 for more details.

Limitations

The minimum, DT delay start is the latest when the measured value is 20 times the setting. There are limitations at high setting values due to the measurement range. See Table 61 for more details.

Table 61 - Available Standard Delay Families and Types

Delay Type		Curve Family				
		DT	IEC	IEEE	IEEE2	RI
DT	Definite time	X				
NI1	Normal inverse		X		X	
VI	Very inverse		X	X	X	
EI	Extremely inverse		X	X	X	
LTI	Long time inverse		X	X		
LTEI	Long time extremely inverse			X		
LTVI	Long time very inverse			X		
MI	Moderately inverse			X	X	
STI	Short time inverse			X		
STEI	Short time extremely inverse			X		
RI	Old ASEA type					X
RXIDG	Old ASEA type					X

IEC Inverse-time Operation

The operation time depends on the measured value and other parameters according to Equation 3.4 . This equation can only be used to draw graphs or when the measured value I is constant during the fault. A modified version is implemented in the Protection System for real-time usage.

Equation 3.4

$$t = \frac{kA}{\left(\frac{I}{I_{pickup}}\right)^B - 1}$$

t	=	Operation delay in seconds.
k	=	User multiplier.
I	=	Measured value.
I_{pickup}	=	User pickup setting.
A, B	=	Constants parameters according to Table 62.

There are three different delay types of according to IEC 60255-3, Normal Inverse (NI), Extremely Inverse (EI), Very Inverse (VI), and a VI extension. Additionally there is a Long Time Inverse (LTI).

Table 62 - Constants for IEC Inverse Delay Equation

Delay Type		Parameter	
		A	B
NI	Normal inverse	0.14	0.02
EI	Extremely inverse	80	2
VI	Very inverse	13.5	1
LTI	Long time inverse	120	1

Example for Delay Type "Normal Inverse (NI)":

k	=	0.50
I	=	4 pu (constant current)
I_{pickup}	=	2 pu
A	=	0.14
B	=	0.02

$$t = \frac{0.50 \bullet 0.14}{\left(\frac{4}{2}\right)^{0.02} - 1} = 5.0$$

The operation time in this example is 5 seconds. The same result can be read from Figure 80.

Figure 80 - IEC Normal Inverse Delay

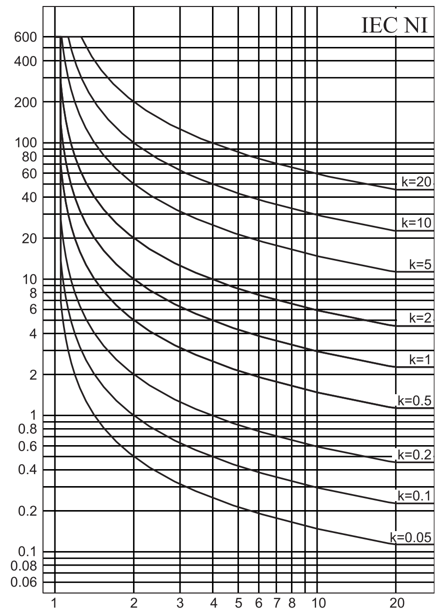


Figure 82 - IEC Extremely Inverse Delay

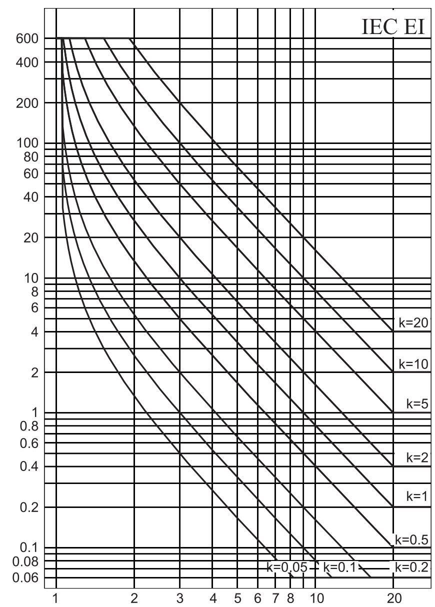


Figure 81 - IEC Very Inverse Delay

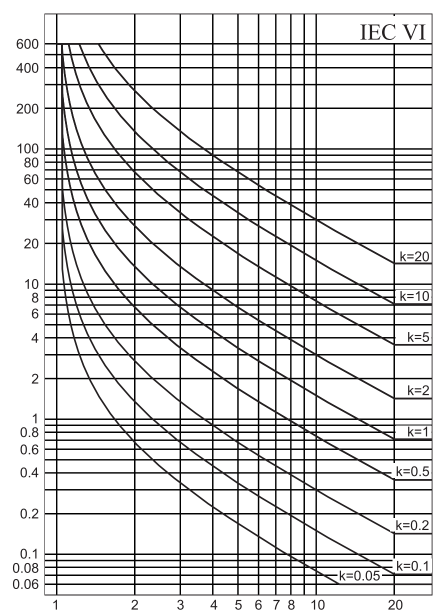
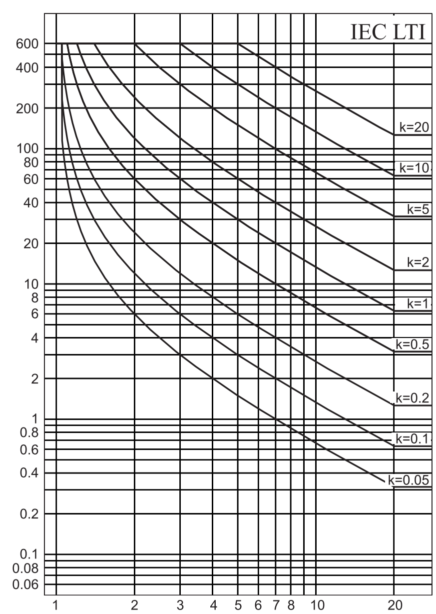


Figure 83 - IEC Long Time Inverse Delay



IEEE/ANSI Inverse-time Operation

There are three different delay types according to IEEE Std C37.112-1996 (MI, VI, EI) and many variations of these versions according to Table 63. The IEEE standard defines inverse delay for both trip and release operations. However, in the 857 Protection System, only the trip time is inverse according to the standard but the release time is constant.

The operation delay depends on the measured value and other parameters according to Equation 3.5 . This equation can only be used to draw graphs or when the measured value I is constant during the fault. A modified version is implemented in the Protection System for real-time usage.

Equation 3.5

$$t = k\left[\frac{A}{\left(\frac{I}{I_{pickup}}\right)^{C} - 1} + B\right]$$

t	=	Operation delay in seconds.
k	=	User multiplier.
I	=	Measured value.
I_{pickup}	=	User pickup setting.
A,B,C	=	Constant parameter according to Table 63.

Table 63 - Constants for IEEE/ANSI Inverse Delay Equation

Delay Type		Parameter		
		A	B	C
LTI	Long time inverse	0.086	0.185	0.02
LTVI	Long time very inverse	28.55	0.712	2
LTEI	Long time extremely inverse	64.07	0.250	2
MI	Moderately inverse	0.0515	0.1140	0.02
VI	Very inverse	19.61	0.491	2
EI	Extremely inverse	28.2	0.1217	2
STI	Short time inverse	0.16758	0.11858	0.02
STEI	Short time extremely inverse	1.281	0.005	2

Example for Delay Type "Moderately Inverse (MI)":

k	=	0.50
I	=	4 pu
I_{pickup}	=	2 pu
A	=	0.0515
B	=	0.114
C	=	0.02

$$t = 0.50\left[\frac{0.0515}{\left(\frac{4}{2}\right)^{0.02} - 1} + 0.1140\right] = 1.9$$

The operation time in this example is 1.9 seconds. The same result can be read from Figure 90.

Figure 84 - ANSI/IEEE Very Inverse Delay

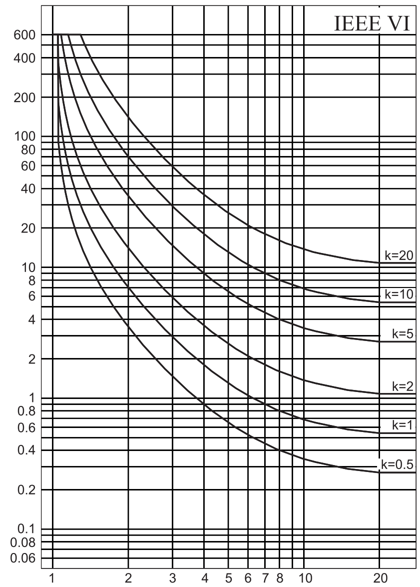


Figure 85 - ANSI/IEEE Extremely Inverse Delay

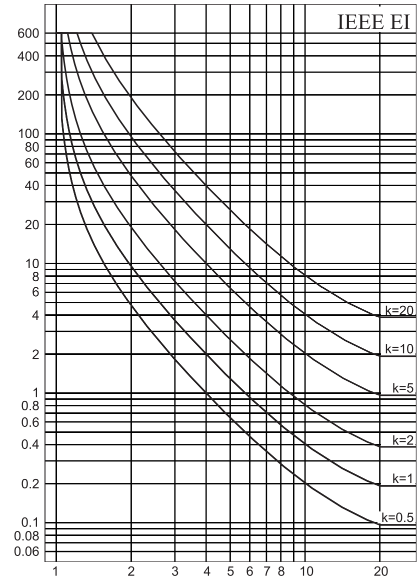


Figure 86 - ANSI/IEEE Long Time Inverse Delay

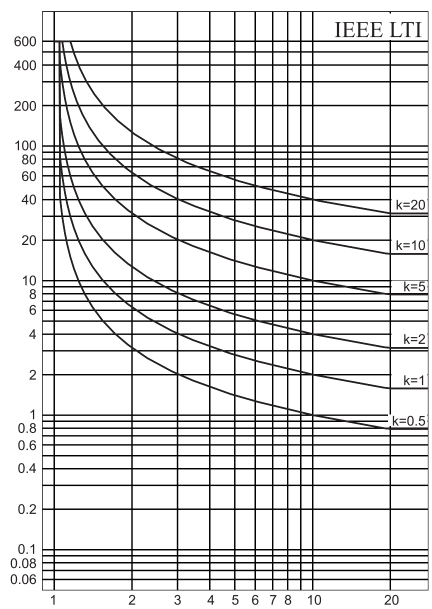


Figure 87 - ANSI/IEEE Long Time Very Inverse Delay

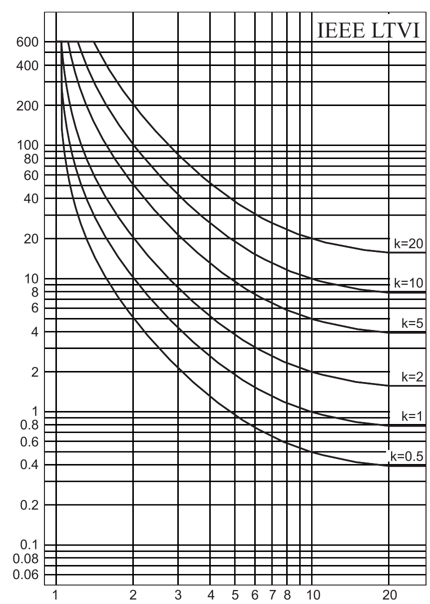


Figure 88 - ANSI/IEEE Long Time Extremely Inverse Delay

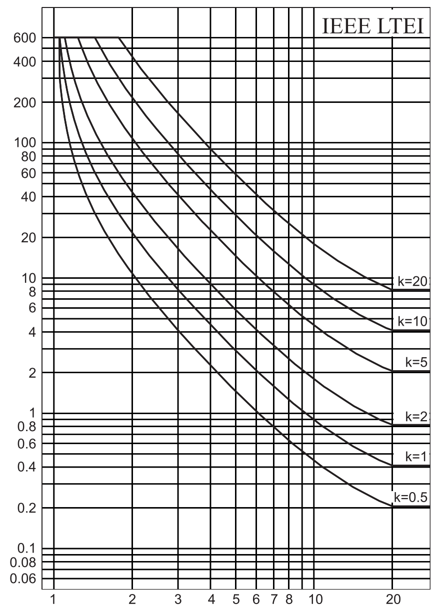


Figure 89 - ANSI/IEEE Short Time Inverse Delay

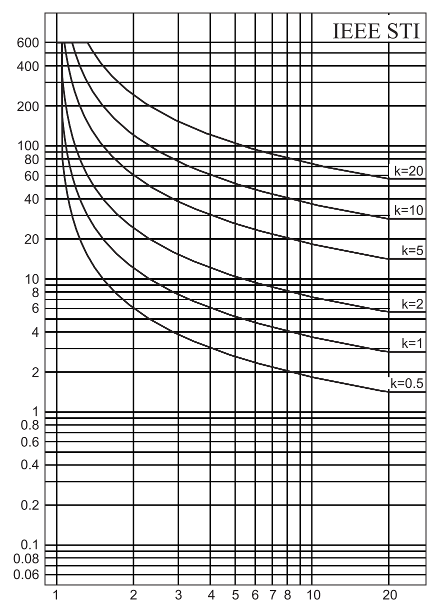


Figure 90 - ANSI/IEEE Moderately Inverse Delay

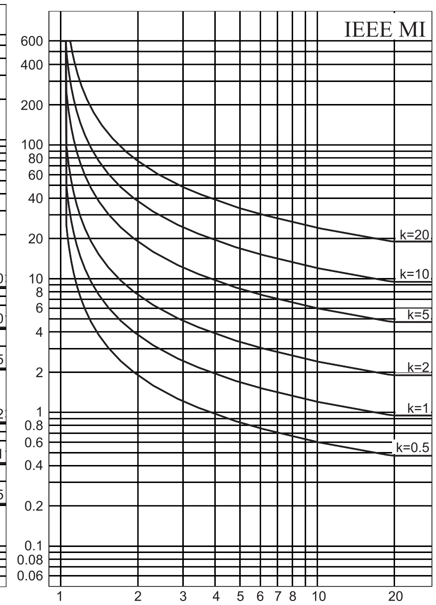
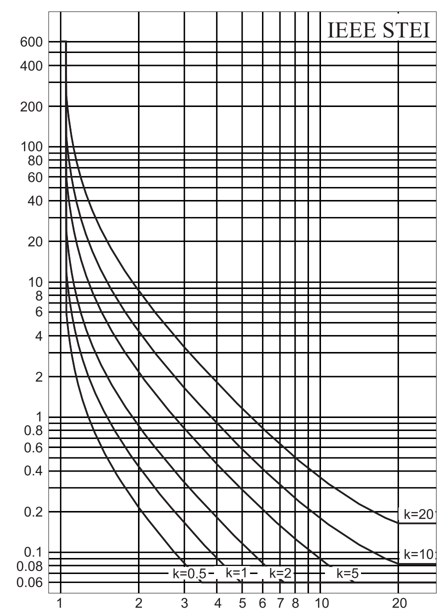


Figure 91 - ANSI/IEEE Short Time Extremely Inverse Delay



IEEE2 Inverse-time Operation

Before 1996 and the release of ANSI standard C37.112, microprocessor relays were using equations that approximated the behavior of various induction disc types of relays. An approximation that is shown in Equation 8, which in the protection system is called IEEE2. Another common name is IAC, from older General Electric IAC relays that were modeled using the same equation.

There are four different delay types according toTable 64. The older electromechanical induction disc relays have inverse delay for both trip and release operations. However, in the 857Protection System, only the trip time is inverse with the release time being constant.

The operation delay depends on the measured value and other parameters according to Equation 3.6 . This equation can only be used to draw graphs or when the measured value It is constant during the fault. A modified version is implemented in the Protection System for real-time usage.

Equation 3.6

$$t = k\left[A + \frac{B}{\left(\frac{I}{I_{pickup}} - C\right)} + \frac{D}{\left(\frac{I}{I_{pickup}} - C\right)^2} + \frac{E}{\left(\frac{I}{I_{pickup}} - C\right)^3}\right]$$

t	=	Operation delay in seconds.
k	=	User multiplier.
I	=	Measured value.
I_{pickup}	=	User pickup setting.
A,B,C,D	=	Constant parameter according to Table 64.

Table 64 - Constants for IEEE2 Inverse Delay Equation

Delay Type		Parameter				
		A	B	C	D	E
MI	Moderately inverse	0.1735	0.6791	0.8	-0.08	0.1271
NI	Normally inverse	0.0274	2.2614	0.3	-0.1899	9.1272
VI	Very inverse	0.0615	0.7989	0.34	-0.284	4.0505
EI	Extremely inverse	0.0399	0.2294	0.5	3.0094	0.7222

Example for Delay Type "Moderately Inverse (MI)":

k	=	0.50
I	=	4 pu
I_{pickup}	=	2 pu
A	=	0.1735
B	=	0.6791
C	=	0.8
D	=	-0.08
E	=	0.127

$$t = 0.5\left[0.1735 + \frac{0.6791}{\left(\frac{4}{2} - 0.8\right)} + \frac{-0.08}{\left(\frac{4}{2} - 0.8\right)^2} + \frac{0.127}{\left(\frac{4}{2} - 0.8\right)^3}\right] = 0.38$$

The operation time in this example is 0.38 seconds. The same result can be read from Figure 92.

Figure 92 - IEEE2 Moderately Inverse Delay

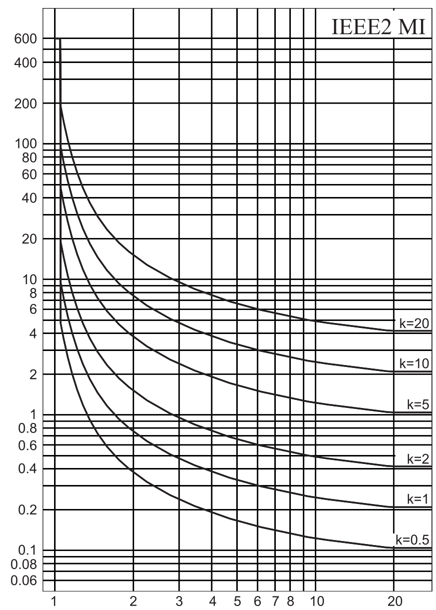


Figure 93 - IEEE2 Normal Inverse Delay

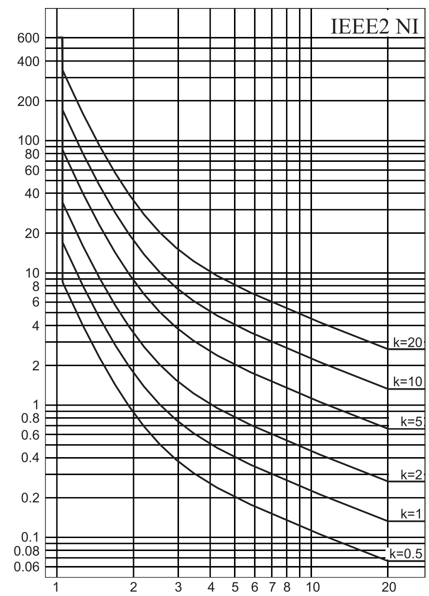


Figure 94 - IEEE2 Very Inverse Delay

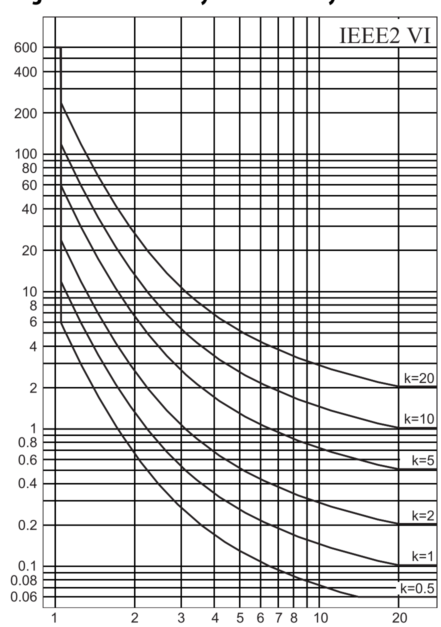
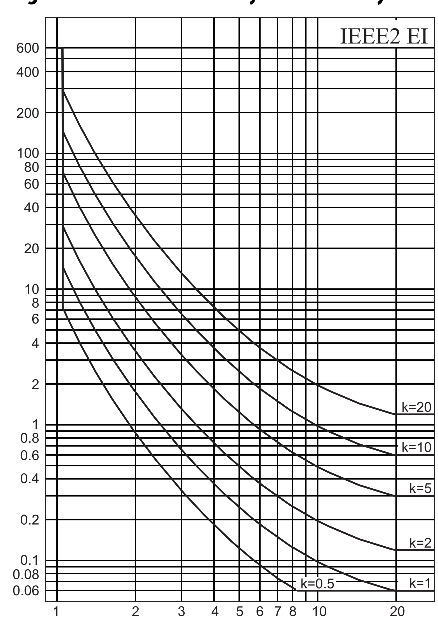


Figure 95 - IEEE2 Extremely Inverse Delay



RI and RXIDG type Inverse-time Operation

These two inverse delay types have their origin in older ASEA (now ABB) earth-fault Protection Systems.

The operation delay of types RI and RXIDG depends on the measured value and other parameters according to Equation 3.7 - RI and Equation 3.8– RXIDG . Actually these equations can only be used to draw graphs or when the measured value I is constant during the fault. Modified versions are implemented in the Protection System for real-time usage.

Equation 3.7 - RI

$$t_{RI} = \frac{k}{0.339 - \frac{0.236}{\left(\frac{I}{I_{pickup}}\right)}}$$

Equation 3.8– RXIDG

$$t_{RXIDG} = 5.8 - 1.35 1n \frac{I}{kI_{pickup}}$$

t	=	Operation delay in seconds.
k	=	The User multiplier.
I	=	Measured value.
I_{pickup}	=	The User pickup setting.

Example for Delay Type RI:

k	=	0.50
I	=	4 pu
I_{pickup}	=	2 pu

$$t_{RI} = \frac{0.5}{0.339 - \frac{0.236}{\left(\frac{4}{2}\right)}} = 2.3$$

The operation time in this example is 2.3 seconds. The same result can be read from Figure 96.

Figure 96 - Inverse Delay of Type RI

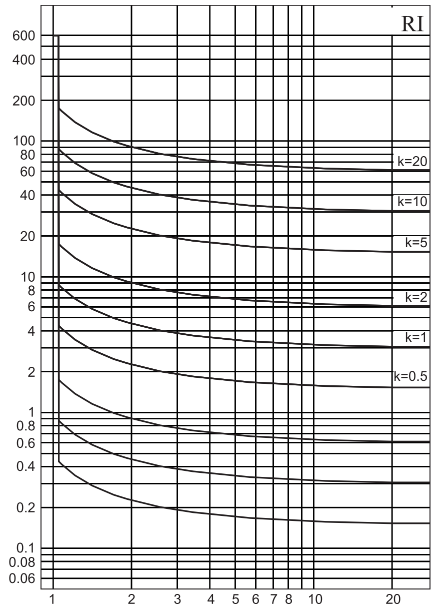
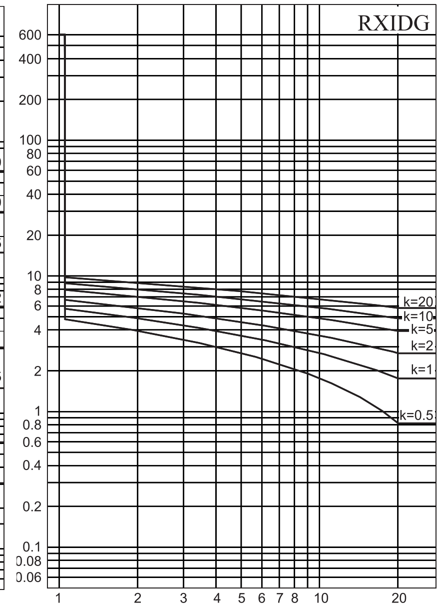


Figure 97 - Inverse Delay of Type RXIDG



Example for Delay Type RXIDG:

k = 0.50.
I = 4 pu.
I_{pickup} = 2 pu.

$$t_{RXIDG} = 5.8 - 1.35 \ln \frac{4}{0.5 \bullet 2} = 3.9$$

The operation time in this example is 3.9 seconds. The same result can be read from Figure 97.

Free Parameter Settings with IEC, IEEE, and IEEE2 Equations

This mode is activated by setting delay type to "Parameters". Edit the delay function constants, parameters A to E. Use the standard equations with constants instead of the standardized constants as in the previous chapter.

Example for GE-IAC51 Delay Type Inverse:

$k = 0.50$
$I = 4$ pu
$I_{pickup} = 2$ pu
$A = 0.2078$
$B = 0.8630$
$C = 0.8000$
$D = -0.4180$
$E = 0.1947$

$$t = 0.5\left[0.2078 + \frac{0.8630}{\left(\frac{4}{2} - 0.8\right)} + \frac{-0.4180}{\left(\frac{4}{2} - 0.8\right)^2} + \frac{0.1947}{\left(\frac{4}{2} - 0.8\right)^3}\right] = 0.37$$

The operation time in this example is 0.37 seconds. The resulting time/current characteristic of this example matches with the characteristic of the old electromechanical IAC51 induction disc relay.

Inverse-time Setting Error Signal

The inverse-time setting error signal becomes active, if interpolation with the given parameters is not possible. See Inverse Time Operation on page 154.

Limitations

The minimum, DT delay start, is when the measured value is 20 times the setting. However, there are limitations at high setting values due to the measurement range. See Inverse Time Operation on page 154 for more details.

Programmable Inverse-time Curves

The [current, time] curve points are programmed by using the SetPointPS software. The rules for defining the curve points are the following:

- The configuration must begin from the topmost line.
- The row order must be: the smallest current (longest operation time) on the top. The largest current (shortest operation time) on the bottom.
- Fill all unused rows (on the bottom) with 1.00 in the Current I/I_{pickup} cells and 0.00 in the Operational delay cells.

Table 65 is an example configuration of curve points.

Table 65 - Curve Point Configurations

Point	Current I/I_{pickup}	Operation Delay
1	1.00	10.00 s
2	2.00	6.50 s
3	5.00	4.00 s
4	10.00	3.00 s
5	20.00	2.00 s
6	40.00	1.00 s
7	1.00	0.00 s
8	1.00	0.00 s
9	1.00	0.00 s
10	1.00	0.00 s
11	1.00	0.00 s
12	1.00	0.00 s
13	1.00	0.00 s
14	1.00	0.00 s
15	1.00	0.00 s
16	1.00	0.00 s

Inverse-time Setting Error Signal

The inverse-time setting error signal is activated, if interpolation with the given points fails. See Inverse Time Operation on page 154.

Limitations

The minimum DT delay start is the latest when the measured value is 20 times the setting. However, there are limitations at high setting values due to the measurement range. See Inverse Time Operation on page 154.

86 Lockout Functionality

The 86 lockout functionality is provided for all protective elements trip and status conditions and all output devices. It can be activated through the latching functionality that is provided in the Output Matrix. When the lockout functionality for an output relay or protective or control function is activated, it must be manually or remotely reset. Determine the reason for the for lockout condition before resetting the latched or lockout condition. Do not automatically reset a lockout function without following proper safety practices.

WARNING: When any latched condition is reset, it can result in an automatic restart of the application. Extra care and a good understanding of the application are required when applying any lockout functionality to the control circuit.
To reset the lockout function, press the appropriate keys on the front panel of the 857 or initiate a remote reset command remotely through a separate communication parameter.

Notes:

Support Functions

Event Log

Event log is a buffer of event codes and time stamps, including date and time. For example, each start-on, start-off, trip-on, or trip-off of any protection stage has a unique event-number code. The code and the corresponding time stamp are called an event.

As an example of information that is included with a typical event, an overvoltage trip event of the first 59 stage U> is shown in Table 66.

Table 66 - Overvoltage Trip Event (Typical)

Event	Description	Local Panel	Available Over Communication Protocols
Code: IE2	Channel 30, event 2	Yes	Yes
I> trip on	Event text	Yes	No
2.7 x In	Fault value	Yes	No
2007-01-31	Date	Yes	Yes
08:35:13.413	Time	Yes	Yes
Type: U12,23,31	Fault type	Yes	No

Event log can also be scanned using the front panel or by using SetPointPS. With SetPointPS, the events can be stored to a file if the relay is not connected to any system. Some of the data is also available through the associated communication interface.

Only the latest event can be read when using communication protocols or SetPointPS. Every reading increments the internal read pointer to the event buffer. If a communication error occurs, the latest event can be read any number of times by using another parameter. On the local panel, the event buffer can be scanned back and forth.

Event Enabling/Masking

An uninteresting event can be masked, which keeps the particular event from being written in the event buffer.

The default setting allows for the 200 latest events in the event buffer. The oldest one is overwritten, when a new event does occur (first in, first out). The event buffer size can be modified to hold between 50…2000 events. The event buffer size can be modified using the SetPointPS software, in the ALocal Panel Conf menu. The Alarm screen can also be enabled in this same menu location within the SetPointPS program. The shown resolution of a time stamp is 1 millisecond, but the actual resolution depends on the particular function that creates the event. For example, most protection stages create events with 10 ms or 20-ms resolution. The absolute accuracy of all time stamps depends on the time synchronization of the relay. See System Clock and Synchronization on page 193.

Event Buffer Overflow

The normal procedure is to poll events from the device every time. If not done, the event buffer eventually overflows. On the local screen, overflow is indicated with string "OVF" after the event code.

Table 67 - Setting Parameters for Events

Parameter	Value	Description	Note
Count		Number of events	
ClrEn	– Clear	Clear event buffer	Set
Order	Old-New New-Old	Order of the event buffer for local display	Set
FVSca	PU Pri	Scaling of event fault value: Per unit scaling Primary scaling	Set
Display Alarms	On Off	Alarm popup display is enabled No alarm display	Set
FORMAT OF EVENTS ON THE LOCAL DISPLAY			
Code: CHENN		CH = event channel, NN = event code	
Event description		Event channel and code in plain text	
yyyy-mm-dd		Date (for available date formats. See System Clock and Synchronization on page 193)	
hh:mm:ss:ms		Time	

Disturbance Recorder

The 12 channel disturbance recorder can be used to record all measured signals. Such as, currents, voltages, and the status information of digital inputs (DI) and digital outputs (DO). The digital inputs include the arc protection signals S1, S2, BI, and BO, if the optional arc protection is available. It can be useful for troubleshooting applications and controls during commissioning or abnormal events.

Triggering the Recorder

Any start or trip signal from any protection stage, or by a digital input, triggers the recorder. The triggering signal is selected in the output matrix (vertical signal DR). The recording can also be triggered manually. All disturbance recordings have a time stamp.

Reading the Recordings

The recordings can be uploaded, viewed, and analyzed with the SetPointPS program. The disturbance recordings are in COMTRADE format. Other programs can be used to view and analyze the recordings that are made by the relay.

For more details, see publication 857-PM001.

Number of Channels

There can be a maximum of 12 recordings. The maximum selection of channels in one recording is 12 (limited in waveform recording). The digital inputs reserve one channel (includes all inputs). Also the digital outputs reserve one channel (includes all outputs). If digital inputs and outputs are recorded, there are still 10 channels that are left for analog waveforms.

Table 68 - Disturbance Recorder Waveforms

Channel	Description	Available for Waveform				
		Voltage Measurement Mode				
		2LL+Uo	3LN	1LL+Uo/LLy	2LL/LLy	LL/LLy/LLz
IL, IL2, IL3	Phase Current	Yes	Yes	Yes	Yes	Yes
Io1, Io2	Measured Residual Current	Yes	Yes	Yes	Yes	Yes
U12	Line-to-line Voltage	Yes	—	Yes	Yes	Yes
U23	Line-to-line Voltage	Yes	—	—	Yes	—
U31	Line-to-line Voltage	—	—	—	—	—
UL1, UL2, UL3	Phase-to-neutral Voltage	—	Yes	—	—	—
Uo	Zero Sequence Voltage	Yes	—	Yes	—	—
f	Frequency	—	—	—	—	—
P, Q, S	Active, reactive, apparent power	—	—	—	—	—

Table 68 - Disturbance Recorder Waveforms (Continued)

Channel	Description	Available for Waveform				
		Voltage Measurement Mode				
		2LL+Uo	3LN	1LL+Uo/LLy	2LL/LLy	LL/LLy/LLz
P.F.	Power Factor	—	—	—	—	—
CosPhi	cosφ	—	—	—	—	—
IoCalc	Phasor sum I/0 = (IL1+IL2+IL3)/3	—	—	—	—	—
I1	Positive Sequence Current	—	—	—	—	—
I2	Negative Sequence Current	—	—	—	—	—
I2/I1	Relative Current Unbalance	—	—	—	—	—
I2/Imode	Current Unbalance [xImode]	—	—	—	—	—
U1	Positive Sequence Current	—	—	—	—	—
U2	Negative Sequence Current	—	—	—	—	—
U2/U1	Relative Current Unbalance	—	—	—	—	—
IL	Average (IL1+IL2+IL3)/3	—	—	—	—	—
Uphase	Average (UL1+UL2+UL3)/3	—	—	—	—	—
Uline	Average (U12+U23+U31)/3	—	—	—	—	—
DO	Digital Outputs	Yes	Yes	Yes	Yes	Yes
DI	Digital Inputs	Yes	Yes	Yes	Yes	Yes
TanPhi	tanφ	—	—	—	—	—
THDIL1	Total Harmonic Distortion of IL1	—	—	—	—	—
THDIL2	Total Harmonic Distortion of IL2	—	—	—	—	—
THDIL3	Total Harmonic Distortion of IL3	—	—	—	—	—
THDUa	Total Harmonic Distortion of Ua	—	—	—	—	—
THDUb	Total Harmonic Distortion of Ub	—	—	—	—	—
THDUc	Total Harmonic Distortion of Uc	—	—	—	—	—
DI_2	Digital Inputs 21…32	Yes	Yes	Yes	Yes	Yes
Prms	Active Power rms value	—	—	—	—	—
Qrms	Reactive Power rms value	—	—	—	—	—
Srms	Apparent Power rms value	—	—	—	—	—
fy	Frequency behind Circuit Breaker	—	—	—	—	—
fz	Frequency behind second Circuit Breaker	—	—	—	—	—
U12y	Voltage behind Circuit Breaker	—	—	Yes	Yes	Yes
U12z	Voltage behind second Circuit Breaker	—	—	—	—	—
IL1RMS	IL1 RMS for Average Sampling	—	—	—	—	—
IL2RMS	IL2 RMS for Average Sampling	—	—	—	—	—
IL3RMS	IL3 RMS for Average Sampling	—	—	—	—	—

Table 69 - Disturbance Recorder Parameters

Parameter	Value	Unit	Description	Note
Mode	Saturated Overflow		Behavior in memory full situation: No more recordings are accepted The oldest recorder is overwritten (F1F0)	Set
SR	 32/cycle 16/cycle 8/cycle 1/10 ms 1/20 ms 1/200 ms 1/1 s 1/5 s 1/10 s 1/15 s 1/30 s 1/1 min		Sample rate: Waveform Waveform Waveform One cycle value (1) One cycle value (2) Average Average Average Average Average Average Average	Set
Time		s	The recording length	Set
PreTrig		%	Amount of recording data before the trigger moment	Set
MaxLen		s	Maximum time setting. This value depends on sample rate, number and type of the selected channels, and the configured recording length.	
Status	 – Run Trig FULL		Status of recording: Not active Waiting for a triggering Recording Memory is full in saturated mode	
ManTrig	– Trig		Manual triggering	Set
ReadyRec	n m		Available recordings = n Maximum number of recordings= m The value of "m" depends on sample rate, number and type of the selected channels, and the configured recording length.	

Table 69 - Disturbance Recorder Parameters (Continued)

Parameter	Value	Unit	Description	Note
AddCh			Add one channel. Maximum simultaneous number of channels is 12.	Set(3)
	IL1, IL2, IL3		Phase current	
	Io1, Io2		Measured residual current	
	U12, U23, U31		Line-to-line voltage	
	UL1, UL2, UL3		Phase-to-neutral voltage	
	Uo		Zero sequence voltage	
	f		Frequency	
	P, Q, S		Active, reactive, apparent power	
	P.F.		Power factor	
	CosPhi		cosφ	
	IoCalc		Phasor sum I/0 = (IL1+IL2+IL3)/3	
	I1		Positive sequence current	
	I2		Negative sequence current	
	I2/I1		Relative current unbalance	
	I2/In		Current unbalance [xIGN]	
	U1		Positive sequence voltage	
	U2		Negative sequence voltage	
	U2/U1		Relative voltage unbalance	
	IL		Average (IL1 + IL2 + IL3)/3	
	Uphase		Average (UL1 + UL2 + UL3)/3	
	Uline		Average (U12 + U23 + U31)/3	
	DO		Digital outputs	
	DI		Digital inputs	
	TanPhi		tanφ	
	THDIL1		Total harmonic distortion of IL1	
	THDIL2		Total harmonic distortion of IL2	
	THDIL3		Total harmonic distortion of IL3	
	THDUa		Total harmonic distortion of input Ua	
	THDUb		Total harmonic distortion of input Ub	
	THDUc		Total harmonic distortion of input Uc	
	DI_2		Digital inputs 21 …32	
	Prms		Active power rms value	
	Qrms		Reactive power rms value	
	Srms		Apparent power rms value	
	fy		Frequency behind circuit breaker	
	fz		Frequency behind second circuit breaker	
	U12y		Voltage behind circuit breaker	
	U12z		Voltage behind second circuit breaker	
	IL1RMS		IL1 RMS for average sampling	
	IL2RMS		IL2 RMS for average sampling	
	IL3RMS		IL3 RMS for average sampling	
ClrCh	– Clear		Remove all channels	Set(3)
(Ch)			List of selected channels	

(1) The fundamental frequency rms value of one cycle COMTRADE update is every 10 ms.
(2) The fundamental frequency rms value of one cycle I/O self-diagnostic update is every 20 ms.
(3) Set = An editable parameter (password required).

Figure 98 - Typical Disturbance Recording

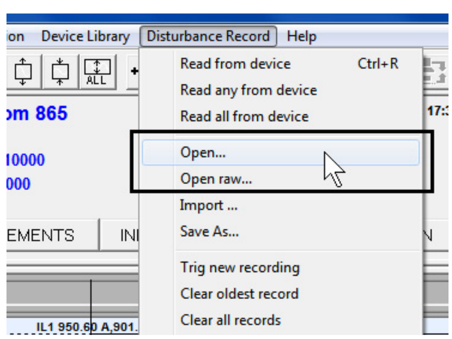
Virtual COMTRADE Files

Virtual COMTRADE files can be run with the 857 Protection Systems. Relay behavior can be analyzed by replaying the recorder data repeatedly in the relay memory.

IMPORTANT	Not applicable to the Arc Flash protection functions.

Use the SetPointPS programming tool to open the file. See SetPointPS software publication 857-PM001 for details.

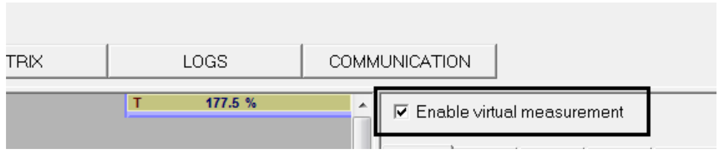
1. Connect to a relay SetPoint PS.
2. In SetPointPS, click the Disturbance Recorder Icon and select Open.



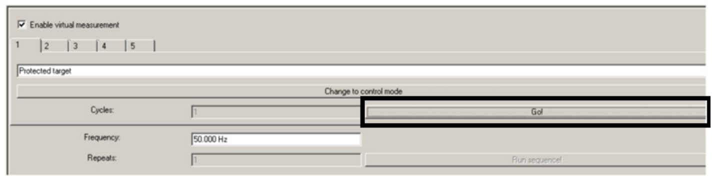
3. Select the COMTRADE file from the hard disk or other source location.

   SetPointPS is now ready to read the recording.

4. Check “Enable Virtual Measurement”.



5. Click the Refresh icon to send record data to the relay, which takes a few seconds.
6. Click the Go icon to initiate playback of the file.



The “Change to control mode” button takes you back to the virtual measurement.

TIP The sample rate of the COMTRADE file must be 32/cycle (625ϕs when 50 Hz is used). The channel names have to correspond to the channel names in the 857 Protection System: I_{L1}, I_{L2}, I_{L3}, I_{o1}, I_{o2}, U_{12}, U_{23}, U_{L1}, U_{L2}, UL3, and U_o.

Cold Load Pick-up and Inrush Current Detection

Cold Load Pick-up

The signal for cold load detection is activated for a given time when:

- The three phase currents are less than a given idle value.
- At least one of the currents exceeds a given pick-up level within 80 ms.

This signal is available for use within the output matrix and the blocking matrix. Virtual outputs of the output matrix of the group control setting can be used.

Application for Cold Load Detection

Right after closing a circuit breaker or contactor a given amount of overload can be allowed for a limited time. This overload is to take care of concurrent thermostat-controlled loads. For example, the cold load pick-up function selects a coarser setting group for overcurrent stages. It is also possible to use the signal for cold load detection to block any set of protection stages for a given time.

Inrush Current Detection

Inrush current detection is similar to the cold load detection. However, it also includes a condition for second harmonic relative content of the currents. The inrush detection signal is activated when:

- All phase currents are less than a given idle value.
- At least one-phase current exceeds a given pick-up level, within 80 ms.
- The ratio second harmonic ratio to fundamental frequency, I_{f2}/I_{f1}, of at least one phase exceeds the given setting.

This signal is available for both the output and the blocking matrix. Use of virtual outputs of the output matrix for the setting group control is possible.

By setting the Pickupf2 parameter for I_{f2}/I_{f1} to zero, the inrush signal behaves equally with the cold load pick-up signal.

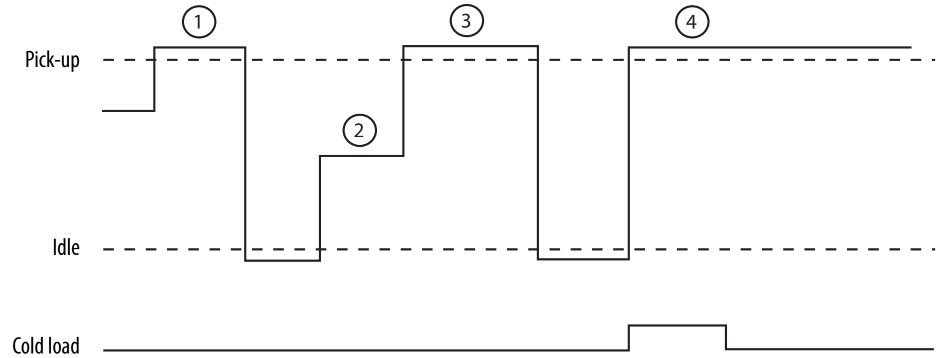
IMPORTANT	Inrush detection is based on an FFT calculation, which requires a full cycle of data for analyzing the harmonic content.

Application for Inrush Current Detection

The inrush current of transformers usually exceeds the pick-up setting of sensitive overcurrent stages and contains many even harmonics. After closing a circuit breaker or contactor, the pick-up and trip of sensitive overcurrent stages can be avoided by selecting a coarser setting group for the overcurrent stage with inrush detect signal. It is also possible to use the detection signal to block any set of protection stages for a given time.

IMPORTANT	Inrush detection is based on FFT (Fast Fourier Transform) calculation, which requires full cycle of data for analyzing the harmonic content. When using the inrush blocking function, the cold load pick-up starting conditions are used for activating the inrush blocking when the current rise is noticed. If the second harmonic component is found in the signal after the 1st cycle, the blocking is continued. Otherwise the 2nd harmonic based blocking signal is released. Inrush blocking is recommended in time delayed overcurrent stages, while non-blocked instant overcurrent stage is set to 20% higher than expected inrush current. By using this scheme, fast reaction time (in short circuit faults during the energization) can be achieved while the inrush function blocks the time delayed stages.

Figure 99 - Functionality of Cold Load and Inrush Current Feature



1. No activation because the current has not been under the set I_{dle} current.
2. Current dropped under the I_{dle} current level but now it stays between the Idle current and the pick-up current for over 80 ms.
3. No activation because the phase two lasted longer than 80 ms.
4. A cold load activation exists, which lasts as long as the operation time was set. Or as long as the current stays above the pick-up setting.

Table 70 - Parameters of the Cold Load and Inrush Detection Function

Parameter	Value	Unit	Description	Note
ColdLd	- Start Trip		Status of cold load detection: Cold load situation is active Timeout	
Inrush	- Start Trip		Status of inrush detection: Inrush is detected Timeout	
ILmax		A	The supervised value. Max. of IL1, IL2, and IL3	
Pickup		A	Primary scaled pick-up value	
Idle		A	Primary scaled upper limit for idle current	
MaxTime		s		Set(1)
Idle		xImode	Current limit setting for idle situation	Set(1)
Pickup		xImode	Pick up setting for minimum start current	Set(1)
	80	ms	Maximum transition time for start recognition	
Pickupf2		%	Pick up value for relative amount of second harmonic, I_{f2}/I_{f1}	Set(1)

(1) Set = An editable parameter (password required).

Voltage Sags and Swells

One of the most important power quality functions are voltage sag and swell monitoring. The power quality of electrical networks and the sophisticated loads (for example computers) requires an uninterruptible supply of “clean” electricity. The 857 Protection System provides many power quality functions that can evaluate, monitor, and alarm that is based on the power quality.

The protection system provides separate logs to monitor sags and swells. The voltage log is triggered if any voltage input goes under the sag limit (U<) or exceeds the swell limit (U>). There are four registers for both sags and swells in the fault log. Each register has start time, phase information, duration, minimum, average, maximum voltage values of each sag and swells event. There is total number of sags and swells counters, and total timers for sags and swells.

The voltage power quality functions are located under the submenu “U”.

Table 71 - Setting Parameters of Sags and Swells Monitoring

Parameter	Value	Unit	Default	Description
U>	20…150	%	110	Setting value of swell limit
U<	10…120	%	90	Setting value of sag limit
Delay	0.06…1.00	s	0.06	Delay for sag and swell detection
Low voltage blocking	0...50	%	1.0	Percentage of Un (Low voltage blocking is checking the maximum of line to line voltages.)
SagOn	On Off	-	On	Sag on event
SagOff	On Off	-	On	Sag off event
SwelOn	On Off	-	On	Swell on event
SwelOf	On Off	-	On	Swell off event

Table 72 - Recorded Values of Sags and Swells Monitoring

	Parameter	Value	Unit	Description
Recorded values	Count		-	Cumulative sag counter
	Total		-	Cumulative sag-time counter
	Count		-	Cumulative swell counter
	Total		-	Cumulative swell-time counter
Sag/ swell logs 1–4	Date		-	Date of the sag/swell
	Time		-	Time stamp of the sag/swell
	Type		-	Voltage inputs that had the sag/swell
	Time		s	Duration of the sag/swell
	Min1		%Un	Minimum voltage value during the sag/swell in the input 1
	Min2		%Un	Minimum voltage value during the sag/swell in the input 2
	Min3		%Un	Minimum voltage value during the sag/swell in the input 3
	Ave1		%Un	Average voltage value during the sag/swell in the input 1
	Ave2		%Un	Average voltage value during the sag/swell in the input 2
	Ave3		%Un	Average voltage value during the sag/swell in the input 3
	Max1		%Un	Maximum voltage value during the sag/swell in the input 1
	Max2		%Un	Maximum voltage value during the sag/swell in the input 2
	Max3		%Un	Maximum voltage value during the sag/swell in the input 3

Current Transformer Supervision

The 857 Protection System can supervise the external wiring between the protection system terminals and current transformers (CT) and the CT themselves. Also is a safety function, as an open secondary on a CT can cause dangerous voltages.

The CT supervisor function measures phase currents. The function issues an alarm after the operation delay has elapsed if:

One of the three phase currents drops below I_{min}< setting, while, another phase current is exceeding the I_{max}> setting.

Table 73 - Setting Parameters of CT Supervisor: CTSV ( )

Parameter	Value	Unit	Default	Description
Imax>	0.0…10.0	xIn	2.0	Upper setting for CT supervisor
Imin<	0.0…10.0	xIn	0.2	Lower setting for CT supervisor
t>	0.02…600.0	s	0.10	Operation delay
CT on	On Off	-	On	CT supervisor on event
CT off	On Off	-	On	CT supervisor off event

Table 74 - Measured and Recorded Values of CT Supervisor: CTSV ( )

	Parameter	Value	Unit	Description
Measured value	ILmax		A	Maximum of phase currents
	ILmin		A	Minimum of phase currents
Display	Imax> Imin<		A	Setting values as primary values
Recorded Values	Date		-	Date of CT supervision alarm
	Time		-	Time of CT supervision alarm
	Imax		A	Maximum phase current
	Imin		A	Minimum phase current

Voltage Transformer Supervision

The 857 Protection System supervises the VTs and VT wiring between the relay terminals and the VTs. If there is a blown fuse in the voltage transformer circuitry, the prevented or distorted voltage measurement could issue an alarm. In some applications, protection functions that use voltage signals are blocked to avoid a spurious trip.

The VT supervisor function measures the three phase voltages and currents. The negative sequence voltage U_2 and the negative sequence current I_2 are calculated. The function issues an alarm after the operation delay has elapsed if:

- U2 exceeds the U_2> setting and simultaneously;
- I_2 is less than the I_2< setting.

Table 75 - Setting Parameters of VT Supervisor: VTSV ( )

Parameter	Value	Unit	Default	Description
U2>	0.0…200.0	%Un	34.6	Upper setting for VT supervisor
I2<	0.0…200.0	%In	100.0	Lower setting for VT supervisor
t>	0.02…600.0	s	0.10	Operation delay
VT on	On Off	-	On	VT supervisor on event
VT off	On Off	-	On	VT supervisor off event

Table 76 - Measured and Recorded Values of VT Supervisor: VTSV ( )

	Parameter	Value	Unit	Description
Measured Values	U2		%Un	Measured negative sequence voltage
	I2		%In	Measured negative sequence current
Recorded Values	Date		-	Date of VT supervision alarm
	Time		-	Time of VT supervision alarm
	U2		%Un	Recorded negative sequence voltage
	I2		%In	Recorded negative sequence current

Circuit Breaker Condition Monitoring

The 857 Protection System has a monitoring function for conditions that supervises the wearing of the circuit-breaker. The condition monitoring can give alarms for the need of CB maintenance well before the CB condition is critical.

The CB wear function measures the breaking current of each CB pole separately. The function then estimates the wearing of the CB according to the permissible cycle diagram. The breaking current is registered when the trip relay supervised by the circuit breaker failure protection (CBFP) is activated. (See Circuit Breaker Failure Protection CBFP (50BF) on page 147 and the setting parameter “CBrelay” in Table 53).

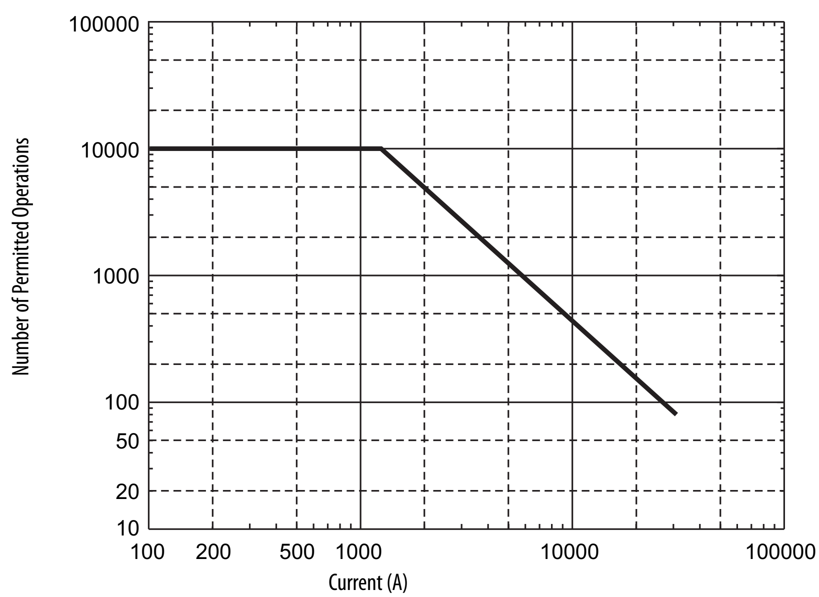
Breaker Curve and Its Approximation

The permissible cycle diagram is available in the documentation that is provided by the circuit breaker manufacturer (Figure 100). The diagram specifies the permissible number of cycles for every level of the breaking current. This diagram is parameterized to the function for condition monitoring with maximum eight [current, cycles] points. (Table 77). If fewer than eight points are needed, the unused points are set to [I_{BIG}, 1], where I_{BIG} is more than the maximum breaking capacity.

If the wearing characteristics of the CB, or part of it, is a straight line on a log/log graph. The two endpoints are enough to define that part of the characteristics. The device uses logarithmic interpolation for any current values that fall in between the given current points 2–8.

The points 4–8 are not needed for the CB in Figure 100. They are set to 100 kA and the algorithm discards one operation.

Figure 100 - Example of a Circuit Breaker Wearing Characteristic Graph



TIP The values in Table 77are taken from Figure 100. The table is edited with SETPOINTPS under menu "BREAKER CURVE".

Table 77 - Example of Circuit-breaker Wearing Characteristics in Tabular Format

Table format in SetPointPS. Example values from Figure 100.

Point	Interrupted Current (kA)	Number of Permitted Operations
1	0 (mechanical age)	10000
2	1.25 (rated current)	10000
3	31.0 (maximum breaking current)	80
4	100	1
5	100	1
6	100	1
7	100	1
8	100	1

Setting Alarm Points

There are two alarm points available, each having two setting parameters each.

- **Current**
  The first alarm can be set, for example, to nominal current of the CB or any application typical current. The second alarm can be set, for example, according to a typical fault current.

- **Operations left alarm limit**
  An alarm is activated when there are fewer operations that are left, at the defined current level, than this limit.

Any actual interrupted currents are logarithmically weighted for the two given alarm current levels. The number of operations that are left at the alarm points is decreased accordingly. When the “operations left” goes under the given alarm limit, an alarm signal is issued to the output matrix. An event is generated depending on the event enabling.

Clear “Operations Left” Counters

To clear the Operations Left counter, the breaker curve table must be filled and the alarm currents defined. The wearing function is initialized by clearing the decreasing operation counters with parameter “Clear” (Clear oper. left cntrs). After clearing, the device shows the maximum allowed operations for the defined alarm current levels.

Operation Counters to Monitor the Wearing

The operations that are left can be read from the counters “Al1Ln” (Alarm 1) and “Al2Ln” (Alarm 2). There are three values for both alarms, one for each phase. The two alarm functions supervise the smallest of the three values.

Logarithmic Interpolation

The permitted number of operations for currents in between the defined points are logarithmically interpolated using these equations:

Equation 4.1

$$C = \frac{a}{I^n}, \text{ where}$$

C	=	Permitted operations
I	=	Interrupted current
a	=	Constant according to Equation 4.2
n	=	Constant according to

Equation 4.2

$$n = \frac{\ln \frac{C_k}{C_{k+1}}}{\ln \frac{I_{k+1}}{I_k}}$$

Equation 4.3

$$a = C_k I_k^2$$

ln	=	Natural logarithm function
C_k	=	Permitted operations, k = row 2–7 in Table 77
I_k	=	The corresponding current, k = row 2–7 in Table 77
C_{k+1}	=	Permitted operations, k = row 2–7 in Table 77
I_{k+1}	=	The corresponding current, k = row 2–7 in Table 77

Example of the Logarithmic Interpolation

Alarm 2 current is set to 6 kA. What is the maximum number of operations according to Table 77.

The current 6 kA lies between points 2 and 3 in the table. That gives value for the index k. Using:

$k = 2$
$C_k = 10000$
$C_{k+1} = 80$
$I_{k+1} = 31\ \text{kA}$
$I_k = 1.25\ \text{kA}$

And the Equation 4.2 and Equation 4.3, the device calculates

$$n = \frac{\ln\frac{10000}{80}}{\ln\frac{31000}{1250}} = 1.5038$$

$$a = 10000 \bullet 1250^{1.5038} = 454 \bullet 10^6$$

Using Equation 4.1, the device gets the number of permitted operations for current 6 kA.

$$C = \frac{454 \bullet 10^6}{6000^{1.5038}} = 945$$

Thus the maximum number of current breaking at 6 kA is 945. This number can be verified with the original breaker curve in Figure 100. The figure shows that at 6 kA the operation count is between 900…1000. A useful alarm level for operation-left, could be in this case, for example, 50, being about five per cent of the maximum.

Example of Operation Counter Decrementing When the Circuit Breaker Is Breaking a Current

Alarm 2 is set to 6 kA. CBFP is supervising trip relay T1 and trip signal of an overcurrent stage detects a two-phase fault is connected to this trip relay T1. The interrupted phase currents are 12.5 kA, 12.5 kA, and 1.5 kA.

How Alarm 2 Counters Are Decremented

If the Equation 4.1 and values *n* and *a* (from the previous example) are used, the device gets the number of permitted operations at 10 kA.

$$C_{10kA} = \frac{454 \bullet 10^{6}}{12500^{1.5038}} = 313$$

At alarm level 2, 6 kA, the corresponding number of operations is calculated according to Equation 4.4.

Equation 4.4

$$\Delta = \frac{C_{AlarmMax}}{C}$$

$$\Delta_{L1} = \Delta_{L2} = \frac{945}{313} = 3$$

The decrement of Alarm 2 counters is 3 for phases L1 and L2. In phase L1, the currents are less than the alarm limit current 6 kA. For such currents, the decrement is one.

$$\Delta_{L3} = 1$$

Table 78 - Local Panel Parameters of CBWEAR Function

The breaker curve table is edited with SETPOINTPS.

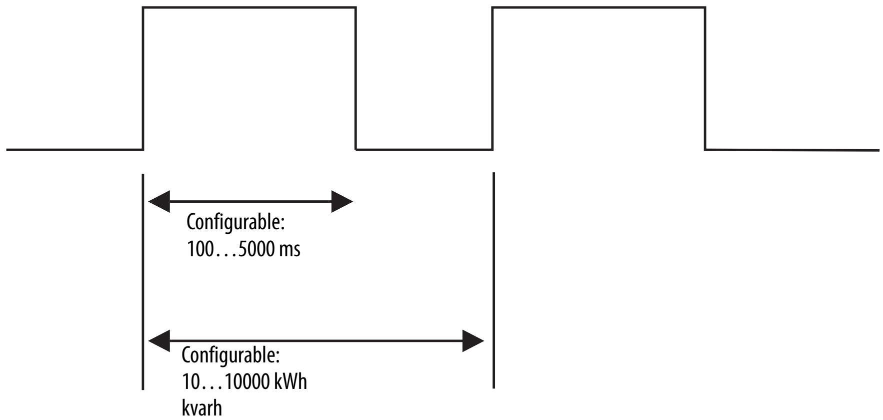
Parameter	Value	Unit	Description	Set
CBWEAR STATUS				
 Al1L1 Al1L2 Al1L3 Al2L1 Al2L2 Al2L3			Operations that are left for: - Alarm 1, phase L1 - Alarm 1, phase L2 - Alarm 1, phase L3 - Alarm 2, phase L1 - Alarm 2, phase L2 - Alarm 2, phase L3	
Latest trip				
Date Time			Time stamp of the latest trip operation	
IL1 IL2 IL3		A A A	Broken current of phase L1 Broken current of phase L2 Broken current of phase L3	
CBWEAR SET				
Alarm1				
Current	0.00…100.00	kA	Alarm1 current level	Set (1)
Cycles	100000…1		Alarm1 limit for operations left	Set (1)
Alarm2				
Current	0.00…100.00	kA	Alarm2 current level	Set (1)
Cycles	100000…1		Alarm2 limit for operations left	Set (1)
CBWEAR SET2				
Al1On	On Off		"Alarm1 on" event enabling	Set (1)
Al1Off	On Off		"Alarm1 off" event enabling	Set (1)
Al2On	On Off		"Alarm2 on" event enabling	Set (1)
Al2Off	On Off		"Alarm2 off" event enabling	Set (1)
Clear	– Clear		Clearing of cycle counters	Set (1)

(1) Set = An editable parameter (password required).

Energy Pulse Outputs

The 857 Protection System can be configured to send a pulse whenever certain amount of energy is imported or exported. The principle is presented in Figure 101. Each time the energy level reaches the pulse size, an output relay is activated. The output relay stays active as long as defined by a pulse duration setting.

Figure 101 - Principle of Energy Pulses



The device has four energy pulse outputs. The output channels are:

- Active exported energy.
- Reactive exported energy.
- Active imported energy.
- Reactive imported energy.

Each channel can be connected to any combination of the output relays with output matrix. The parameters for the energy pulses can be found in the E menu under the submenus E-PULSE SIZES and E-PULSE DURATION.

Table 79 - Energy Pulse Output Parameters

	Parameter	Value	Unit	Description
E-PULSE SIZES	E+	10…10,000	kWh	Pulse size of active exported energy
	Eq+	10…10,000	kVARh	Pulse size of reactive exported energy
	E-	10…10,000	kWh	Pulse size of active imported energy
	Eq-	10…10,000	kVARh	Pulse size of reactive imported energy
E-PULSE DURATION	E+	100…5000	ms	Pulse length of active exported energy
	Eq+	100…5000	ms	Pulse length of reactive exported energy
	E-	100…5000	ms	Pulse length of active imported energy
	Eq-	100…5000	ms	Pulse length of reactive imported energy

Scaling Examples

Example 1

Average active exported power is 250 MW.
Peak active exported power is 400 MW.
Pulse size is 250 kWh.
The average pulse frequency is 250/0.250 = 1000 pulses/h.
The peak pulse frequency is 400/0.250 = 1600 pulses/h.
Set pulse length to 3600/1600 – 0.2 = 2.0 s or less.
The lifetime of the mechanical output relay is 50 x 10^6/1000 h = 6 years.

This example is not a practical scaling example unless an output relay lifetime of about six years is accepted.

Example 2

Average active exported power is 100 MW.
Peak active exported power is 800 MW.
Pulse size is 400 kWh.
The average pulse frequency is 100/0.400 = 250 pulses/h.
The peak pulse frequency is 800/0.400 = 2000 pulses/h.
Set pulse length to 3600/2000 – 0.2 = 1.6 s or less.
The lifetime of the mechanical output relay is 50 x 10^6/250 h = 23 years.

Example 3

Average active exported power is 20 MW.
Peak active exported power is 70 MW.
Pulse size is 60 kWh.
The average pulse frequency is 25/0.060 = 416.7 pulses/h.
The peak pulse frequency is 70/0.060 = 1166.7 pulses/h.
Set pulse length to 3600/1167 – 0.2 = 2.8 s or less.
The lifetime of the mechanical output relay is 50 x10^6/417 h = 14 years.

Example 4

Average active exported power is 1900 kW.
Peak active exported power is 50 MW.
Pulse size is 10 kWh.
The average pulse frequency is 1900/10 = 190 pulses/h.
The peak pulse frequency is 50000/10 = 5000 pulses/h.
Set pulse length to 3600/5000 – 0.2 = 0.5 s or less.
The lifetime of the mechanical output relay is 50 x 10^6/190 h = 30 years.

Figure 102 - Application Example of Wiring the Energy Pulse Outputs to a PLC Having Common Plus and Using an External Wetting Voltage

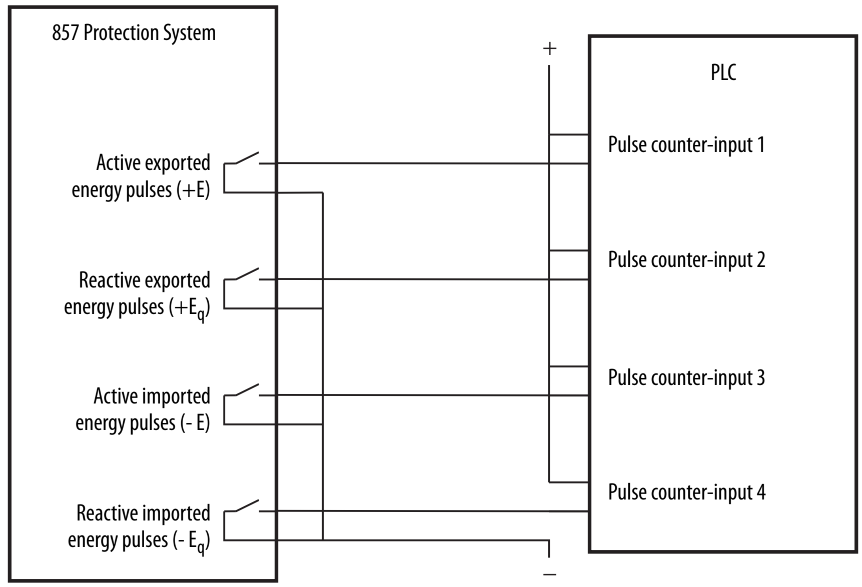


Figure 103 - Application Example of Wiring the Energy Pulse Outputs to a PLC Having Common Minus and Using an External Wetting Voltage

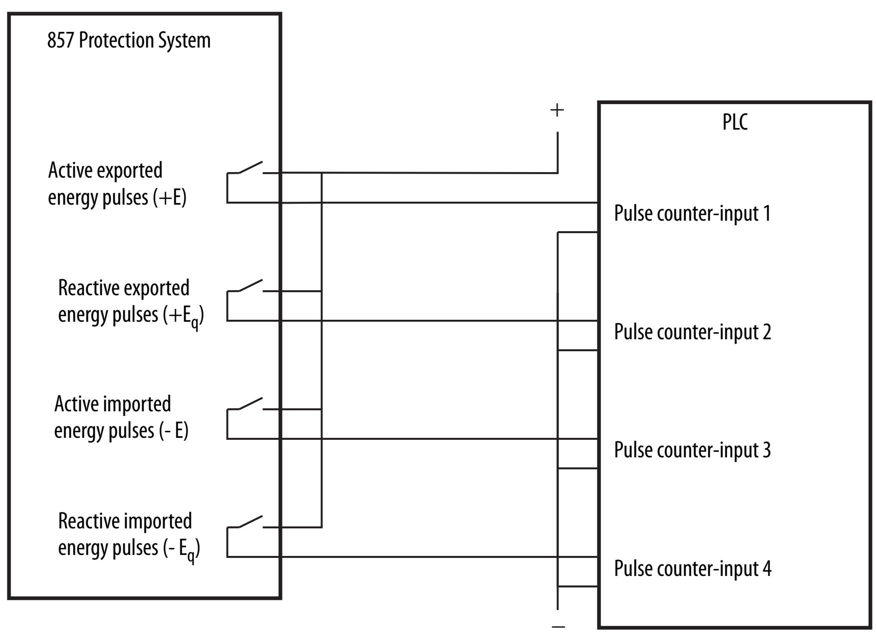
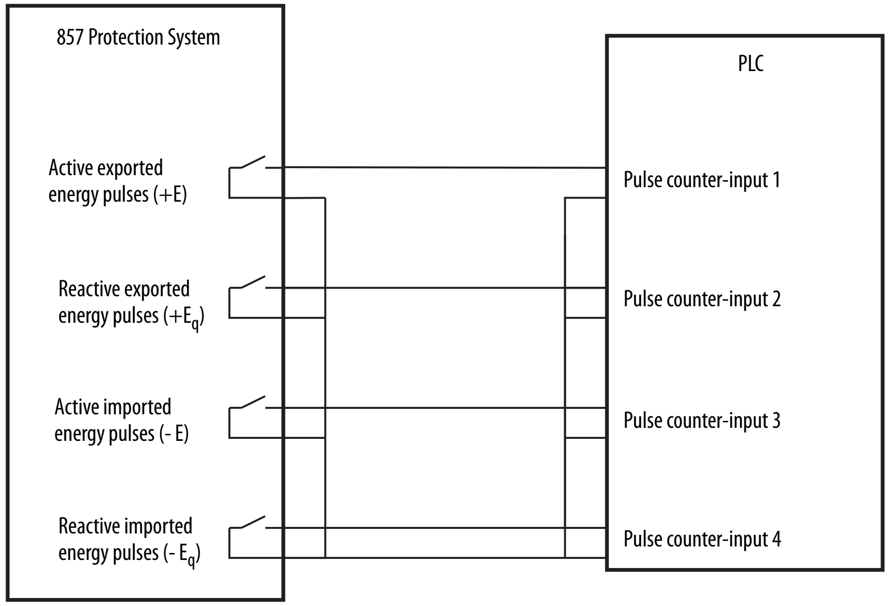


Figure 104 - Application Example of Wiring the Energy Pulse Outputs to a PLC Having Common Minus and an Internal Wetting Voltage



System Clock and Synchronization

The internal clock of the device is used to time stamp events and disturbance recordings. The system clock must be externally synchronized to get event time stamps that are comparable for all relays in the system.

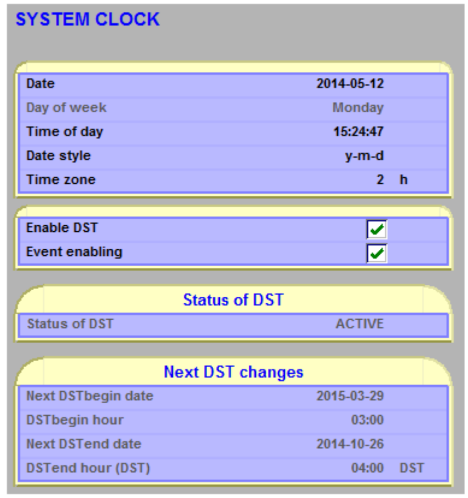
The synchronizing is based on the difference of the internal time and the synchronizing message or pulse. This deviation is filtered and the internal time is corrected softly towards a zero deviation.

Time Zone Offsets

Time zone offset (or bias) can be provided to adjust the local time for IED. The Offset can be set as a Positive (+) or Negative (-) value within a range of -15.00…+15.00 hours and a resolution of 0.01/h. Basically quarter hour resolution is enough.

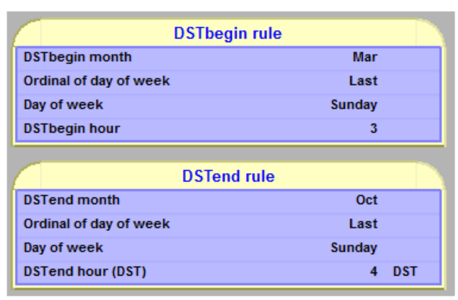
Daylight Savings Time (DST)

The 857 Protection System provides automatic DST adjustments when configured. A DST (summer time) adjustment can be configured separately with a time zone offset.



DST time standards vary widely throughout the world. Traditional daylight/summer time is configured as 1-hour positive bias. The current US/Canada DST standard, adopted in 2007 is: 1-hour positive bias, starts at 2:00 a.m. on the second Sunday in March, and ends at 2:00 a.m. on the first Sunday in November.

In the European Union, daylight change times are defined relative to the UTC time of day instead of local time of day (as in U.S.). European customers, verify your local rules for DST.



Automatic daylight time adjustments must be configured using the “Enable DST”. Do not use the time zone offset option.

Adapt Auto Adjust

During tens of hours of synchronizing, the device learns its average error and makes small corrections by itself. The target is that when the next synchronizing message is received, the deviation is near zero. Parameters “AAIntv” and “AvDrft” shows the adapted correction time interval of this ±1 ms auto-adjust function.

Time Drift Correction without External Sync

To correct the clock error, if the system clock has a steady drift and no external synchronizing source is available, edit the parameters "AAIntv" and "AvDrft". Use this equation if the previous "AAIntv" value has been zero:

$$\mathrm{AAIntv} = \frac{604.8}{\mathrm{DriftInOneWeek}}$$

If the auto-adjust interval "AAIntv" has not been zero, but further trimming is still needed. Use this equation to calculate a new auto-adjust interval:

$$\mathrm{AAIntv} = \frac{1}{\frac{1}{\mathrm{AAIntv}_{\mathrm{PREVIOUS}}} + \frac{\mathrm{DriftInOneWeek}}{604.8}}$$

The term DriftInOneWeek/604.8 can be replaced with the relative drift that is multiplied by 1000, if some other period than one week has been used. For example if the drift has been 37 seconds in 14 days, the relative drift is 37 x 1000/(14 x 24 x 3600) = 0.0306 ms/s.

Example 1

If there is no external sync and the device clock is leading 61 seconds a week and the parameter AAIntv is 0, the parameters are set as:

$$\mathrm{AvDrft} = \mathrm{Lead}$$

$$\mathrm{AAIntv} = \frac{604.8}{61} = 9.9\mathrm{s}$$

With these parameter values, the system clock corrects itself with –1 ms every 9.9 seconds, which equals –61.091 s/week.

Example 2

If external sync is unavailable, the device clock lags 5 seconds in 9 days, and the AAIntv is 9.9 s, then the parameters are set as:

$$\mathrm{AAIntv}_{\mathrm{NEW}} = \frac{1}{\frac{1}{9.9} - \frac{5000}{9(24 \bullet 3600)}} = 10.6$$

$$\mathrm{AvDrft} = \mathrm{Lead}$$

TIP When the internal time is roughly correct, deviation is less than 4 seconds, any synchronizing or auto-adjust does not turn the clock backwards. Instead, in case the clock is leading, it is softly slowed to maintain causality.

Table 80 - System Clock Parameters

Parameter	Value	Unit	Description	Note
Date			Current date	Set [4]
Time			Current time	Set[4]
Style	 y-d-m d.m.y m/d/y		Date format: Year-Month-Day Day.Month.Year Month/Day/Year	Set[4]
SyncDI	– DI1…DI6		DI not used for synchronizing Minute pulse input	[3]
TZone	–15.00…+15.00 [1]		UTC time zone for SNTP synchronization. Note: A decimal number. For example, for state of Nepal the time zone 5:45 is given as 5.75.	Set[4]
DST	No Yes		Daylight Savings Time for SNTP	Set[4]
SySrc	 Internal DI SNTP SPA-Bus ModBus Modbus TCP PROFIBUS IEC-103 IEC-101 DNP3		Clock synchronization source: No sync that is recognized since 200 s Digital input Protocol sync Protocol sync Protocol sync Protocol sync Protocol sync Protocol sync Protocol sync Protocol sync	
	IRIG-B003		IRIG timecode B003[2]	
MsgCnt	0…65535, 0… And so on		The number of received synchronization messages or pulses	
Dev	±32767	ms	Latest time deviation between the system clock and the received synchronization	
SyOS	±10000.000	s	Synchronization correction for any constant error in the synchronizing source	Set[4]
AAIntv	±10000	s	Adapted auto adjust interval for 1-ms correction	Set[4]
AvDrft	Lead Lag		Adapted average clock drift sign	Set[4]
FilDev	±125	ms	Filtered synchronization deviation	

(1) A range of -11…+12 h would cover the whole Earth. But because the International Date Line does not follow the 180° meridian, a wider range is needed.

(2) The relay is required to be equipped with a hardware option module to receive IRIG-B clock synchronization signal. See Catalog Number Explanation on page 20.

(3) Set the DI delay to its minimum and the polarity such that the leading edge is the synchronizing edge.

(4) If external synchronization is used, this parameter is set automatically. Set is an editable parameter (configurator password required).

Synchronization Using a Digital Input

The clock can be synchronized by reading minute pulses from digital inputs, virtual inputs, or virtual outputs. Sync source is selected with **SyncDI** setting. When a rising edge is detected from the selected input, system clock is adjusted to the nearest minute. The digital input pulse must be at least 50 ms. Delay of the selected digital input must be set to zero.

Synchronization Correction

If the sync source has a known offset delay, it can be compensated with **SyOS** setting. This setting is useful when compensating for hardware delays or transfer delays of communication protocols. A positive value compensates a lagging external sync and communication delays. A negative value compensates any leading offset of the external sync source.

Sync Source

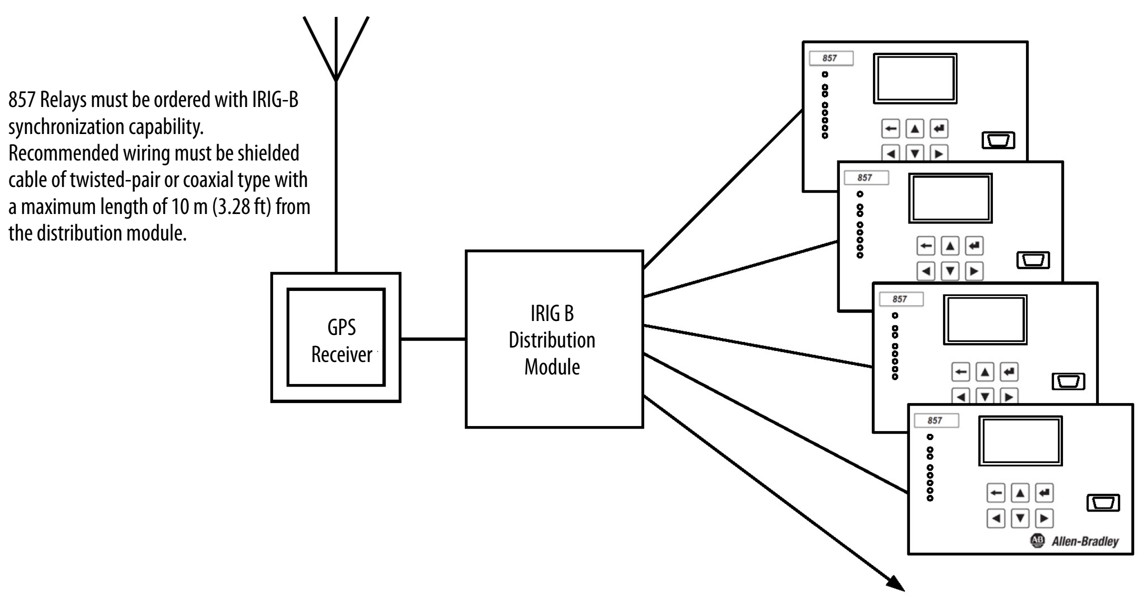
When the device receives new sync message, the sync source display is updated. If no new sync messages are received within next 1.5 minutes, the device changes to internal sync mode.

Sync Source: IRIG-B003

IRIG-B003 synchronization is supported with a dedicated communication option with a two-pole or two pins in a D9 rear connector (see Catalog Number Explanation on page 20). Special signal isolation is required. Contact Rockwell Automation® for details.

IRIG-B003 input clock signal voltage-level is TLL. The input clock signal that is originated in the GPS receiver must be taken to multiple relays through an IRIG-B distribution module. This module acts as a centralized unit for a point-to-multiple point connection.

IMPORTANT	Daisy chain connections of IRIG-B signal inputs to multiple relays must be avoided.



Deviation

The time deviation means how much the system clock time differs from sync source time. Time deviation is calculated after receiving new sync message. The filtered deviation means how much the system clock was adjusted and takes care of small errors in sync messages.

Auto-Lag/Lead

The device synchronizes to the sync source, meaning it starts automatically leading or lagging to stay in perfect sync with the master. The learning process takes few days.

The Running Hour Counter

This function calculates the total active time of the selected digital input, virtual I/O, or output matrix output-signal. The resolution is ten seconds.

Table 81 - The Running Hour Counter Parameters

Parameter	Value	Unit	Description	Note
Runh	0…876000	h	Total active time, hours Note: The label text "Runh" can be edited with SETPOINTPS.	(Set)(1)
Runs	0…3599	s	Total active time, seconds	(Set)(1)
Starts	0…65535		Activation counter	(Set)(1)
Status	Stop Run		Status of the selected digital signal	
DI	 - DI1…DI32 VI1…VI4 LedAl LedTr LedA LedB LedC LedDR VO1…VO6		Select the supervised signal: None Physical inputs Virtual inputs Output matrix out signal Al Output matrix out signal Tr Output matrix out signal LA Output matrix out signal LB Output matrix out signal LC Output matrix out signal DR Virtual outputs	Set(2)
Started at			Date and time of the last activation	
Stopped at			Date and time of the last inactivation	

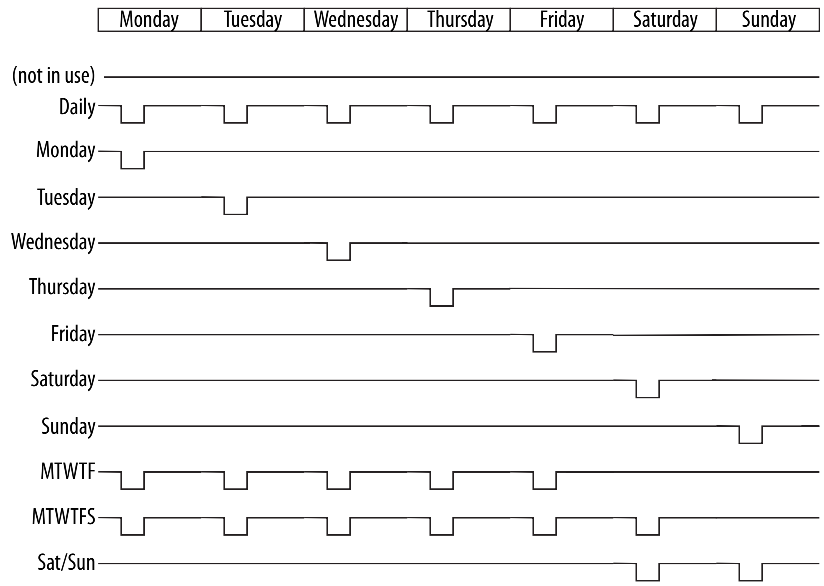
(1) (Set) = An informative value that can be edited.

(2) Set = An editable parameter (password required).

Timers

The 857 Protection System includes four settable timers. These timers can be used together with the programmable logic. Or to control setting groups and other applications that require actions that are based on calendar time. Each timer has its own independent settings. The selected on-time and off-time is set. The activation of the timer can be set as daily or according to the day of week (See the setting parameters for details). The timer outputs are available for logic functions and for the block and output matrix.

Figure 105 - Timer Output Sequence in Simultaneously Modes



Any timer that is in use on or off can be forced by writing a new status value. No forcing flag is needed, as in, for example, forcing the output relays.

The forced time is valid until the next forcing or until the next reversing timed act from the timer itself.

The status of each timer is stored in nonvolatile memory when the auxiliary power is switched off. At startup, the status of each timer is recovered.

Table 82 - Setting Parameters of Timers

Parameter	Value	Description
TimerN	 – 0 1	Timer status: Not in use Output is inactive Output is active
On	"hh: mm: ss"	Activation time of the timer
Off	"hh: mm: ss"	De-activation time of the timer
Mode		For each of the four timers there are 12 simultaneously modes available:
	–	The timer is off and not running. The output is off, 0.
	Daily	The timer switches on and off once every day.
	Monday	The timer switches on and off every Monday.
	Tuesday	The timer switches on and off every Tuesday.
	Wednesday	The timer switches on and off every Wednesday.
	Thursday	The timer switches on and off every Thursday.
	Friday	The timer switches on and off every Friday.
	Saturday	The timer switches on and off every Saturday.
	Sunday	The timer switches on and off every Sunday.
	MTWTF	The timer switches on and off every day except Saturdays and Sundays
	MTWTFS	The timer switches on and off every day except Sundays.
	SatSun	The timer switches on and off every Saturday and Sunday.

Combined Overcurrent Status

This function collects faults, fault types, and registered fault currents of all enabled overcurrent stages.

Table 83 - Line Fault Parameters

Parameter	Value	Unit	Description	Note
IFltLas		xImode	Current of the latest overcurrent fault	(Set)(3)
LINE ALARM				
AlrL1 AlrL2 AlrL3	 0 1		Start (=alarm) status for each phase: 0=No start since alarm ClrDly 1=Start is on	
OCs	 0 1		Combined overcurrent start status: AlrL1=AlrL2=AlrL3=0 AlrL1=1 orAlrL2=1 or AlrL3=1	
LxAlarm	 On Off		"On" Event enabling for AlrL1…3: Events are enabled Events are disabled	Set(4)
LxAlarmOff	 On Off		"Off" Event enabling for AlrL1…3: Events are enabled Events are disabled	Set(4)
OCAlarm	 On Off		"On" Event enabling for combined o/c starts: Events are enabled Events are disabled	Set(4)
OCAlarmOff	 On Off		"Off" Event enabling for combined o/c starts: Events are enabled Events are disabled	Set(4)
IncFltEvnt	 On Off		Disabling several start and trip events of the same fault: Several events are enabled(1) Several events of an increasing fault are disabled(2)	Set(4)
ClrDly	0…65535	s	Duration for active alarm status AlrL1, Alr2, AlrL3, and OCs	Set(4)
LINE FAULT				
FltL1 FltL2 FltL3	 0 1		Fault (=trip) status for each phase: 0=No fault since fault ClrDly 1=Fault is on	
OCt	 0 1		Combined overcurrent trip status: FltL1=FltL2=FltL3=0 FltL1=1 or FltL2=1 or FltL3=1	
LxTrip	 On Off		"On" Event enabling for FltL1…3: Events are enabled Events are disabled	Set(4)
LxTripOff	 On Off		"Off" Event enabling for FltL1…3: Events are enabled Events are disabled	Set(4)
OCTrip	 On Off		"On" Event enabling for combined o/c trips: Events are enabled Events are disabled	Set(4)

Table 83 - Line Fault Parameters (Continued)

Parameter	Value	Unit	Description	Note
OCTripOff	 On Off		"Off" Event enabling for combined o/c starts: Events are enabled Events are disabled	Set(4)
IncFltEvnt	 On Off		Disabling several events of the same fault: Several events are enabled(1) Several events of an increasing fault are disabled(2)	Set(4)
ClrDly	0…65535	s	Duration for active alarm status FltL1, Flt2, FltL3, and OCt	Set(4)

(1) Used with IEC 60870-105-103 communication protocol. The alarm screen shows the latest if it is the biggest registered fault current, too. Not used with SPA-bus, because SPA-bus masters usually do not like to have unpaired On/Off events.
(2) Used with SPA-bus protocol, because most SPA-bus masters do need an off-event for each corresponding on-event.
(3) (Set) = An informative value that can be edited.
(4) Set = An editable parameter (password required).

Self-supervision

The functions of the micro controller, the associated circuitry, and the program execution are supervised with a separate watchdog circuit. The watchdog circuit supervises the device and attempts to restart the micro controller in a fault situation. If the restart fails, the watchdog issues a self-supervision alarm to indicate a permanent internal fault.

When the watchdog circuit detects a permanent fault, it blocks any control of other output relays (except for the self-supervision output relay).

In addition, the internal supply voltages are supervised. If the auxiliary supply of the device disappears, an alarm is automatically given because the internal fault (IF) output relay functions on a working current principle. The IF relay is energized when the auxiliary supply is on and no internal fault is detected.

Diagnostics

The device runs self-diagnostic tests for hardware and software in every boot sequence and also accesses runtime checking.

Fatal Errors	If fatal error has been detected, the device releases IF relay contact and error status indicator is set on. Local panel also displays an error message about the detected fault. Fatal error state is entered when the device cannot handle protections.
Runtime Errors	When self-diagnostic function detects a fault, **Selfdiag Alarm** matrix signal is set and an event (E56) is generated. In case the error was only temporary, an off event is generated (E57). Self-diagnostic error can be reset through local panel interface.
Error Registers	There are four 16-bit error registers that are readable through remote protocols. Table 84 shows the meaning of each error register and their bits.

Table 84 - Error Registers

The error code is displayed in self-diagnostic events and on the diagnostic menu on local panel and SetPointPS.

Table 85 - Error Registers

Register	Bit	Code	Description
SelfDiag1	0 (LSB)	T1	Output relay fault
	1	T2	
	2	T3	
	3	T4	
	4	A1	
	5	A2	
	6	A3	
	7	A4	
	8	A5	
	10	T5	
	11	T6	
	12	T7	
	13	T8	
	14	T9	
SelfDiag2	0 (LSB)	T10	Output relay fault
	1	T11	
	2	T12	
	3	T13	
	4	T14	
	5	T15	
	6	T16	
	7	T17	
	8	T18	
	9	T19	
	10	T20	
	11	T21	
	12	T22	
	13	T23	
	14	T24	
SelfDiag3	0 (LSB)	DAC	mA-output fault
	1	STACK	OS: stack fault
	2	MemChk	OS: memory fault
	3	BGTask	OS: background task timeout
	4	DI	Digital input fault (DI1, DI2)
	5		
	6	Arc	Arc card fault

Table 85 - Error Registers (Continued)

Register	Bit	Code	Description
SelfDiag3	7	SecPulse	Hardware error
	8	RangeChk	Database: Setting outside range
	9	CPULoad	OS: overload
	10	+24V	Internal voltage fault
	11	-15V	
	12	ITemp	Internal temperature too high
	13	ADChk1	A/D converter error
	14	ADChk2	A/D converter error
	15 (MSB)	E2prom	E2prom error
SelfDiag4	0 (LSB)	+12V	Internal voltage fault
	1	ComBuff	BUS: buffer error

Incomer Short Circuit Fault Locator (Feeder Mode)

The 857 Protection System includes a standalone fault locator algorithm. The algorithm can locate a short circuit in radial operated networks. The fault location is given as in reactance (ohms) and kilometers. The fault value can then be exported, for example, with the event log to a Distribution Management System (DMS). The system can then localize the fault. If a DMS is not available, the distance to the fault is displayed as kilometers, and a reactance value. However, the distance value is valid only if the line reactance is set correctly.

The wire type of the line must be the same for the whole length. If there are several wire types on the same line, use the value of average line reactance to get an approximate distance value to the fault. Examples of line reactance values: Overhead wire Line A: 0.408 Ω/km and Line B: 0.378 Ω/km).

The fault locator is normally used in the incoming bay of the substation. The fault location is obtained for the whole network with just one device.

Order of Algorithmic Functions

Perform the algorithm functions in this order:

1. The measurements (phase currents and voltages) are continuously available.
2. The fault distance calculation can be triggered in two ways:
   - By opening a feeder circuit-breaker, due to a fault and sudden increase in phase currents (Enable X_{fault} $calc_1$ + triggering digital input).
   - By using only the sudden increase, in the phase currents (Enable X_{fault} $calc_1$).
3. Phase currents and voltages are registered in three stages: before the fault, during the fault and after the faulty feeder circuit-breaker was opened.
4. The fault distance quantities are calculated.
5. Two phases with the biggest fault current are selected.
6. The load currents are compensated.
7. The faulty line length reactance is calculated.

Table 86 - Setting Parameters of Incomer Short Circuit Fault Locator

Parameter	Value	Unit	Default	Description
Triggering digital input	-; DI1…DI18 VI1…VI4 VO1…VO6 NI1…NI64 POC1…POC16			Trigger mode (trigger is based on sudden increase of phase current, otherwise sudden increase of phase current + DIx/VIx).
Line reactance	0.010…10.000	Ohms/km	0.389	Line reactance of the line. Used only to convert the fault reactance to kilometers.
dItrig	10…800%	Imode	50	Trig current (sudden increase of phase current)
Blocked before next trig	10…600	s	70	Blocks function for this time after trigger. Used for the blocking calculation in autoreclose.
Xmax limit	0.5…500.0	Ohm	11.0	Limit for maximum reactance. If reactance value is above set limit, calculation results are not shown.
Event	Disabled; Enabled	—	Enabled	Event mask

Table 87 - Measured and Recorded Values of Incomer Short Circuit Fault Locator

Parameter	Value	Unit	Description
Distance		km	Distance to the fault
Xfault		ohm	Fault reactance
Date		—	Fault date
Time		—	Fault time
Time		ms	Fault time
Cntr		—	Number of faults
Pre		A	Pre-fault current (=load current)
Fault		A	Current during the fault
Post		A	Post-fault current
Udrop		% Un	Voltage dip during the fault
Durati		s	Fault duration
Type		—	Fault type (1-2,2-3,1-3,1-2-3)

Figure 106 is a representation of an application example where the fault location algorithm is used at the incomer side.

Figure 106 - Incomer SC Fault Locator, Incomer Side Algorithm

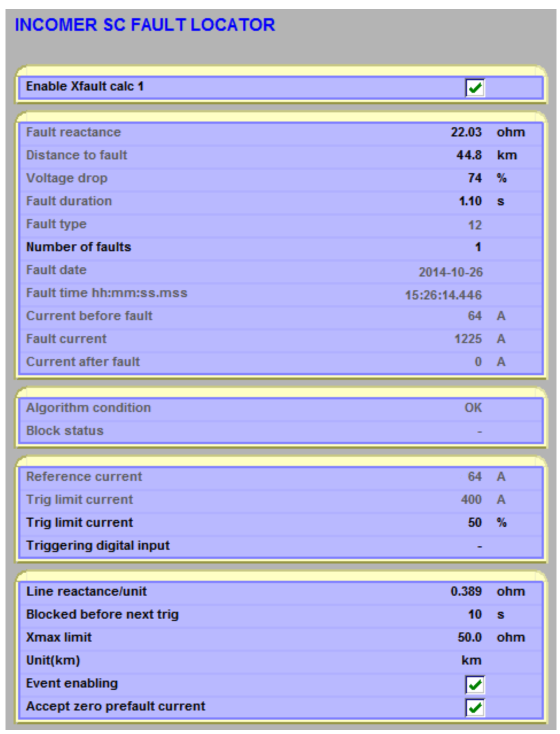


Figure 107 - Incomer Side Algorithm (Example)

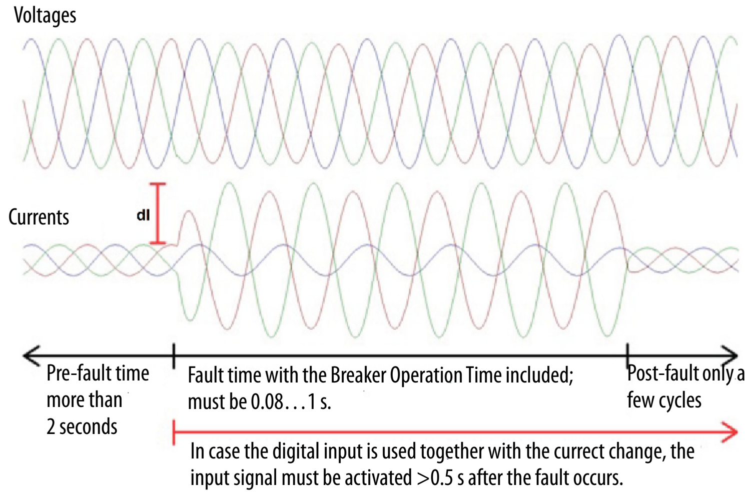
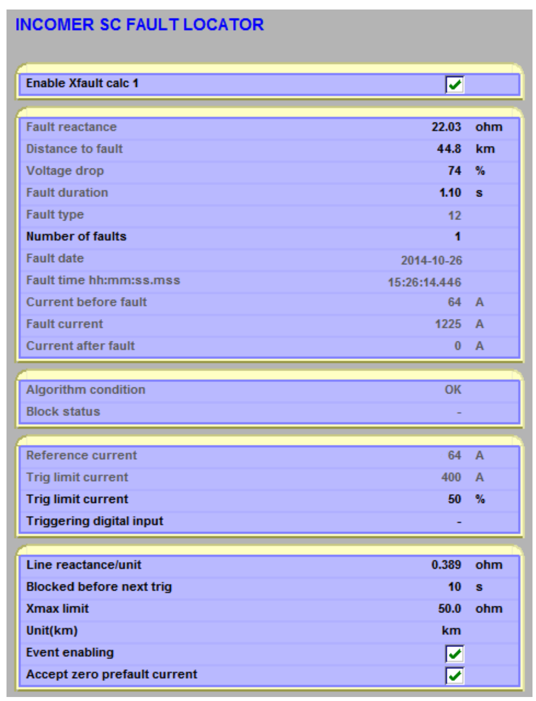


Figure 107 is an application example where the fault location algorithm is used at the feeder side.

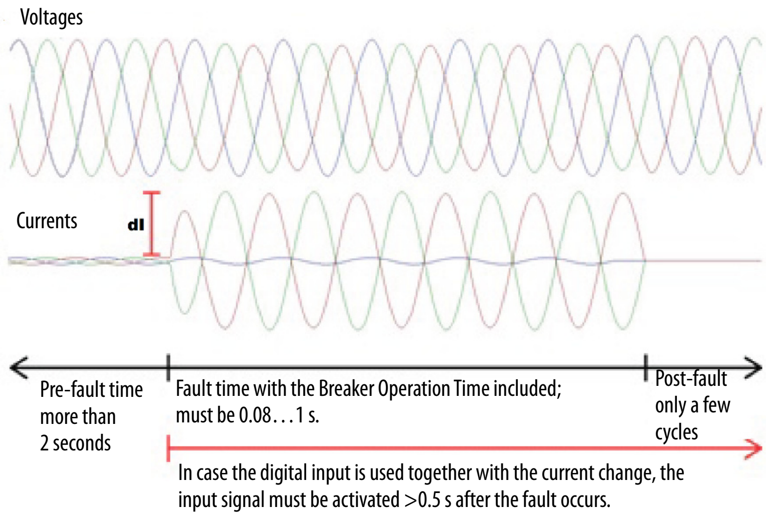
Figure 108 - Incomer SC Fault Locator, Feeder Side Algorithm



INCOMER SC FAULT LOCATOR

Enable Xfault calc 1	☑	
Fault reactance	22.03	ohm
Distance to fault	44.8	km
Voltage drop	74	%
Fault duration	1.10	s
Fault type	12	
Number of faults	1	
Fault date	2014-10-26	
Fault time hh:mm:ss.mss	15:26:14.446	
Current before fault	64	A
Fault current	1225	A
Current after fault	0	A
Algorithm condition	OK	
Block status	-	
Reference current	64	A
Trig limit current	400	A
Trig limit current	50	%
Triggering digital input	-	
Line reactance/unit	0.389	ohm
Blocked before next trig	10	s
Xmax limit	50.0	ohm
Unit(km)	km	
Event enabling	☑	
Accept zero prefault current	☑	

Figure 109 - Feeder Side Algorithm (Example)



Feeder Fault Locator

The device includes a standalone fault locator algorithm. The algorithm can locate a short circuit and earth-fault in radial operated networks. The fault location is given as in reactance (ohms) and kilometers. Fault value can then be exported, for example, with event to a Distribution Management System (DMS). The system can then localize the fault. If a DMS is not available, the distance to the fault is displayed as kilometers and a reactance value.

The distance value is valid only if the line reactance is set correctly. The wire type of the line must be the same for the whole length. If there are several wire types on the same line, use an average line reactance value to get an approximate distance value to the fault. Examples of line reactance values: Overhead wire Line A: 0.408 Ω/km and Line B: 0.378 Ω/km).

This fault locator cannot be used in incomer because this locator has not ability to compensate healthy feeders away. When feeder fault locator is calculating short circuit impedance, this formula is used:

$$Z_{AB} = \frac{\overline{U_A} - \overline{U_B}}{\overline{I_A} - \overline{I_B}}$$

- U_A = Vector between the voltage and the ground.
- U_B = Vector between the voltage and the ground.
- I_A = Vector between the current and the ground.
- I_B = Vector between the current and the ground.

When feeder fault locator is calculating ground fault impedance, this formula is used:

$$Z_A = \frac{\overline{U_A}}{\overline{I_A} + k + 3\overline{I_0}}$$

- U_A = Vector between the voltage and the ground.
- I_A = Vector between the current and the ground.
- k = Earth factor k. Set by you.
- $3I_0$ = Residual current, which is calculated from phase currents (I_0Calc).

Earth factor k is calculated with following formula:
- $K_0 = (Z_{0L}-Z_{1L}) / (3 \times Z_{1L})$.
- Z_{0L} = Zero sequence line impedance.
- Z_{1L} = Positive sequence line impedance.

The fault reactance calculation is triggered when the “Pick-up setting” value is exceeded. Or if both “Pick-up setting” and “Triggering digital input” terms are configured and fulfilled. When used, “Triggering digital input” can be digital or virtual input.

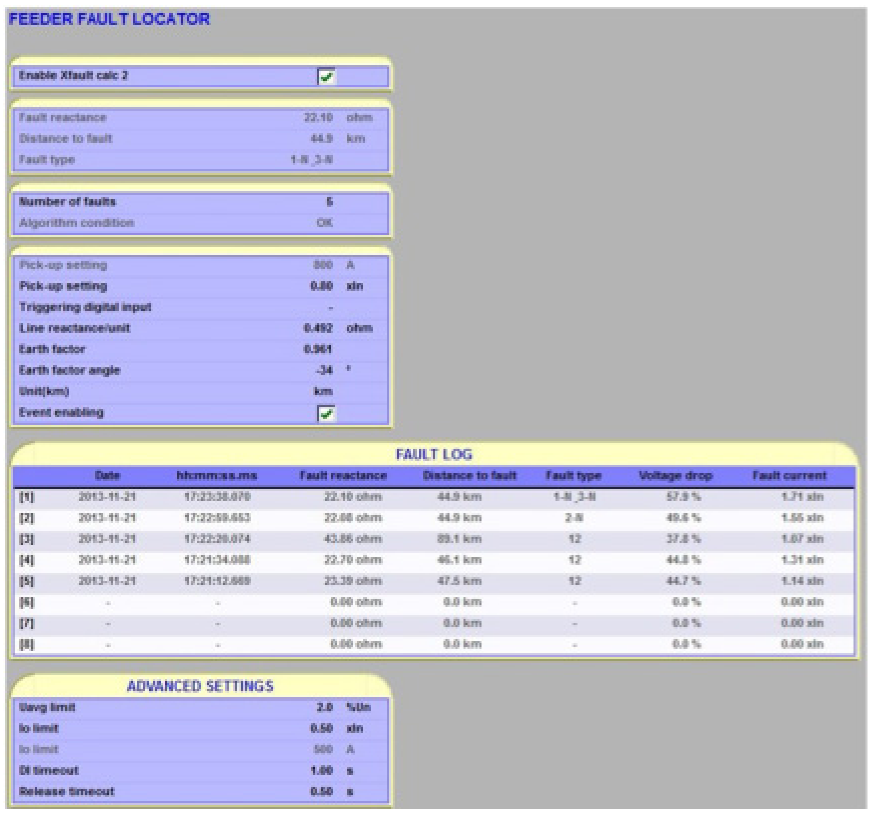
Table 88 - Setting Parameters of Feeder Fault Locator

Parameter	Value	Unit	Default	Description
Pick-up setting	0.10…5.00	xIn	1.2	Current limit for triggering.
Triggering digital input	-		—	Trigger mode (The triggering is based on sudden increase of phase current, or sudden increase of phase current + DIx/VIx/VOx/NIx/POCx).
	DI1…DI18			
	VI1…VI4			
	VO1…VO6			
	NI1…NI64			
	POC1…POC16			
Line reactance	0.010 … 10.000	Ohms/km	0.491	Line reactance of the line. Used only to convert the fault reactance to kilometers.
Earth factor	0.000…10.000	—	0.678	Calculated earth factor from line specifications.
Earth factor angle	-60…60	°	10	Angle of calculated earth factor from line specifications.
Event enabling	Off; On	—	On	Event mask.

Table 89 - Measured and Recorded Values of Feeder Fault Locator

Parameter	Value	Unit	Description
Distance		km	Distance to the fault
Xfault		ohm	Fault reactance
Date		—	Fault date
Time		—	Fault time
Cntr		—	Number of faults
Fault		A	Current during the fault
Udrop		% Un	Voltage dip during the fault
Type		—	Fault type (1-2, 2-3,1-3,1-2-3,1-N, 2-N, 3-N, 1-N-2-N, 2-N-3-N, 3-N-1-N, 1-N-2-N-3-N).

Figure 110 - Feeder Fault Locator, Fault Log, and Settings



Earth-fault Location

The 857 Protection System includes a sophisticated standalone earth-fault location algorithm that can locate an earth-fault accurately in radically operated compensated earthed networks.

The function can locate a fault only if the fault resistance is less than 50 ohms. The fault location is given in reactance value. This value can then be exported, for example, with event to a DMS (Distribution Management System). The system can then localize the fault and display it on a map.

The fault location must be used in the incoming bay of the substation. It can be obtained for the whole network with just one 857 Protection System. A cost-effective upgrade of an existing system.

IMPORTANT	**ATTENTION:** The earth-fault location function requires a change during an earth-fault. This change is done by switching the secondary resistor of the compensation coil on or off. The fault must be allowed to be on at least 200 ms, of which 100 ms without the resistor. The resistor change can be done by using the logic functionality of the Protection System.

The reactance value is converted to distance in the DMS by using this formula:

$$s = \frac{3 \bullet X}{X_0 + X_1 + X_2}, \text{ where}$$

s	=	Distance in km
X	=	Reactance. Calculated by the 857 Protection System
X_0	=	Zero sequence reactance per kilometer of the line
X_1	=	Positive sequence reactance per kilometer of the line
X_2	=	Negative sequence reactance per kilometer of the line

Algorithm Functions

1. The measurements of phase currents and voltages are continuously available.
2. The fault distance calculation can be triggered in two ways. By a digital input to switch the secondary resistor ON or OFF, or by a change in earth-fault or negative sequence current.
3. The fault phase is identified and the voltage of the faulted phase is decreased at least by half.
4. The fault distance is calculated by dividing the change of the voltage by the change of the negative sequence current.
5. Only the imaginary part is used, so then the reactance is solved.

Table 90 - Setting Parameters of Earth-fault Location: EFDi

Parameter	Value	Unit	Default	Description
EFMode	Normal Reverse	–	Normal	Normal: The resistor is switched ON during a fault. Reverse: The resistor is switched OFF during a fault
TrigIn	 Io1 Io2 DI1	–	Io	The triggering input: I/O1: earth-fault current will trig the function. I/O2: negative-phase sequence current will trig the function DI1: the function is triggered by activating the digital input 1
UoTrig	1…80	% Uon	20	Trig level for Uo
Itrig	10…800	% In	80	Trig level for current
Event	On Off	–	On	Event mask

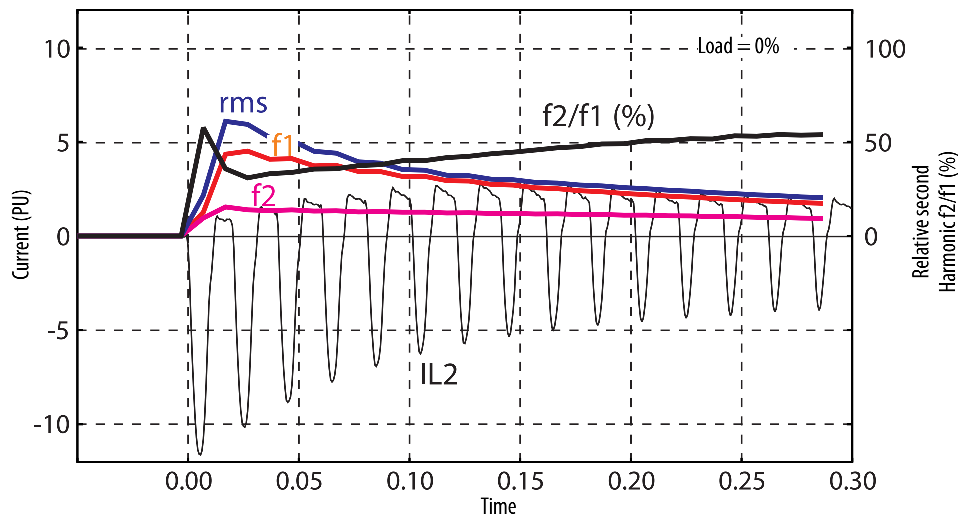
Table 91 - Measured and Recorded Values of Earth-fault Location: EFDi

	Parameter	Value	Unit	Description
Measured values/ recorded values	Fault ph			Fault phase information
	X		ohm	Fault reactance
	Date		–	Fault date
	Time		–	Fault time
	Time		ms	Fault time
	Count		–	Number of faults

Measurement Functions

All direct measurements are based on fundamental frequency values (the exceptions are frequency and instantaneous current for arc protection). Figure 111 shows a current waveform and the corresponding fundamental frequency component, second harmonic and rms value in a special case, when the current deviates significantly from a pure sine-wave.

Figure 111 - Example of Various Current Values of a Transformer Inrush Current



Measurement Accuracy

Table 92 - Phase Current Inputs I_{L1}, I_{L2}, I_{L3}

The Measuring Range		25 mA – 250 A (5 A)
Inaccuracy	I ≤ 7.5 A	0.5% of value or 15 mA
	I > 7.5 A	3% of value

The specified frequency range is 45…65 Hz.

Squelch Limit	
Phase Current Inputs	0.5% of I_{NOM} (±0.05%)
Residual Current	0.2% of I_{NOM} (±0.05%)

U_A, U_B, U_C Voltage Inputs

The use of voltage inputs depends on the configuration parameter "voltage measurement mode". For example, U_c is the zero sequence voltage input U_0 if the mode "1LL+U_0/LLy" is selected.

Table 93 - Voltage Inputs U_A, U_B, U_C

Measurement Range	0.5…175V
Inaccuracy	±0.5% or ±0.3V

The specified frequency range is 45…65 Hz.

The rated input I_n is 5 A, 1 A, or 0.2 A. It is specified in the order code of the device.

Table 94 - Residual Current Inputs I_{01}, I_{02}

Measurement Range		0…10 x I_n
Inaccuracy	I ≤ 1.5 x I_n	±0.3% of value or ±0.2% of I_n
	I > 1.5 x I_n	±3% of value

The specified frequency range is 45…65 Hz.

Table 95 - Frequency

Measurement Range	16…75 Hz
Inaccuracy	±10 MHz

Table 96 - Power Measurement P, Q, S

Inaccuracy	|PF| > 0.5	±1% of value or ±3VA_{SEC}

The specified frequency range is 45…65 Hz.

Table 97 - Power Factor

Inaccuracy	|PF| > 0.5	±0.02 unit or ±2°

The specified frequency range is 45…65 Hz.

Table 98 - Energy Counters E+, Eq+, E-, Eq-

Inaccuracy	|PF| > 0.5	±1% of value or ±3 $Wh_{secondary}$/1 h

The specified frequency range is 45…65 Hz.

Table 99 - THD and Harmonics

Inaccuracy	I, U > 0.1 PU	±2% units
Update rate		Once a second

The specified frequency range is 45…65 Hz.

RMS Values

RMS Currents

The 857 Protection System calculates the RMS value of each phase current. The minimum and the maximum of RMS values are recorded and stored (see Minimum and Maximum Values on page 216).

$$I_{rms} = \sqrt{I_{f1}^2 + I_{f2}^2 + \ldots + I_{f15}^2}$$

RMS Voltages

The 857 Protection System calculates the RMS value of each voltage input. The minimum and the maximum of RMS values are recorded and stored (see Minimum and Maximum Values on page 216).

$$U_{rms} = \sqrt{U_{f1}^2 + U_{f2}^2 + \ldots + U_{f15}^2}$$

Harmonics and Total Harmonic Distortion (THD)

The 857 Protection System calculates THDs as percentage of the base frequency for currents and voltages. The device calculates the harmonics from the second to the 15th of phase currents and voltages. The 17th harmonic component is shown partly in the value of the 15th harmonic component, due to the nature of digital-sampling. The harmonic distortion is calculated using the equation.

$$THD = \frac{\sqrt{\sum_{i=2}^{15} h_i^2}}{h_1}$$, where

h_1 = Fundamental value

$h_{2...15}$ = Harmonics

Example:

h_1 = 100 A

h_3 = 10 A

h_7 = 3 A

h_{11} = 8 A

$$THD = \frac{\sqrt{10^2 + 3^2 + 8^2}}{100} = 13.2\%$$

For reference, the RMS value is:

$$RMS = \sqrt{100^2 + 10^2 + 3^2 + 8^2} = 100.9A$$

Another way to calculate THD is to use the RMS value as reference instead of the fundamental frequency value. In the example above, the result would be 13%.

Demand Values

The device calculates an average value of the phase currents I_{L1}, I_{L2}, I_{L3}, and power values S, P, and Q. The demand time is configurable from 10...30 minutes with parameter "Demand time".

Table 100 - Demand Value Parameters

Parameter	Value	Unit	Description	Set
Time	10…30	min	Demand time (average time)	Set
Fundamental frequency values				
IL1da		A	Demand of phase current IL1	
IL2da		A	Demand of phase current IL2	
IL3da		A	Demand of phase current IL3	
Pda		kW	Demand of active power P	
PFda			Demand of power factor PF	
Qda		kVAR	Demand of reactive power Q	
Sda		kVA	Demand of apparent power S	
RMS values				
IL1da		A	Demand of phase current IL1	
IL2da		A	Demand of phase current IL2	
IL3da		A	Demand of phase current IL3	

Minimum and Maximum Values

Minimum and maximum values are registered with a time stamp (since the last manual clear or since the last device restart). The available registered minimum and maximum values are listed in this table.

Table 101 - Minimum and Maximum Values

Minimum and Maximum Measurement	Description
IL1, IL2, IL3	Phase current (fundamental frequency value)
IL1RMS, IL2RMS, IL3RMS	Phase current, rms value
Io1, Io2	Residual current
U12, U23, U31	Line-to-line voltage
Uo	Zero sequence voltage
f	Frequency
P, Q, S	Active, reactive, apparent power
IL1da, IL2da, IL3da	Demand values of phase currents
IL1da, IL2da, IL3da (rms value)	Demand values of phase currents, rms values
PFda	Power factor demand-value

The clearing parameter "ClrMax" is common for all these values.

Table 102 - Parameters

Parameter	Value	Description	Set
ClrMax	– Clear	Reset all minimum and maximum values	S

Maximum Values of the Last 31 Days and 12 Months

Some minimum and maximum values of the last 31 days and the last 12 months are stored in the nonvolatile memory of the device. The corresponding time stamps are stored for the last 31 days.

Table 103 - Registered Values

Measurement	Maximum	Minimum	Description
IL1, IL2, IL3	X		Phase current (fundamental frequency value)
Io1, Io2	X		Residual current
S	X		Apparent power
P	X	X	Active power
Q	X	X	Reactive power

The value can be a one cycle value or an average, according to the Time Base parameter.

Table 104 - Parameters of the Day and Month Registers

Parameter	Value	Description	Set
Timebase	 20 ms 200 ms 1 s 1 min Demand	Parameter to select the type of the registered values: Collect minimum and maximum of one cycle values(1) Collect minimum and maximum of 200-ms average values Collect minimum and maximum of 1-s average values Collect minimum and maximum of 1-minute average values Collect minimum and maximum of demand values (see Demand Values on page 216)	S
ResetDays		Reset the 31-day registers	S
ResetMon		Reset the 12-month registers	S

(1) Update of the fundamental frequency rms value of one cycle is every 20 ms.

Voltage Measurement Mode

The Bulletin 857 can be connected to line-to-line or phase-to-ground voltages. The connection is dependent on the application and available voltage transformers. Set the configuration parameter "Voltage measurement mode" according to the used connection. The available modes are:

Table 105 - Available Voltage Measurement Modes

Mode	Description
"2LL+U0"	The device is connected to line-to-line voltages U_{12} (X1-11 and X1-12) and U_{23} (X1-13 and X1-14). Also to zero sequence voltage U_0 (X1-17 and X1-18). The phase-to-ground voltages are calculated. The network must use only three wires. Any neutral wire must not exist (two PTs/VTs in open delta).
"3LN"	The device is connected to phase-to-ground voltages U_{L1} (X1-11 and X1-12), U_{L2} (X1-13 and X1-14), and U_{L3} (X1-17 and X1-18). The zero sequence voltage is calculated. A neutral wire can exist (three PTs/VTs "Y" connected).

Table 105 - Available Voltage Measurement Modes (Continued)

"1LL+U_0/LLy"	This mode is used with the Synchrocheck function. See Table 49 on page 142 (Chapter 3).
2LL/LLy"	This mode is used with the Synchrocheck function. See Table 49 on page 142 (Chapter 3).
""LL/LLy/LLz"	This mode is used with the Synchrocheck function. See Table 49 on page 142 (Chapter 3).

The overvoltage protection is based on the line-to-line voltage regardless of the measurement mode.

Power Calculations

The power calculations in the 857 are dependent on the voltage measurement mode (see Voltage Measurement Mode on page 217).

Line-to-Line Voltages

When the 857 is connected to line-to-line voltages, the voltage measurement mode is set to equal to "2LL+Uo". The following Aron equation is used for power calculation.

$\overline{S} = \overline{U}_{12} \bullet \overline{I}^{*}_{LI} - \overline{U}_{23} \bullet \overline{I}^{*}_{L3}$, where

$\overline{S}$ = Three-phase power phasor.

$\overline{U}_{12}$ = Measured voltage phasor that corresponds to the fundamental frequency voltage between phases L1 and L2.

$\overline{I}^{*}_{LI}$ = Complex conjugate of the measured phase L1 fundamental frequency current phasor.

$\overline{U}_{23}$ = Measured voltage phasor that corresponds to the fundamental frequency voltage between phases L2 and L3.

$\overline{I}^{*}_{L3}$ = Complex conjugate of the measured phase L3 fundamental frequency current phasor.

Apparent power, active power, and reactive power are calculated as follows:

$$S = |\overline{S}|$$

$$P = real(\overline{S})$$

$$Q = imag(\overline{S})$$

$$\cos\varphi = \frac{P}{S}$$

Line-to-Neutral Voltages

When the device is connected to line-to-neutral voltages, the voltage measurement mode is set to equal to “3LN”. The following equation is used for power calculation.

$\overline{S} = \overline{U}_{L1} \bullet \overline{I}^{*}_{L1} + \overline{U}_{L2} \bullet \overline{I}^{*}_{L2} + \overline{U}_{L3} \bullet \overline{I}^{*}_{L3}$, where

$\overline{S}$ = Three-phase power phasor

$\overline{U}_{L1}$ = Measured voltage phasor that corresponds to the fundamental frequency voltage of phase L1.

$\overline{I}^{*}_{L1}$ = Complex conjugate of the measured phase L1 fundamental frequency current phasor.

$\overline{U}_{L2}$ = Measured voltage phasor that corresponds to the fundamental frequency voltage of phase L2.

$\overline{I}^{*}_{L2}$ = Complex conjugate of the measured phase L2 fundamental frequency current phasor.

$\overline{U}_{L3}$ = Measured voltage phasor that corresponds to the fundamental frequency voltage of phase L3.

$\overline{I}^{*}_{L3}$ = Complex conjugate of the measured phase L3 fundamental frequency current phasor.

Apparent power, active power, and reactive power are calculated similarly as with line-to-line voltages by using the following equation:

$$S = \left|\overline{S}\right|$$

$$P = real(\overline{S})$$

$$Q = imag(\overline{S})$$

$$\cos\varphi = \frac{P}{S}$$

Direction of Power and Current

[Figure 112](#) shows the concept of three-phase current direction and sign of cosφ and power factor PF. [Figure 113](#) shows the same concepts, but on a PQ-power plane.

Figure 112 - Quadrants of Voltage/Current Phasor Plane

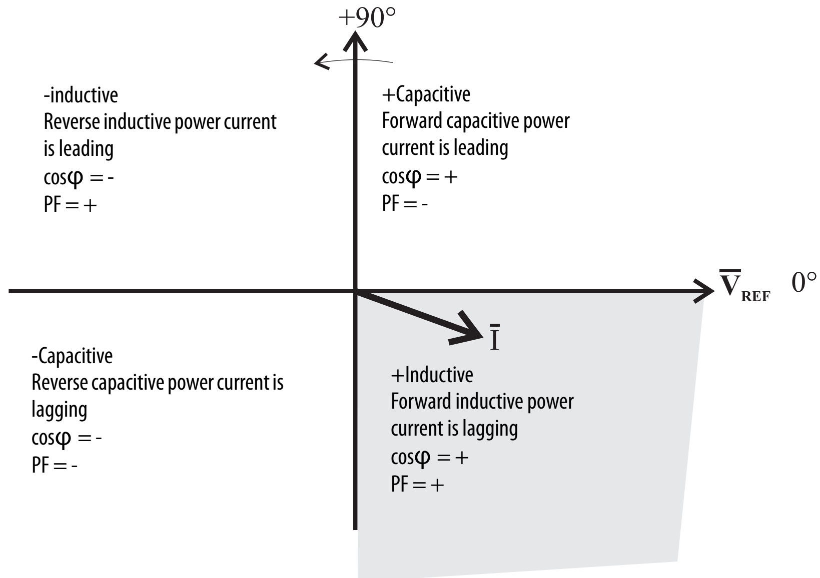


Figure 113 - Quadrants of Power Plane

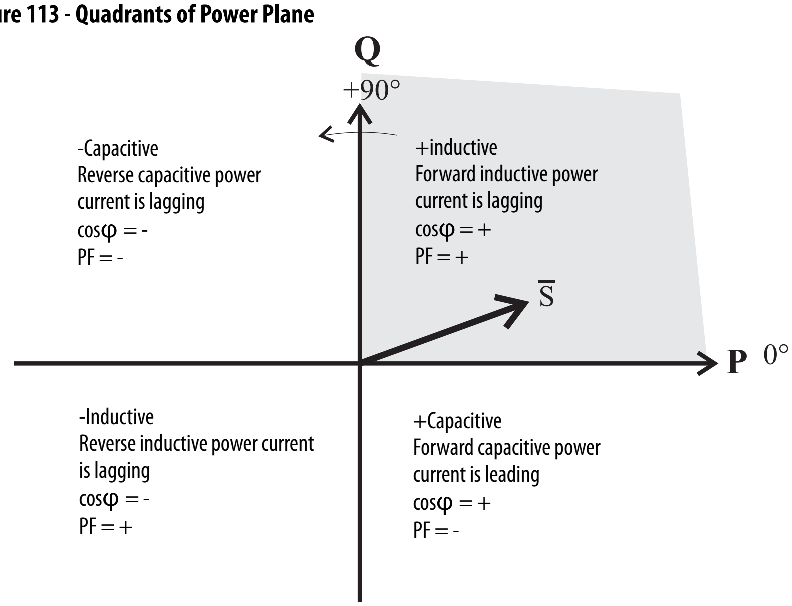


Table 106 - Table of Power Quadrants

Power Quadrant	Current Related to Voltage	Power Direction	cosφ	Power Factor PF
+ inductive	Lagging	Forward	+	+
+ capacitive	Leading	Forward	+	-
- inductive	Leading	Reverse	-	+
- capacitive	Lagging	Reverse	-	-

Symmetric Components

In a three-phase system, the voltage or current phasors can be divided in the symmetric components:

- Positive sequence 1.
- Negative sequence 2.
- Zero sequence 0.

Symmetric components are calculated according to these equations.

$$\begin{bmatrix} \underline{S}_0 \\ \underline{S}_1 \\ \underline{S}_2 \end{bmatrix} = \frac{1}{3}\begin{bmatrix} 1 & 1 & 1 \\ 1 & \underline{a} & \underline{a}^2 \\ 1 & \underline{a}^2 & \underline{a} \end{bmatrix}\begin{bmatrix} \underline{U} \\ \underline{V} \\ \underline{W} \end{bmatrix} \text{, where}$$

$\underline{S}_0$ = Zero sequence component.
$\underline{S}_1$ = Positive sequence component.
$\underline{S}_2$ = Negative sequence component.

$$\underline{a} = 1\angle 120^\circ = -\frac{1}{2} + j\frac{\sqrt{3}}{2} \text{, a phasor rotating constant}$$

$\underline{U}$ = Phasor of phase L1 (phase current or line-to-neutral voltage).
$\underline{V}$ = Phasor of phase L2.
$\underline{W}$ = Phasor of phase L3.

In case the voltage measurement mode is "2LL+Uo" (that is two line-to-line voltages are measured) this equation is used:

$$\begin{bmatrix} \underline{U}_1 \\ \underline{U}_2 \end{bmatrix} = \frac{1}{3}\begin{bmatrix} 1 & -\underline{a}^2 \\ 1 & -\underline{a} \end{bmatrix}\begin{bmatrix} \underline{U}_{12} \\ \underline{U}_{23} \end{bmatrix} \text{, where}$$

U_{12} = Voltage between phases L1 and L2.
U_{23} = Voltage between phases L2 and L3.

When using line-to-line voltages, any zero sequence voltage cannot be calculated.

TIP The zero sequence or residual measurement signals connected to the device are $-U_0$ and $3I_0$. However, usually the name "I_0" is used instead of the correct name "$3I_0$"

Example 1 – Single Phase Injection

U_N = 100V
Voltage measurement mode is “2LL+Uo”.
Injection:
U_a = U_{12}= 100V
U_b = U_{23}= 0

$$\begin{bmatrix} \underline{U}_1 \\ \underline{U}_2 \end{bmatrix} = \frac{1}{3}\begin{bmatrix} 1 & -\underline{a}^2 \\ 1 & -\underline{a} \end{bmatrix}\begin{bmatrix} 100\angle 0° \\ 0 \end{bmatrix} = \frac{1}{3}\begin{bmatrix} 100\angle 0° \\ 100\angle 0° \end{bmatrix} = \begin{bmatrix} 33 \\ 33 \end{bmatrix}$$

U_1 = 33%
U_2 = 33%
U_2/U_1 = 100%

When using a single-phase test device, the relative unbalance U_2/U_1 is 100%.

Example 2 – Two-phase Injection with Adjustable Phase Angle

U_N = 100V
Voltage measurement mode is “2LL+Uo”.
Injection:
U_a = U_{12} = 100V ∠0°
U_b = U_{23} = 100/√ 3V ∠–150° = 57.7V ∠–150°

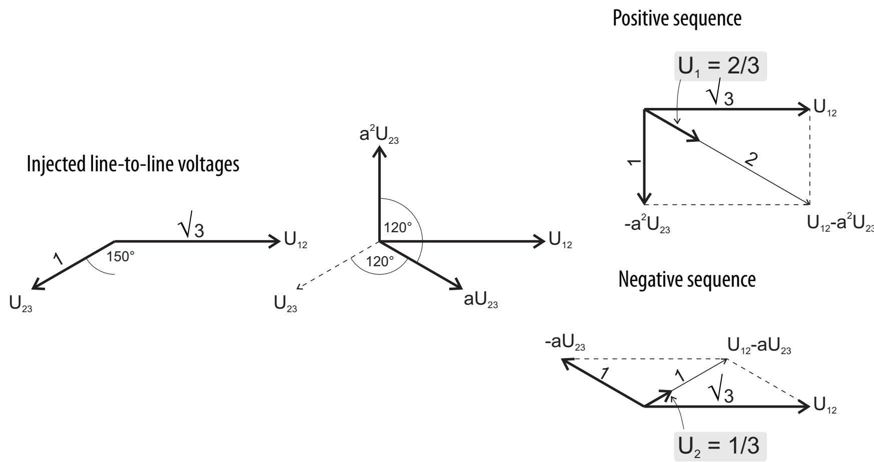
$$\begin{bmatrix} \underline{U}_1 \\ \underline{U}_2 \end{bmatrix} = \frac{1}{3}\begin{bmatrix} 1 & \underline{a}^2 \\ 1 & \underline{a}^2 \end{bmatrix}\begin{bmatrix} 100\angle 0° \\ 100/\sqrt{3}\angle -150° \end{bmatrix} = \frac{100}{3}\begin{bmatrix} 1\angle 0° - 1/\sqrt{3}\angle +90° \\ 1\angle 0° - 1/\sqrt{3}\angle -30° \end{bmatrix} =$$

$$= \frac{100}{3}\begin{bmatrix} 2/\sqrt{3}\angle -30° \\ 1/\sqrt{3}\angle +30° \end{bmatrix} = \begin{bmatrix} 38.5\angle -30° \\ 19.2\angle +30° \end{bmatrix}$$

U_1 = 38.5%
U_2 = 19.2%
U_2/U_1 = 50%

Figure 114 shows a geometric solution. The input values have been scaled with √ 3/100 to make the calculation easier.

Figure 114 - Example of Symmetric Component Calculation Using Line-to-Line Voltages



Unscaling the geometric results gives:

$U_1 = 100/\sqrt{3} \times 2/3 = 38.5\%$
$U_2 = 100/\sqrt{3} \times 1/3 = 19.2\%$
$U_2/U_1 = 1/3:2/3 = 50\%$

Example 3 – Two-phase Injection with Adjustable Phase Angle

$U_N = 100V$
Voltage measurement mode is "3LN".
Injection:
$U_a = U_{L1} = 100/\sqrt{3}V \angle 0° = 57.7V \angle 0°$
$U_b = U_{L2} = 100/\sqrt{3}V \angle -120° = 57.7V \angle -120°$
$U_c = U_{L3} = 0V$
An identical case with Example 2. The resulting line-to-line voltages $U_{12}=U_{L1} - U_{L2}=100V \angle 30°$ and $U_{23}= U_{L2} - U_{L3} =U_{L2}=100/\sqrt{3}V\angle 120°$ are the same. The only difference is a 30° phase angle difference, but without any absolute angle reference the device does not see this phase angle difference.

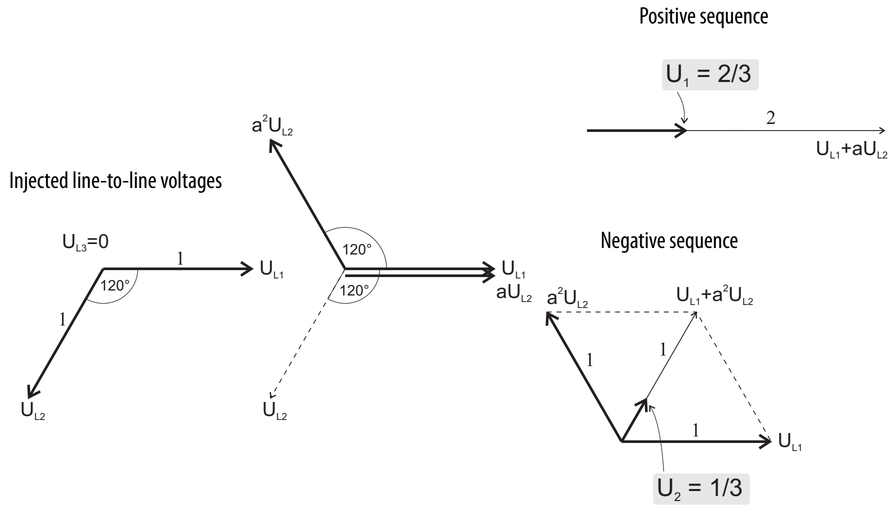
$$\begin{bmatrix} \underline{U}_0 \\ \underline{U}_1 \\ \underline{U}_2 \end{bmatrix} = \frac{1}{3}\begin{bmatrix} 1 & 1 & 1 \\ 1 & \underline{a} & \underline{a}^2 \\ 1 & \underline{a}^2 & \underline{a} \end{bmatrix}\begin{bmatrix} \frac{100}{\sqrt{3}}\angle 0° \\ \frac{100}{\sqrt{3}}\angle -120° \\ 0 \end{bmatrix} = \frac{1}{3\sqrt{3}}\begin{bmatrix} 100\angle 0° + 100\angle -120° \\ 100\angle 0° + 100\angle 0° \\ 100\angle 0° + 100\angle +120° \end{bmatrix} =$$

$$= \frac{1}{3\sqrt{3}}\begin{bmatrix} 100\angle -60° \\ 200\angle 0° \\ 100\angle 60° \end{bmatrix} = \begin{bmatrix} 19.2\angle -60° \\ 38.5\angle 0° \\ 19.2\angle +60° \end{bmatrix}$$

$U_0 = 19.2\%$
$U_1 = 38.5\%$
$U_2 = 19.2\%$
$U_2/U_1 = 50\%$

Figure 115 shows a graphical solution. The input values have been scaled with √ 3/100 to make the calculation easier.

Figure 115 - Example of Symmetric Component Calculation Using Line-to-Neutral Voltages



Unscaling the geometric results gives

U_1	=	100/√ 3 x 2/3	=	38.5%
U_2	=	100√ 3 x 1/3	=	19.2%
U_2/U_1	=	1/3:2/3	=	50%

Primary, Secondary, and Per Unit Scaling

Many measurement values are shown as primary values although the 857 is connected to secondary signals. Some measurement values are shown as relative values – per unit or percent. Almost all pick-up setting values are using relative scaling. The scaling is done using the given CT, VT in feeder mode and motor nameplate values in motor mode.

For scaling equations that are useful when doing secondary testing see:

- Current Scaling on page 225
- Per Unit [pu] Scaling of Line-to-Line Voltages on page 228
- Primary, Secondary, and Per Unit Scaling on page 224
- Voltage Scaling on page 227

Current Scaling

TIP The current input, 5 A or 1 A rated value of the device, has no effect in the scaling equations. It defines the measurement range and the Maximum allowed continuous current. See Measuring the Circuitry on page 345 for details.

Table 107 - Primary and Secondary Scaling

	Current scaling
Secondary ⇒ Primary	$I_{PRI} = I_{SEC} \bullet \frac{CT_{PRI}}{CT_{SEC}}$
Primary ⇒ Secondary	$I_{SEC} = I_{PRI} \bullet \frac{CT_{SEC}}{CT_{PRI}}$

For residual currents to inputs I_{01} or I_{02}, use the corresponding CT_{PRI} and CT_{SEC} values. For earth-fault stages that use I_{0Calc} signals, use the phase current CT values for CT_{PRI} and CT_{SEC}.

Example 1 – Secondary to Primary

CT = 500/5
Current to the device input is 4 A.
⇒ Primary current is $I_{PRI} = 4 \times 500/5 = 400$ A.

Example 2 – Primary to Secondary

CT = 500/5
The device displays $I_{PRI} = 400$ A
⇒ Injected current is $I_{SEC} = 400 \times 5/500 = 4$ A.

Per unit [pu] Scaling

For phase currents excluding ArcI> stage
$I_{PU} = 1 \times I_{MODE} = 100\%$, where
I_{MODE} is the rated current according to the mode (see page 483).

For residual currents and ArcI> stage
$I_{PU} = 1 \times CT_{SEC}$ for secondary side and
$I_{PU} = 1 \times CT_{PRI}$ for primary side.

Table 108 - Phase Current Scaling

	Phase Current Scaling for Motor Mode	Phase Current Scaling for Feeder Mode, ArcI> Stage and Residual Current ($3I_0$)
Secondary ⇒ Per unit	$I_{PU} = \frac{I_{SEC} \bullet CT_{PRI}}{CT_{SEC} \bullet I_{MOT}}$	$I_{PU} = \frac{I_{SEC}}{CT_{SEC}}$
Per unit ⇒ Secondary	$I_{PU} = I_{PU} \bullet CT_{SEC} \bullet \frac{I_{MOT}}{CT_{PRI}}$	$I_{SEC} = I_{PU} \bullet CT_{SEC}$

Example 1 – Secondary to per unit for Feeder Mode and ArcI>

CT = 750/5
Current injected to the device inputs is 7 A.
⇒ Per unit current is
$I_{PU} = 7/5 = 1.4$ pu= 140%

Example 2 – Secondary to per unit and Percent for Phase Currents in Motor Mode Excluding ArcI>

CT = 750/5
$I_{MOT} = 525$ A
Current injected to the device inputs is 7 A.
⇒ Per unit current is
$I_{PU} = 7 \text{ x } 750/(5 \text{ x } 525) = 2.00$ pu= 2.00 x I_{MOT} = 200%

Example 3 – Per unit to Secondary for Feeder Mode and ArcI>

CT = 750/5
The device setting is 2 pu= 200%.
⇒ Secondary current is
$I_{SEC} = 2 \text{ x } 5 = 10$ A

Example 4 – Per unit and Percent to Secondary for Phase Currents in Motor Mode Excluding ArcI>

CT = 750/5
$I_{MOT} = 525$ A
The device setting is 2 x I_{MOT} = 2 pu= 200%.
⇒ Secondary current is
$I_{SEC} = 2 \text{ x } 5 \text{ x } 525/750 = 7$ A

Example 5 – Secondary to per unit for Residual Current

Input is I_{01} or I_{02}.
$CT_0 = 50/1$
Current injected to the device input is 30 mA.
⇒ Per unit current is
$I_{PU} = 0.03/1 = 0.03$ pu= 3%

Example 6 – Per unit to Secondary for Residual Current

Input is I_{01} or I_{02}.
$CT_0 = 50/1$
The device setting is 0.03 pu= 3%.
$\Rightarrow$ Secondary current is
$I_{SEC} = 0.03 \times 1 = 30$ mA

Example 7 – Secondary to per unit for Residual Current

Input is I_{0Calc}.
CT = 750/5
Currents that are injected to the device IL1 input are 0.5 A.
$I_{L2} = I_{L3} = 0$.
$\Rightarrow$ Per unit current is
$I_{PU} = 0.5/5 = 0.1$ pu= 10%

Example 8 – Per unit to Secondary for Residual Current

Input is I_{0Calc}.
CT = 750/5
The device setting is 0.1 pu= 10%.
$\Rightarrow$ If $I_{L2} = I_{L3} = 0$, then secondary current to $I_{L1}1$ is
$I_{SEC} = 0.1 \times 5 = 0.5$ A

Voltage Scaling

Table 109 - Primary/Secondary Scaling of Line-to-Line Voltages

	Line-to-line Voltage Scaling	
	Voltage Measurement Mode = "2LL+Uo"	Voltage Measurement Mode = "3LN"
Secondary ⇒ Primary	$U_{PRI} = U_{SEC} \bullet \frac{VT_{PRI}}{VT_{SEC}}$	$U_{PRI} = \sqrt{3} \bullet U_{SEC} \bullet \frac{VT_{PRI}}{VT_{SEC}}$
Primary ⇒ Secondary	$U_{SEC} = U_{PRI} \bullet \frac{VT_{SEC}}{VT_{PRI}}$	$U_{SEC} = \frac{U_{PRI}}{\sqrt{3}} \bullet \frac{VT_{SEC}}{VT_{PRI}}$

Example 1 – Secondary to Primary. Voltage Measurement Mode Is "2LL+Uo"

VT = 12000/110
Voltage that is connected to the device input U_a or U_b is 100V.
$\Rightarrow$ Primary voltage is $up_{RI} = 100 \times 12000/110 = 10909V$

Example 2 – Secondary to Primary. Voltage Measurement Mode Is "3LN"

VT = 12000/110
Three-phase symmetric voltages that are connected to the device inputs U_a, U_b and U_c are 57.7V.
$\Rightarrow$ Primary voltage is $up_{RI} = \sqrt{} 3 \times 58 \times 12000/110 = 10902V$

Example 3 – Primary to Secondary. Voltage Measurement Mode Is “2LL+Uo”

VT = 12000/110
The device displays up_{RI} = 10910V.
⇒ Secondary voltage is U_{SEC} = 10910 x 110/12000 = 100V

Example 4 – Primary to Secondary. Voltage Measurement Mode Is “3LN”

VT = 12000/110
The device displays $U_{12} = U_{23}$ = U31 = 10910V.
⇒ Symmetric secondary voltages at U_a, Ub, and U_c are
U_{SEC} = 10910/√ 3 x 110/12000 = 57.7 V4

Per Unit [pu] Scaling of Line-to-Line Voltages

1 per unit= 1 pu= 1 x U_N = 100%, where U_N = rated voltage of the VT.

Table 110 - Scaling of Line-to-Line Voltages

	Line-to-line Voltage Scaling	
	Voltage Measurement Mode = “2LL+Uo”, “1LL+Uo/LLy”, “2LL/LLy”, “LL/LLy/LLz”	Voltage Measurement Mode = “3LN”
Secondary ⇒ per unit	$U_{PU} = \frac{U_{SEC}}{VT_{SEC}} \bullet \frac{VT_{PRI}}{U_N}$	$U_{PRI} = \sqrt{3} \bullet \frac{U_{SEC}}{VT_{SEC}} \bullet \frac{VT_{PRI}}{U_N}$
per unit ⇒ Secondary	$U_{SEC} = U_{PU} \bullet VT_{SEC} \bullet \frac{U_N}{VT_{PRI}}$	$U_{SEC} = U_{PU} \bullet \frac{VT_{SEC}}{\sqrt{3}} \bullet \frac{U_N}{VT_{PRI}}$

Example 1 – Secondary to per unit. Voltage Measurement Mode Is “2LL+Uo”

VT = 12000/110
Voltage that is connected to the device input U_a or U_b is 110V.
⇒ Per unit voltage is
up_U = 110/110 = 1.00 pu= 1.00 x U_N = 100%

Example 2 – Secondary to per unit. Voltage Measurement Mode Is “3LN”

VT = 12000/110
Three symmetric phase-to-neutral voltages that are connected to the device inputs U_a,U_b and U_c are 63.5V
⇒ Per unit voltage is
up_U = √ 3 x 63.5 /110 x 12000 /11000 = 1.00 pu = 1.00 x U_N = 100%

Example 3 – Per unit to Secondary. Voltage Measurement Mode Is “2LL+Uo”

VT = 12000/110
The device displays 1.00 pu= 100%.
⇒ Secondary voltage is
U_{SEC} = 1.00 x 110 x 11000/12000 = 100.8V

Example 4 – Per unit to Secondary. Voltage Measurement Mode Is "3LN"

VT = 12,000/110
U_N = 11,000V
The device displays 1.00 pu= 100%.
⇒ Three symmetric phase-to-neutral voltages that are connected to the device inputs U_a, U_b and U_c are
$U_{SEC} = 1.00 \times 110/\sqrt{3} \times 11000/12000 = 58.2V$

Table 111 - Per Unit [pu] Scaling of Zero Sequence Voltage

	Zero-sequence Voltage (U_0) Scaling	
	Voltage Measurement Mode = "2LL+Uo", "1LL+Uo/LLy"	**Voltage Measurement Mode = "3LN"**
Secondary⇒ Per unit	$U_{PU} = \frac{U_{SEC}}{U_{0SEC}}$	$U_{PU} = \frac{1}{VT_{SEC}} \bullet \frac{\lvert \overline{U}_a + \overline{U}_b + \overline{U}_c \rvert}{3}$
Per unit ⇒ Secondary	$U_{SEC} = U_{PU} \bullet U_{0SEC}$	$\lvert \overline{U}_a + \overline{U}_b + \overline{U}_c \rvert_{SEC} = 3 \bullet U_{PU} \bullet VT_{SEC}$

Example 1 – Secondary to per unit. Voltages Measurement Mode Is "2LL+Uo"

U_{0SEC} = 110V (A configuration value that corresponds to U_0 at full earth-fault)
Voltage that is connected to the device input U_c is 22V.
⇒ Per unit voltage is
up_U = 22/110 = 0.20 pu= 20%

Example 2 – Secondary to per unit. Voltage Measurement Mode Is "3LN"

VT = 12000/110
Voltage that is connected to the device input U_a is 66V, while
$U_a = U_b = 0$.
⇒ Per unit voltage is
up_U = (66+0+0)/(3x110) = 0.20 pu= 20%

Example 3 – Per unit to Secondary. Voltage Measurement Mode Is "2LL+Uo"

U_{0SEC} = 110V (A configuration value that corresponds to U_0 at full earth-fault)
The device displays U_0 = 20%.
⇒ Secondary voltage at input U_c is
U_{SEC} = 0.20 x 110 = 22V

Example 4 – Per unit to Secondary. Voltage Measurement Mode Is "3LN"

VT = 12000/110
The device displays U_0 = 20%.
⇒ If $U_b = U_c = 0$, then secondary voltages at U_a are
$U_{SEC} = \sqrt{3} \times 0.2 \times 3 \times 110 = 38.1V$

Notes:

Control Functions

Output Relays

Output relays are also called digital outputs. Any internal signal can be logically connected to the output relays by using output matrix. An output relay can be configured as latched or non-latched. See Output Matrix on page 234 for more details.

The difference between trip contacts and alarm contacts is the DC break capacity. See Table 173 on page 347 and Table 174 on page 347 for details. The contacts are SPST, except alarm relays A1 and A5, which have change over contacts (SPDT). T1...T14 and A1...A5 can be configured for N.O. or N.C. polarity through the front panel or SetPointPS.

Table 112 - Parameters of Output Relays

Parameter	Value	Unit	Description	Note
T1…T14	0 1		Status of trip output relay. (The actual number of relays depends on the ordering code).	F(3)
A1…A5	0 1		Status of alarm output relay.	F(3)
IF	0 1		Status of the internal fault-indication relay.	F(3)
Force	On Off		Force flag for output relay, forcing for test purposes. A common flag for all output relays and protection stage status. Any forced relays and this flag are automatically reset by a 5-minute timeout.	Set(4)
REMOTE PULSES				
A1…A5	0.00…99.98 Or 99.99	s	Pulse length for direct output relay control through communication protocols. 99.99 s = Infinite. Release by writing "0" to the direct control parameter.	Set(4)
POLARITY				
T1…T14(1)=NC A1…A5 = NO	NO (2) NC		Output relay polarity Normally Open (N.O.) or Normally Closed (N.C.).	Set(4)
NAMES for OUTPUT RELAYS (Editable with SetPointPS Only)				
Description	String of max. 32 characters		Names for DO on SetPointPS screens. Default is "Trip relay n", n=1…14 or "Alarm relay n", n=1…5.	Set(4)

(1) Dependent on order code. More output relays are available on some models.
(2) All relay polarities can be selected for N.O. or N.C..
(3) F = Editable when force flag is on.
(4) Set = An editable parameter (password required).

Digital Inputs

There are up to 32 digital inputs available for control purposes (varies by model). The polarity – normal open (N.O.) / normal closed (N.C.) – and a delay can be configured according to the application. The signals are available for the output matrix, block matrix, programmable logic, and so on. When 120V or 220V AC is used to activate the digital input. Use the SetPointPS software to select the AC Mode.

The contacts that are connected to digital inputs DI1...DI6 must be dry. These inputs use the common internal 48-Vdc wetting-voltage from terminal X3:1, only.

TIP Do not connect Digital inputs DI1… DI6 parallel with inputs of another device.

Label and description texts can be edited with SetPointPS according to the application. Labels are the short parameter names that are used on the local panel and descriptions are the longer names that are used by SetPointPS.

Table 113 - Parameters of Digital Inputs

Parameter	Value	Unit	Description	Set
DI1…DI_n	0 1		Status of digital input (The actual number of digital inputs depends on the ordering code)	
DI COUNTERS				
DI1…DI_n	0…65535		Cumulative active edge counter (The actual number of digital inputs depends on the ordering code)	(Set)(1)
DELAYS FOR DIGITAL INPUTS				
DI1…DI_n	0.00…60.00	s	Definite delay for both on and off transitions (The actual number of digital inputs depends on the ordering code)	Set(1)
CONFIGURATION DI1…DI6 (32)				
Inverted	No Yes		For normal open contacts (N.O.). Active edge is 0 $\Rightarrow$ 1 For normal closed contacts (N.C.).Active edge is 1 $\Rightarrow$ 0	Set(1)
Alarm display	No Yes		No popup display Alarm popup display is activated at active DI edge	Set(1)
On event	On Off		Active edge event enabled Active edge event disabled	Set(1)
Off event	On Off		Inactive edge event enabled Inactive edge event disabled	Set(1)
NAMES for DIGITAL INPUTS (Editable with SetPointPS Only)				
Label	String of max. 10 characters		Short name for DIs on the local display Default is “DIn”, n=1…32	Set(1)
Description	String of max. 32 characters		Long name for DIs. Default is “Digital input n”, n=1…32	Set(1)

(1) @Set = An editable parameter (password required).

An additional input card is available as an option. The additional option card is in the X8 location and has the same ratings as the card in X7.

Table 114 - Summary of Digital Inputs

DI	Terminal	Operating Voltage	Availability
-	X3:1	48V DC supply for DI1…6	Always available
1	X3:2	Internal 48V DC	
2	X3:3		
3	X3:4		
4	X3:5		
5	X3:6		
6	X3:7		
7	X7:1	External 18…265V DC 50…250 V AC	
8	X7:2		
9	X7:3		
10	X7:4		
11	X7:5		
12	X7:6		
-	X7:7	Common for DI7…12	
13	X7:8	External 18…265V DC 50…250 V AC	
14	X7:9		
15	X7:10		
16	X7:11		
17	X7:12		
18	X7:13		
-	X7:14	Common for DI13…17	
19	X6:1…2	External 18…265V DC 50…250V AC	ARC card with 2 DIs
20	X6:3…4		

The digital input signals can be used for blocking and control signals for the output relays. An additional input card is available as an option. The additional option card is in the X8 location and has the same ratings as the card in X7.

Table 115 - Digital Input Threshold Voltages

Common input	Input group	Wetting-voltage	
		On	Off
X7:7	X7: 1…6 (DI 7…12)	≥18V DC or ≥50V AC	≤ 10V DC or ≤ 5V AC
X7:14	X7: 8…13 (DI 13…18)	≥18V DC or ≥50V AC	≤ 10 Vdc or ≤ 5V AC

Virtual Inputs and Outputs

There are four virtual inputs and six virtual outputs. The four virtual inputs act like normal digital inputs. The state of the virtual input can be changed from the display, through a communication bus and from SetPointPS. The setting of groups can be done using virtual inputs. The polarity (V=value) can be configured, according to the application use, using the SetPointPS tool.

Table 116 - Parameters of Virtual Inputs

Parameter	Value	Unit	Description	Set
VI1…VI4	0 1		Status of virtual input	
Events	On Off		Event enabling	Set (1)
NAMES for VIRTUAL INPUTS (Editable with SetPointPS Only)				
Label	String of max. 10 characters		Short name for VIs on the local display Default is "VIn", n=1…4	Set (1)
Description	String of max. 32 characters		Long name for VIs. Default is "Virtual input n", n=1…4	Set (1)

(1) Set = An editable parameter (password required).

The six virtual outputs act like output relays, but there are no physical contacts. Virtual outputs are shown in the output matrix and the block matrix. Virtual outputs can be used with the programmable logic and to change the active setting group, and so on. Virtual inputs and outputs can be used to start and stop an application remotely. They can also be used for condition or switching device status feedback, or to open, or close, the main switching device such as a contactor or circuit breaker.

Output Matrix

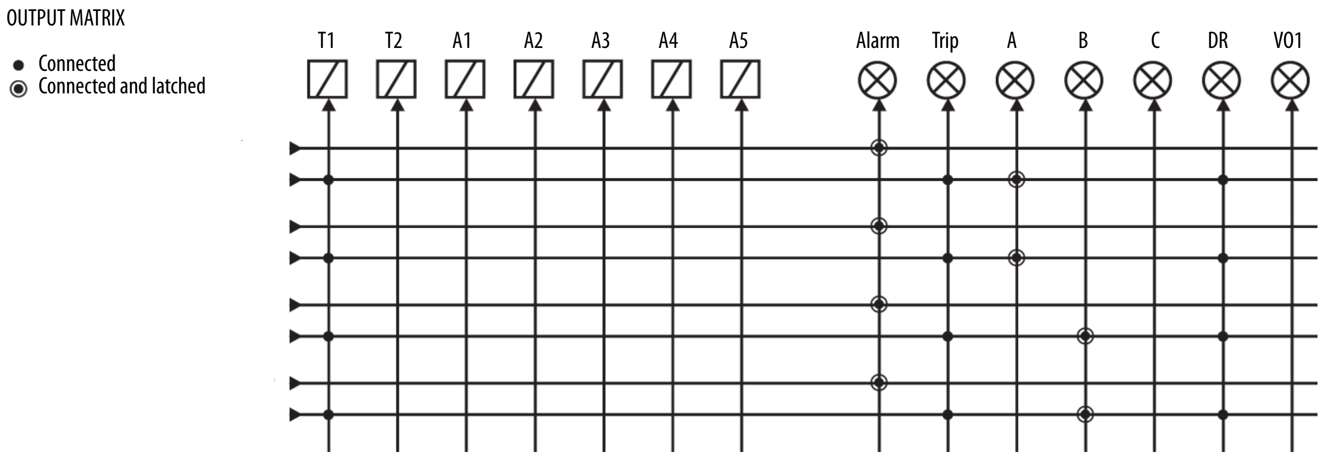
The output matrix connects, the output signals of the various protection stages, digital inputs, and logic outputs. The output matrix also connects to other internal signals to the output relays, front-panel status indicators, virtual outputs, and so on.

There are two status indicators named 'Alarm'" and 'Trip' on the front panel. There are three general-purpose status indicators – 'A', 'B', and 'C' – available for customer-specific indications. In addition, the triggering of the disturbance recorder (DR) and virtual outputs are configurable in the output matrix. See an example in Figure 116.

An output relay or status indicator can be configured as latched or non-latched. A non-latched relay follows the controlling signal. A latched relay remains activated although the controlling signal releases.

There is a common "release latched" signal to release all latched relays. This release signal resets all latched output relays and indicators. Use a digital input, a keypad, or by communication.to give the reset signal. Any digital input can be used for resetting. The selection of the input is done with the SetPointPS software under the menu 'Release output matrix latches'. Under the same menu, the 'Release latches' parameter can be used for resetting. The enter key releases the latches from the front panel.

Figure 116 - Typical Output Matrix (Varies by Model)



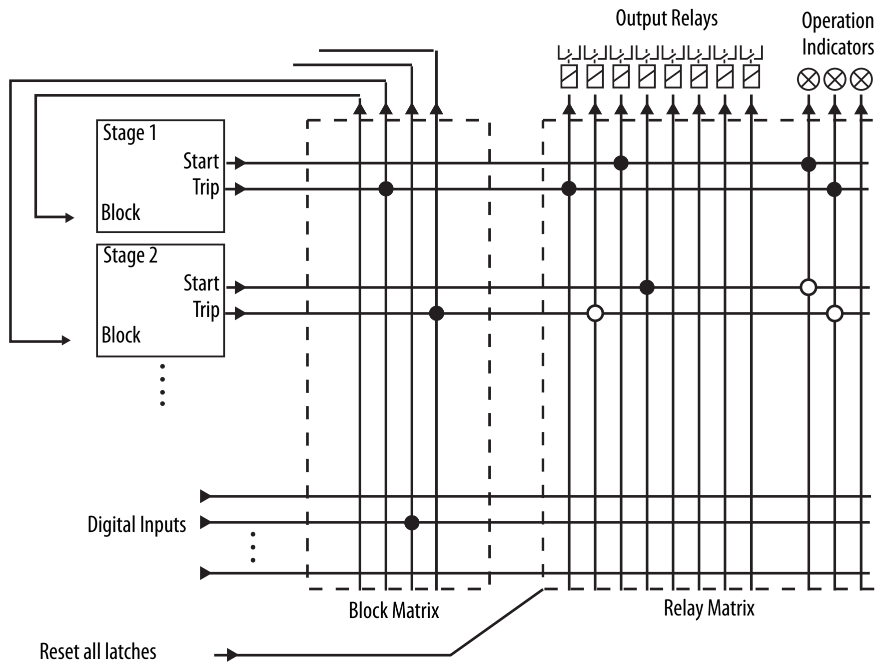
Block Matrix

With a block matrix, the operation of any protection stage can be blocked. The blocking signal can:

- Originate from the digital inputs DI1 to DIn (see chapter order code).
- Be a start or trip signal from a protection stage.
- Be an output signal from the programmable logic.

In the block matrix (Figure 117), active blocking is indicated with a black dot (•) in the crossing point of a blocking signal and the signal to be blocked.

Figure 117 - Block Matrix and Output Matrix



Controllable Objects

The relay allows controlling of six objects, that is, circuit-breakers, disconnectors and earthing switches. Control is done using the "select-execute" or "direct control" principle.

The logic functions can configure interlocking for controlling before the output pulse is issued. Objects 1…6 are controllable while objects 7…8 are only able to show the status. Control is possible through:

- The local HMI.
- Remote communication.
- Digital input.

The connection of an object to specific output relays is done through an output matrix (object 1…6 open output, object 1…6 close output). There is an output signal "Object failed", which is activated if the control of an object fails.

Object States

Each object has the states shown in Table 117.

Table 117 - Object States

Setting	Value	Description
Object state	Undefined (00) Open Close Undefined (11)	Actual state of the object

Basic Settings for Controllable Objects

Each controllable object has the settings shown in the following table.

Table 118 - Basic Settings for Controllable Objects

Setting	Value	Description
DI for "obj open"	None, any digital input, virtual input, or virtual output	Open information
DI for "obj close"		Close information
DI for "obj ready"		Ready information
Max ctrl pulse length	0.02…600 s	Pulse length for open and close commands
Completion timeout	0.02…600 s	Timeout of ready indication
Object control	Open/Close	Direct object control

If a state change exceeds the "Max ctrl pulse length" setting, the object fails and the "Object failure" matrix signal is set. Also an undefined-event is generated. "Completion timeout" is only used for the ready indication. If "DI for 'obj ready'" is not set, completion timeout has no meaning.

Output Signals of Controllable Objects

Each controllable object has two control signals in matrix.

Table 119 - Output Signals of Controllable Objects

Output Signal	Description
Object x Open	Open control signal for the object
Object x Close	Close control signal for the object

When digital input, remote bus, auto-reclose (and so forth) control an object, these signals send a control pulse.

Settings for Read-only Objects

Each read-only object has the settings shown in the following table.

Table 120 - Settings for Read-only Objects

Setting	Value	Description
DI for "obj open"	None, any digital input, virtual input, or virtual output	Open information
DI for "obj close"		Close information
Object timeout	0.02…600 s	Timeout for state changes

If a state change takes longer than the time defined by the "Object timeout" setting, the object fails and an"Object failure" matrix signal is set. Also undefined-event is generated.

Controlling with DI

Objects can be controlled with digital input, virtual input, or virtual output. There are four settings for each controllable object.

Table 121 - Controlling with DI

Setting	Active
DI for remote open control	In remote state
DI for remote close control	
DI for local open control	In local state
DI for local close control	

If the device is in local control state, the remote control inputs are ignored and vice versa. Object is controlled when a rising edge is detected from the selected input. The length of a digital input pulse is at least 60 ms.

Local/Remote Selection

In Local mode, the output relays can be controlled through a local HMI. Also a serial communication interface cannot control the output relays remotely.

In Remote mode, the output relays cannot be controlled though a local HMI, but a serial communication interface can control them remotely.

The selection of the Local/Remote mode is done by using a local HMI, or by one selectable digital input. The digital input is normally used to change a whole station to a local or remote mode. The selection of the L/R digital input is done in the "Objects" menu of the SetPointPS software.

TIP A password is not required for a remote control operation.

Auto-reclose Function (79)

The 857 Protection System protection relays include a sophisticated Auto-reclosing (AR) function. The AR function is normally used in feeder protection relays that helps protect an overhead line. Most overhead line faults are temporary. An estimated 85% can be cleared by using the AR function.

General

Normal protection functions detect the fault. The protection function then triggers the AR function. After tripping the circuit-breaker (CB) or contactor, the AR function can reclose the CB or contactor. Normally, the first reclose (or shot) is so short in time that consumers cannot notice anything. However, the fault is cleared and the feeder continues in normal service.

Terminology

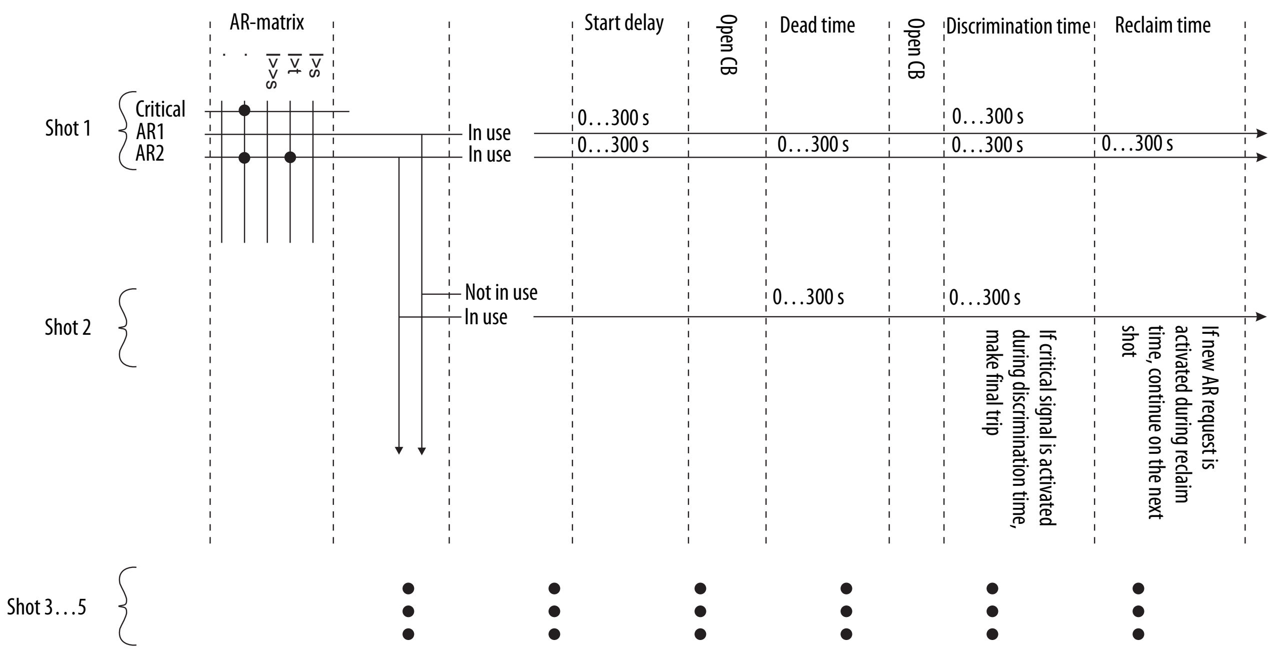
There are five reclose shots. A shot consists of open time (so called "dead" time) and close time (so called "burning" time or discrimination time). A high-speed shot means that the dead time is less than 1 s. The time-delayed shot means longer dead times up to 2…3 minutes.

There are four AR lines. A line means an initialization signal for AR. Normally, start or trip signals of protection functions are used to initiate an AR-sequence. Each AR line has a priority. AR1 has the highest and AR4 has the lowest one. If two lines are initiated simultaneously, AR follows only the highest priority line. A typical configuration of the lines is that the instantaneous overcurrent stage initiates the AR1 line, time-delayed overcurrent stage the AR2 line, and earth-fault-protection uses lines AR3 and AR4.

Contact Rockwell Automation® for more information or see our application notes regarding the Auto-reclosing function in the 857 Protection System relays.

The auto-reclose (AR) matrix in Figure 118 describes the start and trip signals that are forwarded to the auto-reclose function.

Figure 118 - Auto-reclose Matrix



The AR matrix (Figure 118) defines which signals (the start and trip signals from protection stages or digital input) are forwarded to the auto-reclose function. In the AR function, the AR signals can be configured to initiate the reclose sequence. Each shot from 1...5 has its own enabled/disabled flag. If multiple AR signals activate simultaneously, AR1 has highest priority and AR2 the lowest. Each AR signal has an independent start delay for the shot 1. If a higher priority AR signal activates during the start delay, the start delay setting is changed to that of the highest priority AR signal.

After the start delay, the circuit-breaker (CB) opens. When the CB opens, a dead time timer is started. Each shot from 1...5 has its own dead time setting.

After the dead time, the CB closes and a discrimination time timer is started. Each shot from 1...5 has its own discrimination time setting. If a critical signal is activated during the discrimination time, the AR function makes a final trip. The CB opens and the AR sequence is locked. The CB manually clears the "locked" state when it is closed

After the discrimination time has elapsed, the reclaim time timer starts. If any AR signal is activated during the reclaim time or the discrimination time, the AR function moves to the next shot. The reclaim time setting is common for every shot.

If the reclaim time expires, the auto-reclose sequence is successfully executed and the AR function moves to ready-state and waits for a new AR request in shot 1.

A trip signal from the protection stage can be used as a backup. Configure the start signal of the protection stage to initiate the AR function. If something fails in the AR function, the trip signal of the protection stage opens the CB.

The delay setting for the protection stage must be longer than the AR start delay and discrimination time.

If a critical signal is used to interrupt an AR sequence, the discrimination time setting must be long enough for the critical stage, usually at least 100 ms.

Manual Closing

When a CB is closed manually, for example with the local panel, remote bus, digital inputs, the reclaim state is activated. Within the reclaim time, all AR requests are ignored. It is up to the protection stages to take care of tripping. Trip signals of the protection stages must be connected to a trip relay in the output matrix.

Manual Opening

If a manual CB open command is given during AR sequence, it stops the sequence and leaves the CB open.

Reclaim Time Setting

There are two Reclaim Time Settings.

- **Use shot specific reclaim Time: No** - The reclaim time setting defines reclaim time between simultaneously shots during sequence and reclaim time after manual closing.
- **Use shot specific reclaim time: Yes** - The reclaim time setting defines reclaim time only for manual control. Shot specific reclaim time settings defines reclaim time between simultaneous shots.

Support for Two Circuit Breakers

AR function can be configured to manage two controllable objects. Object 1 is used as CB1 and any other controllable object can be used as CB2. The object selection for CB2 is made with the Breaker 2 object setting. To switch between the two objects, use a digital input, virtual input, virtual output, or choose Auto CB selection. AR controls CB2 when the input defined by Input for selecting CB2 setting is active. The exception being, when using auto CB selection when operated CB 1 or 2 is that which was last in close state. Control is changed to another object only if the current object is not close.

Blocking of AR Shots

Each AR shot can be blocked with a digital input, virtual input, or virtual output. The blocking input, is selected with Block setting. When selected input is active, the shot is blocked. A blocked shot is treated like it does not exist and AR sequence jumps over it. If the last shot in use is blocked, any AR request during the reclaiming of the previous shot causes a final trip.

Starting AR Sequence

Each AR request has a separate counter for the starting delay. The one where the starting delay has elapsed first, is selected. If multiple delays elapse simultaneously, an AR request of the highest priority is selected. AR1 has the highest priority and AR4 has the lowest priority. First shot is selected according to the AR request. Next AR opens the CB and starts counting dead time.

The Starting Sequence at Shot 2…5 and Skipping of AR Shots

Each AR request line can be enabled to any combination of the five shots. For example, a sequence of Shot 2 and Shot 4 for AR request 1 is done by enabling AR1 only for those two shots.

TIP If AR sequence is started at shot 2…5, the starting delay is taken from the discrimination time setting of the previous shot. For example, if Shot 3 is the first shot for AR2, Discrimination time of Shot 2 for AR2 defines the starting delay for the sequence.

Critical AR Request

Critical AR request stops the AR sequence and causes final tripping. Critical request is ignored when AR sequence is not running and when AR is reclaiming. Critical signal is accepted only during dead time and discrimination time.

Shot Active Matrix Signals

When a starting delay has elapsed, active signal of the first shot is set. If successful reclosing is executed at the end of the shot, the active signal is reset after reclaim time. If reclosing was not successful or new fault appears during reclaim time, the active of the current shot is reset. Then the active signal of the next shot is set (if any shots remain before final trip).

AR Running Matrix Signal

This signal indicates dead time. The signal is set after controlling CB open. When dead time ends, the signal is reset and CB is controlled close.

Final Trip Matrix Signals

There are five final trip signals in the matrix, one for each AR request (1...4 and critical). When final trip is generated, one of these signals is set according to the AR request, which caused the final tripping. The final trip signal stays active for 0.5 seconds and then resets automatically.

Digital Input to Block AR Setting

This setting is useful with an external Synchrocheck device. This setting only affects the reclosing of the CB. Reclosing can be blocked with a digital input, virtual input, or virtual output. CB does not close while the blocking input is active. CB closes when the blocking input is inactive. When blocking becomes inactive, the CB is controlled closed immediately.

AR Info for Mimic Display Setting

When AR info is enabled, the local panel mimic display shows a small info box during AR sequence.

Table 122 - Setting Parameters

Parameter	Value	Unit	Default	Description
ARena	ARon; ARoff	-	ARon	Enabling/disabling the Auto reclose.
Block	None Any digital input, virtual input, or virtual output	-	-	The digital input for block information, can be used, for example, for Synchrocheck.
AR_DI	None Any digital input, virtual input, or virtual output	-	-	The digital input for toggling the ARena parameter.
AR2grp	ARon; ARoff	-	ARon	Enabling/disabling the Auto reclose for group 2.
RecIT	0.02…300.00	s	10.00	Reclaim time setting. Common for all shots.
ARreq	On Off	-	Off	AR request event.
ShotS	On Off	-	Off	AR shot start event.
ARlock	On Off	-	Off	AR locked event
CritAr	On Off	-	Off	AR critical signal event.

Table 122 - Setting Parameters (Continued)

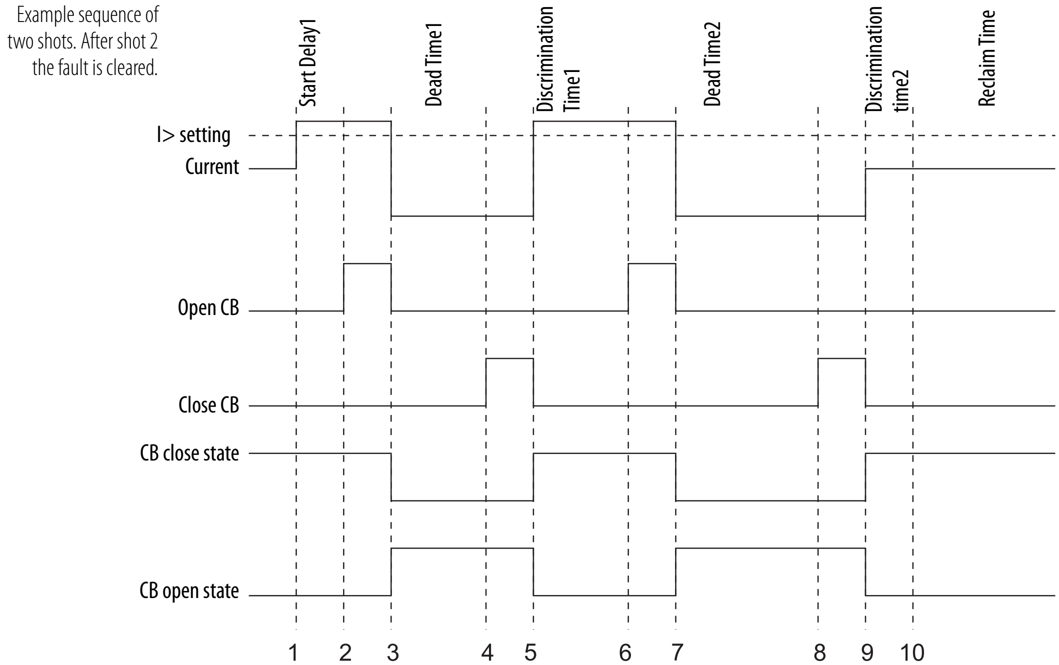
Parameter	Value	Unit	Default	Description
ARrun	On Off	-	Off	AR event running.
FinTrp	On Off	-	Off	AR final trip event.
ReqEnd	On Off	-	Off	AR end of request event.
ShtEnd	On Off	-	Off	AR end of shot event.
CriEnd	On Off	-	Off	AR end of critical signal event.
ARUnl	On Off	-	Off	AR release event.
ARStop	On Off	-	Off	AR stopped event.
FTrEnd	On Off	-	Off	AR final trip ready event.
ARon	On Off	-	Off	AR enabled event.
ARoff	On Off	-	Off	AR disabled event.
CRITri	On Off	-	On	AR critical final trip on event.
AR1Tri	On Off	-	On	AR AR1 final trip on event.
AR2Tri	On Off	-	On	AR AR2 final trip on event.
Shot Settings				
DeadT	0.02…300.00	s	5.00	The dead time setting for this shot. A common setting for all AR lines in this shot.
AR1	On Off	-	Off	Indicates if this AR signal starts this shot.
AR2	On Off	-	Off	Indicates if this AR signal starts this shot.
AR3	On Off	-	Off	Indicates if this AR signal starts this shot.
AR4	On Off	-	Off	Indicates if this AR signal starts this shot.
Start1	0.02…300.00	s	0.02	AR1 Start delay setting for this shot.
Start2	0.02…300.00	s	0.02	AR2 Start delay setting for this shot.
Start3	0.02…300.00	s	0.02	AR3 Start delay setting for this shot.
Start4	0.02…300.00	s	0.02	AR4 Start delay setting for this shot.
Discr1	0.02…300.00	s	0.02	AR1 Discrimination time setting for this shot.
Discr2	0.02…300.00	s	0.02	AR2 Discrimination time setting for this shot.
Discr3	0.02…300.00	s	0.02	AR3 Discrimination time setting for this shot.
Discr4	0.02…300.00	s	0.02	AR4 Discrimination time setting for this shot.

Table 123 - Measured and Recorded Values of AR Function

	Parameter	Value	Unit	Description
Measured or recorded values	Obj1	UNDEFINED OPEN CLOSE OPEN_REQUEST CLOSE_REQUEST READY NOT_READY info_NOT_AVAILABLE FAIL	-	Object 1 state
	Status	INIT RECLAIM_TIME READY WAIT_CB_OPEN WAIT_CB_CLOSE DISCRIMINATION_TIM E LOCKED FINAL_TRIP CB_FAIL INHIBIT	-	AR-function state
	Shot#	1…5	-	The currently running shot
	ReclT	RECLAIMTIME STARTTIME DEADTIME DISCRIMINATIONTIME	-	The currently running time (or last executed)
	SCntr		-	Total start counter
	Fail		-	The counter for failed AR shots
	Shot1(1)		-	Shot1 start counter
	Shot2 (1)		-	Shot2 start counter
	Shot3 (1)		-	Shot3 start counter
	Shot4(1)		-	Shot4 start counter
	Shot5(1)		-	Shot5 start counter

(1) There are five counters available for each one of the two AR signals.

Figure 119 - AR Signals (after Shot 2 the Fault is Cleared)



1. Current exceeds the I> setting; the start delay from shot 1 starts.
2. After the start delay, an OpenCB relay output closes.
3. A CB opens. The dead time from shot 1 starts, and the OpenCB relay output opens.
4. The dead time from shot 1 expires; a CloseCB output relay closes.
5. The CB closes. The CloseCB output relay opens, and the discrimination time from shot 1 starts. The current is still over the I> setting.
6. The discrimination time from the shot 1 expires; the OpenCB relay output closes.
7. The CB opens. The dead time from shot 2 starts, and the OpenCB relay output opens.
8. The dead time from shot 2 expires; the CloseCB output relay closes.
9. The CB closes. The CloseCB output relay opens, and the discrimination time from shot 2 starts. The current is now under I> setting.
10. Reclaim time starts. After the reclaim time, the AR sequence is successfully executed. The AR function moves to wait for a new AR request in shot 1.

Logic Functions

The device supports customer-defined programmable logic for Boolean signals with the same functionality as DeviceLogix™. However, this implementation is not in the same format as DeviceLogix™ and is not configurable other than through SetPointPS.

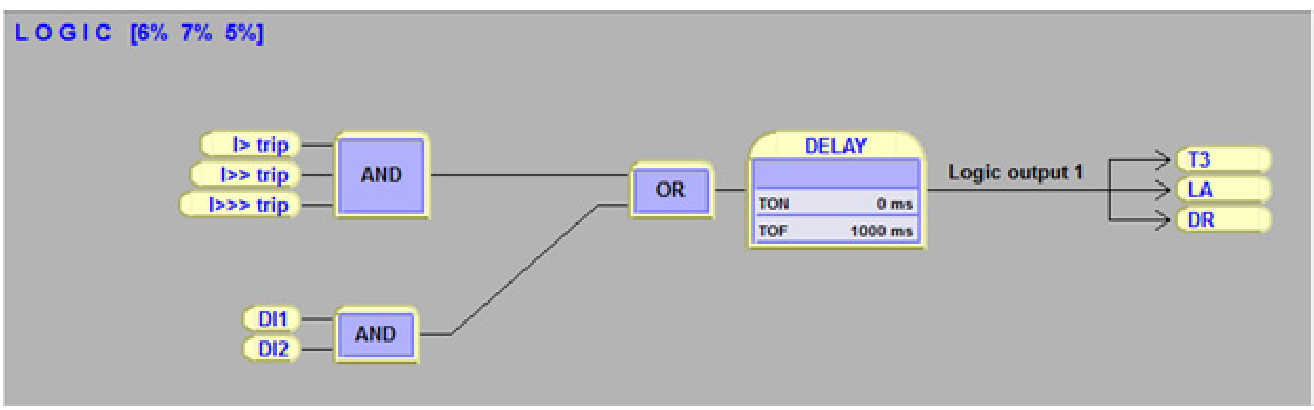
The logic is designed by using the SetPointPS setting tool and downloaded to the device. Functions available are:

- NOT
- COUNTERs
- RS and D flip-flops
- AND
- OR
- XOR

The maximum number of outputs is 20, and the maximum number of input gates is 31. An input gate can include any number of inputs.

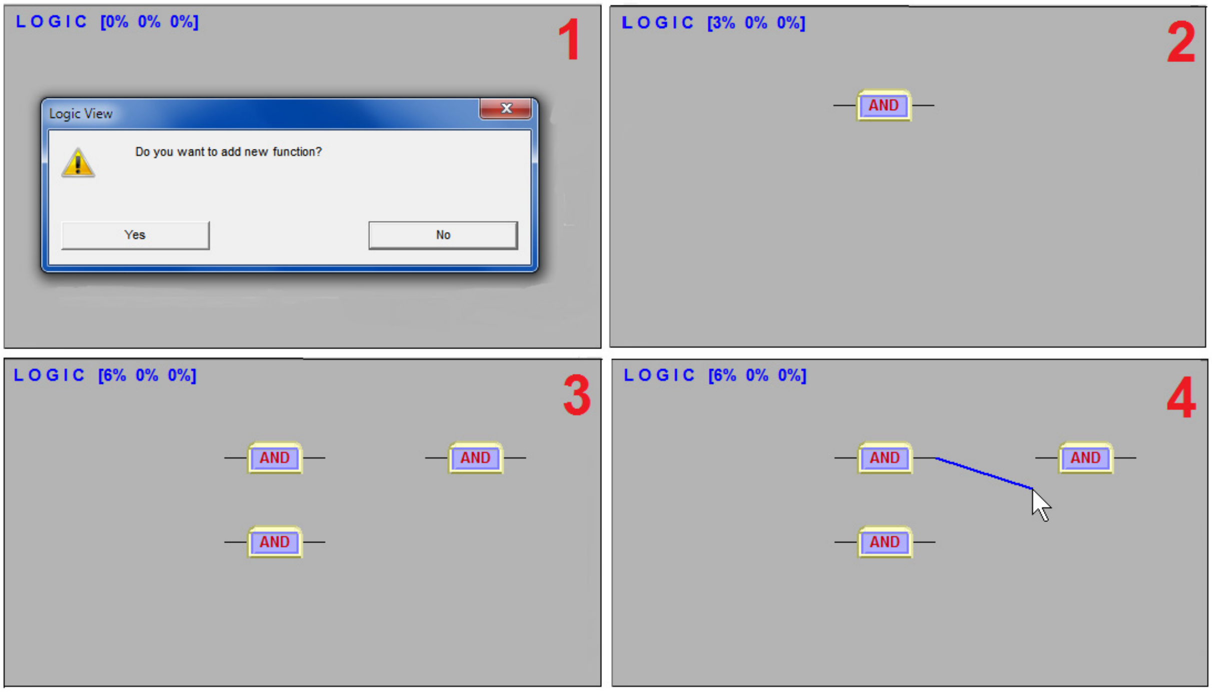
Logic is generated by using the SetPointPS setting tool. The amount of consumed memory is dynamically shown in percentage on the top left corner of the configuration view. The first value indicates amount of used inputs, second amount of gates, and third values shows amount of outputs consumed. These values cannot exceed 100%.

Figure 120 - Logic Menu in SetPointPS



See Figure 121 ...Figure 123 that illustrate the basics of logic creation.

Figure 121 - Create Logical Nodes

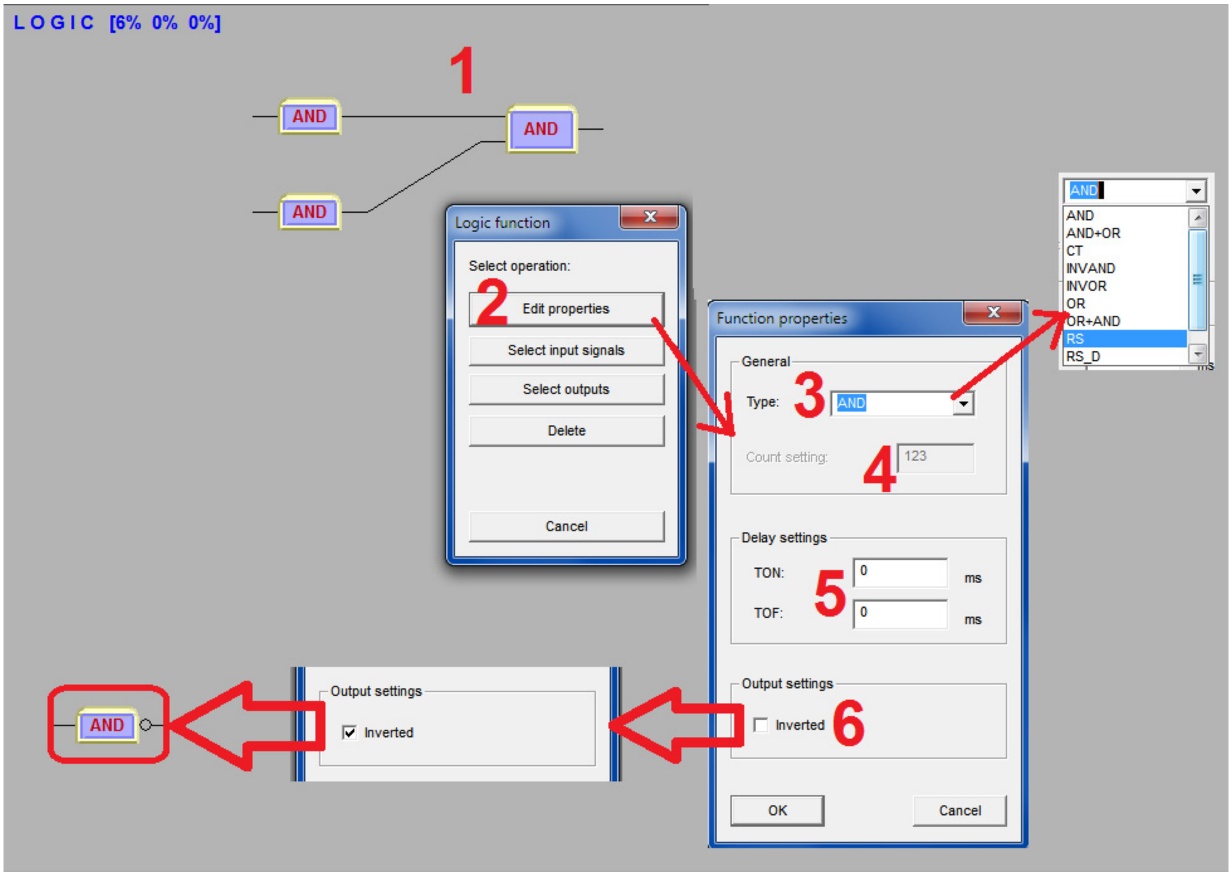


1. To add a logic gate, click an empty area
2. Confirm a new function by clicking “Yes”.
3. The added Logic Function Block defaults to an “AND" gate.

   The logic function can be changed, see Figure 122.

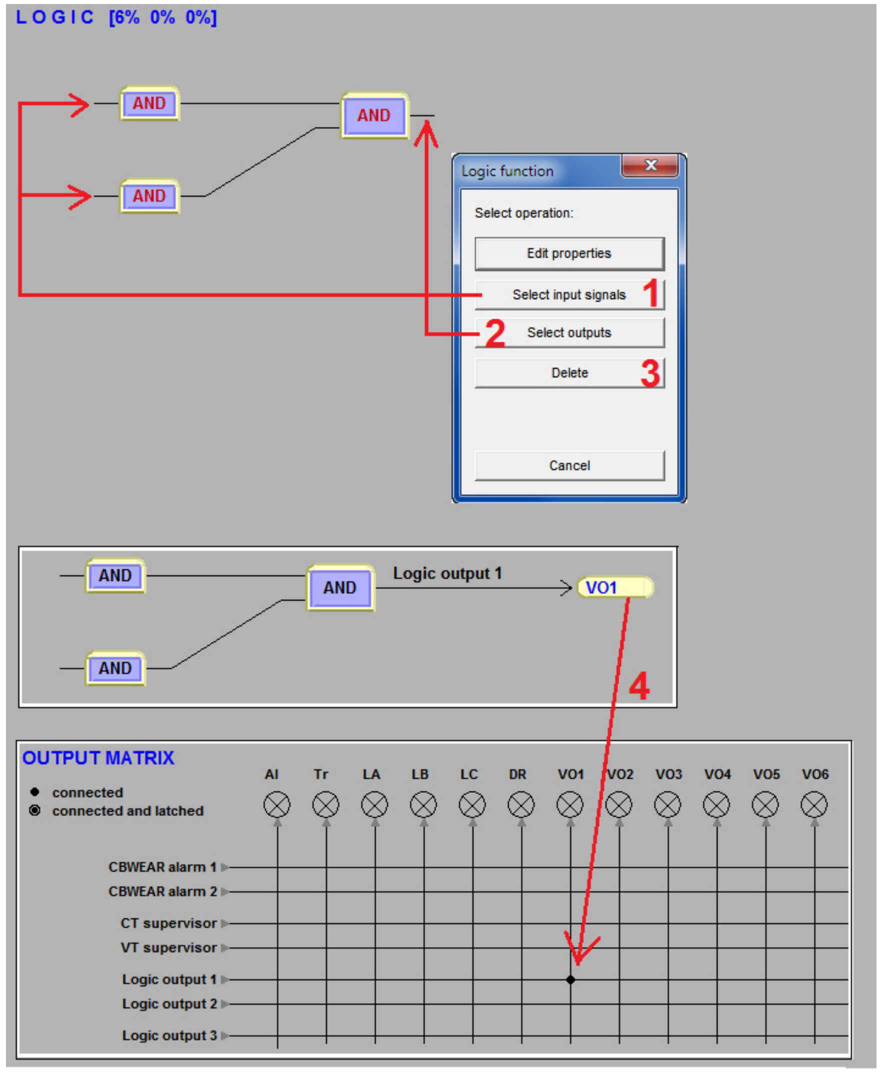
   As the number of logic devices increases, the memory capacity is decreased.
4. To make the connection to other logic functions input, use the mouse to left click and drag the output line of the gate to an adjacent logic element.

Figure 122 - Logic Creation (Edit Properties)



1. Left click any logic function to activate the "Select operation" view.
2. Edit properties button opens the "Function properties" window.
3. It is possible to choose the type of logic function required. The pull-down option window displays all available logic functions available.
4. When a counter element is selected, counter-setting must be set.
5. Separate Time ON (TON) and Time OFF (TOF) delay setting for logic activation and deactivation.
6. It can be possible to invert the output of logic. Any inverted logic output is marked with a small circle at the output.

Figure 123 - Logic Creation



1. To select the input signals for a logic element, click the "1"button. Or left click the logic input line.
2. To select the outputs for a logic element, click the "2" button. Or left click the logic output line.
3. To delete the logic function, click the button "1".
4. When logic is created and settings are written to the IED, the unit requires a restart. After restarting the logic, output is automatically assigned in Output Matrix.

IMPORTANT	SetPointPS software requires a unit restart whenever new logic is written to the 857.

Communications

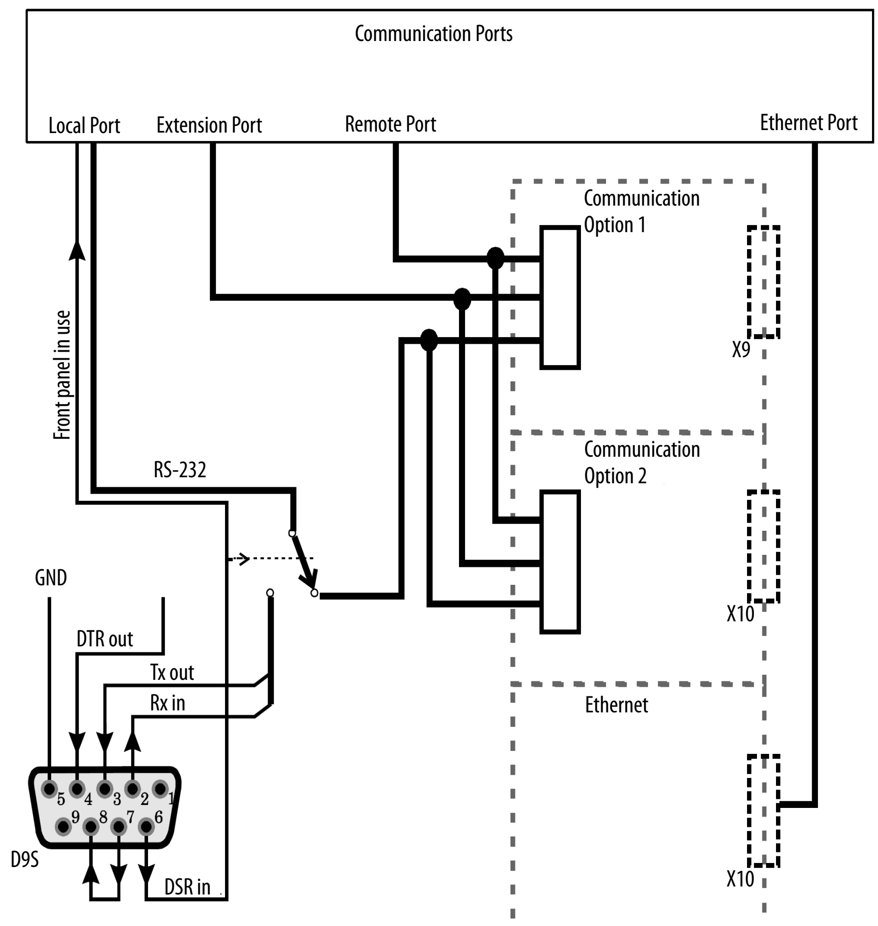
Communication Ports

The relay has the option of having multiple communication ports. An additional Ethernet port is available as an option. When this option is chosen, it takes over the option 2 slot.

There can be up to three ports in the rear panel. The front panel RS-232 port shuts off the local port on the rear panel when a programming cable (857-VX003-3) is inserted.

The connector type (X9 or X10) depends on the type of Communication option that is configured (see Chapter 9).

Figure 124 - Communication Ports and Connectors



Local Port

The local port has two connectors:

- One on the front panel.
- One on the rear panel (see Chapter 9).

Only one can be used at a time.

TIP The local port functionality can be available through connector X9 or X10, depending on the type of communication modules and DIP switch settings (see Chapter 9).

TIP When the programming cable (857-VX003-3) is inserted to the front panel connector, it activates the front panel port. This action disables the rear-panel local port by connecting the DTR pin 6 and DSR pin 4 together. See Figure 124.

Protocol for the Local Port

The front panel port uses the command-line protocol for SetPointPS, regardless of the selected protocol for the rear-panel local port.

If a protocol other than "None" is selected for the rear-panel local port.

The front panel connector continues using the plain command-line interface with the original speed, parity, and so on, when selected.

For example, if the rear-panel local port is used for remote SetPointPS communication using SPA-bus default 9600/7E1. It is possible to connect a personal computer, temporarily, with SetPointPS to the front panel connector with the default 38400/8N1. While the front panel connector is in use, the rear-panel local port is disabled. The communication parameter display on the local display shows the active parameter values for the local port.

Physical Interface

The physical standard of this port is RS-232. The physical connector depends on the option module selected.

Table 124 - Local Port Parameters

Parameter	Value	Unit	Description	Note
Protocol	 None SPA-Bus PROFIBUSDP ModbusSla ModbusTCPs IEC-103 ExternalIO DNP3		Protocol selection for the rear-panel local port: Command-line interface for SetPointPS SPA-bus (slave) PROFIBUS Data base (slave) Modbus RTU slave Modbus TCP slave IEC-60870-5-103 (slave) Modbus RTU master for external I/O-modules DNP 3.0	Set(1)
Msg#	0…2^{32}–1		Message counter since the device has restarted or since last clearing	C(2)
Errors	0…2^{16}–1		Protocol errors since the device has restarted or since last clearing	C(2)
Tout	0…2^{16}–1		Timeout errors since the device has restarted or since last clearing	C(2)
	 speed/DPS Default = 38400/ 8N1 for SetPointPS		Display of actual Communication parameters. Speed = bit/s. D = number of Data bits P = parity: none, even, odd S = number of stop bits	(3)
SetPointPS Communication (Direct or SPA-bus embedded command-line interface)				
Tx	bytes/size		Unsent bytes in transmitter buffer/size of the buffer	
Msg#	0…2^{32}–1		Message counter since the device has restarted or since last clearing	C(2)
Errors	0…2^{16}–1		Errors since the device has restarted or since last clearing	C(2)
Tout	0…2^{16}–1		Timeout errors since the device has restarted or since last clearing	C(2)

(1) Set = An editable parameter (password required).
(2) C = Clearing to zero is possible.
(3) The Communication parameters are set in the protocol-specific menus. For the local port command-line interface, the parameters are set in configuration menu.

Remote Port X9

Physical Interface

The physical interface of this port depends on the communication letter in the order code. See Figure 124 and Table 125. The TTL interface is for external converters and converter cables only. It is not suitable for direct connection in excess of 1 meter.

Table 125 - Physical Interface and Connector Types of Remote Port X5 with Various Options. TTL (A) Is the Default

Order Code	Communication Interface	Connector Type
A	TTL (for external converters only)	D9S
B	Plastic fiber interface	HFBR-0500
C	Not available	–
D	RS-485 (isolated)	Screw crimp

Table 125 - Physical Interface and Connector Types of Remote Port X5 with Various Options. TTL (A) Is the Default (Continued)

Order Code	Communication Interface	Connector Type
E	Glass fiber interface (62.5/125 µm) (For 857-RAD)	SMA
F	Plastic Rx/glass (62.5/125 µm) Tx fiber interface	HFBR-0500/SMA
G	Glass (62.5/125 µm) Rx/plastic fiber interface	SMA/HFBR-0500
I	RJ45 (RS-232)	–
M	Dual ST 100-Mbps fiber Ethernet	SMA
N	Single glass fiber interface (62.5/125 µm) for 857-RAA	SMA

Table 126 - Remote Port X9 Parameters

Parameter	Value	Unit	Description	Note
Protocol 	 None SPA-bus PROFIBUSDP ModbusSla ModbusTCPs IEC-103 ExternalIO DNP3		Protocol selection for remote port: – SPA-bus (slave) PROFIBUS Data base (slave) Modbus RTU slave Modbus TCP slave IEC-60870-5-103 (slave) Modbus RTU master for external I/O-modules DNP 3.0	Set(1)
Msg#	$0\ldots2^{32}–1$		Message counter since the device has restarted or since last clearing	C(2)
Errors	$0\ldots2^{16}–1$		Protocol errors since the device has restarted or since last clearing	C(2)
Tout	$0\ldots2^{16}–1$		Timeout errors since the device has restarted or since last clearing	C(2)
	 speed/DPS		Display of current Communication parameters. Speed = bit/s. D = number of Data bits P = parity: none, even, odd S = number of stop bits	(3)
Debug	 No Binary ASCII		Echo to local port: No echo For binary protocols For SPA-bus protocol	Set(1)

(1) Set = An editable parameter (password required).

(2) C = Clearing to zero is possible.

(3) The Communication parameters are set in the protocol-specific menus. For the local port command-line interface, the parameters are set in configuration menu.

Extension Port

The physical interface of this port depends on the type of communication module selected. Typically this port is an RS-485 port for external I/O devices. The port is in the same rear panel connector X9 or X10. See Figure 124 and Chapter 9.

Table 127 - Extension Port X4 Parameters

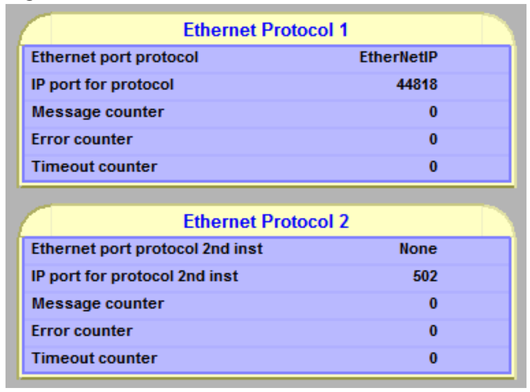
Parameter	Value	Unit	Description	Note
Protocol	 None SPA-bus PROFIBUSDP ModbusSla ModbusTCPs IEC-103 ExternalIO DNP3		Protocol selection for the extension port: Command-line interface for SetPointPS SPA-bus (slave) PROFIBUS dB (slave) Modbus RTU slave Modbus TCP slave IEC-60870-5-103 (slave) Modbus RTU master for external I/O-modules DNP 3.0	Set(1)
Msg#	$0\ldots2^{32}-1$		Message counter since the device has restarted or since last clearing	C(2)
Errors	$0\ldots2^{16}-1$		Protocol errors since the device has restarted or since last clearing	C(2)
Tout	$0\ldots2^{16}-1$		Timeout errors since the device has restarted or since last clearing	C(2)
	 speed/DPS Default = 38400/ 8N1 for SetPointPS		Display of actual Communication parameters. Speed = bit/s. D = number of Data bits P = parity: none, even, odd S = number of stop bits	(3)

(1) Set = An editable parameter (password required).
(2) C = Clearing to zero is possible.
(3) The Communication parameters are set in the protocol-specific menus. For the local port command-line interface, the parameters are set in configuration menu.

Ethernet Port (Optional)

The 857 supports two Ethernet protocols that run simultaneously on the same physical port. These settings are defined in Ethernet Protocol 1and 2. For each protocol, an IP (logical) port number is required. The default port numbers in the relay are 44818 for EtherNet/IP™, 102 for 61850, 502 for Modbus TCP, and 502 when no port is selected. Other protocols require an alternate port number to be set.

Figure 125 - Ethernet Protocol 1 and 2



The Protocol Configuration Menu contains the address and other related information for the Ethernet port. TCP port 1st and 2nd instance include selection for the protocol, IP port settings, message, error, and timeout counters. See Table 128 for more information.

Figure 126 - Protocol Configuration Menu

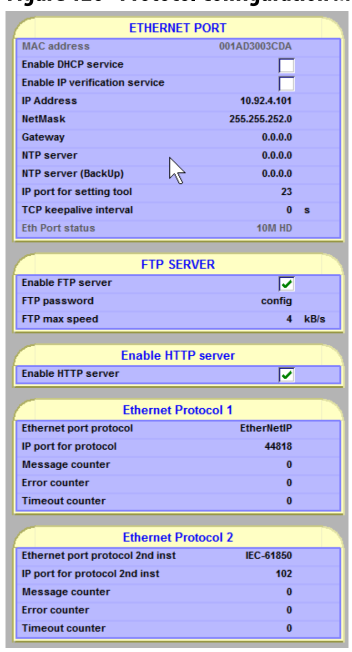


Table 128 - Main Configuration Parameters (Local Display), Built in Ethernet Port

Parameter	Value	Description	Note
Protocol		Protocol selection for the extension port	Set[3]
	None	Command-line interface for SetPointPS	
	ModbusTCPs	Modbus TCP slave	
	IEC-101	IEC-101	
	IEC 61850	IEC-61850 protocol[2]	
	EtherNet/IP	EtherNet/IP protocol	
	DNP3	DNP/TCP	
Port	nnn	Ip port for protocol, default 502	Set[3]

Table 128 - Main Configuration Parameters (Local Display), Built in Ethernet Port (Continued)

Parameter	Value	Description	Note
IpAddr	n.n.n.n	Internet Protocol address (set with SetPointPS)	Set(3)
NetMsk	n.n.n.n	Net mask (set with SetPointPS)	Set(3)
Gatew	Default = 0.0.0.0	Gateway IP Address (set with SetPointPS)	Set(3)
NTPSvr	n.n.n.n	Network-time protocol server (set with SetPointPS) 0.0.0.0 = no SNTP	Set(3)
KeepAlive(1)	nn	TCP keep alive interval	Set(3)
FTP server	on/off	Enable FTP server (click to turn on)	Set(3)
FTP speed	4 Kb/s (default)	Maximum transmission speed for FTP	Set(3)
FTP password	? = User Mode Config =configurator mode	FTP password	Set(3)
MAC address	001D9CF23B40 through 001D9CF2433F	Media Access Control Address	—
IP Port for setting tool	Nn 23 (default)	IP port for SetPointPS	Set(3)
Msg#	nnn	Message counter	—
Errors	nnn	Error counter	—
Tout	nnn	Timeout counter	—
EthSffEn	on/off	Sniffer port enabled	Set(3)
SniffPort	Port2	Sniffer port	—

(1) The KeepAlive parameter sets the time between two keep alive packets that are sent from the 857 (in seconds). The setting range for this parameter is 1…20 seconds. A set long duration time can be set by entering zero. The zero entry defines a 120 seconds (2 minutes) time. The purpose of a Keep Alive packet is for the 857 to send a probe packet to a connected client. It checks the status of the TCP-connection when no other packet is being sent, for example client does not poll Data from the 857. If the Keep Alive packet is not acknowledged, the 857 closes the TCP connection. Connection must be resumed on the client side.

(2) The IEC 61850 protocol must be specified at the time of order placement. A relay with the standard Ethernet option does not support IEC 61850.

(3) Set = An editable parameter (password required).

Table 129 - Ethernet Protocol 1 Parameters

Parameter	Value	Description	Note
Protocol		Protocol selection for the extension port.	Set(2)
	None	Command-line interface for SetPointPS	
	ModbusTCPs	Modbus TCP slave	
	IEC 61850	IEC-61850 protocol	
	EtherNet/IP	EtherNet/IP protocol(1)	
	DNP3	DNP/TCP	
Port	nnn	Ip port for protocol, default 502 EtherNet/IP =44818	Set(2)
Msg#	nnn	Message counter	
Errors	nnn	Error counter	
Tout	nnn	Timeout counter	

(1) The Data Base IEC 61850 protocol must be specified at the time of order placement. A relay with the standard Ethernet-option does not support IEC 61850.
(2) Set = An editable parameter (password required).

Table 130 - Ethernet Protocol 2 Parameters

Parameter	Value	Description	Note
Ethernet port protocol (TCP PORT second INST)		Protocol selection for the extension port.	Set(2)
	None	Command-line interface for SetPointPS	
	ModbusTCP	Modbus TCP slave	
	IEC 61850	IEC-61850 protocol(1)	
	EtherNet/IP	EtherNet/IP protocol	
	DNP3	DNP/TCP	
Port	nnn	Ip port for protocol, default 502 EtherNet/IP =44818	Set(2)
Msg#	nnn	Message counter	-
Errors	nnn	Error counter	-
Tout	nnn	Timeout counter	-

(1) The IEC 61850 protocol must be specified at the time of order placement. A relay with the standard Ethernet-option does not support IEC 61850.
(2) Set = An editable parameter (password required).

Communication Protocols

These protocols enable the transfer of this type of data:

- Events
- Status information
- Measurements
- Control Commands
- Clock synchronizing
- Settings (SPA-bus and embedded SPA-bus only)

Personal Computer Communication

Personal computer communication is using an Allen-Bradley® specified command-line interface. The SetPointPS program can communicate using the local RS-232 port or the Ethernet interface. It is also possible to select SPA-bus protocol for the local port and configure the SetPointPS to embed the command-line interface inside SPA-bus messages.

Modbus TCP and Modbus RTU

These Modbus protocols are often used in power plants and in industrial applications. The difference between these two protocols is the media. Modbus TCP uses Ethernet and Modbus RTU uses asynchronous communication (RS-485, optic fiber, RS-232).

SetPointPS shows the list of all available data items for Modbus. See page 445 for a list of Modbus parameters.

The Modbus communication is activated for remote port through a menu selection with parameter "Protocol". See Communication Ports on page 251.

Table 131 - Modbus TCP and Modbus RTU Parameters

Parameter	Value	Unit	Description	Note
Addr	1…247		Modbus address for the device. Broadcast address 0 can be used for clock synchronizing. Modbus TCP also uses the TCP port settings.	Set(1)
bit/s	1200 2400 4800 9600 19200	bps	Communication speed for Modbus RTU	Set(1)
Parity	None Even Odd		Parity for Modbus RTU	Set(1)

(1) Set = An editable parameter (password required).

Configure the Modbus Protocol

Overview

This section describes the configuration and use of the Modbus RTU (Remote Terminal Unit) and Modbus TCP protocols in 857 Protection Systems.

IMPORTANT	To configure an 857 Protection System, the SetPointPS relay setting and configuration tool is needed (obtain SetPointPS from www.rockwellautomation.com).

The configurator of a relay must be logged in with access level *Configurator* to change the protocol settings. Enter the password when connecting to the relay with SetPointPS (the default password for the configurator access level is “2”).

Modbus RTU Overview

The Modbus protocol is a Master-Slave protocol that is typically implemented on an RS-232 or RS-485 physical interface. There are two versions of the (serial) Modbus protocol, Modbus RTU and Modbus ASCII, Modbus RTU is available in 857 Protection Systems. There is also a TCP/IP implementation of the protocol, Modbus TCP, which is covered at the end of this section. Modbus TCP is available in 857 Protection Systems.

In the master-slave setup of Modbus, only the master can initiate transactions (queries). The slaves respond by supplying the requested data to the master, or by the action that is requested in the query. The master can address individual slaves, or initiate a broadcast message to all slaves. The address space for slaves in Modbus RTU ranges from 1…247 on one data link. Address 0 is reserved for broadcast.

The Modbus protocol defines four simultaneously categories of data (Table 132). The mapping of data to these categories is implementation-dependent. In 857 Protection Systems, all data is mapped to the Holding Registers.

Table 132 - Modbus Data Organization

Primary Tables	Object Type	Type of	Comments
Discrete Input	Single bit	Read-only	I/O system can provide Data
Coils	Single bit	Read-write	An application program can alter and provide Data
Input Registers	16-bit word	Read-only	I/O system can provide Data
The Holding Registers	16-bit word	Read-write	An application program can provide Data

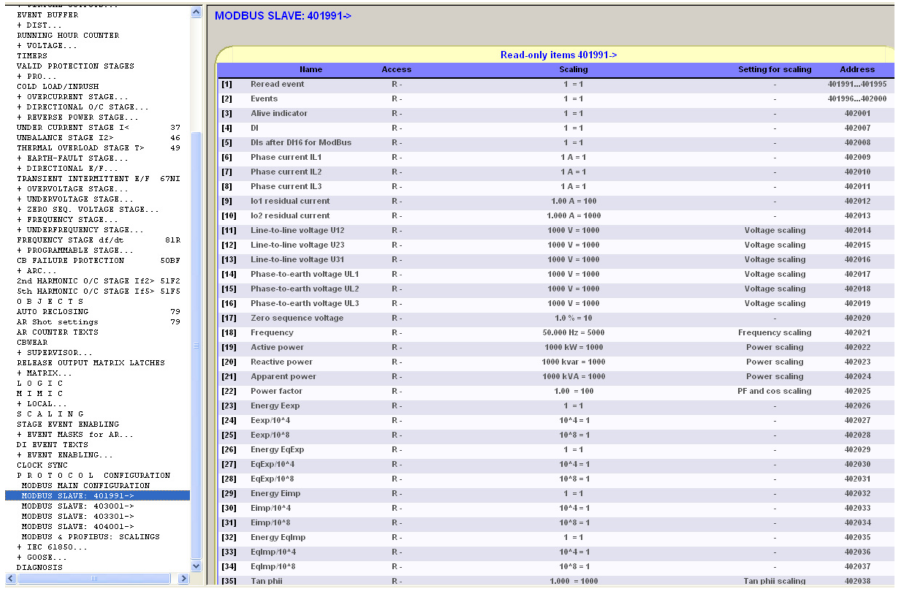
To check the mapping of particular data items to the holding registers in 857 Protection Systems, use SetPointPS. Select the items below the Modbus Main Configuration (see Figure 127). See page 445 for Modbus mappings.

TIP The data mappings are not visible if the Modbus protocol is not activated. See See Configuration on page 261 for instructions how to activate the protocol.

The values in the Address column (ex. “40xxxx”) consist of two parts: “40” and “xxxx”. The prefix “40” denotes a reference to Read/Write Output or Holding Registers. The “xxxx” denotes the address of a particular register.

The bit rate of Modbus RTU is typically 9600 bps and for the transmission of frames, a parity check mode must be selected (even, odd, or none parity checking).

Figure 127 - Modbus Data Mappings in SetPointPS (from 857 Protection System)



The Modbus RTU and Modbus TCP protocols in 857 Protection System can transfer these types of data:

- Events
- Status information
- Measurements
- Control commands
- Clock synchronization

Configuration

This section describes how to configure an 857 Protection System to use the Modbus RTU protocol.

TIP The configuration and features vary between simultaneously 857 Protection System models, such as what scaling settings there are and what data is available in the holding registers.

General

The Modbus RTU protocol is activated by setting it as the Port protocol for a serial port on the relay at hand. This setting can be found by navigating to the Protocol Configuration List in SetPointPS. See Figure 128, Figure 129, and Figure 130 for a series of graphics to illustrate the enabling of the Modbus protocol on the Remote port of a relay.

Figure 128 - Protocol Selection for the Remote Port without Any Protocol Selected

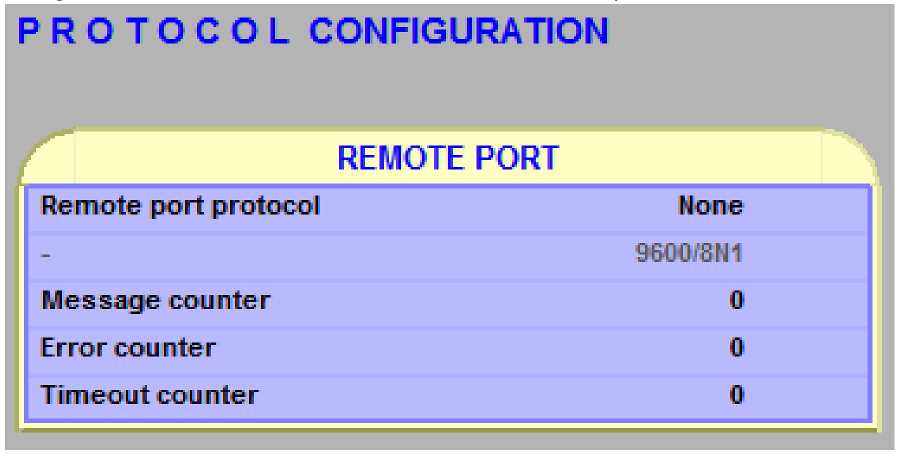


Figure 129 - Protocol Selection Box Visible for the Remote Port. ModBusSlv (Modbus as Slave) Highlighted

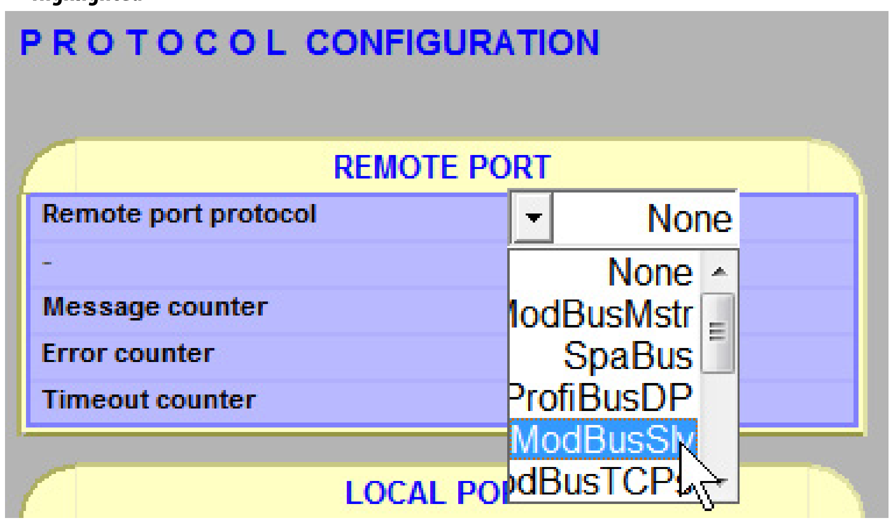
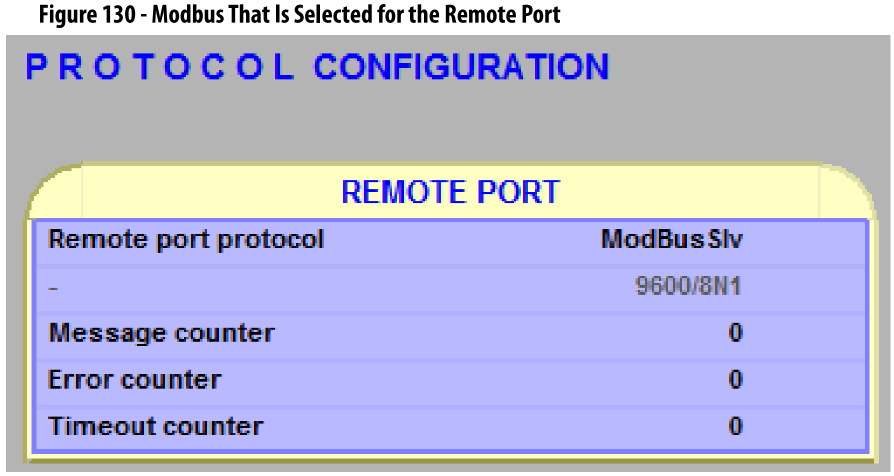


Figure 130 - Modbus That Is Selected for the Remote Port



The protocol is enabled through the local panel of an 857 Protection System (enter the password for the configurator access level).

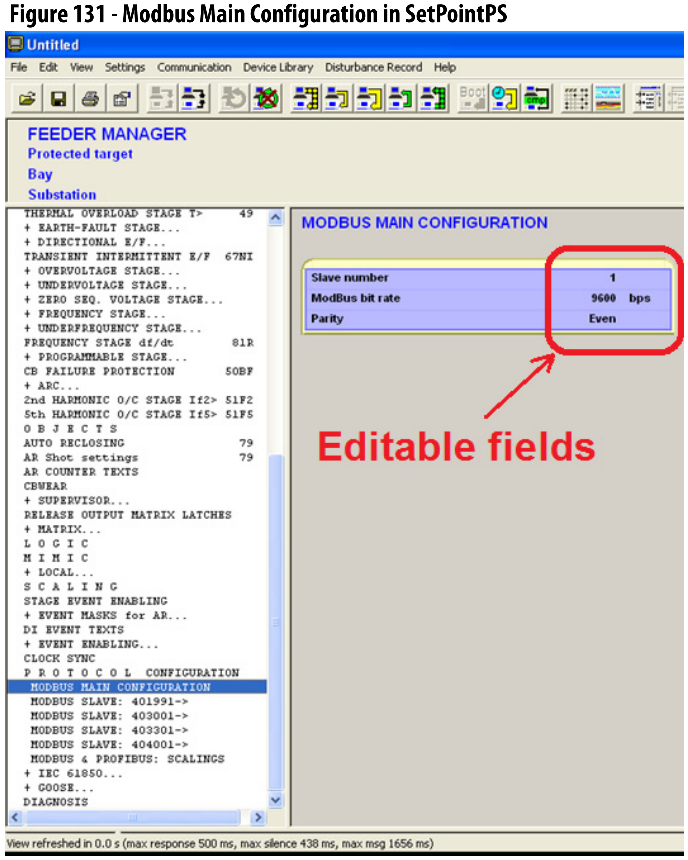
After the protocol is activated, it must be configured with SetPointPS in the Modbus Main Configuration. Go to the group view that is located under the Protocol Configuration item in the Group List, see Figure 131.

IMPORTANT	To set a relay to function as a Modbus RTU Slave: select the protocol that is called "ModbusSlv" in SetPointPS and on the Bus-menu of the local display of the relay. Restart the relay for a communication protocol change, for any port, to take effect. The holding register address, which is sent though Modbus, is one less than that indicated by an 857 Protection System. For example, if the Alive Indicator, with the holding register address 2001 (see Figure 127), is sent over a Modbus data link. The frame indicates that the address of the holding register is 2000.

In the Modbus main configuration, you can view the Modbus Slave Address (or number), and the bit rate. You can also set the parity of the connection (highlighted as "Editable fields" in Figure 131).

IMPORTANT	The parity and bit rate must be set to the same value on all devices that are connected to the same data link.

Figure 131 - Modbus Main Configuration in SetPointPS



Clock Synchronization

The internal clock of a relay can be synchronized through the Modbus protocol. This feature is not a Modbus protocol, but an 857 Protection System specific system. The accuracy of the clock synchronization is in the scale of a few hundred milliseconds.

The clock can be synchronized (all fields: seconds, minutes, hours, days, month, and year) or by synchronizing only the minutes, which in turn sets the seconds and milliseconds to zero.

EXAMPLE For minute synchronization, when the reference clock is 7 minutes past (any hour), a minute synchronization is performed. The result is that the internal clock, of the relay, is set to HH: 07:00.000 ("Hours: Minutes: Seconds: Milliseconds") "HH" does not change. As a recommendation, perform time synchronization hourly.

These two ways to synchronize the clock, "Set RTC", where "RTC" represents "Real-Time Clock" and "Synchronize Minutes" in the data map. The holding register address of the minute synchronization is 2502. See Table 133 for the holding registers allocated to the *Set RTC* synchronization.

Table 133 - Description of Holding Registers Allocated to Set RTC Synchronization

The Holding Register	Content
402504	Lower byte: seconds, milliseconds are Zero
402505	Upper byte: Minutes Lower byte: Hours
402506	Upper byte: Day Lower byte: Month
402507	Year

Events

Use the Modbus RTU Protocol to read the event buffer of an 857 Protection System, one event at a time, from the holding registers 2101…2105. The event registers contain the latest event, and are cleared when they are read. The registers are then updated to contain the following event from the event buffer. A description of the registers is shown in Table 134.

If an error occurs when reading an event from registers 2101…2105, then the previously read event is available registers 2490…2494 for re-reading.

IMPORTANT Events can also be read from holding registers996…2000.

Events are coded with a numbering starting from 0…8900 (software version Rockwell Automation® 12.001. New features are added to software that create event codes. For the meaning of event codes, contact Rockwell Automation or run the GETSET-command "to get event codes" in the SetPointPS Terminal. To start type "Ctrl + T".

Table 134 - Description of Events in Holding Registers

The Holding Register	Content
402101	Event Code
402102	Event Time Stamp Bits 15…6 = milliseconds Bits 5…0 = seconds
402103	Event Time Stamp Upper byte: Minutes Lower byte: Hours
402104	Event Time Stamp Upper byte: Day Lower byte: Month
402105	Event Time Stamp, Year

Scaling

The holding registers are 16 bits. They can directly represent $2^{16} = 65535$ simultaneously values, which are not enough to describe the values of some physical quantity such as voltage or power. Therefore, values that are transmitted over a Modbus data link must be scaled.

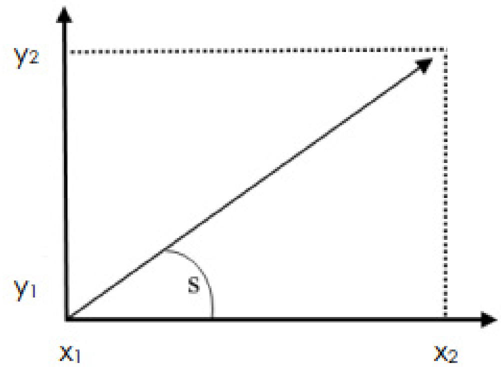
The equation of the line where two points are connected in a two-dimensional space (x_1, y_1) and (x_2, y_2) determines the scaling. That is, the trajectory of the line and the offset from origin (Figure 132).

IMPORTANT	There is no offset in the example if the point (x1, y1) is assumed to lie at the origin.

It is common to use a scale factor with base ten (10, 100, 1000…) since, in such cases, the original measurements only lose decimals. The values are easy to read and rescale to actual values on the client side after transmission.

IMPORTANT	Scaled measurements get rounded.

Figure 132 - Line Defined by Two Points in a Two Dimensional Space



Settings for scaling can be used for the power-, power factor-, tan phi-, voltage-, and frequency scaling. Settings can be done by navigating to the MODBUS & PROFIBUS: SCALINGS item in the Group List in SetPointPS (see Figure 134.

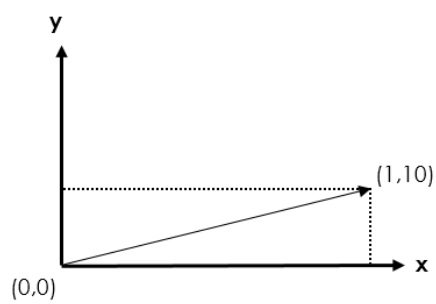
A short example: The frequency is internally (in the relay) stored as an integer value, which also holds three decimal places, that is, 50.000 Hz is represented as 50000. A value too large to be represented with 16 bits (signed integer). By default, frequency is scaled with the points: $(x_1, y_1) = (0, 0)$ and $(x_2, y_2) = (10, 1)$ (see Figure 133 and Figure 134), so it to be sent over Modbus.

The slope is: $\frac{y_2 - y_1}{x_2 - x_1} = \frac{1 - 0}{10 - 0} = 0.1$ and there is no offset.

Thus, the value on the receiving side (the Modbus value) is:

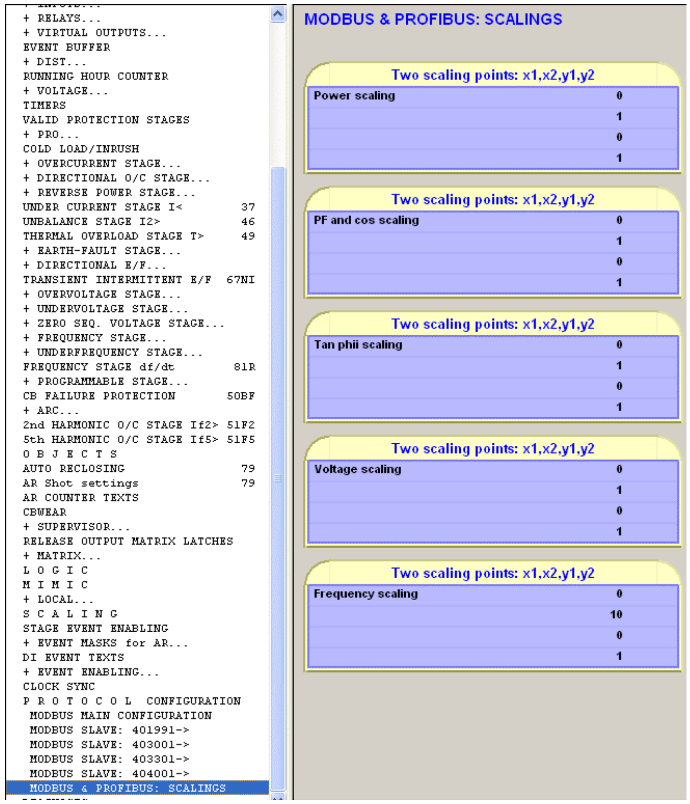
$$value_{modbus} = k \bullet value_{internal} = 0.1 \bullet 50000 = 5000$$

Figure 133 - Default Frequency Scaling



To make sure that a scaling has been set as intended, it can be checked in SetPointPS by viewing the Scaling column for each holding register in the *MODBUS SLAVE: 40xxxx->* items in the Group List in SetPointPS, see Figure 135.

Figure 134 - Default Scaling Settings in SetPointPS



An example is shown in Figure 136, which shows the voltage scaling changed (x_2 changed to 10 from 1). Figure 137, shows the meaning of the scaling for some affected and non-affected holding registers. Compare the value of the scaling for the holding registers that use Voltage scaling in Figure 135.

IMPORTANT It is highly recommended to scale values so that they are kept in the interval 0…32768 to avoid overflow.

Figure 135 - Meaning of the Default Scaling for Some Holding Registers

Read-only items 401991->

	Name	Access	Scaling	Setting for scaling	Address
[1]	Reread event	R -	1 = 1	-	401991...401995
[2]	Events	R -	1 = 1	-	401996...402000
[3]	Alive indicator	R -	1 = 1	-	402001
[4]	DI	R -	1 = 1	-	402007
[5]	DIs after DI16 for ModBus	R -	1 = 1	-	402008
[6]	Phase current IL1	R -	1 A = 1	-	402009
[7]	Phase current IL2	R -	1 A = 1	-	402010
[8]	Phase current IL3	R -	1 A = 1	-	402011
[9]	Io1 residual current	R -	1.00 A = 100	-	402012
[10]	Io2 residual current	R -	1.000 A = 1000	-	402013
[11]	Line-to-line voltage U12	R -	1000 V = 1000	Voltage scaling	402014
[12]	Line-to-line voltage U23	R -	1000 V = 1000	Voltage scaling	402015
[13]	Line-to-line voltage U31	R -	1000 V = 1000	Voltage scaling	402016
[14]	Phase-to-earth voltage UL1	R -	1000 V = 1000	Voltage scaling	402017
[15]	Phase-to-earth voltage UL2	R -	1000 V = 1000	Voltage scaling	402018
[16]	Phase-to-earth voltage UL3	R -	1000 V = 1000	Voltage scaling	402019
[17]	Zero sequence voltage	R -	1.0 % = 10	-	402020
[18]	Frequency	R -	50.000 Hz = 5000	Frequency scaling	402021
[19]	Active power	R -	1000 kW = 1000	Power scaling	402022
[20]	Reactive power	R -	1000 kvar = 1000	Power scaling	402023
[21]	Apparent power	R -	1000 kVA = 1000	Power scaling	402024
[22]	Power factor	R -	1.00 = 100	PF and cos scaling	402025

Figure 136 - Voltage Scaling Is Changed from Default

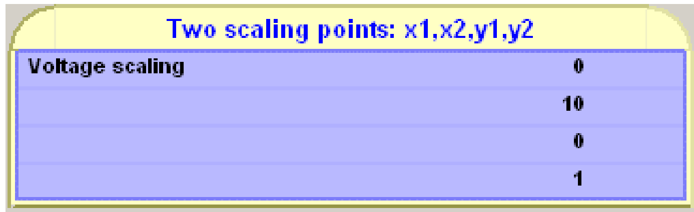


Figure 137 - Result of the Change in Voltage Scaling

[9]	Io1 residual current	R -	1.00 A = 100	-	402012
[10]	Io2 residual current	R -	1.000 A = 1000	-	402013
[11]	Line-to-line voltage U12	R -	1000 V = 100	Voltage scaling	402014
[12]	Line-to-line voltage U23	R -	1000 V = 100	Voltage scaling	402015
[13]	Line-to-line voltage U31	R -	1000 V = 100	Voltage scaling	402016
[14]	Phase-to-earth voltage UL1	R -	1000 V = 100	Voltage scaling	402017
[15]	Phase-to-earth voltage UL2	R -	1000 V = 100	Voltage scaling	402018
[16]	Phase-to-earth voltage UL3	R -	1000 V = 100	Voltage scaling	402019
[17]	Zero sequence voltage	R -	1.0 % = 10	-	402020
[18]	Frequency	R -	50.000 Hz = 5000	Frequency scaling	402021
[19]	Active power	R -	1000 kW = 1000	Power scaling	402022
[20]	Reactive power	R -	1000 kvar = 1000	Power scaling	402023
[21]	Apparent power	R -	1000 kVA = 1000	Power scaling	402024
[22]	Power factor	R -	1.00 = 100	PF and cos scaling	402025

Modbus TCP

Modbus TCP (or Modbus TCP/IP) is the Modbus protocol encapsulated with a TCP interface that runs on Ethernet. TCP/IP refers to the Transmission Control Protocol and Internet Protocol that provide the transmission medium for Modbus TCP/IP messaging. In practice, Modbus TCP embeds a standard Modbus data frame into a TCP frame.

Several devices can be connected to one IP address, provided the appropriate equipment is used (some Modbus TCP-to-Modbus RTU bridge). These devices are differentiated from each other with a *Unit Identifier* in the TCP frame, which corresponds to the *Slave ID*. The range of the Unit Identifier is 1…247. In VAMP relays, the Modbus Slave ID corresponds to the Unit Identifier when Modbus TCP is used, see Figure 131.

IMPORTANT	Default port for Modbus TCP is 502. There are cases where it can change depending on the device that is used to poll it.

Configuration

The Modbus TCP protocol is activated by configuring the Ethernet port settings (Figure 138). The IP address, subnet mask, and Gateway must be set.

IMPORTANT	857 Protection Systems do not support DHCP, Dynamic Host Configuration Protocol, and require a static IP address to be configured

Considered DHCP before connecting a relay to an existing network, so that no conflicts emerge

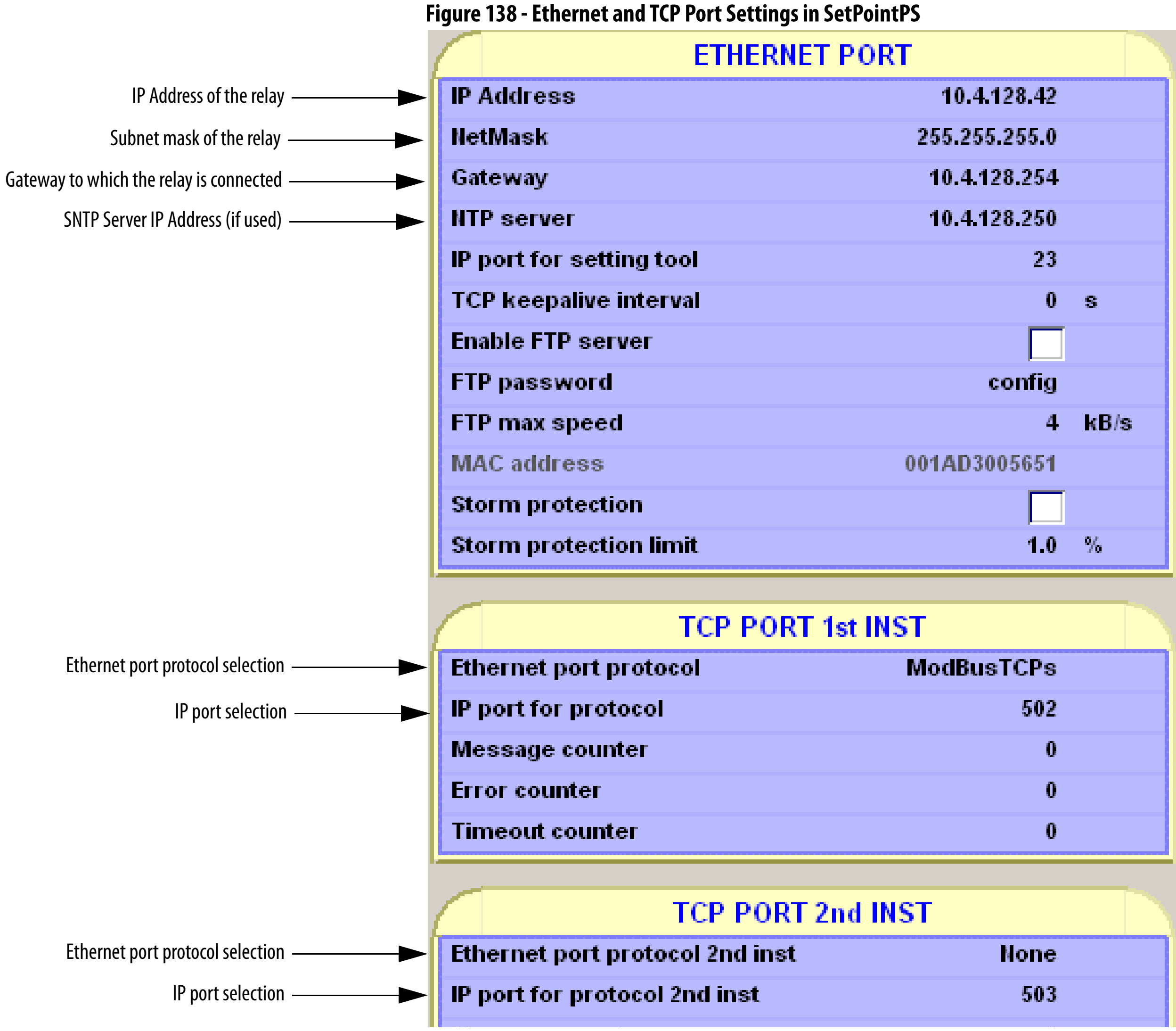
IMPORTANT	There are two TCP port instances "TCP PORT first INST" and "TCP PORT second INST", that is, two independent sockets for two simultaneously protocols. The default TCP/IP port for Modbus TCP is 502.

When these settings are configured, one of the TCP PORT *Ethernet port protocol* selections can be set to "ModbusTCPs" (Modbus TCP, slave), see Figure 138.

Before the protocol is activated, SetPointPS prompts for a device restart when any of the settings, mentioned earlier, are changed.

Data access can be done by using SNTP (Simple Network Time Protocol). SNTP is used for reading and writing to the holding registers, event reading, clock synchronization, and scaling work as described in the previous sections, with the addition that clock synchronization. An NTP server is required with the address set in the Ethernet Port setting-section of the Protocol Configuration view in SetPointPS, see Figure 138.

Figure 138 - Ethernet and TCP Port Settings in SetPointPS



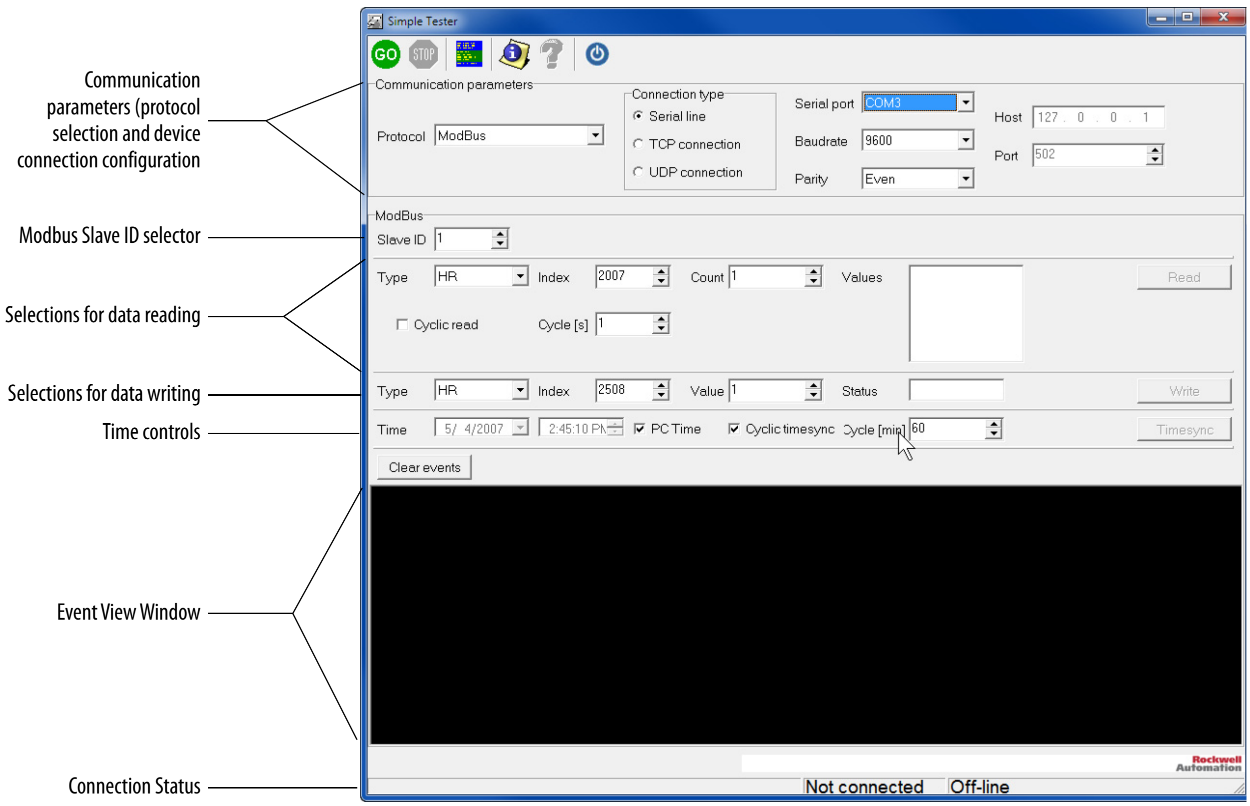
Testing Modbus with Simple Tester

This section gives examples of how to test that the Modbus protocol (Modbus RTU or Modbus TCP) is successfully configured using the 857 Protection System protocol test tool, Simple Tester.

Simple Tester Overview

Simple Tester is a basic protocol tool for testing (for Personal Computer) that supports several protocols, including Modbus RTU and TCP. Simple Tester can be used to test reading data from the holding registers, writing to the holding registers, event viewing, and clock synchronization from the personal computer. The user interface of Simple Tester with Modbus selected as protocol (but not connected to a relay) is shown and explained in Figure 139. Simple Tester can be requested from Rockwell Automation® as required.

Figure 139 - User Interface of Simple Tester with Modbus Selected as Protocol



Connect with Modbus RTU

To connect a relay with Modbus RTU, the device must first be configured as described in Configuration on page 261. A physical connection must be made to the relay. As the physical connection varies depending on the relay models and selection of serial ports to be used, the making of the physical connection is not described in this section.

When a physical connection has been made, Simple Tester can be connected to the relay with these steps:

1. Select “Modbus” in the *Protocol* selector in the *Communication Parameters* section.
2. In the *Connection type* selection, mark *Serial line*. Select the COM-port that corresponds to the USB port (or personal computer serial port if available) to which the relay is connected to.
3. Set the *Communication Rate* (bit rate) and *Parity* to the same values as the relay is configured to use.
4. Set the *Slave ID* in the Modbus Slave ID selector to the slave ID set on the relay.
5. Click “GO”.
6. OK indicates a successful connection. OK is displayed in the rightmost connection Status Indicator furthest down in the Simple Tester window. An example of a successful connection is shown in Figure 6.

Connect with Modbus TCP

To connect a relay with Modbus TCP, the device Ethernet port and TCP port instances must be configured as described in Modbus TCP on page 268. An Ethernet connection (physical) to the relay from the personal computer that is running Simple Tester must be made.

To connect Simple Tester to a relay configured to use Modbus TCP, follow these steps:

1. Select “Modbus” in the *Protocol* selector in the *Communication Parameters* section.
2. In the *Connection type* selection, mark *TCP Connection* and set the *Host* to the IP address set on the relay.
3. Set the *Port* to the same TCP/IP port as configured on the relay. (“IP port for protocol in Figure 138).
4. Set the *Slave ID* in the Modbus Slave ID selector to the slave ID set on the relay.
5. Click “GO”.

6. OK indicates a successful connection. OK is displayed in the rightmost connection status indicator furthest down in the Simple Tester window. An example of a successful connection is shown in Figure 140.Simple Tester When Connected with Modbus RTU

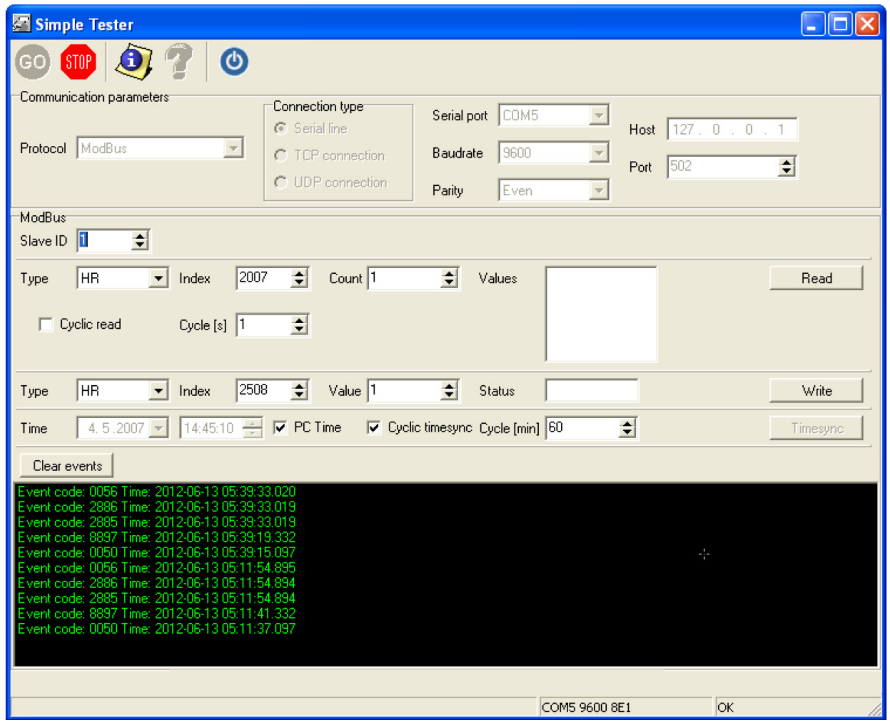
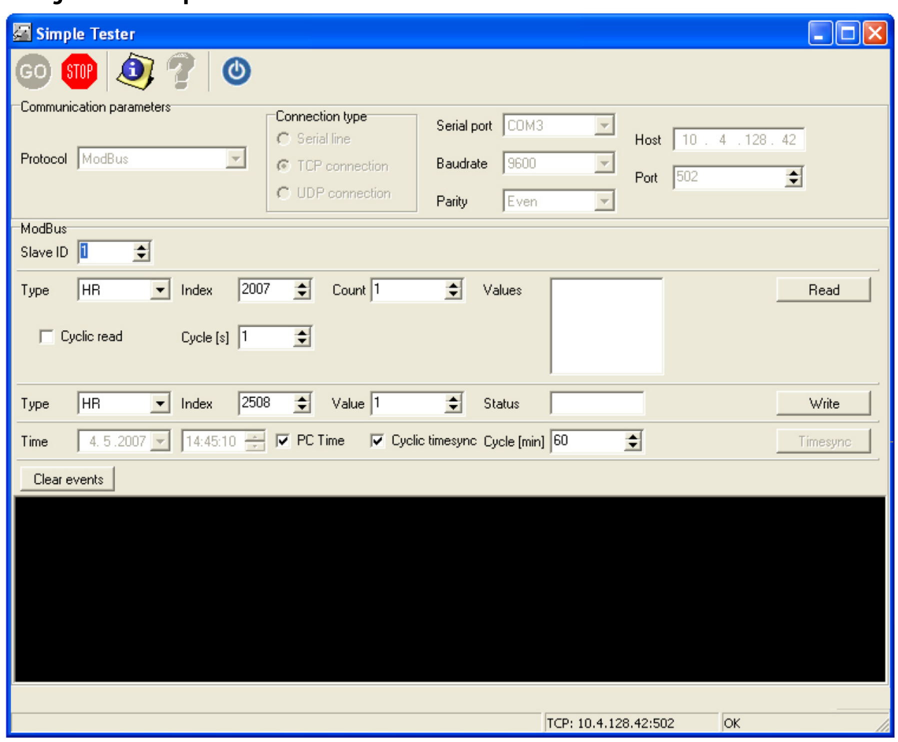


Figure 140 - Simple Tester When Connected with Modbus TCP



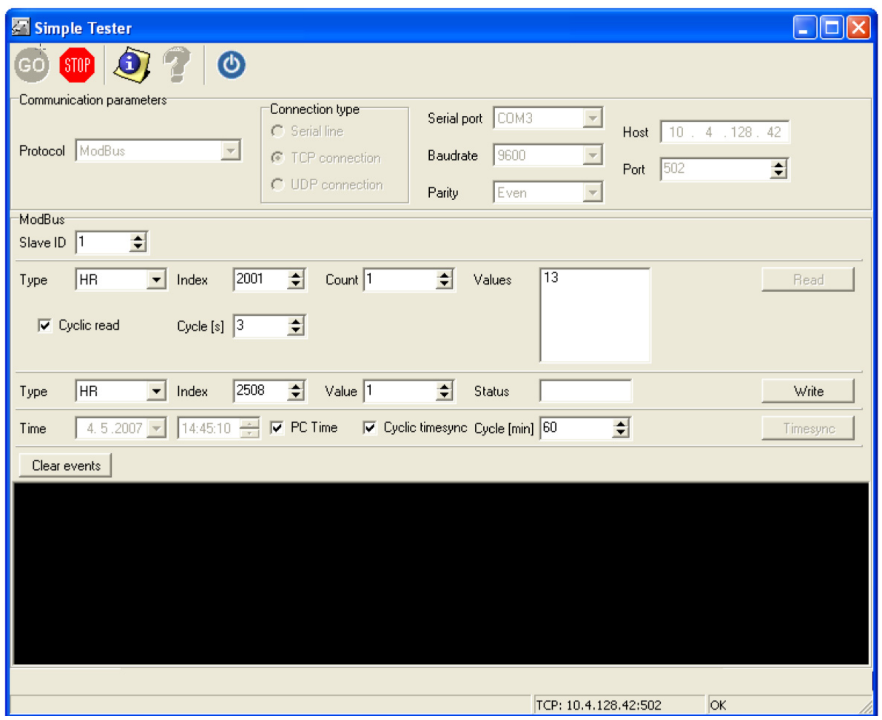
Read Data

To read Data, follow these steps (for reference see Figure 6 or Figure 140):

1. Set *Type* of Data (HR = Holding register).
2. Select which *Index* to be read, to read some data item from an 857 Protection System (see the Data map that is provided by SetPointPS, see Figure 127).
3. The *Count* value indicates how many consecutive indices are read. For instance, setting Index to 2001 and Count to Click2 displays the values of Index 2001 and Index 2002 in the *Values*-box.
4. To initiate a read, click *Read*. Reads can also be done cyclically, by checking the *Cyclic read* box. To change the length of one cycle, set a value in the *Cycles* field (seconds).

Figure 141 features an example of reading the Alive Counter (HR 2001) cyclically every 3 seconds.

Figure 141 - Performing a Cyclic Read on the Alive Counter with Simple Tester

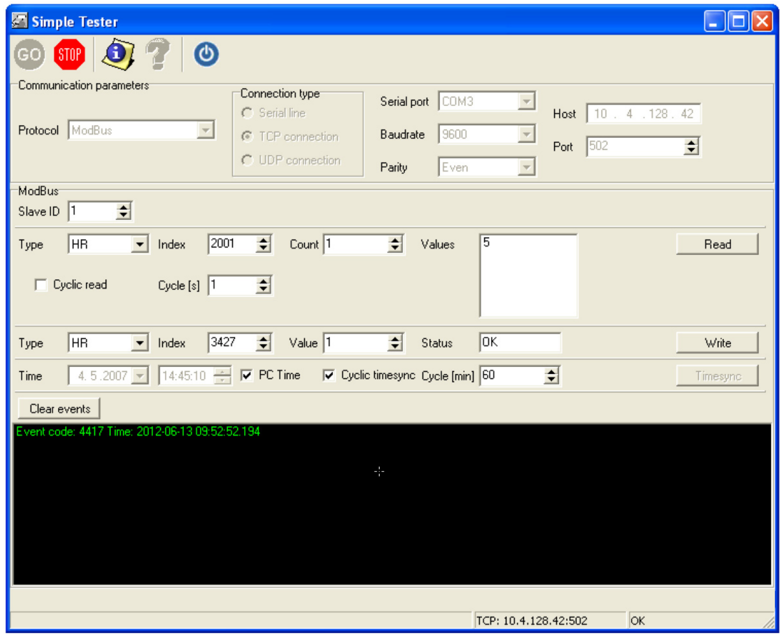


Write Data

1. Set *Type* of Data to be written. (HR = Holding register).
2. Select which *Index* is used
3. Set *Value* to be written.
4. Click *Write*.
5. The *Status* field indicates the success of the operation.

Figure 142 features an example of the value 1 to Virtual Input 1 (the holding register 3427).

Figure 142 - Simple Tester after Write to Virtual Input 1



The Event view of Simple Tester now contains an event, which corresponds to "Virtual Input 1 ON".

If there are events in the event buffer when Simple Tester is connected, they are listed in the event view. Writes that are done with Simple Tester trigger new events that also show up.

A clock synchronization can be performed with Simple Tester. Set the desired behavior in the Time Controls (Figure 139).

The two leftmost fields are used for setting the time manually. The time can be taken from the personal computer, by checking the Time checkbox in Simple Tester.

To set the clock synchronization to be cyclic, check the Cyclic timesync checkbox in Simple Tester. The length of a cycle is set in the rightmost field (minutes).

PROFIBUS DP

The PROFIBUS DP protocol is widely used in parts of the world. An external module (857-VPA3CG) is required along with an 857-VX007-F3 cable. See publication 857-UM003, which includes the code available for the continuous mode and request mode.

Device Profile "Continuous Mode"

In this mode, the device is sending a configured set of data parameters continuously to the PROFIBUS DP master. The benefit is the speed and easy access to the data in the PROFIBUS master. The drawback is the maximum buffer size of 128 bytes, which limits the number of data items that are transferred to the master. Some PLCs have their own limitation for the PROFIBUS buffer size, which can further limit the number of transferred data items.

Device Profile "Request Mode"

Use the request mode to read all available data from the 857 device and still use only a short buffer for PROFIBUS data transfer. The drawback is slower data transfer and increased data that is processed at the PROFIBUS master. The master requests every data item separately.

TIP In request mode, it is not possible to read continuously — only one single data item. At least two data items must be read in turn to get updated data from the device.

Available Data

SetPointPS shows the list of all available data items for both modes.

The PROFIBUS DP communication is activated for remote port through a menu selection with parameter "Protocol". See Communication Ports on page 251.

Table 135 - PROFIBUS DP Parameters

Paramete r	Value	Unit	Description	Note
Mode	 Cont Reqst		Profile selection: Continuous mode Request mode	Set(1)
bit/s	2400	bps	Communication speed from the main CPU to the PROFIBUS converter. The PROFIBUS master automatically sets the actual PROFIBUS bit rate and can be up to 12 Mbit/s.	
Emode	 Channel (Limit60) (NoLimit)		Event number style: Used for new installations. (The other modes are for compatibility with old systems).	(Set)
InBuf		bytes	Size of PROFIBUS master Rx buffer. (data to the master).	(2)(4)
OutBuf		bytes	Size of PROFIBUS master Tx buffer. (data from the master).	(3)(4)
Addr	1…247		This address must be unique within the PROFIBUS network system.	Set(1)
Conv	 – VE		Converter type: No converter is recognized Converter type "VE" is recognized	(5)

(1) Set = An editable parameter (password required).
(2) In continuous mode, the size depends on the biggest configured data offset of a data item to be sent to the master. In request mode, the size is 8 bytes.
(3) In continuous mode, the size depends on the biggest configured data offset of a data to be read from the master. In request mode, the size is 8 bytes.
(4) When configuring the PROFIBUS master system, the length of these buffers is needed. The device calculates the lengths according to the PROFIBUS data and profile configuration, and the values define the in/out module to be configured for the PROFIBUS master.
(5) If the value is "–", PROFIBUS protocol has not been selected or the device has not restarted after protocol change. Or there is a communication problem between the main CPU and the PROFIBUS ASIC.

SPA-Bus

The 857 relay has full support for the SPA-bus protocol including reading and writing the setting values. Reading multiple (or consecutive) status data bits, measurement values, or setting values with one message is supported.

Several simultaneous instances of this protocol that simultaneously physical ports are possible, but one instance reads the events. Contact Rockwell Automation® for more details.

Table 136 - SPA-Bus Parameters

Parameter	Value	Unit	Description	Note
Addr	1…899		SPA-bus address. Must be unique in the system.	Set[1]
bit/s	1200 2400 4800 9600 (default) 19200	bps	Communication speed	Set[1]
Emode	 Channel (Limit60) (NoLimit)		Event number style: Used for new installations. (The other modes are for compatibility with old systems).	(Set)

(1) Set = An editable parameter (password required).

IEC 60870-5-103

The IEC standard 60870-5-103 *"Companion standard for the informative interface of protection equipment"* provides standardized communication interface to a primary system (master system).

The unbalanced transmission mode of the protocol is used, and the device functions as a secondary station (slave) in the communication. Data is transferred to the primary system by using "data acquisition by polling" principle. The IEC functionality includes these application functions:

- Station initialization
- General interrogation
- Clock synchronization and
- Command transmission

Parameter data or disturbance recordings cannot transfer through the IEC 103 protocol interface.

Application Service Data Unit (ASDU) types are used in communication from the device are:

- ASDU 1: time tagged message
- ASDU 3: Measurands I
- ASDU 5: Identification message
- ASDU 6: Time synchronization and
- ASDU 8: Termination of general interrogation

The device accepts:

- ASDU 6: Time synchronization
- ASDU 7: Initiation of general interrogation and
- ASDU 20: General command

The identity of the message frame data is by:

- Type identification
- Function type
- Information number

These identifications are fixed for data items in the compatible range of the protocol. For example, the trip of I> function has: type identification = 1, function type = 160 and information number = 90. “Private range” function types are used for data items that are undefined by the standard. For example, the status of the digital inputs and the control of the objects.

The function type and information number that is used in private range messages is configurable to enable flexible interfacing to simultaneously master systems. For more information on IEC 60870-5-103 in the 857 Protection System, contact Rockwell Automation.

Table 137 - Parameters

Parameter	Value	Unit	Description	Note
Addr	1…254		A unique address within the system	Set[1]
bit/s	9600 19200	bps	Communication speed	Set[1]
MeasInt	200…10000	ms	Minimum measurement response-interval	Set[1]
SyncRe	Sync Sync+Proc Msg Msg+Proc		ASDU6 response time mode	Set[1]

(1) Set = An editable parameter (password required).

Table 138 - Parameters for Disturbance Record Reading

Parameter	Value	Unit	Description	Note
ASDU23	On Off		Enable record info message	Set[1]
Smpls/msg	1…25		Record samples in one message	Set[1]
Timeout	10…10000	s	Record the reading timeout	Set[1]
Fault			Fault identifier number for IEC-103. Starts + trips of all stages.	
TagPos			Position of read pointer	
Chn			Active channel	
ChnPos			Channel read position	
Fault numbering				
Faults			Total number of faults	
GridFlts			Fault burst identifier-number	
Grid			Time window to classify faults together to the same burst.	Set[1]

(1) Set = An editable parameter (password required).

DNP 3.0

The relay uses DNP 3.0 protocol to support communication.

These DNP 3.0 data types are supported:
- Binary input
- Binary input change
- Double-bit input
- Binary output
- Analog input
- Counters

A menu selection activates DNP 3.0 communication. RS-485 interface is often used but also RS-232 and fiber-optic interfaces are possible.

Table 139 - DPN 3.0 Parameters

Parameter	Value	Unit	Description	Set
bit/s	4800 9600 (default) 19200 38400	bps	Communication speed	Set(1)
Parity	None (default) Even Odd		Parity	Set(1)
SlvAddr	1…65519		A unique address for the device within the system	Set(1)
MstrAddr	1…65519 (255 = default)		Address of master	Set(1)
LLTout	0…65535	ms	Link layer confirmation-timeout	Set(1)
LLRetry	1…255 (1 = default)		Link layer retry-count	Set(1)
APLTout	0…65535 (5000 = default)	ms	Application layer confirmation-timeout	Set(1)
CnfMode	EvOnly (default) All		Application layer confirmation-mode	Set(1)
DBISup	No (default) Yes		Double-bit input support	Set(1)
SyncMode	0…65535	s	Clock synchronization request-interval. 0 = only at boot.	Set(1)

(1) Set = An editable parameter (password required).

IEC 60870-5-101

The IEC 60870-5-101 standard is derived from the IEC 60870-5 protocol standard definition. In 857 devices, IEC 60870-5-101 communication protocol is available through menu selection. The 857 relay works as a controlled outstation (slave) unit in unbalanced mode.

Supported application functions include process data transmission, event transmission, command transmission, general interrogation, clock synchronization, transmission of integrated totals, and acquisition of transmission delay.

For more information on IEC 60870-5-101 with the 857, contact Rockwell Automation.

Table 140 - IEC 60870-5-101 Parameters

Parameter	Value	Unit	Description	Note
bit/s	1200 2400 4800 9600	bps	Bitrate that is used for serial communication.	Set(1)
Parity	None Even Odd		Parity that is used for serial communication	Set(1)
LLAddr	1…65534		Link layer address	Set(1)
LLAddrSize	1…2	bytes	Size of Link layer address	Set(1)
ALAddr	1…65534		ASDU address	Set(1)
ALAddrSize	1…2	Bytes	Size of ASDU address	Set(1)
IOAddrSize	2…3	Bytes	Information object address-size. (3-octet addresses are created from 2-octet addresses by adding MSB with value 0).	Set(1)
COTsize	1	Bytes	Cause of transmission size	
TTFormat	Short Full		The parameter determines time tag format: 3-octet time tag or 7-octet time tag.	Set(1)
MeasFormat	Scaled Normalized		The parameter determines measurement data format: normalized value or scaled value.	Set(1)
DbandEna	No Yes		Deadband calculation enable flag	Set(1)
DbandCy	100…10000	ms	Deadband calculation interval	Set(1)

(1) Set = An editable parameter (password required).

External I/O (Modbus RTU Master)

External Modbus I/O devices can be connected to the device uses this protocol. See External Input/Output Modules on page 336 for more information.

IEC 61850

IEC 61850 protocol with native implementation is used by relay to support communication. IEC 61850 protocol is available with the optional in-built Ethernet port. The protocol can be used to read/write static data from the relay or to receive events and to receive/send GOOSE messages to other relays.

See publication 857-UM004, Bulletin 857/865 Protection Systems IEC 61850 Interface Configuration Instructions, for complete details on relay configuration and 61850 protocol troubleshooting.

IEC 61850 serve interface has:

- Configurable data model: selection of logical nodes that correspond to active application functions
- Configurable pre-defined data sets
- Supported dynamic data sets created by clients
- Supported report function with buffered and unbuffered Report Control Blocks
- Supported control model: direct with normal security
- Supported horizontal communication with GOOSE: configurable GOOSE publisher data sets, configurable filters for GOOSE subscriber inputs, GOOSE inputs available in the application logic matrix

Table 141 - IEC 61850 Parameters

Parameter	Value	Unit	Description	Note
Port	0…64000		IP protocol port	Set(1)
Check upper addresses	Yes No		If the checkbox "Check upper addresses" is checked, the parameters are also checked and used for addressing when the client is communicating to the device. By default "Check upper addresses" is disabled. The following parameters are ACSE association parameters that are described in the standard part 61850-8-1.	Set(1)
AP ID	nnn.nnn.nnn.n nn		ACSE AP title value.	Set(1)
AE Qualifier	0…64000		ACSE AE qualifier.	
P Selector	0…420000000 0		Presentation selector.	
S Selector	0…64000		Session selector.	
T Selector	0…64000		Transport selector.	
IED Name	String		Identification of the device. Each device must have unique name..	
Delete dynamic datasets	Command		Send command to clear all dynamic datasets.	

(1) Set = An editable parameter (password required)

EtherNet/IP

The relay, when configured, uses EtherNet/IP for communication, which is a part of CIP™ (Common Industrial Protocol) family. EtherNet/IP is available with the optional built-in Ethernet port. EtherNet/IP can be used to read / write data from the relay using request / response communication or throough cyclic messages transporting data that are assigned to assemblies (sets of data).

EtherNet/IP main features:

- Static data model: Two standard objects (Overload and Control Supervisor), two private objects (one for digital data and one for analog data), and 14 configuration objects for protection functions configuration. See Appendix C.
- One configurable and eight static assemblies (one producing and one consuming) with the maximum capacity of 128 bytes can be generated at any time. All changes to EtherNet/IP configuration (see configuration parameters in Table 142) or to the assembly content require the generation of the new EDS file.
- Three types are supported: UCMM (one time request/response), Class 3 connection (cyclic request / response), and Class 1 connection (cyclic I/O messages that contain the assembly data).

EtherNet/IP implementation on the 857 relay serves as a server and is not capable of initiating communication.

Table 142 - EtherNet/IP Main Configuration Parameters

Parameter	Range	Description
IP address		IP protocol address identifying the device in the network.
Multicast IP		Multicast IP Address that is used for sending I/O messages.
Multicast TTL	1…100	Time to live of the I/O messages sent to multi-cast address.
Vendor ID	1…65535	Identification of a vendor by number.
Device Type	0…65535	Indication of general type of product.
Product Code	1…65535	Identification of a particular product of an individual vendor.
Major Revision	1…127	Major revision of the item the Identity Object represents.
Minor Revision	1…255	Minor revision of the item the Identity Object represents.
Serial Number	0…429496729 5	Serial number of device.
Product Name	32 chars	Human readable identification.
Producing Instance	1…1278	Instance number of the producing assembly.
Include Run/Idle Header (Producing)	On Off	Include or exclude Run/Idle Header in an outgoing I/O message.
Consuming Instance	1…1278	Instance number of the consuming assembly.
Include Run/Idle Header (Consuming)	On Off	Expect presence or absence of Run/Idle Header in an incoming I/O message.

File Transfer Protocol (FTP) Server

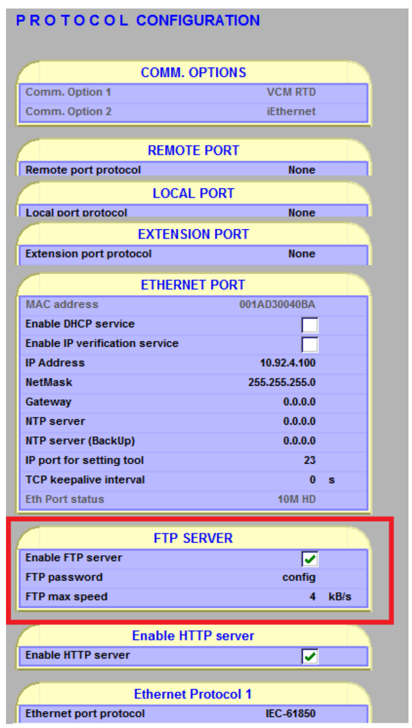
The FTP server is available on the 857 devices that are equipped with a built-in or optional Ethernet card.

The FTP server is used to pull these files from an 857:
- Disturbance recordings.
- The MasterICD and MasterICDEd2 files.

The FTP server can be enabled using one these processes:[1]

- With SetPointPS version 2.2.134 or higher, place a check mark in the box "Enable FTP server" in the Protocol Configuration group (Figure 143).
- Use the 857 HMI by navigating to Bus, Ethernet Port, FTP server, and setting the value to "On".
- Use the Terminal application within SetPointPS. Enter the command "*s ftpserver=On*".

Figure 143 - Configuration of the FTP Server in SetPointPS Version 2.2.134 or Higher.



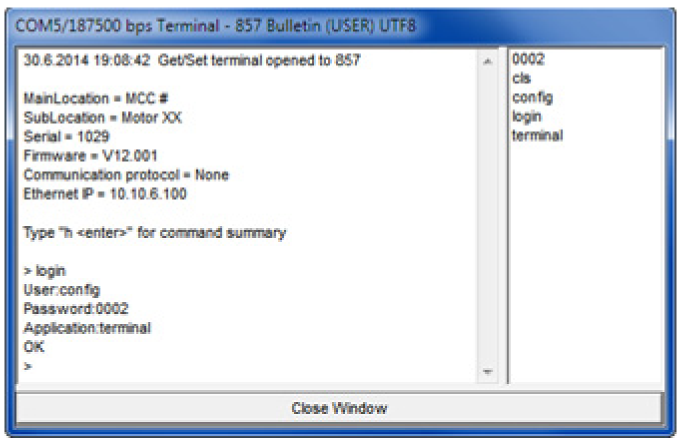
IMPORTANT	For information about how to log in with SetPointPS version 2.2.134 or higher, publication 857-PM001.

(1) In all of these cases, a 0, 1login with configurator access level is required.

To log in use the Terminal routines in SetPointPS and with the 857, follow these Terminal steps (Bold text indicates user entered data).

Step	Parameter	User Input	Result
1	Communication initiation	**Terminal** or [**Control T**]	
2	Login	**login [enter]**	
3	User:	**config [enter]**	The 857prompts you to enter "config".
4	Password:	**2 or 0002 [enter]**	The 857 prompts for a Password to be entered. Enter the password for the configurator access level. In this example, the default password "2" was entered.
5	Application:	**terminal [enter]**	The 857prompts for the Application - enter "terminal".
6		**OK**	Login completed.
7	Command line (>)		Terminal commands can be entered.

Figure 144 - Terminal Command Screen



The MasterICD and MasterICDEd2 files are specific reference files that can be used for offline IEC61850 configuration. The built-in FTP client in Microsoft® Windows or any other compatible FTP client can be used to pull files from the device.

Table 143 - FTP Server Selections

Parameter	Value	Unit	Description	Note
Enable FTP server	Yes		Enable or disable the FTP server.	Set(1)
	No			
FTP password	Max 33 characters		Required to access the FTP server with an FTP client. Default is "config".	Set(1)
FTP max speed	1…10	KB/s	The maximum speed at which the FTP server transfers data.	Set(1)

(1) Set = An editable parameter (password required).

Connect to the FTP Server Using Windows DOS

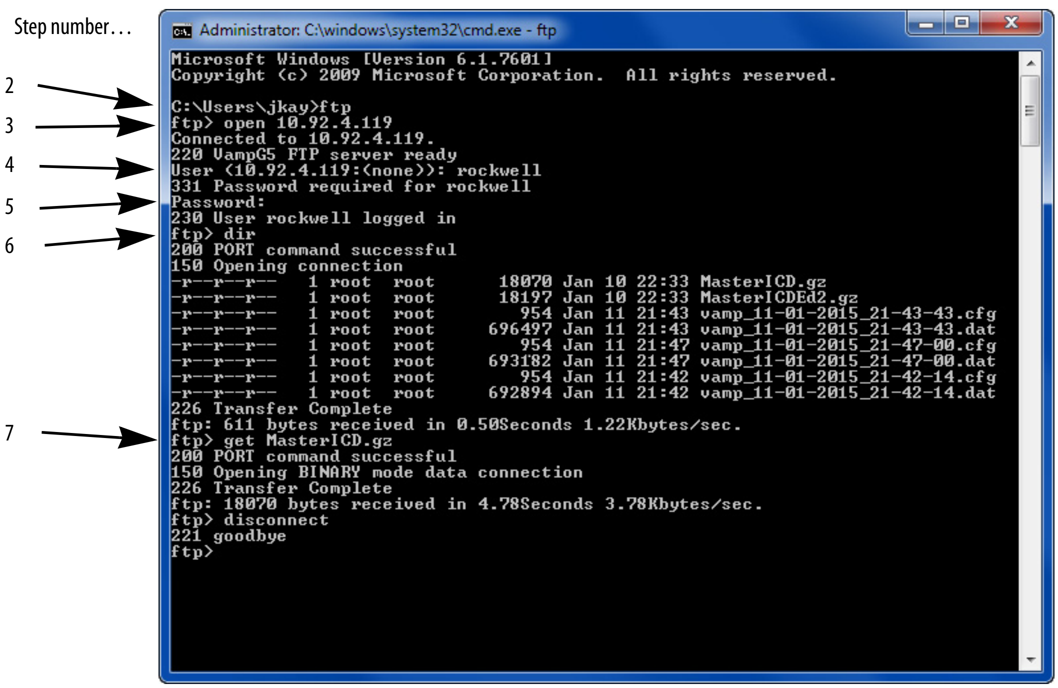
Once the FTP server has been enabled and the Ethernet connection is established between a personal computer and the 857, there are two options for connecting to it: The FTP client through the command-line, and the FTP client by Windows Explorer.

Using the FTP Client in Windows by Command Line

See Figure 145.

1. Click Win + R, type in “cmd”, and click Enter.
2. Type “ftp”, press Enter.
3. Type “open” (+ space) and the IP address of the 857.
4. Type “rockwell” as the user.
5. Type the FTP password. The default password is “config”.
6. Issue the DIR command, to display the available files. Pull any of the files by issuing the command “get” (+ space) and the desired file name.
7. Disconnect from the FTP server by issuing the commands “disconnect” and “bye”. The downloaded file is now in the current directory on the personal computer.

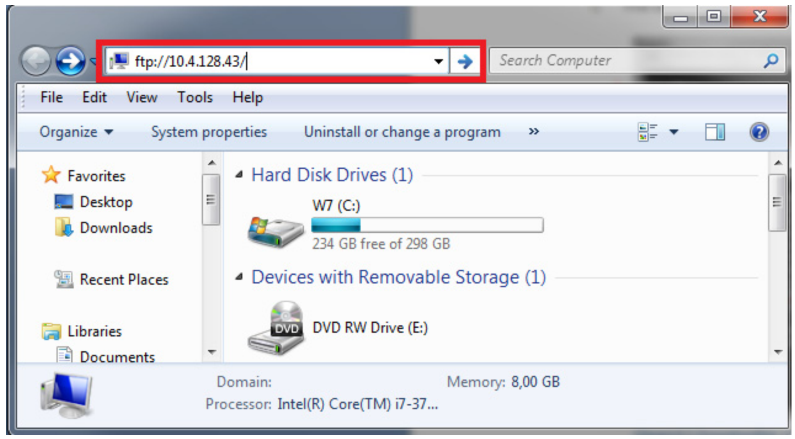
Figure 145 - Pulling a File



Using the FTP Client in Windows Through Windows Explorer

1. Open Windows Explorer.
2. In the Address field, type ftp:// and the IP address of the IED. See Figure 146.
3. Press Enter.

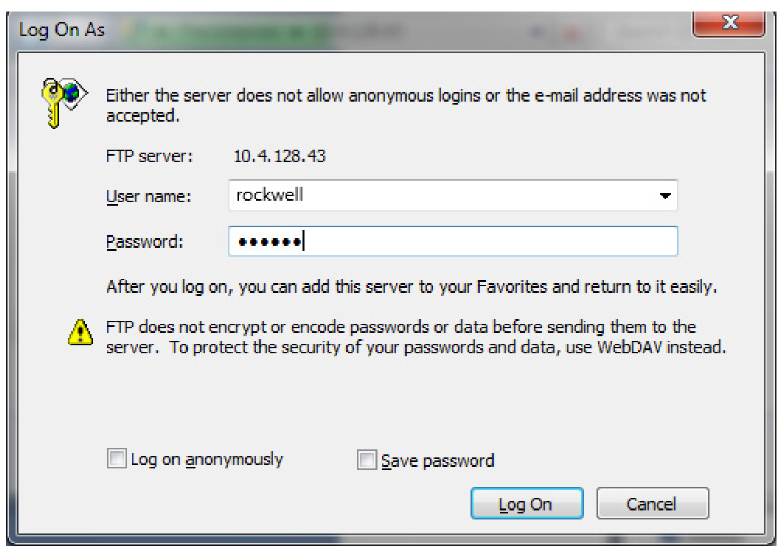
Figure 146 - Enter the IP Address Into the Address Field of Windows Explorer



4. Type user name “vamp” and password into the prompt. The default password is “config”. See Figure 147.
5. Click “Log on”.

   The files appear in the Explorer™ window.

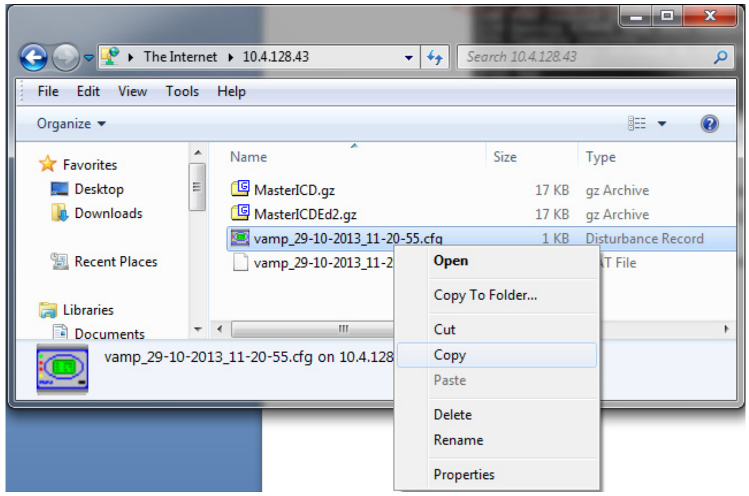
Figure 147 - Enter Credentials Into the FTP Authorization Prompt



6. Right-click on the desired file. Select “Copy” to copy the file to the clipboard. See Figure 148.

   The file can now be pasted to a desired directory on the personal computer.

Figure 148 - Selecting a File for Download by Copying It



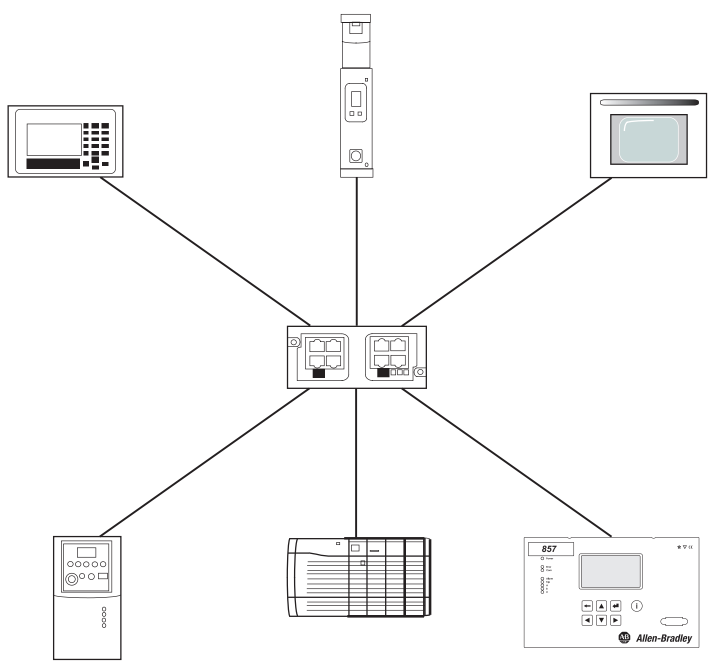
EtherNet/IP

Network Design

The 857 Protection System can be supplied with one Ethernet with a RJ45 port to connect Ethernet CAT5 or better cables or an optional dual fiber-optic interface. Rockwell Automation offers a wide variety of Allen-Bradley® Ethernet patch cables with its Bulletin 1585 line of Ethernet cables (http://ab.rockwellautomation.com/Connection-Devices/RJ45-Network-Media).

The 857 Protection System supports a Star, Linear, and Ring Ethernet topology. A Star Ethernet Topology is shown in Figure 149, where all Ethernet nodes wire back to a central Ethernet switch, hub, or router.

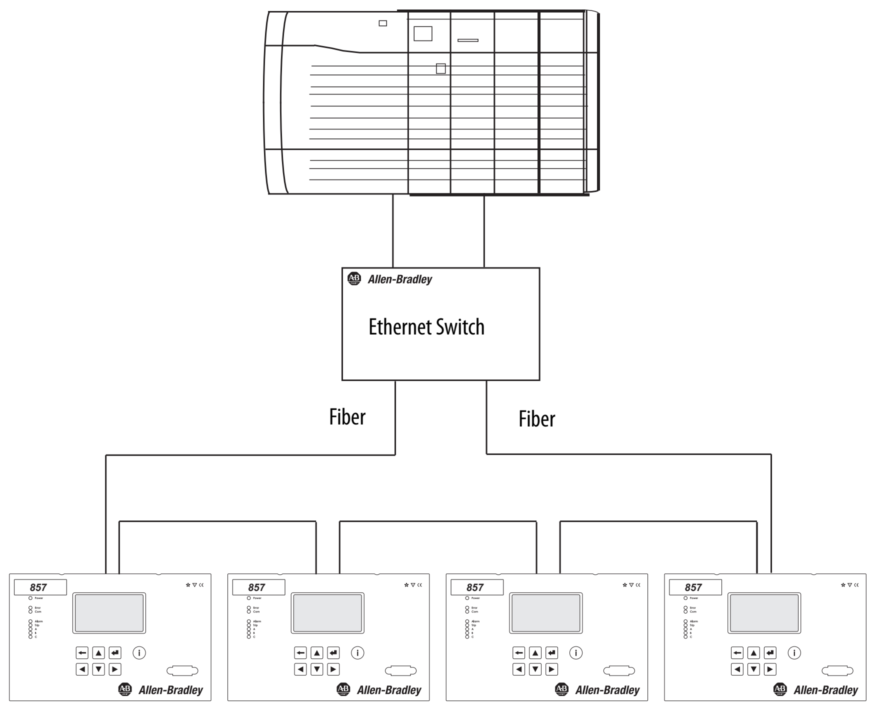
Figure 149 - Star Ethernet Topology



Rockwell Automation offers a line of managed and unmanaged Allen-Bradley® Ethernet switches with its Stratix™ family of Ethernet switches. See http://ab.rockwellautomation.com/Connection-Devices/RJ45-Network-Media for more information.

The EtherNet/IP 857 Protection Relay supports an Ethernet Ring topology. All Ethernet nodes are wired in series with one another until a complete network ring is made as shown in Figure 150. The 857 Protection System supports Rockwell Automation® Device Level Ring (DLR) topology as a slave device. The EtherNet/IP network continues to communicate when one of the network chains is disrupted.

Figure 150 - Ring Ethernet Topology



Determine Network Parameters

To operate an EtherNet/IP network, you must define these parameters.

Table 144 - EtherNet/IP Network Parameters

Network Parameter	Description
IP Address	The IP Address uniquely identifies the module. The IP Address is in the form xxx.xxx.xxx.xxx where each xxx is a number from 0...255. Do not use these IP Addresses, they are reserved values: • 0.0.0.1…0.255.255.255 • 127.0.0.0…127.255.255.255 • 224.255.255.255…255.255.255.255
Subnet Mask	Subnet addressing is an extension of the IP Address scheme that allows a site to use one network ID for multiple physical networks. Routing outside of the site continues by dividing the IP Address into a net ID and a host ID by the class. Inside a site, the Subnet Mask is used to redivide the IP Address into a custom network ID portion and host ID portion. **Important:** If the Subnet Mask of a configured module is changed, cycle power to the module for the change to take effect.
Gateway	A gateway connects individual physical networks into a system of networks. When a node is required to communicate with a node on another network, a gateway transfers the data between the two networks.

Define these parameters if DNS addressing is used or if a Host Name in an MSG instruction references the module.

IMPORTANT Consult with your Ethernet network administrator to determine if these parameters must be specified.

Table 145 - EtherNet/IP Network Parameters for DNS Addressing

Network Parameter	Description
Host Name	A Host Name is part of a text address that identifies the module. The full text address of a module is: *host_name.domain_name*.
Domain Name	A domain name is part of a text address that identifies the domain in which the module resides. The full text address of a module is: *host_name.domain_name*. The domain name has a 48-character limit.
Primary DNS Server Address Secondary DNS Server Address	Identifies any DNS servers that are used in the network. You must have a DNS server that is configured if you specify an SMTP server with a name. The DNS server converts the domain name or Host Name to an IP Address that is used by the network.

Set the Network IP Address

The 857 Protection System is shipped with DHCP disabled. To set the network Internet Protocol (IP) address, use the following tools and software:

- The SetPointPS Configuration Software Tool.
- A Bootstrap Protocol (BOOTP)/Dynamic Host Configuration Protocol (DHCP) server (for example, the Rockwell Automation® BOOTP-DHCP Server Utility, which is included RSLinx® Classic software).
- A web browser and MAC scanner software.

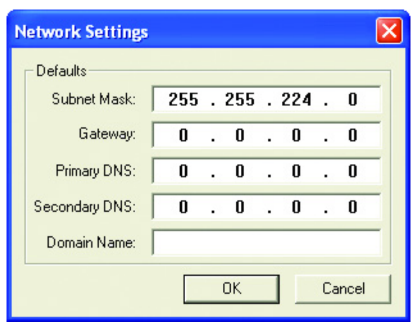
Assign Network Parameters with the BOOTP/ DHCP Utility

By default, the 857 has DHCP disabled. It can only be enabled by using the SetPointPS software. The BOOTP/DHCP utility is a standalone program that is a separate program available as part of the Rockwell Software suite. The utility is located in the BOOTPDHCP Server folder that is accessed from the Start menu.

IMPORTANT	Before starting the BOOTP/DHCP utility, make sure that you have the hardware MAC ID of the module. The module is located in the Port Settings section while connected through the SetPointPS software. The module can also be accessed from the Ethernet display screens from the front panel. The MAC ID has a format similar to the following: 00-0b-db-14-55-35.

This utility recognizes DHCP-enabled devices and provides an interface to configure a static IP address for each device. To assign network parameters with the BOOTP/DHCP utility, perform this procedure:

1. Execute the BOOTP/DHCP software.
2. Choose Tool >Network Settings.
3. If appropriate for the network, type the subnet mask, gateway address, primary/secondary server addresses, and domain name in their respective fields.



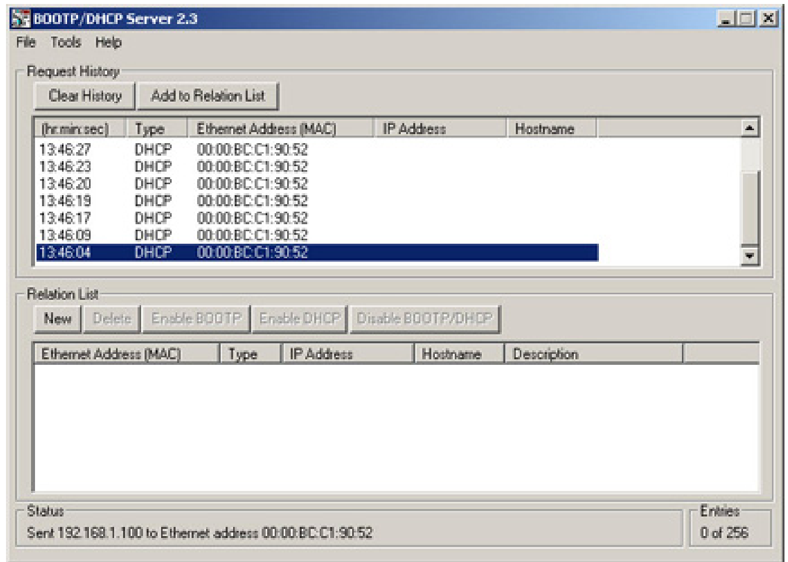
4. Click OK.

   The Request History panel displays the hardware addresses of modules that are issuing BOOTP or DHCP requests.

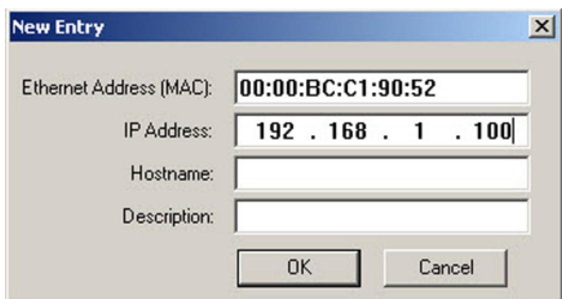
5. Double-click the MAC address of the module to be configured.

IMPORTANT	The MAC address of the relay can be located in the Port Settings while connected through the SetPointPS software or in the Ethernet section from the front panel displays.

The format of the hardware address resembles the following: 00-0b-db-14-55-35.



The New Entry dialog appears with the Ethernet Address (MAC) of the module.



6. Type the IP address, host name, and a module description.
7. Click OK.
8. Cycle power to the 857 Protection System.
9. To assign this configuration to the module permanently: Select the module in the Relation List panel and click Disable BOOTP/DHCP.

When module power is cycled, it uses the assigned configuration and does not issue a DHCP request.

If you do not click Disable BOOTP/DHCP, on a power cycle, the module clears the current IP configuration and starts sending DHCP requests.

Electronic Data Sheet (EDS) File

Before the 857 Relay is configured to communicate on an EtherNet/IP network, it must be registered to the software that configures the network. For example, Rockwell Automation® RSLinx® Classic and RSNetWorx™ for EtherNet/IP software). Register the module by installing an EDS file. EDS files are simple text files that are used by network configuration tools to identify products and commission them on a network. Relay firmware, version 13 and higher, supports an EtherNet/IP EDS AOP approach within the Studio5000 environment. The EDS file for the 857 Protection System can be obtained directly from the relay.

Upload the EDS File

The EDS file for the 857 Protection System is embedded within the device. To upload the file, use the SetPointPS software.

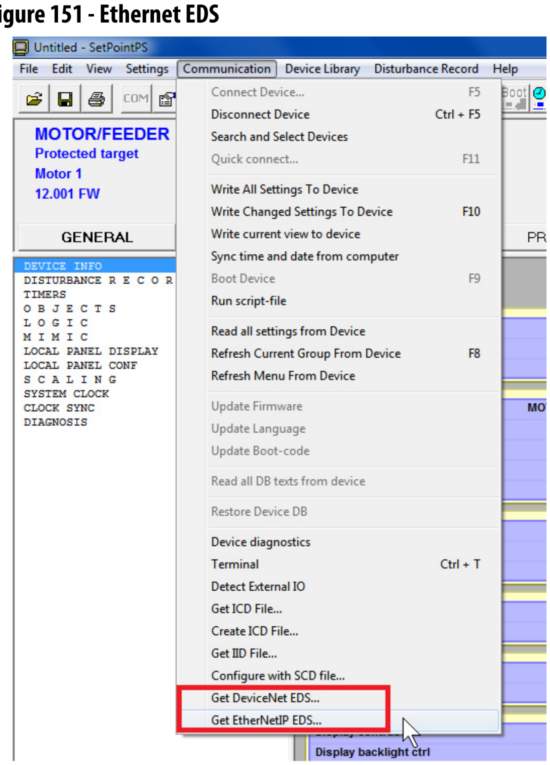
See the Software Programming Tool documentation for details on how to connect to the 857 Protection System.

To upload the current EDS file for the device (recommended), use these steps.

1. Connected to the 857 Protection System in Configurator Mode
2. Select the tab.
3. Click Get Ethernet EDS (Figure 151).

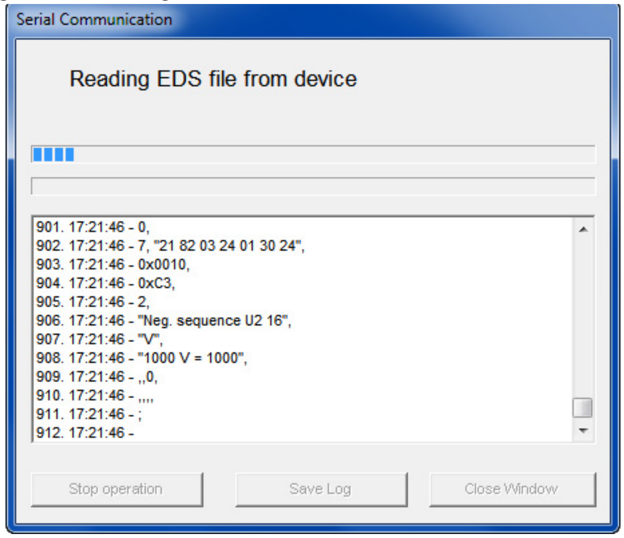
IMPORTANT DeviceNet® is not supported in the 857 Protection System.

Figure 151 - Ethernet EDS



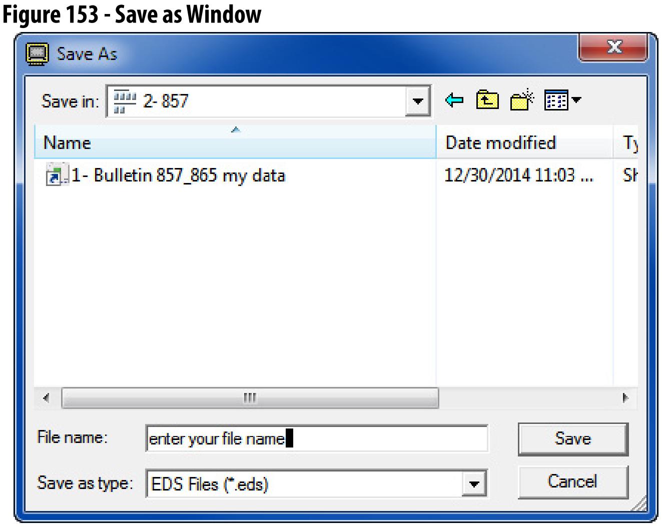
The relay reads the EDS information from the relay in preparation to create an EDS data file.

Figure 152 - Reading EDS File



4. Navigate to the desired location.
5. Enter a file name
6. Click Save.

Figure 153 - Save as Window



EDS Add On Profile Support

The 857 relay with firmware version 13.001 or higher provides for EDS Add On Profile (AOP) support. The EDS (AOP) feature in combination with Studio 5000 Logix Designer® provides an easy integration path within the Logix Designer environment. The EDS file format for the Ethernet Common Industrial Protocol (CIP) networks is defined by ODVA.

The EDS file can be extracted directly from the 857 using the SetPointPS software Configuration tool. The EDS AOP provides both the values for Input and Output assembly and the tags for the static assembly selected. This support is provided only for the static assemblies and the pre-configured in the device. The selection of static assembly within Logix Designer must match the selection that is made in the relay.

The 857 does support one dynamic assembly (input/output assembly 100+150). The dynamic input and output assembly (100+150) is available for you to create a custom input/output assembly configuration if the predefined static assemblies are not suitable. The use of a dynamic assembly requires that a Generic Device AOP be used. The generic device user interface only specifies the basic connection parameters (Assembly Instance and the size of the Configuration, Input, and Output arrays). You must still create documentation that describes the instance values and tag details based on the parameters selected in the 100+150 input/output assembly in the 857. You must manually enter all configuration parameters. The generic approach does not facilitate the automatic transmission of all data tags.

Predefined Static Ethernet Input and Output Assemblies

The mapping for static assemblies is permanently programmed in the Read Only Memory (ROM) of the 857 protection system. They cannot be modified in any way and must be used as is. The content of the predefined static assemblies, which exist within the 857 protection system with firmware version 13.001 or higher, are listed in the following tables. See Appendix C for more information related to the parameters.

Table 146 - Summary of Static and Dynamic Assemblies (Version 13.001 or Higher Firmware)

Assembly Reference	Name shown in Studio 5000	Assembly Type	3 PH Voltage Transformers Supported	857-RAA Support	857-RAD Support	Protection Mode	Parameter Count
2+50	Basic	Static	No	No	No(1)	—	2
100+150	Configurable	Dynamic	Yes	Yes	Yes	Motor/Feeder	Up to 255
101+151	Static Advance	Static	No	No	No(1)	Motor	31
102+152	Static Advance 2	Static	2 in Open Delta	Yes	No(1)	Motor	50
103+153	Static Advance 3	Static	3 in 'Y' connected	Yes	No(1)	Motor	50
104+154	Static Advance 4	Static	2 in Open Delta	No	No(1)	Motor	38
105+155	Static Advance 5	Static	3 in 'Y' connected	No	No(1)	Motor	38
106+156	Static Advance 6	Static	2 in Open Delta	No	No(1)	Feeder	39
107+157	Static Advance 7	Static	3 in 'Y' connected	No	No(1)	Feeder	39

(1) 857-RAD only supported via dynamic assembly.

2+50 Static Assembly (Basic)

Table 147 - 2+50 Static Assembly (Basic)

Name	Description	Byte Count	Scaling	Byte Offset	Assembly Type
Control Supervisor#10	Faulted	1	1 = 1		Producing
Control Supervisor#12	Fault Reset	1	1 = 1		Consuming

100+150 Dynamic Assembly (Configurable)

The dynamic assembly can be modified and extended through dynamic mapping in the random access memory (RAM) of the 857 protection relay. Dynamic Assembly Objects can be used in more complex applications but it requires the individual parameter selection and the parsing of the data. Object tags are not supported with the dynamic assembly.

101+151 Advanced Static Assembly (Static Advanced)

This assembly is designed for configurations where the 857 protection system that has no voltage potential connections and NO RTD scanner connected.

Table 148 - 101+151 Advanced Static Assembly (Static Advanced) Parameter List

Parameter Number	Object	Attribute number	Name	Description	Byte Count	Scaling	Byte Offset	Assembly Type
4	0x29	10	Control Supervisor	Faulted	1	1 = 1	000	Producing
5	0x29	11	Control Supervisor	Warning	1	1 = 1	001	
7	0x29	13	Control Supervisor	Fault Code	1	See Appendix A for details	002	
8	0x29	14	Control Supervisor	Warn Code	1	See Appendix A for details	003	
11	0x2C	6	Overload	%Phase Unbalance	1	1% =1	004	
12	0x2C	7	Overload	%Thermal	1	1% =1	005	
1	0x389	1	857/865 Special	1 byte padding	1	1 = 1	006	
1	0x389	1	857/865 Special	1 byte padding	1	1 = 1	007	
9	0x29	22	Control Supervisor	Cycle Count	4	1 = 1	008	
10	0x2C	5	Overload	Average Current	2	1A=1	012	
13	0x2C	8	Overload	Current L1	2	1 A=1	014	
14	0x2C	9	Overload	Current L2	2	1A=1	016	
15	0x2C	10	Overload	Current L3	2	1 A=1	018	
16	0x2C	11	Overload	Ground Current	2	1A=1	020	
78	0x382	62	857/865 Digital	N> alarm	1	1 = 1	022	
80	0x382	64	857/865 Digital	Motor starting	1	1 = 1	023	
17	0x382	1	857/865 Digital	Digital inputs	4	1 = 1	024	
18	0x382	2	857/865 Digital	Output relays	4	1 = 1	028	
895	0x384	54	857/865 Analog 2	Estimated time to trip	4	1 = 1	032	
81	0x382	65	857/865 Digital	Motor running	1	1 = 1	036	
896	0x382	170	857/865 Digital	Virtual output 1	1	1 = 1	037	
897	0x382	171	857/865 Digital	Virtual output 2	1	1 = 1	038	
898	0x382	172	857/865 Digital	Virtual output 3	1	1 = 1	039	
899	0x382	173	857/865 Digital	Virtual output 4	1	1 = 1	040	
900	0x382	174	857/865 Digital	Virtual output 5	1	1 = 1	041	
901	0x382	175	857/865 Digital	Virtual output 6	1	1 = 1	042	
9	0x29	22	Control Supervisor	Cycle Count	4	1 = 1	000	Consuming
6	0x29	12	Control Supervisor	Fault Reset	1	1 = 1	004	
123	0x382	107	857/865 Digital	Virtual input 1	1	0, 1	005	
124	0x382	108	857/865 Digital	Virtual input 2	1	0, 1	006	
125	0x382	109	857/865 Digital	Virtual input 3	1	0, 1	007	
126	0x382	110	857/865 Digital	Virtual input 4	1	0, 1	008	

102+152 Advanced Static Assembly 2 (Static Advanced 2)

This assembly is when the 857 protection system is configured as a MOTOR protection device. It has voltage potential connections from two open delta voltage transformers and an optional 857-RAA, 12-channel RTD scanner. The dynamic assembly 100+150 must be used for the 857-RAD if any of the 4-analog inputs or 4-analog outputs or the PTC input are configured for use.

Table 149 - 102+152 Advanced Static Assembly 2 (Static Advanced 2) Parameter List

Parameter Number	Object	Attribute number	Name	Description	Byte Count	Scaling	Byte Offset	Assembly Type
4	0x29	10	Control Supervisor	Faulted	1	1 = 1	000	Producing
5	0x29	11	Control Supervisor	Warning	1	1 = 1	001	
11	0x2C	6	Overload	%Phase Unbalance	1	1% =1	002	
12	0x2C	7	Overload	%Thermal	1	1% =1	003	
78	0x382	62	857/865 Digital	N> alarm	1	1 = 1	004	
80	0x382	64	857/865 Digital	Motor starting	1	1 = 1	005	
81	0x382	65	857/865 Digital	Motor running	1	1 = 1	006	
8	0x29	14	Control Supervisor	Warn Code	1	See Appendix A for details	007	
7	0x29	13	Control Supervisor	Fault Code	1	See Appendix A for details	008	
1	0x389	1	857/865 Special	1 byte padding	1	1 = 1	009	
10	0x2C	5	Overload	Avg. Current	2	1A=1	010	
13	0x2C	8	Overload	CurrentL1	2	1A=1	012	
14	0x2C	9	Overload	CurrentL2	2	1A=1	014	
15	0x2C	10	Overload	CurrentL3	2	1A=1	016	
16	0x2C	11	Overload	Ground Current	2	1A=1	018	
17	0x382	1	857/865 Digital	Digital inputs	4	1 = 1	020	
18	0x382	2	857/865 Digital	Output relays	4	1 = 1	026	
9	0x29	22	Control Supervisor	Cycle Count	4	1 = 1	030	
896	0x382	170	857/865 Digita	Virtual output 1	1	1 = 1	031	
897	0x382	171	857/865 Digital	Virtual output 2	1	1 = 1	032	
898	0x382	172	857/865 Digital	Virtual output 3	1	1 = 1	033	
899	0x382	173	857/865 Digital	Virtual output 4	1	1 = 1	034	
900	0x382	174	857/865 Digital	Virtual output 5	1	1 = 1	035	
901	0x382	175	857/865 Digital	Virtual output 6	1	1 = 1	036	
1	0x389	1	857/865 Special	1 byte padding	1	1 = 1	037	
1	0x389	1	857/865 Special	1 byte padding	1	1 = 1	038	
373	0x383	188	857/865 Analog	External AI1	4	1.00C=100	042	
374	0x383	189	857/865 Analog	External AI2	4	1.00C=100	044	
375	0x383	190	857/865 Analog	External AI3	4	1.00C=100	048	
376	0x383	191	857/865 Analog	External AI4	4	1.00C=100	052	
377	0x383	192	857/865 Analog	External AI5	4	1.00C=100	056	
378	0x383	193	857/865 Analog	External AI6	4	1.00C=100	060	

Table 149 - 102+152 Advanced Static Assembly 2 (Static Advanced 2) Parameter List (Continued)

Parameter Number	Object	Attribute number	Name	Description	Byte Count	Scaling	Byte Offset	Assembly Type
379	0x383	194	857/865 Analog	External AI7	4	1.00C=100	064	Producing
380	0x383	195	857/865 Analog	External AI8	4	1.00C=100	068	
381	0x383	196	857/865 Analog	External AI9	4	1.00C=100	072	
382	0x383	197	857/865 Analog	External AI10	4	1.00C=100	076	
383	0x383	198	857/865 Analog	External AI11	4	1.00C=100	080	
384	0x383	199	857/865 Analog	External AI12	4	1.00C=100	084	
842	0x384	1	857/865 Analog 2	Frequency	4	50.000 Hz=5000	088	
846	0x384	5	857/865 Analog 2	Line-to-line voltage U12	4	1000V=1000	092	
847	0x384	6	857/865 Analog 2	Line-to-line voltage U23	4	1000V=1000	096	
848	0x384	7	857/865 Analog 2	Line-to-line voltage U31	4	1000V=1000	100	
849	0x384	8	857/865 Analog 2	Power factor	4	1.00=100	104	
854	0x384	13	857/865 Analog 2	Average line voltage	4	1000V=1000	108	
895	0x384	54	857/865 Analog 2	Estimated time to trip	4	1 = 1	112	
9	0x29	22	Control Supervisor	Cycle Count	4	1 = 1	000	Consuming
6	0x29	12	Control Supervisor	Fault Reset	1	1 = 1	004	
123	0x382	107	857/865 Digital	Virtual input 1	1	0, 1	005	
124	0x382	108	857/865 Digital	Virtual input 2	1	0, 1	006	
125	0x382	109	857/865 Digital	Virtual input 3	1	0, 1	007	
126	0x382	110	857/865 Digital	Virtual input 4	1	0, 1	008	

103+153 Advanced Static Assembly 3 (Static Advanced 3)

This assembly is for an 857 protection system that is configured as a MOTOR protection device. It has voltage potential connections from three wye connected voltage transformers and an optional 857-RAA, 12-channel RTD scanner. The dynamic assembly 100+150 must be used for the 857-RAD).

Table 150 - 103+153 Advanced Static Assembly 3 (Static Advanced 3) Parameter List

Parameter Number	Object	Attribute number	Name	Description	Byte Count	Scaling	Byte Offset	Assembly Type
4	0x29	10	Control Supervisor	Faulted	1	1 = 1	000	Producing
5	0x29	11	Control Supervisor	Warning	1	1 = 1	001	
8	0x29	14	Control Supervisor	Warn Code	1	See Appendix A for details	002	
7	0x29	13	Control Supervisor	Fault Code	1	See Appendix A for details	003	
11	0x2C	6	Overload	%PhImbal	1	1%=1	004	
12	0x2C	7	Overload	%Thermal	1	1%=1	005	
78	0x382	62	857/865 Digital	N> alarm	1	1 = 1	006	
80	0x382	64	857/865 Digital	Motor starting	1	1 = 1	007	

Table 150 - 103+153 Advanced Static Assembly 3 (Static Advanced 3) Parameter List (Continued)

Parameter Number	Object	Attribute number	Name	Description	Byte Count	Scaling	Byte Offset	Assembly Type
81	0x382	65	857/865 Digital	Motor running	1	1 = 1	008	Producing
1	0x389	1	857/865 Special	1 byte padding	1	1 = 1	009	
10	0x2C	5	Overload	Avg. Current	2	1 A=1	010	
13	0x2C	8	Overload	CurrentL1	2	1 A=1	012	
14	0x2C	9	Overload	CurrentL2	2	1 A=1	014	
15	0x2C	10	Overload	CurrentL3	2	1 A=1	016	
16	0x2C	11	Overload	Ground Current	2	1 A=1	018	
17	0x382	1	857/865 Digital	Digital inputs	4	1 = 1	020	
18	0x382	2	857/865 Digital	Output relays	4	1 = 1	026	
9	0x29	22	Control Supervisor	Cycle Count	4	1 = 1	030	
896	0x382	170	857/865 Digital	Virtual output 1	1	1 = 1	031	
897	0x382	171	857/865 Digital	Virtual output 2	1	1 =1	032	
898	0x382	172	857/865 Digital	Virtual output 3	1	1 = 1	033	
899	0x382	173	857/865 Digital	Virtual output 4	1	1 = 1	034	
900	0x382	174	857/865 Digital	Virtual output 5	1	1 = 1	035	
901	0x382	175	857/865 Digital	Virtual output 6	1	1 = 1	036	
1	0x389	1	857/865 Special	1 byte padding	1	1 = 1	037	
1	0x389	1	857/865 Special	1 byte padding	1	1.00C= 100	038	
373	0x383	188	857/865 Analog	External AI1	4	1.00C= 100	042	
374	0x383	189	857/865 Analog	External AI2	4	1.00C= 100	044	
375	0x383	190	857/865 Analog	External AI3	4	1.00C= 100	048	
376	0x383	191	857/865 Analog	External AI4	4	1.00C= 100	052	
377	0x383	192	857/865 Analog	External AI5	4	1.00C= 100	056	
378	0x383	193	857/865 Analog	External AI6	4	1.00C= 100	060	
379	0x383	194	857/865 Analog	External AI7	4	1.00C= 100	064	
380	0x383	195	857/865 Analog	External AI8	4	1.00C= 100	068	
381	0x383	196	857/865 Analog	External AI9	4	1.00C= 100	072	
382	0x383	197	857/865 Analog	External AI10	4	1.00C = 100	076	
383	0x383	198	857/865 Analog	External AI11	4	1.00C = 100	080	
384	0x383	199	857/865 Analog	External AI12	4	50.000 Hz = 5000	084	
842	0x384	1	857/865 Analog 2	Frequency	4	1.00 = 100	088	
850	0x384	9	857/865 Analog 2	Line-to-line voltage UL1	4	1000 v = 1000	092	
851	0x384	10	857/865 Analog 2	Line-to-linevoltageUL2	4	1000V= 1000	096	
852	0x384	11	857/865 Analog 2	Line-to-line voltage UL3	4	1000V= 1000	100	
849	0x384	8	857/865 Analog 2	Power factor	4	1.00 = 100	104	
855	0x384	14	857/865 Analog 2	Average phase voltage	4	1000V = 1000	108	
895	0x384	54	857/865 Analog 2	Estimated time to trip	4	1 = 1	112	

Table 150 - 103+153 Advanced Static Assembly 3 (Static Advanced 3) Parameter List (Continued)

Parameter Number	Object	Attribute number	Name	Description	Byte Count	Scaling	Byte Offset	Assembly Type
9	0x29	22	Control Supervisor	Cycle Count	4	1 = 1	000	Consuming
6	0x29	12	Control Supervisor	Fault Reset	1	1 = 1	004	
123	0x382	107	857/865 Digital	Virtual input 1	1	0, 1	005	
124	0x382	108	857/865 Digital	Virtual input 2	1	0, 1	006	
125	0x382	109	857/865 Digital	Virtual input 3	1	0, 1	007	
126	0x382	110	857/865 Digital	Virtual input 4	1	0, 1	008	

104+154 Advanced Static Assembly 4 (Static Advanced 4)

This assembly is for when the 857 protection system is configured as a MOTOR protection device with voltage potential connections from two open delta voltage transformers and NO RTD scanner connected.

Table 151 - 104+154 Advanced Static Assembly 4 (Static Advanced 4) Parameter List

Parameter Number	Object	Attribute number	Name	Description	Byte Count	Scaling	Byte Offset	Assembly Type
4	0x29	10	Control Supervisor	Faulted	1	1=1	000	Producing
5	0x29	11	Control Supervisor	Warning	1	1=1	001	
7	0x29	13	Control Supervisor	Fault Code	1	See Appendix A for details	002	
8	0x29	14	Control Supervisor	Warn Code	1	See Appendix A for details	003	
11	0x2C	6	Overload	%PhImbal	1	1%=1	004	
12	0x2C	7	Overload	%Thermal	1	1%=1	005	
78	0x382	62	857/865 Digital	N> alarm	1	1=1	006	
80	0x382	64	857/865 Digital	Motor starting	1	1=1	007	
81	0x382	65	857/865 Digital	Motor running	1	1=1	008	
1	0x389	1	857/865 Special	1 byte padding	1	1=1	009	
10	0x2C	5	Overload	Avg. Current	2	1 A=1	010	
13	0x2C	8	Overload	CurrentL1	2	1 A=1	012	
14	0x2C	9	Overload	CurrentL2	2	1 A=1	014	
15	0x2C	10	Overload	CurrentL3	2	1 A=1	016	
16	0x2C	11	Overload	Ground Current	2	1 A=1	018	
17	0x382	1	857/865 Digital	Digital inputs	4	1=1	020	
18	0x382	2	857/865 Digital	Output relays	4	1=1	026	
9	0x29	22	Control Supervisor	Cycle Count	4	1=1	030	
896	0x382	170	857/865 Digital	Virtual output 1	1	1=1	031	
897	0x382	171	857/865 Digital	Virtual output 2	1	1=1	032	
898	0x382	172	857/865 Digital	Virtual output 3	1	1=1	033	
899	0x382	173	857/865 Digital	Virtual output 4	1	1=1	034	

Table 151 - 104+154 Advanced Static Assembly 4 (Static Advanced 4) Parameter List (Continued)

Parameter Number	Object	Attribute number	Name	Description	Byte Count	Scaling	Byte Offset	Assembly Type
900	0x382	174	857/865 Digital	Virtual output 5	1	1=1	035	Producing
901	0x382	175	857/865 Digital	Virtual output 6	1	1=1	036	
1	0x389	1	857/865 Special	1 byte padding	1	1=1	037	
1	0x389	1	857/865 Special	1 byte padding	1	1=1	038	
842	0x384	1	857/865 Analog 2	Frequency	4	50.000 Hz=5000	042	
846	0x384	5	857/865 Analog 2	Line-to-linevoltageU12	4	1000V = 1000	044	
847	0x384	6	857/865 Analog 2	Line-to-linevoltageU23	4	1000V = 1000	048	
848	0x384	7	857/865 Analog 2	Line-to-line voltage U31	4	1000V = 1000	052	
849	0x384	8	857/865 Analog 2	Power factor	4	1.00 = 100	056	
854	0x384	13	857/865 Analog 2	Average line voltage	4	1000V=1000	060	
895	0x384	54	857/865 Analog 2	Estimated time to trip	4	1=1	064	
9	0x29	22	Control Supervisor	Cycle Count	4	1=1	000	Consuming
6	0x29	12	Control Supervisor	Fault Reset	1	1=1	004	
123	0x382	107	857/865 Digital	Virtual input 1	1	0, 1	005	
124	0x382	108	857/865 Digital	Virtual input 2	1	0, 1	006	
125	0x382	109	857/865 Digital	Virtual input 3	1	0, 1	007	
126	0x382	110	857/865 Digital	Virtual input 4	1	0, 1	008	

105+155 Advanced Static Assembly 5 (Static Advanced 5)

This assembly is for when the 857 protection system is configured as a MOTOR protection device with voltage potential connections from three wye connected voltage transformers and NO RTD scanner connected.

Table 152 - 105+155 Advanced Static Assembly 5 (Static Advanced 5) Parameter List

Parameter Number	Object	Attribute number	Name	Description	Byte Count	Scaling	Byte Offset	Assembly Type
4	0x29	10	Control Supervisor	Faulted	1	1=1	000	Producing
5	0x29	11	Control Supervisor	Warning	1	1=1	001	
7	0x29	13	Control Supervisor	Fault Code	1	See Appendix A for details	002	
8	0x29	14	Control Supervisor	Warn Code	1	See Appendix A for details	003	
11	0x2C	6	Overload	%PhImbal	1	1%=1	004	
12	0x2C	7	Overload	%Thermal	1	1% =1	005	
78	0x382	62	857/865 Digital	N> alarm	1	1 =1	006	
80	0x382	64	857/865 Digital	Motor starting	1	1 =1	007	
81	0x382	65	857/865 Digital	Motor running	1	1 =1	008	
1	0x389	1	857/865 Special	1 byte padding	1	1=1	009	

Table 152 - 105+155 Advanced Static Assembly 5 (Static Advanced 5) Parameter List (Continued)

Parameter Number	Object	Attribute number	Name	Description	Byte Count	Scaling	Byte Offset	Assembly Type
10	0x2C	5	Overload	Avg. Current	2	1% =1	010	Producing
13	0x2C	8	Overload	CurrentL1	2	1 A=1	012	
14	0x2C	9	Overload	CurrentL2	2	1 A=1	014	
15	0x2C	10	Overload	CurrentL3	2	1 A=1	016	
16	0x2C	11	Overload	Ground Current	2	1 A=1	018	
17	0x382	1	857/865 Digital	Digital inputs	4	1=1	020	
18	0x382	2	857/865 Digital	Output relays	4	1=1	026	
9	0x29	22	Control Supervisor	Cycle Count	4	1=1	030	
896	0x382	170	857/865 Digital	Virtual output 1	1	1=1	031	
897	0x382	171	857/865 Digital	Virtual output 2	1	1=1	032	
898	0x382	172	857/865 Digital	Virtual output 3	1	1=1	033	
899	0x382	173	857/865 Digital	Virtual output 4	1	1=1	034	
900	0x382	174	857/865 Digital	Virtual output 5	1	1=1	035	
901	0x382	175	857/865 Digital	Virtual output 6	1	1=1	036	
1	0x389	1	857/865 Special	1 byte padding	1	1=1	037	
1	0x389	1	857/865 Special	1 byte padding	1	1=1	038	
842	0x384	1	857/865 Analog 2	Frequency	4	50.000 Hz=5000	042	
850	0x384	9	857/865 Analog 2	Line-to-line voltage UL1	4	1000V = 1000	044	
851	0x384	10	857/865 Analog 2	Line-to-linevoltageUL2	4	1000V = 1000	048	
852	0x384	11	857/865 Analog 2	Line-to-line voltage UL3	4	1000V = 1000	052	
849	0x384	8	857/865 Analog 2	Power factor	4	1.00 = 100	056	
855	0x384	14	857/865 Analog 2	Average line voltage	4	1000V = 1000	060	
895	0x384	54	857/865 Analog 2	Estimated time to trip	4	1=1	064	
9	0x29	22	Control Supervisor	Cycle Count	4	1=1	000	Consuming
6	0x29	12	Control Supervisor	Fault Reset	1	1=1	004	
123	0x382	107	857/865 Digital	Virtual input 1	1	0, 1	005	
124	0x382	108	857/865 Digital	Virtual input 2	1	0, 1	006	
125	0x382	109	857/865 Digital	Virtual input 3	1	0, 1	007	
126	0x382	110	857/865 Digital	Virtual input 4	1	0, 1	008	

106+156 Advanced Static Assembly 6 (Static Advanced 6)

This assembly is for when the 857 protection system is configured as a FEEDER protection device with voltage potential connections from two open delta voltage transformers and NO RTD scanner connected.

Table 153 - 106+156 Advanced Static Assembly 6 (Static Advanced 6) Parameter List

Parameter Number	Object	Attribute number	Name	Description	Byte Count	Scaling	Byte Offset	Assembly Type
4	0x29	10	Control Supervisor	Faulted	1	1 =1	000	Producing
5	0x29	11	Control Supervisor	Warning	1	1 =1	001	
7	0x29	13	Control Supervisor	Fault Code	1	See Appendix A for details	002	
8	0x29	14	Control Supervisor	Warn Code	1	See Appendix A for details	003	
11	0x2C	6	Overload	%PhImbal	1	1%:1	004	
12	0x2C	7	Overload	%Thermal	1	1%=1	005	
78	0x382	62	857/865 Digital	N> alarm	1	1=1	006	
1	0x389	1	857/865 Special	1 byte padding	1	1=1	007	
10	0x2C	5	Overload	Avg Current	1	1 A=1	008	
13	0x2C	8	Overload	CurrentL1	2	1 A=1	010	
14	0x2C	9	Overload	CurrentL2	2	1 A=1	012	
15	0x2C	10	Overload	CurrentL3	2	1 A=1	014	
16	0x2C	11	Overload	Ground Current	2	1 A=1	016	
1	0x389	1	857/865 Special	1 byte padding	1	1=1	018	
1	0x389	1	857/865 Special	1 byte padding	1	1=1	019	
17	0x382	1	857/865 Digital	Digital inputs	4	1=1	020	
18	0x382	2	857/865 Digital	Output relays	4	1=1	024	
9	0x29	22	Control Supervisor	Cycle Count	4	1=1	028	
896	0x382	170	857/865 Digital	Virtual output 1	1	1=1	032	
897	0x382	171	857/865 Digital	Virtual output 2	1	1=1	033	
898	0x382	172	857/865 Digital	Virtual output 3	1	1=1	034	
899	0x382	173	857/865 Digital	Virtual output 4	1	1=1	035	
900	0x382	174	857/865 Digital	Virtual output 5	1	1=1	036	
901	0x382	175	857/865 Digital	Virtual output 6	1	1=1	037	
819	0x387	108	857/865 StgProt0	CBFP Enable for CBFP	1	Off=0, On=1	038	
1	0x389	1	857/865 Special	1 byte padding	1	1=1	039	
842	0x384	1	857/865 Analog 2	Frequency	4	50.000 Hz= 5000	040	
843	0x384	2	857/865 Analog 2	Active power	4	1000 kW=1000	044	
844	0x384	3	857/865 Analog 2	Reactive power	4	1000kvar=10 00	048	

Table 153 - 106+156 Advanced Static Assembly 6 (Static Advanced 6) Parameter List (Continued)

Parameter Number	Object	Attribute number	Name	Description	Byte Count	Scaling	Byte Offset	Assembly Type
845	0x384	4	857/865 Analog 2	Apparent power	4	1000 kVA=1000	052	Producing
846	0x384	5	857/865 Analog 2	Line-to-linevoltageU12	4	1000V = 1000	056	
847	0x384	6	857/865 Analog 2	Line-to-linevoltageU23	4	1000V = 1000	060	
848	0x384	7	857/865 Analog 2	Line-to-line voltage U31	4	1000V = 1000	064	
849	0x384	8	857/865 Analog 2	Power factor	4	1.00 = 100	068	
854	0x384	13	857/865 Analog 2	Average line voltage	4	1000V = 1000	072	
895	0x384	54	857/865 Analog 2	Estimated time to trip	4	1 =1	076	
9	0x29	22	Control Supervisor	Cycle Count	4	1=1	000	Consuming
6	0x29	12	Control Supervisor	Fault Reset	1	1=1	004	
123	0x382	107	857/865 Digital	Virtual input 1	1	0, 1	005	
124	0x382	108	857/865 Digital	Virtual input 2	1	0, 1	006	
125	0x382	109	857/865 Digital	Virtual input 3	1	0, 1	007	
126	0x382	110	857/865 Digital	Virtual input 4	1	0, 1	008	

107+157 Advanced Static Assembly 7 (Static Advanced 7)

This assembly is for when an 857 protection system is configured as a FEEDER protection device with voltage potential connections from three wye connected voltage transformers and has NO RTD scanner. connected.

Table 154 - 107+157 Advanced Static Assembly 7 (Static Advanced 7) Parameter List

Parameter Number	Object	Attribute number	Name	Description	Byte Count	Scaling	Byte Offset	Assembly Type
4	0x29	10	Control Supervisor	Faulted	1	1 = 1	000	Producing
5	0x29	11	Control Supervisor	Warning	1	1 = 1	001	
7	0x29	13	Control Supervisor	Fault Code	1	See Appendix A for details	002	
8	0x29	14	Control Supervisor	Warn Code	1	See Appendix A for details	003	
11	0x2C	6	Overload	%PhImbal	1	1%=1	004	
12	0x2C	7	Overload	%Thermal	1	1% =1	005	
78	0x382	62	857/865 Digital	N> alarm	1	1=1	006	
1	0x389	1	857/865 Special	1 byte padding	1	1=1	007	
10	0x2C	5	Overload	Avg Current	2	1A=1	008	
13	0x2C	8	Overload#0	CurrentL1	2	1A=1	010	
14	0x2C	9	Overload	CurrentL2	2	1A=1	012	
15	0x2C	10	Overload	CurrentL3	2	1A=1	014	
16	0x2C	11	Overload	Ground Current	2	1A=1	016	
1	0x389	1	857/865 Special	1 byte padding	1	1=1	018	
17	0x382	1	857/865 Digital	Digital inputs	4	1=1	020	

Table 154 - 107+157 Advanced Static Assembly 7 (Static Advanced 7) Parameter List (Continued)

Parameter Number	Object	Attribute number	Name	Description	Byte Count	Scaling	Byte Offset	Assembly Type
18	0x382	2	857/865 Digital	Output relays	4	1=1	024	Producing
9	0x29	22	Control Supervisor	Cycle Count	4	1=1	028	
896	0x382	170	857/865 Digital	Virtual output 1	1	1=1	032	
897	0x382	171	857/865 Digital	Virtual output 2	1	1=1	033	
898	0x382	172	857/865 Digital	Virtual output 3	1	1=1	034	
899	0x382	173	857/865 Digital	Virtual output 4	1	1=1	035	
900	0x382	174	857/865 Digital	Virtual output 5	1	1=1	036	
901	0x382	175	857/865 Digital	Virtual output 6	1	1=1	037	
819	0x387	108	857/865 StgProt0	CBFP Enable for CBFP	1	Off=0, On=1	038	
1	0x389	1	857/865 Special	1 byte padding	1	1=1	039	
842	0x384	1	857/865 Analog 2	Frequency	4	50.000 Hz= 5000	040	
843	0x384	2	857/865 Analog 2	Active power	4	1000 kW=1000	044	
844	0x384	3	857/865 Analog 2	Reactive power	4	1000kvar = 1000	048	
845	0x384	4	857/865 Analog 2	Apparent power	4	1000 kVA=1000	052	
849	0x384	8	857/865 Analog 2	Power factor	4	1.00 = 100	056	
846	0x384	5	857/865 Analog 2	Line-to-linevoltageUL1	4	1000V = 1000	060	
847	0x384	6	857/865 Analog 2	Line-to-linevoltageUL2	4	1000V = 1000	064	
848	0x384	7	857/865 Analog 2	Line-to-line voltage UL3	4	1000V = 1000	068	
854	0x384	13	857/865 Analog 2	Average line voltage	4	1000V = 1000	072	
895	0x384	54	857/865 Analog 2	Estimated time to trip	4	1=1	076	
9	0x29	22	Control Supervisor	Cycle Count	4	1=1	000	Consuming
6	0x29	12	Control Supervisor	Fault Reset	1	1=1	004	
123	0x382	107	857/865 Digital	Virtual input 1	1	0, 1	005	
124	0x382	108	857/865 Digital	Virtual input 2	1	0, 1	006	
125	0x382	109	857/865 Digital	Virtual input 3	1	0, 1	007	
126	0x382	110	857/865 Digital	Virtual input 4	1	0, 1	008	

Notes:

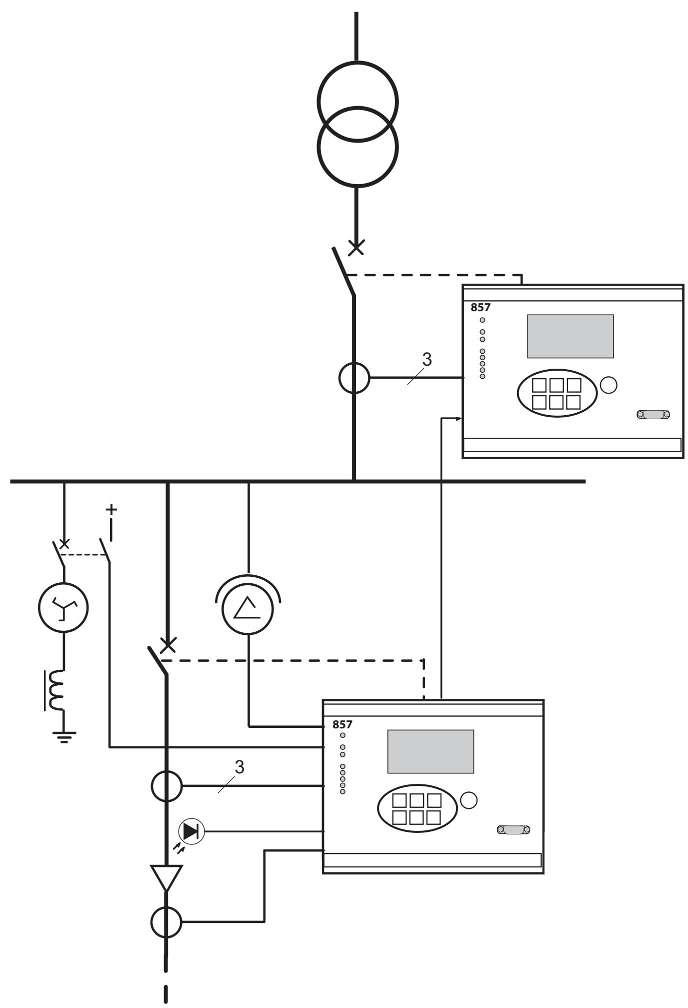
Applications

These examples illustrate the versatile functions in simultaneously applications.

Substation Feeder Protection

The feeder device includes three-phase overcurrent protection, directional earth-fault-protection, and fast arc protection. At the incoming feeder, the instantaneous stage I>>> of the 857 feeder devices is blocked with the start signal of the overcurrent stage. This block helps prevent the trip signal if the fault occurs on the outgoing feeder.

Figure 154 - 857 Feeder and Motor Devices That Are Used in Substation Feeder Protection



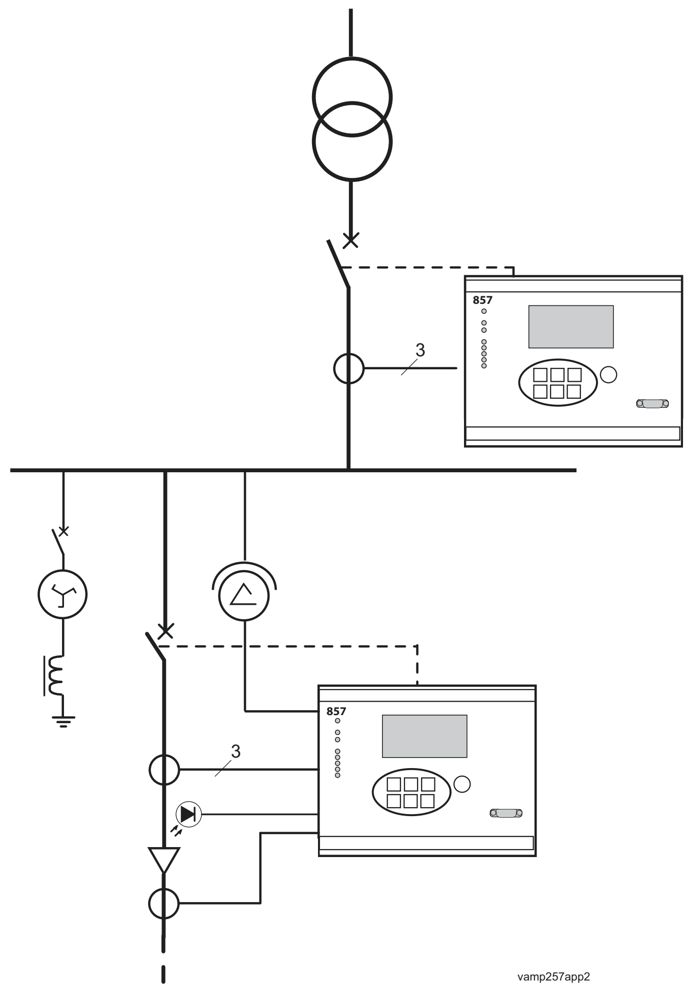
The directional function of earth-fault function uses the status information (on/off) of a Petersen coil. It is routed to one of the digital inputs of the feeder device so that $I_{0sin\varphi}$ or $I_{0cos\varphi}$ function is obtained.

The function $I_{0sin\varphi}$ is used in isolated networks, and the function $I_{0cos\varphi}$ is used in resistance or resonant earthed networks.

Industrial Feeder Protection

Directional earth-fault-protection and three-phase overcurrent protection is required in a cable feeder. The thermal stage can be used to help protect the cable against being overloaded. This example also includes fast arc protection.

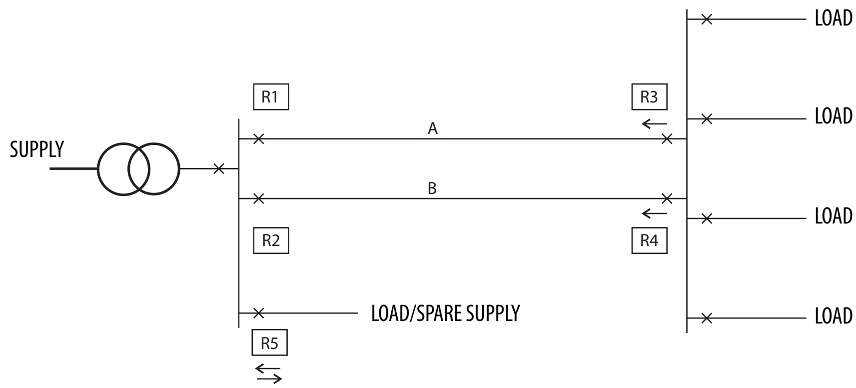
Figure 155 - 857 Feeder and Motor Devices That Are Used in Cable Protection of an Industry Plant Network



Parallel Line Protection

Figure 156 shows two parallel lines, A and B, protected with overcurrent relays R1, R2, R3, and R4. The relays R3 and R4 are directional.

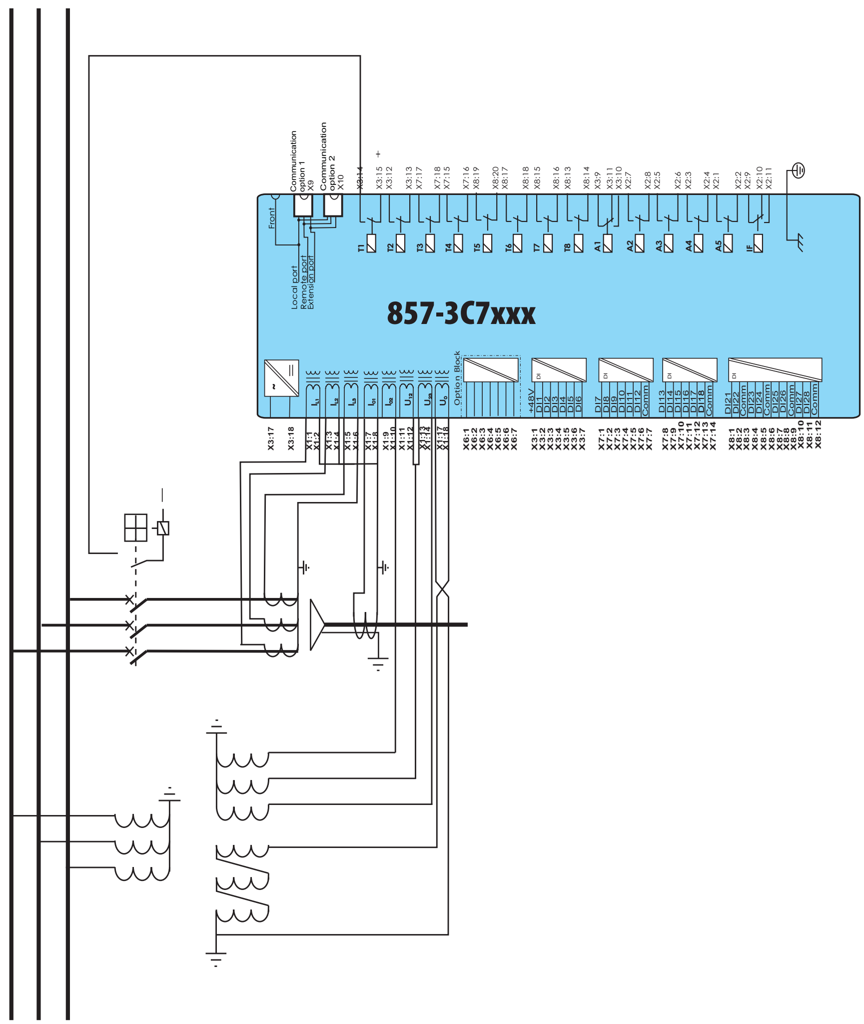
Figure 156 - Feeder and Motor Device Allen-Bradley 857 Used for Protection of Parallel Lines



If there is a fault in one of the lines, only the faulty line is switched off because of the direction functions of the relays R3 and R4. A detailed schematic of, for example, the relay R3 is shown in Figure 157.

Figure 157 - Example Connection of Allen-Bradley 857

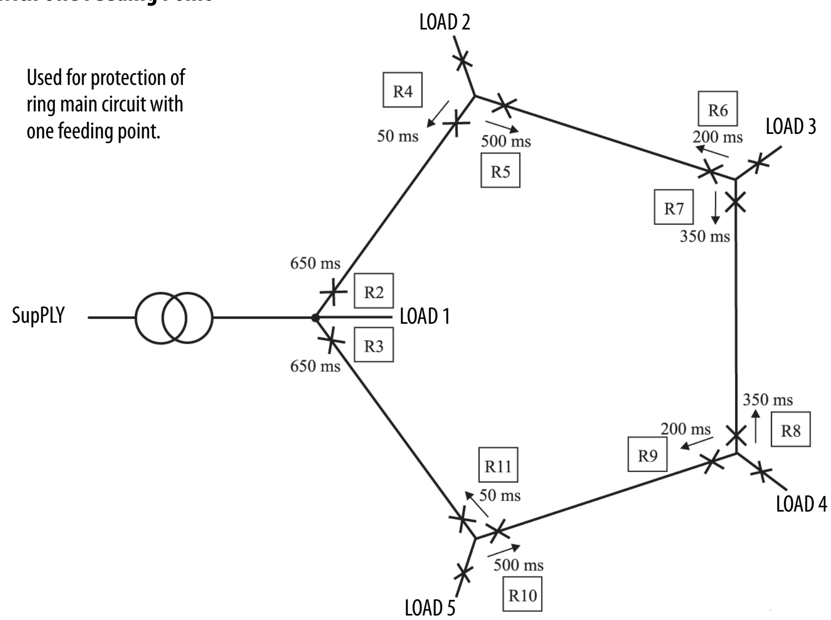
Both short circuits and earth-faults are detected. The outgoing line is one of several parallel lines or the line is feeding a ring network.



Ring Network Protection

Ring networks can be selectively protected, by using directional overcurrent relays, as long as there is only one feeding point in the network. Figure 158 shows an example of a ring main with five nodes that use one circuit breaker at each end of each line section (for example a ring main unit). When there is a short-circuit fault in any line section, only the faulty section is disconnected. The grading time in this example is 150 ms.

Figure 158 - Feeder Terminals, 857 Protection System Used for Protection of Ring Main Circuit with One Feeding Point



Trip Circuit Supervision

Trip circuit supervision is used to make sure that the wiring from a protective device to a circuit-breaker is in order. The circuit is unused most of the time. When a protection device detects a fault in the network, it is too late to notice that the circuit-breaker cannot be tripped because of broken trip circuitry.

The digital inputs of the device can be used for trip circuit monitoring. The dry digital inputs are most suitable for trip circuit supervision. The first six digital inputs of 857 Protection Systems are not dry contacts and an auxiliary miniature relay is needed, if these inputs are used for trip circuit supervision.

The closing circuit can be supervised using the same principle.

The optimum digital inputs for trip circuit supervision are inputs DI29…DI32, which are internally wired in parallel within trip relays T5…T8. These inputs do not share the common terminal with other inputs. DI29…DI32 and T5…T8 are optional by catalog number.

Internal Parallel Digital Inputs

In Allen-Bradley 857-3C7 and Allen-Bradley 857-3C8, the output relays T5 (DI29), T6 (DI30), T7 (DI31) and T8 (DI32) have internal, parallel digital inputs available for trip circuit supervision. They are optional by catalog number.

Trip Circuit Supervision with One Digital Input

The benefits of this scheme are that only one digital input is needed and no extra wiring from the relay to the circuit breaker (CB) is needed. Supervision of a 24 V dc trip circuit is possible.

The drawback is that an external resistor must supervise the trip circuit on both CB positions. If supervision during the closed position only is enough, the resistor is not needed.

- The digital input is connected parallel with the trip contacts (Figure 159).
- The digital input is configured as Normal Closed (NC).
- The digital input delay is configured longer than maximum fault time to inhibit any unnecessary trip circuit fault alarm when the trip contact is closed.
- The trip relay must be configured as non-latched. Otherwise the trip contact operates, a superfluous trip-circuit fault alarm is raised, and the relay remains closed because of latching.

By using an auxiliary contact of the CB for the external resistor, the auxiliary contact in the trip circuit can be supervised.

- When using the dry digital input DI7, there is limited use of the other inputs of the same group and limited common terminal sharing.
- When using the wet digital inputs DI1…DI6, an auxiliary relay is needed.

Figure 159 - Trip Circuit Supervision When the Circuit Breaker Is Closed

The supervised circuitry in this CB position is double-lined. The digital input is in active state. For the application to work when the circuit-breaker is opened, a resistor R1 must be placed. The value for it can be calculated from the external wetting supply, so that the current over R1 is >1 mA.

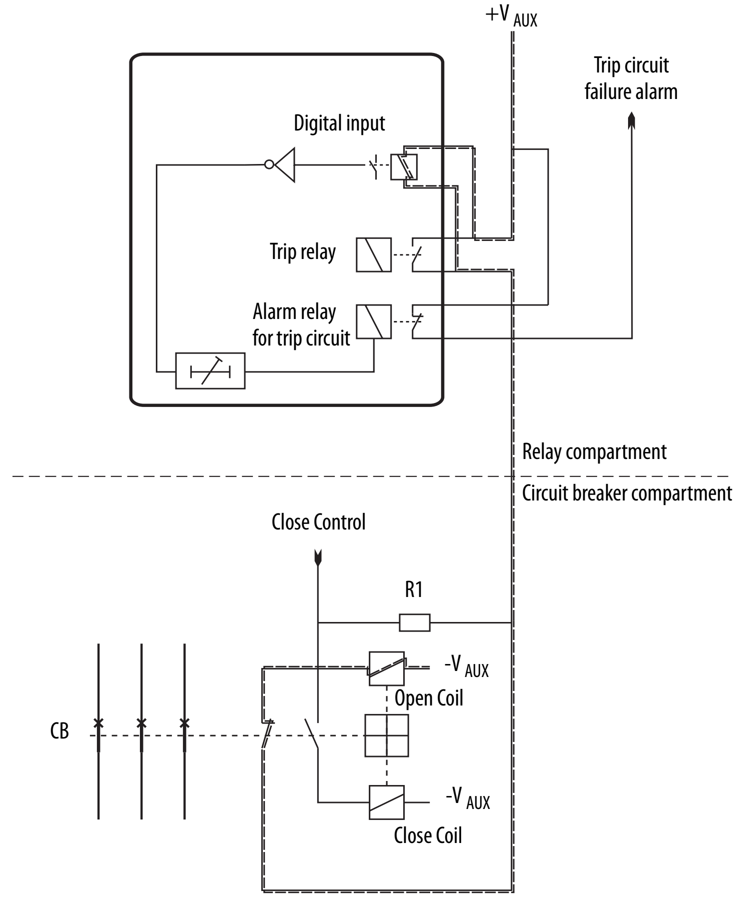
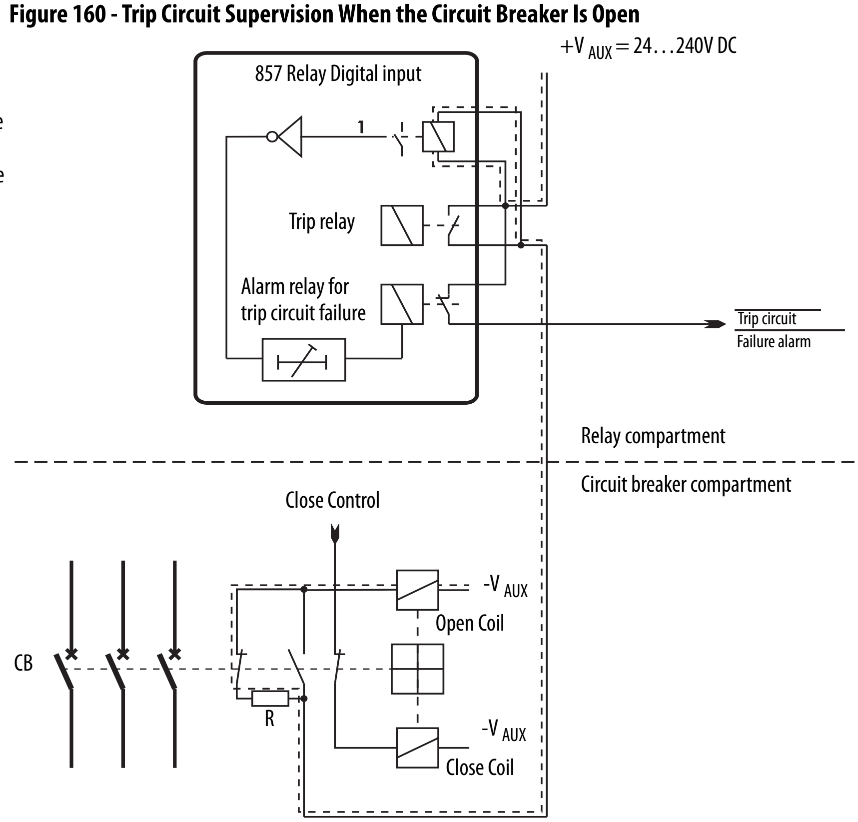


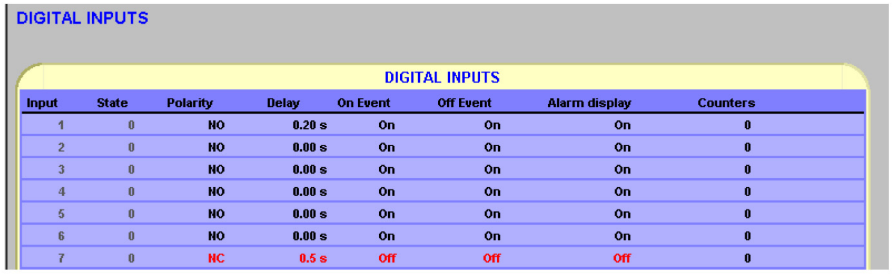
Figure 160 - Trip Circuit Supervision When the Circuit Breaker Is Open

The supervised circuitry in this CB position is doubled-lined. The value for R1 in this application is 3k3 and 2 W. These values can be calculated from the resistance and voltage operating range of the coil of K1 and the tolerance of the wetting voltage.



If DI7 is used for trip circuit supervision, the usage of DI8...DI14 is limited to the same circuitry that shares the V_{aux} in the common terminal.

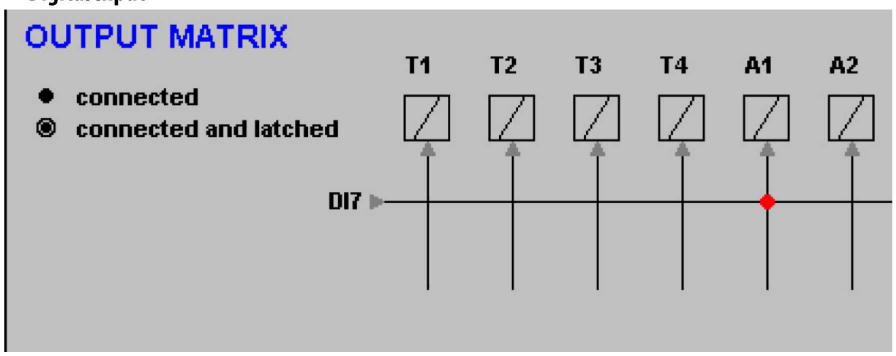
Figure 161 - Example of a Digital Input DI7 Configuration for Trip Circuit Supervision with One Dry Digital Input


DIGITAL INPUTS

DIGITAL INPUTS

Input	State	Polarity	Delay	On Event	Off Event	Alarm display	Counters
1	0	NO	0.20 s	On	On	On	0
2	0	NO	0.00 s	On	On	On	0
3	0	NO	0.00 s	On	On	On	0
4	0	NO	0.00 s	On	On	On	0
5	0	NO	0.00 s	On	On	On	0
6	0	NO	0.00 s	On	On	On	0
7	0	NC	0.5 s	Off	Off	Off	0

Figure 162 - Example of Output Matrix Configuration for Trip Circuit Supervision with One Dry Digital Input



Example of dimensioning the external resistor R:

- U_{AUX} = 110 Vdc - 20% + 10%

Auxiliary voltage with tolerance:

- U_{DI} =18 Vdc

Threshold voltage of the digital input:

- I_{DI} = 3 mA

Typical current that is required to activate the digital input including a 1 mA safety margin:

- P_{Coil}= 50 W

Rated power of the open coil of the circuit breaker. If this value is not known, 0Ω can be used for the R_{Coil} :

- $U_{MIN} = U_{AUX}$ - 20% = 88V
- $U_{MAX} = U_{AUX}$ + 10% = 121V
- $R_{Coil} = U^2{}_{AUX}/P = 242\ \Omega$

The external resistance value is calculated using Equation 8.1.

Equation 8.1

$$R = \frac{U_{MIN} - U_{DI} - I_{DI} \bullet R_{coil}}{I_{DI}}$$

EXAMPLE	$R = \frac{88 - 18 - 003 \bullet 242}{0.003} = 23.1\ k\Omega$

In practice, the coil resistance has no effect. By selecting the next smaller standard size, we get 22 kΩ.

The power rating for the external resistor is estimated using Equation 8.2 and Equation 8.3. The Equation 8.2 is for the CB open situation including a 100% safety margin to limit the maximum temperature of the resistor.

Equation 8.2

$$P = 2 \bullet I_{DI}^2 \bullet R$$

EXAMPLE	$P = 2 \bullet 0.003^2 \bullet 22000 = 0.40\ W$

Select the next bigger standard size, for example 0.5 W.

When the trip contacts are still closed and the CB is open, the resistor must withstand much higher power (Equation 8.3) for this short time.

Equation 8.3

$$P = \frac{U_{MAX}^2}{R}$$

EXAMPLE	$P = \frac{122^2}{22000} = 0.67\ W$

A 0.5 W resistor is enough for this short time peak-power, too. However, if the trip relay is closed for longer time than a few seconds, use a 1 W resistor.

Non-dry Digital Inputs DI1…DI6

In this scheme, an auxiliary relay must connect the wet digital input to the trip circuit (Figure 163). The rated coil voltage of the auxiliary relay is selected according to the rated auxiliary voltage that is used in the trip circuit. The operating voltage range of the relay must be as wide as possible to cover the tolerance of the auxiliary voltage.

In this application, the use of other wet inputs for other purposes is not limited unlike, when using the dry inputs.

Figure 163 - Trip Circuit Supervision

Shown with an internally wetted digital input (DI1…DI6) and an auxiliary relay K1 along with an external resistor, R. The circuit-breaker is in the closed position. The supervised circuitry in this CB position is double-lined. The digital input is in active state when the trip circuit is complete.

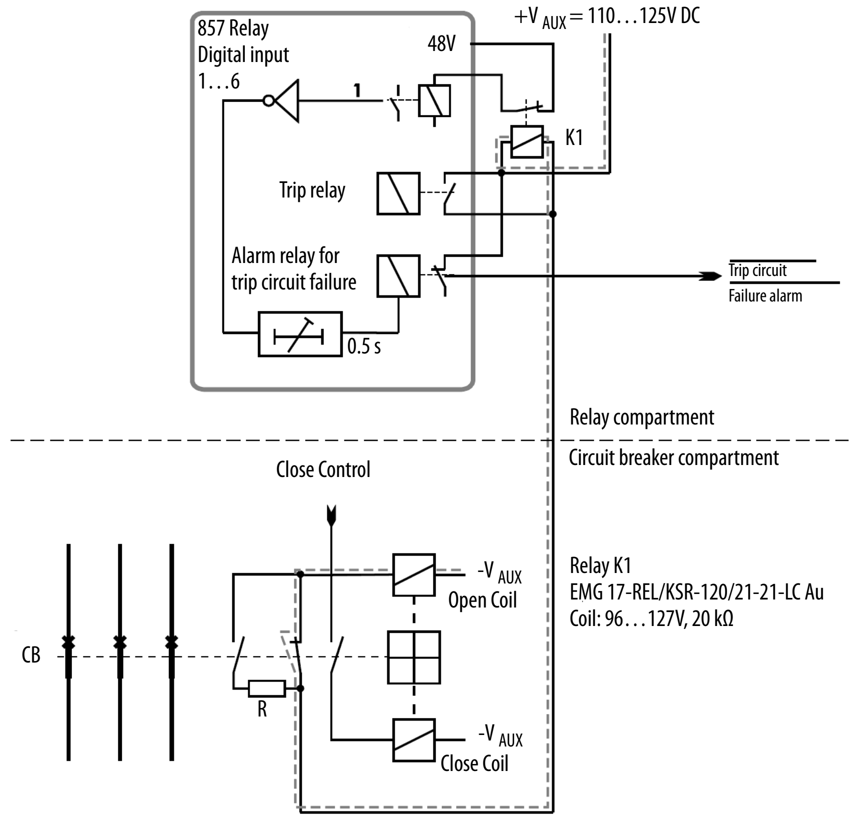


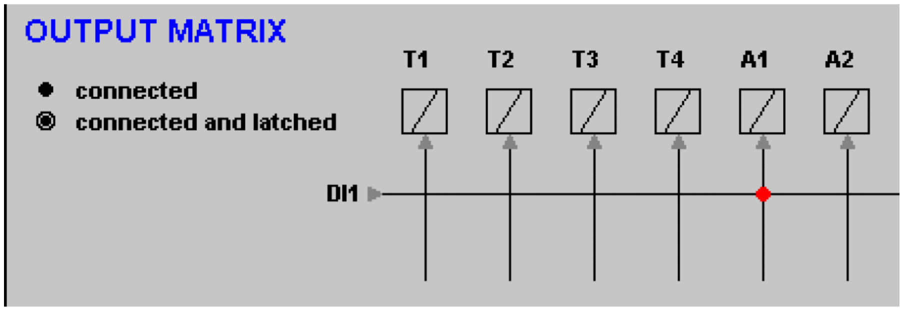
Figure 164 - Digital Input DI1 Configuration for Trip Circuit Supervision with One Wet Digital Input

DIGITAL INPUTS

DIGITAL INPUTS

Input	State	Polarity	Delay	On Event	Off Event	Alarm display	Counters
1	0	NC	0.5 s	Off	Off	On	0

Figure 165 - Output Matrix Configuration for Trip Circuit Supervision with One Wet Digital Input



Example of Dimensioning the External Resistor R:

- U_{AUX} =110 Vdc – 5% + 10%

Auxiliary voltage with tolerance. Short time voltage dips more than 5% are not critical from the trip circuit supervision point of view.

Relay type for the K_1 auxiliary relay:

Phoenix Contact 2941455 EMG 17-REL/KSR-120/21-21-LC Au

- U_{K1}=120 Vac/dc – 20% + 10%

Coil voltage of the auxiliary relay K1:

- I_{K1} = 6 mA

Nom coil current of the auxiliary relay K1:

- P_{CBcoil} = 50 W

Rated power of the open coil of the circuit breaker.:

- U_{MIN} =U_{AUX} – 5% = 104.5V
- U_{MAX} =U_{AUX} + 10% = 121V
- U_{K1Min} = U_{K1} – 10% = 96V
- R_{K1coil} =UK1/IK1 = 20 kΩ
- I_{K1Min} =U_{K1Min}/R_{K1coil} = 4.8 mA
- I_{K1Max}=U_{K1Max}/R_{K1coil} = 6.1 mA
- R_{CBcoil}=U_{2AUX}/P = 242 Ω

The external resistance value is calculated using Equation 8.4:

Equation 8.4

$$R = \frac{U_{MIN} - U_{K1MIN}}{I_{K1MIN}} = R_{Coil}$$

EXAMPLE	$R = \frac{104.5 - 96}{0.0048} - 242 = 1.5\,k\Omega$

By selecting the next smaller standard size, we get 1.5 kΩ.>

The power rating for the external resistor is calculated using Equation 8.5. This equation includes a 100% safety margin to limit the maximum temperature of the resistor, because modern resistors are hot at their rated maximum power.

Equation 8.5

$$P = 2 \bullet I^2_{K1MAX} \bullet R$$

EXAMPLE	$P = 2 \bullet 0.0061^2 \bullet 1500R = 0.11\,W$

Select the next bigger standard size, for example 0.5 W.

When the trip contacts are still closed and the CB is open, the resistor must withstand much higher power (Equation 8.6) for this short time.

Equation 8.6

$$P = \frac{121^2}{1500} = \mathbf{9.8\ W}$$

Select the A 1 W resistor to withstand this short time peak-power. However, if the trip relay can be closed for longer than a few seconds, use a 20 W resistor.

Trip Circuit Supervision with Two Digital Inputs

The benefit of this scheme is that no external resistor is needed.

The drawbacks are that two digital inputs from two separate groups are needed and two extra wires from the relay to the CB compartment are needed. Additionally, the minimum allowed auxiliary voltage is 48V DC, which is more than twice the threshold voltage of the dry digital input. When the CB is in the open position, the two digital inputs are in series.

- The first digital input is connected parallel with the trip contacts (Figure 166).
- Another auxiliary contact is connected in series with the circuitry of the first digital input. This makes it possible to supervise the auxiliary contact in the trip circuit.
- The second digital input is connected parallel with the auxiliary contact of the circuit breaker.
- Both inputs are configured as normal closed (NC).

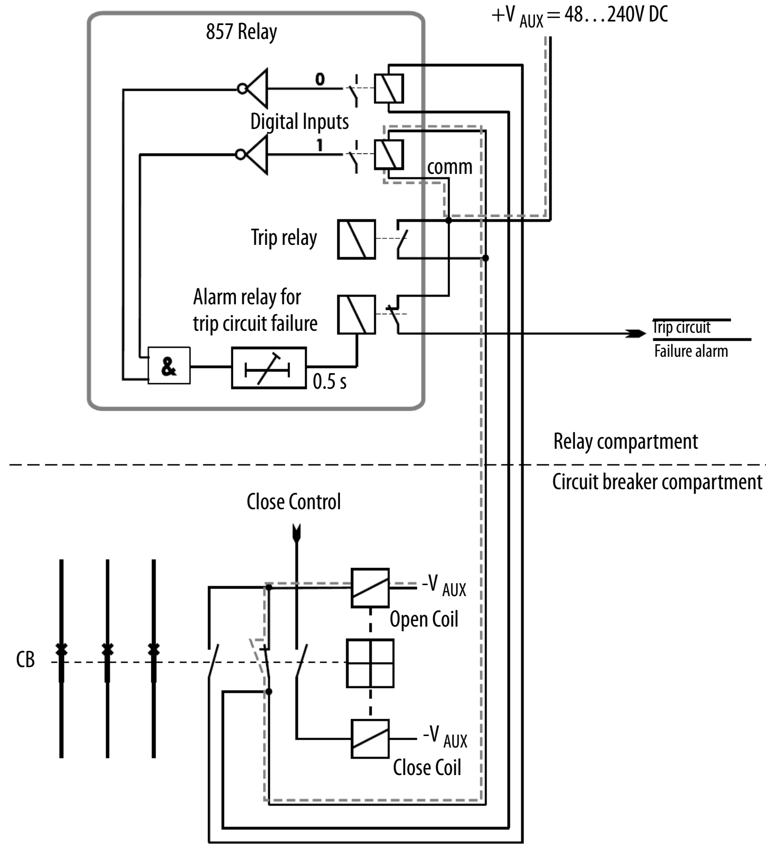
The programmable logic is used to combine the digital input signals with an AND port. The delay is configured longer than the maximum fault time to inhibit any superfluous trip-circuit fault alarm when the trip contact is closed.

- The output from the logic is connected to a relay in the output matrix that gives out any trip circuit alarm.
- Configure the trip relay as non-latched. Otherwise, the trip contact operates, a superfluous trip-circuit fault alarm follows, and the relay remains closed because of latching.
- Both digital inputs must have their own common potential. The use of the other digital inputs in the same group as the upper DI in Figure 166 is not possible in most applications. The use of the other digital inputs in the same group as the lower DI in Figure 166 is limited. Because the whole group is tied to the auxiliary voltage V_{aux}.

TIP For some applications, the optimal digital inputs for trip circuit supervision are the optional inputs DI19 and DI20 because they do not share their terminals with any other digital inputs.

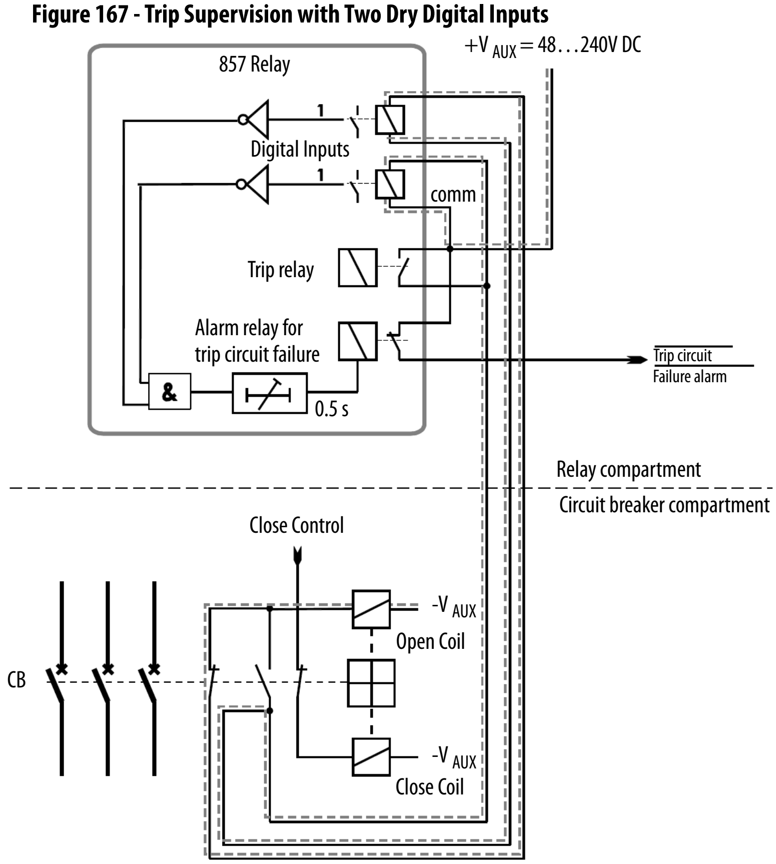
The circuit breaker is closed. The supervisory circuit in this circuit breaker position is double-lined. The digital input state is in active state when the trip circuit is complete. Applicable for dry inputs DI7…DI20 only.

Figure 166 - Trip Circuit Supervision with Two Dry Digital Inputs



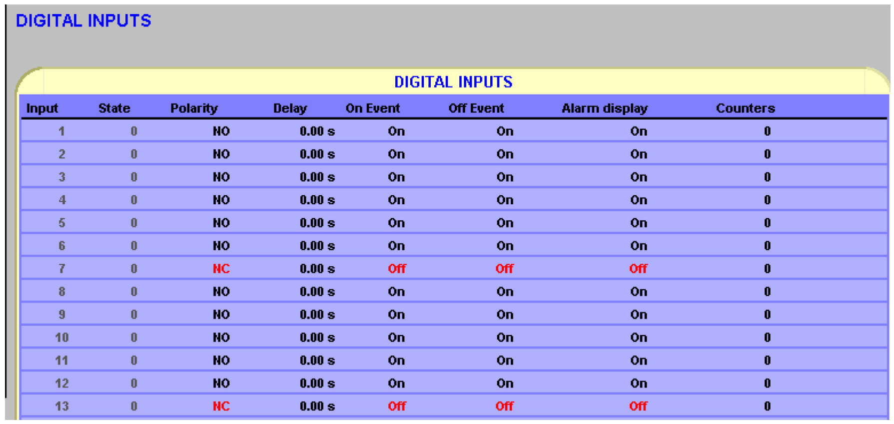
The circuit breaker is in the open position. The two digital inputs are now in series.

Figure 167 - Trip Supervision with Two Dry Digital Inputs



TIP If DI13 and DI7 are used as the upper and lower digital inputs. The usage of DI8… DI14 is limited to the same circuitry shared by the Vaux in the common terminal. The DI14… DI18 and cannot be used, because they share a common terminal with DI13.

Figure 168 - Digital Input Configuration for Trip Circuit Supervision with Two Dry Digital Inputs DI7 and DI13



DIGITAL INPUTS

DIGITAL INPUTS

Input	State	Polarity	Delay	On Event	Off Event	Alarm display	Counters
1	0	NO	0.00 s	On	On	On	0
2	0	NO	0.00 s	On	On	On	0
3	0	NO	0.00 s	On	On	On	0
4	0	NO	0.00 s	On	On	On	0
5	0	NO	0.00 s	On	On	On	0
6	0	NO	0.00 s	On	On	On	0
7	0	NC	0.00 s	Off	Off	Off	0
8	0	NO	0.00 s	On	On	On	0
9	0	NO	0.00 s	On	On	On	0
10	0	NO	0.00 s	On	On	On	0
11	0	NO	0.00 s	On	On	On	0
12	0	NO	0.00 s	On	On	On	0
13	0	NC	0.00 s	Off	Off	Off	0

Figure 169 - Logic Configuration for Trip Circuit Supervision with Two Dry Digital Inputs DI7 and DI13

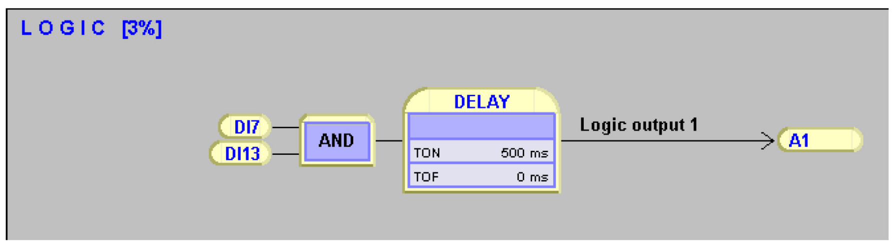
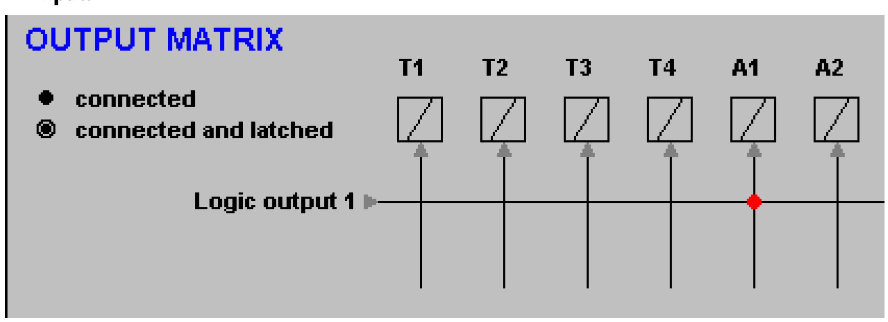


Figure 170 - Output Matrix Configuration for Trip Circuit Supervision with Two Dry Digital Inputs



Connections

Rear Panel View

Allen-Bradley® 857 Protection System is connected to the object (that it helps protect) through the following measuring and control connections.

Figure 171 - Rear Panel Connections of an 857-3C6

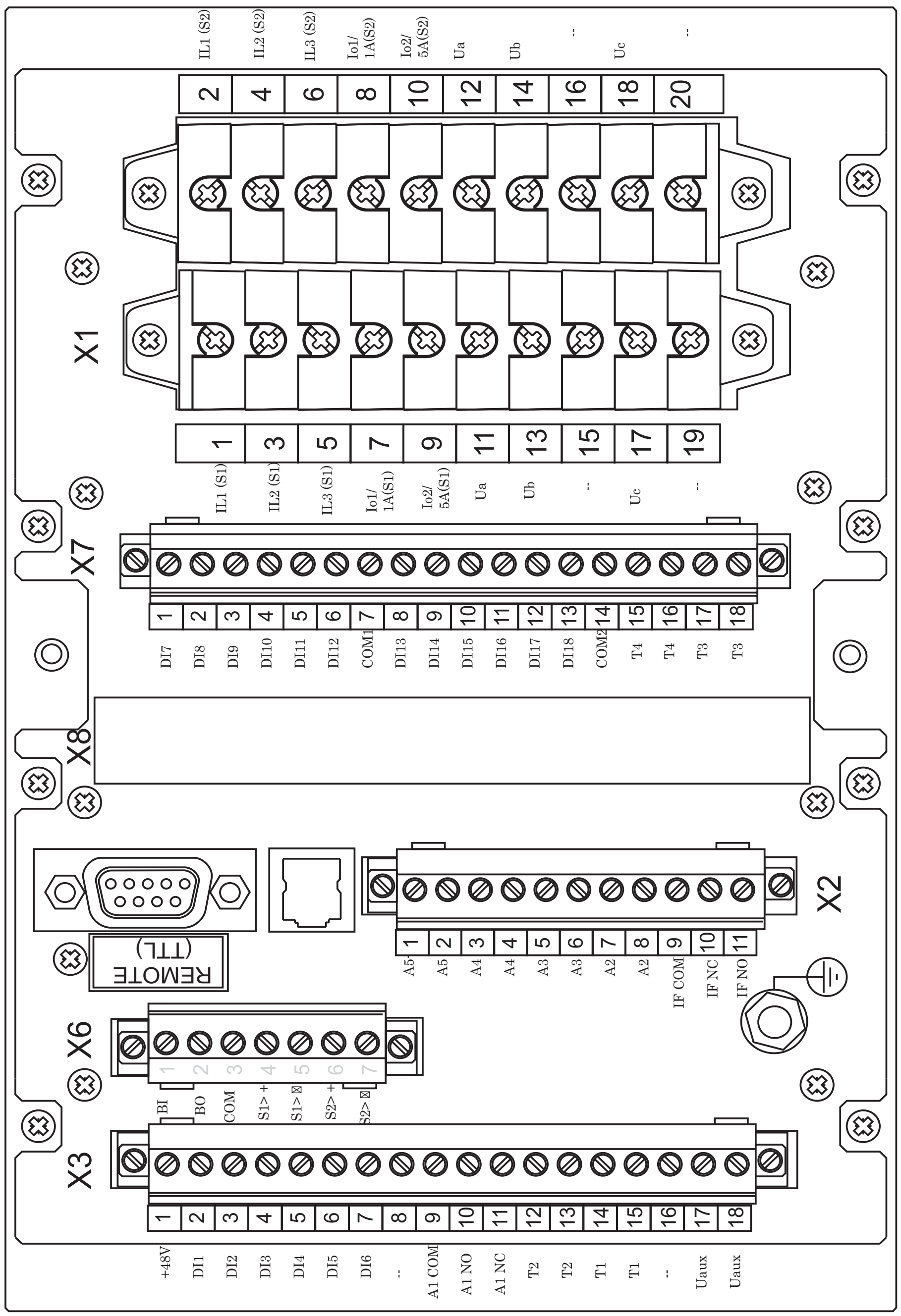


Figure 172 - Rear Panel Connections of an 857-3C7

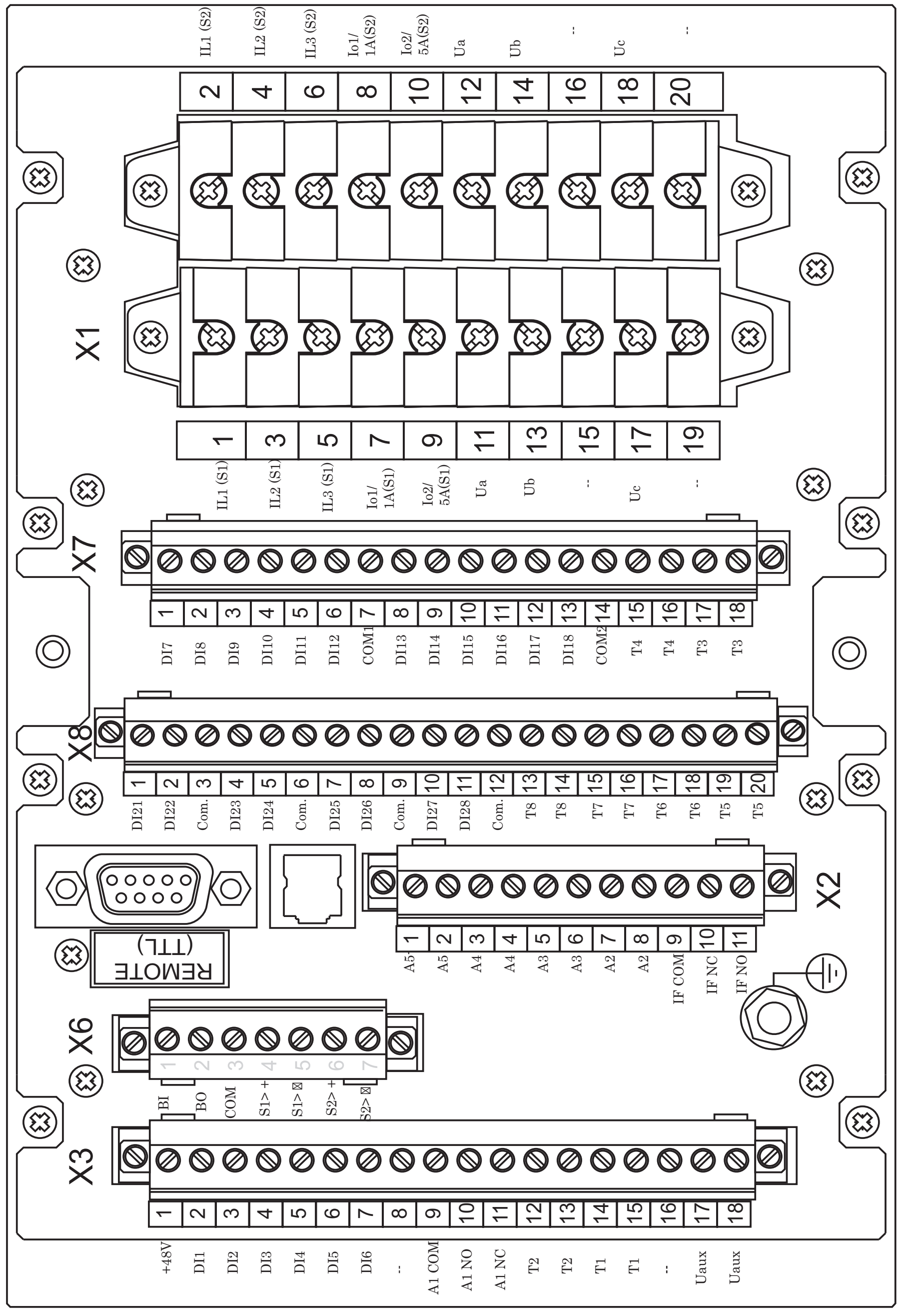
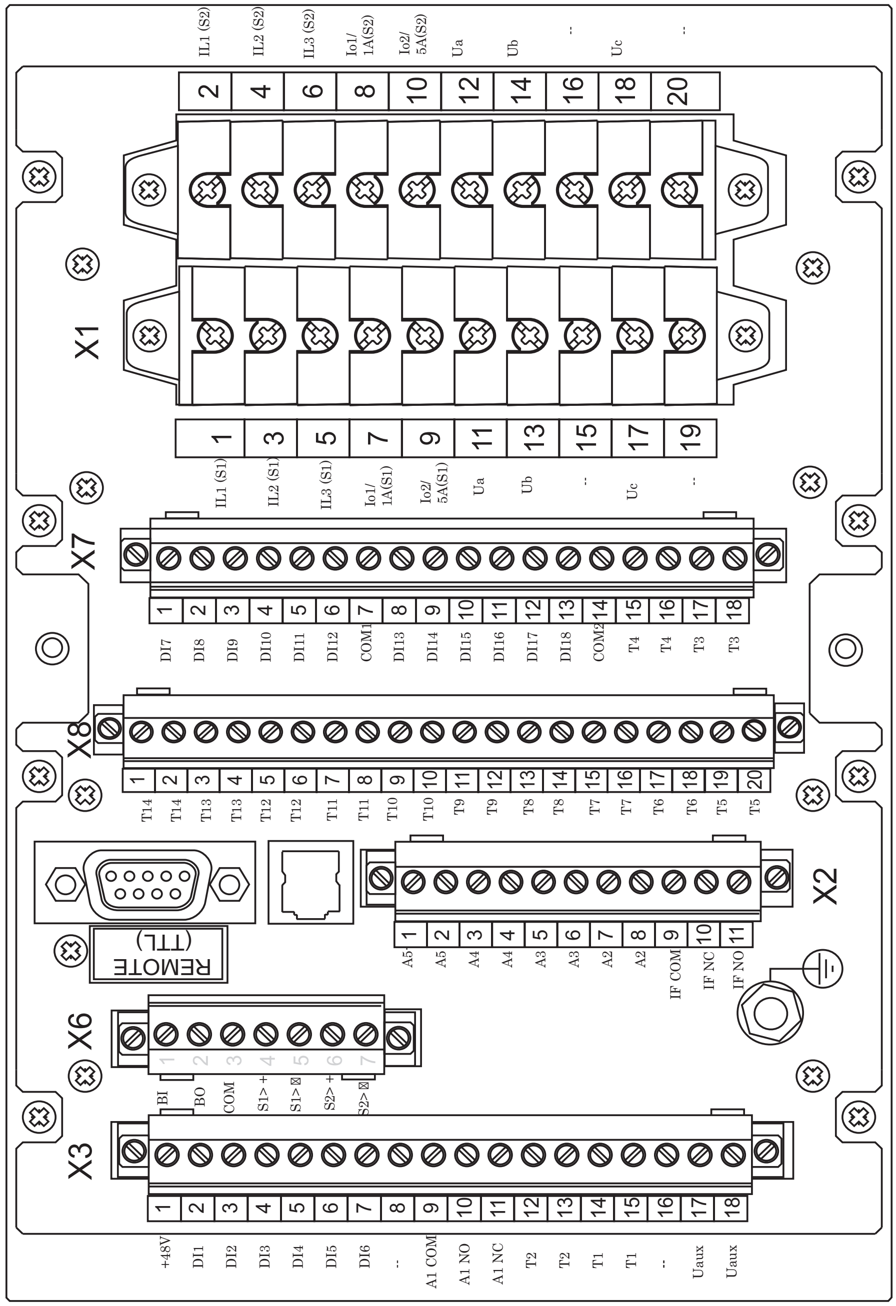
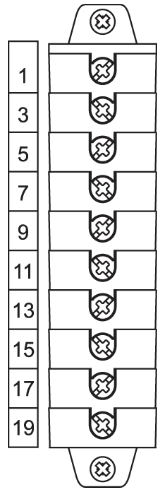


Figure 173 - Rear Panel Connections of an 857-3C8



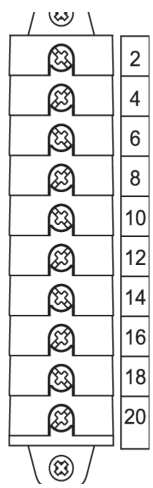
Details of Terminal Connections

Table 155 - Terminal X1 Left Side



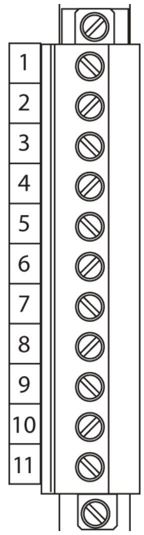
No:	Symbol	Description
1	IL1(S1)	Phase current L1 (S1)
3	IL2(S1)	Phase current L2 (S1)
5	IL3(S1)	Phase current L3 (S1)
7	Io1/1A(S1)	Residual current I/01(S1)
9	Io2/5A(S1)	Residual current I/02(S1)
11	Ua	See Voltage Measurement Mode on page 217
13	Ub	See Voltage Measurement Mode on page 217
15	--	--
17	Uc	See Voltage Measurement Mode on page 217
19	--	--

Table 156 - Terminal X1 Right Side



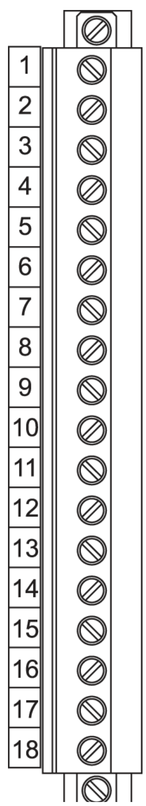
No:	Symbol	Description
2	IL1(S2)	Phase current L1 (S2)
4	IL2(S2)	Phase current L2 (S2)
6	IL3(S2)	Phase current L3 (S2)
8	Io1/1A(S2)	Residual current I/01 (S2)
10	Io2/5A(S2)	Residual current I/02 (S2)
12	Ua	See Voltage Measurement Mode on page 217
14	Ub	See Voltage Measurement Mode on page 217
16	--	--
18	Uc	See Voltage Measurement Mode on page 217
20	--	--

Table 157 - Terminal X2



No:	Symbol	Description
1	A5	Alarm relay 5
2	A5	Alarm relay 5
3	A4	Alarm relay 4
4	A4	Alarm relay 4
5	A3	Alarm relay 3
6	A3	Alarm relay 3
7	A2	Alarm relay 2
8	A2	Alarm relay 2
9	IF COM	Internal fault relay, common connector
10	IF NC	Internal fault relay, normal closed connector
11	IF NO	Internal fault relay, normal open connector

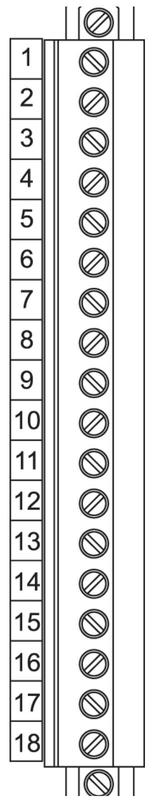
Table 158 - Terminal X3



No:	Symbol	Description
1	+48V	Internal control voltage for digital inputs 1…6
2	DI1	Digital input 1
3	DI2	Digital input 2
4	DI3	Digital input 3
5	DI4	Digital input 4
6	DI5	Digital input 5
7	DI6	Digital input 6
8	--	--
9	A1 COM	Alarm relay 1, common connector
10	A1 NO	Alarm relay 1, normal open connector
11	A1 NC	Alarm relay 1, normal closed connector
12	T2	Trip relay 2
13	T2	Trip relay 2
14	T1	Trip relay 1
15	T1	Trip relay 1
16	--	--
17	Uaux	Auxiliary voltage(1)
18	Uaux	Auxiliary voltage

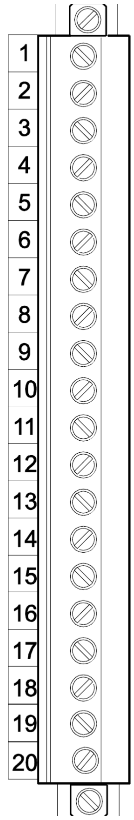
(1) When the optional 18…36V DC power module is used, the DC control voltage (U_{aux}) is applied as follows:
- Input terminal X3-17 is used for the Negative (-) connection
- Input terminal X3-18 is used for the Positive (+) connection.

Table 159 - Terminal X7



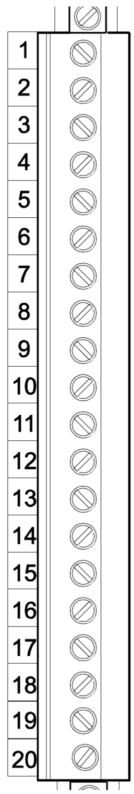
No:	Symbol	Description
1	DI7	Digital input 7
2	DI8	Digital input 8
3	DI9	Digital input 9
4	DI10	Digital input 10
5	DI11	Digital input 11
6	DI12	Digital input 12
7	COM1	Common potential of digital inputs 7…12
8	DI13	Digital input 13
9	DI14	Digital input 14
10	DI15	Digital input 15
11	DI16	Digital input 16
12	D117	Digital input 17
13	DI18	Digital input 18
14	COM2	Common potential of digital inputs 13…18
15	T4	Trip relay 4
16	T4	Trip relay 4
17	T3	Trip relay 3
18	T3	Trip relay 3

Table 160 - Terminal X8 Model 857-3C7



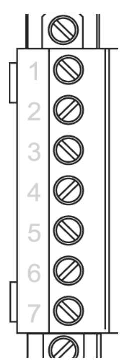
No:	Symbol	Description
1	DI21	Digital input 21
2	DI22	Digital input 22
3	COM1	Common potential of digital inputs 21…2
4	DI23	Digital input 23
5	DI24	Digital input 24
6	COM2	Common potential of digital inputs 23…24
7	DI25	Digital input 25
8	DI26	Digital input 26
9	COM3	Common potential of digital inputs 25…26
10	DI27	Digital input 27
11	DI28	Digital input 28
12	COM4	Common potential of digital inputs 27…28
13	T8	Trip relay 8 / Digital input 32
14	T8	Trip relay 8 / Digital input 32
15	T7	Trip relay 7 / Digital input 31
16	T7	Trip relay 7 / Digital input 31
17	T6	Trip relay 6 / Digital input 30
18	T6	Trip relay 6 / Digital input 30
19	T5	Trip relay 5 / Digital input 29
20	T5	Trip relay 5 / Digital input 29

Table 161 - Terminal X8 Model 857-3C8



No:	Symbol	Description
1	DI21	Trip relay 14
2	DI22	Trip relay 14
3	COM1	Trip relay 13
4	DI23	Trip relay 13
5	DI24	Trip relay 12
6	COM2	Trip relay 12
7	DI25	Trip relay 11
8	DI26	Trip relay 11
9	COM3	Trip relay 10
10	DI27	Trip relay 10
11	DI28	Trip relay 9
12	COM4	Trip relay 9
13	T8	Trip relay 8 / Digital input 32
14	T8	Trip relay 8 / Digital input 32
15	T7	Trip relay 7 / Digital input 31
16	T7	Trip relay 7 / Digital input 31
17	T6	Trip relay 6 / Digital input 30
18	T6	Trip relay 6 / Digital input 30
19	T5	Trip relay 5 / Digital input 29
20	T5	Trip relay 5 / Digital input 29

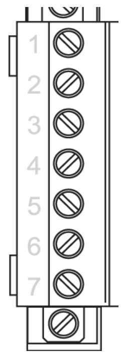
Table 162 - Terminal X6



No:	Symbol	Description
1	BI	External arc light input
2	BO	Arc light output
3	COM	Common connector of arc light I/O
4	S1>+	Arc sensor 1, positive connector [1]
5	S1>–	Arc sensor 1, negative connector [1]
6	S2>+	Arc sensor 2, positive connector [1]
7	S2>–	Arc sensor 2, negative connector [1]

(1) Arc sensor itself is polarity free.

Table 163 - Terminal X6 with DI19/DI20 Option



No:	Symbol	Description
1	DI19	Digital input 19
2	DI19	Digital input 19
3	DI20	Digital input 20
4	DI20	Digital input 20
5	—	—
6	S1>+	Arc sensor 1, positive connector(1)
7	S1>–	Arc sensor 1, negative connector(1)

(1) Arc sensor itself is polarity free.

Auxiliary Voltage

The external auxiliary voltage U_{aux} (standard 40…265V AC or DC) for the terminal is connected to the terminals X3: 17…18.

TIP When optional 18…36V DC power module is used, the polarity is as follows:

X3: 17 = Negative Connection and X3: 18 = Positive Connection.

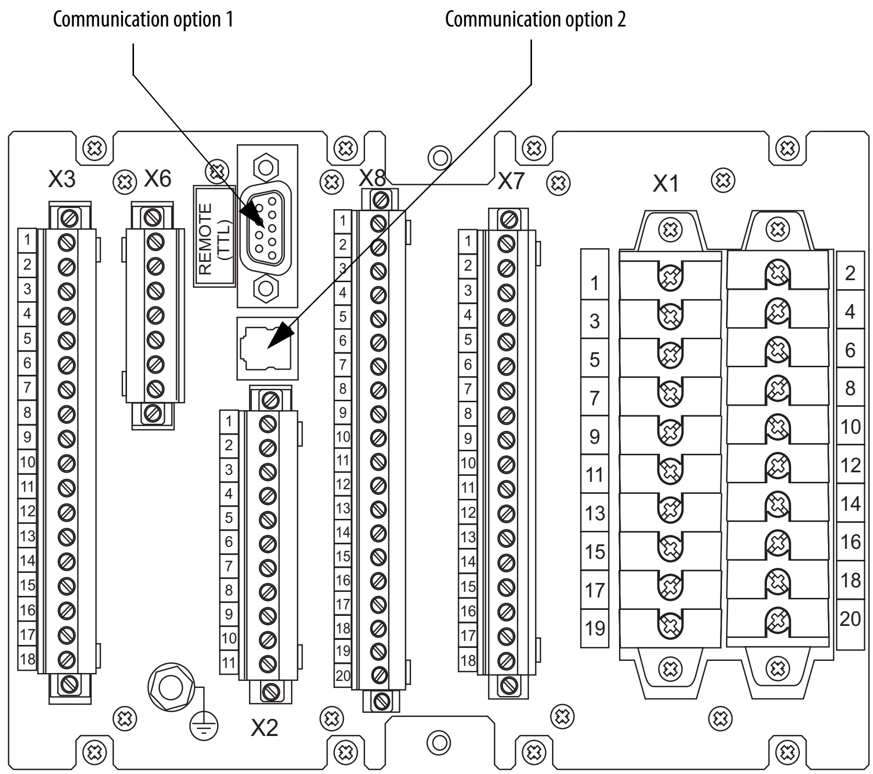
Serial Communication Connection

The device can be equipped with two optional communication interfaces:

- Option 1: inbuilt Ethernet ST-fiber optic interface or option module 1
- Option 2: inbuilt Ethernet RJ45 interface or option module 2

The physical location of the communication options is at the back of the relay. The option modules can be installed at the site, but the built-in Ethernet modules are installed at the factory.

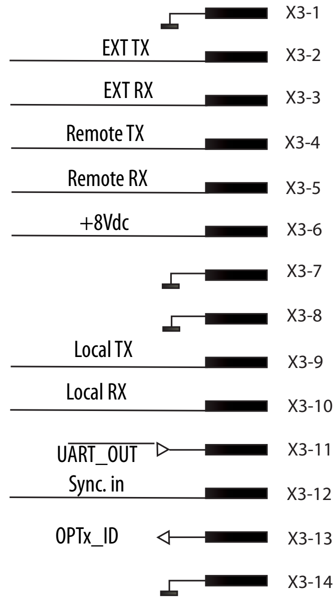
Figure 174 - Example of Allen-Bradley 857 Back Panel Serial Communication Connection



The internal connection in both communication modules is identical (see Figure 175). The transmit and receive lines of all three “logical communication ports” REMOTE, LOCAL, and EXTENSION port are available for both modules (RS-232 signal levels). The module type determines if one or more of these ports are physically available at the external connector.

The communication modules convert the RS-232 signal levels to some other levels, for example, TTL, RS-485 or fiber-optics. The modules can contain intelligence to make protocol conversion on software level.

Figure 175 - Internal Connection to Communication Modules



The internal connection of the communication modules contains the RX/TX signals from the communication ports, general output (UART_OUT), clock sync/general input (Sync.in), and OPTx_ID for module detection.

Figure 176 - TTL Communication Module (31 mm)

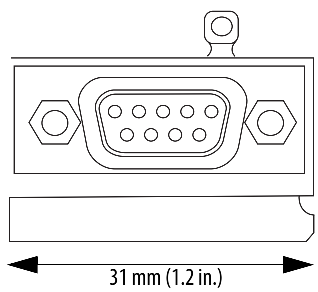
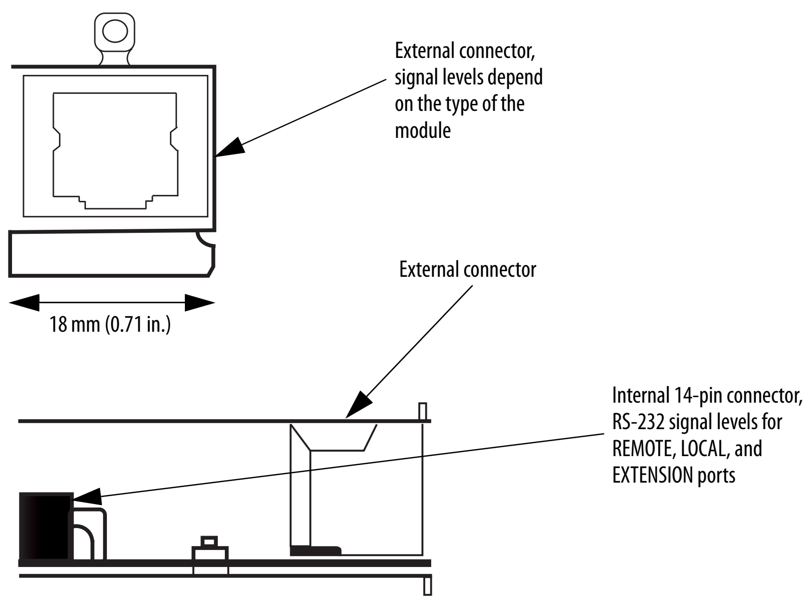


Figure 177 - Communication Module (18 mm)



The device has a 31 mm high "slot" for Communication option 1 and 18 mm high "slot" for Communication option 2. The option modules are 31 mm or 18 mm high, the 18 mm modules can be used in the 31 mm or 18 mm slot.

Pin Assignments of Communication Options

The communication module types and their pin assignments are introduced in these tables.

Table 164 - Optional Built-in Ethernet/61850 Interfaces

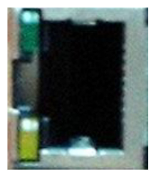
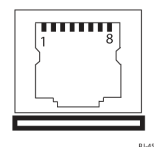
Type	Communication Ports	Signal Levels	Connector	Pin Usage
Ethernet 	TCP Port	Ethernet	RJ45 Connector 	1 = Transmit+ 2 = Transmit- 3 = Receive+ 4 = Reserved 5 = Reserved 6 = Receive- 7 = Reserved 8 = Reserved
Ethernet	TCP Port	Fiber Ethernet	ST Connectors (dual-port)	

Table 165 - 18 mm High Modules

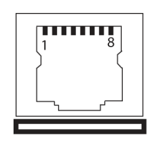
Type	Communication Ports	Signal Levels	Connector	Pin Usage
857-VCM232	REMOTE, LOCAL, and EXTENSION	RS-232	RJ45 Connector 	1 = LOC TX 2 = EXT TX 3 = +8V 4 = GND 5 = REM TX 6 = REM RX 7 = LOC RX 8 = EXT RX
857-VCM485 857-VCM485-2	REMOTE, LOCAL, or EXTENSION port selectable with a DIP switch	RS-485 (2-wire connection)	3-pole screw connector	1 = – 2 = + 3 = GND
857-VCMRTD (required for 857-RAA)	Remote/Local	Light, switch for echo/ no-echo and light/ no-light selection	ST Connector	Used with 857-RAA

Table 166 - 32 mm High Modules

Type	Communication Ports	Signal Levels	Connector	Pin Usage
TTL/RS232(1)	REMOTE LOCAL EXTENSION	REMOTE: TTL or RS-232 selectable with a DIP Switch LOCAL: RS-232 EXTENSION: RS-232	D-connector	1= EXT TX 2= REM TX 3= REM RX 4= SYNC IN 5= LOC TX 6= LOC RX 7= GND 8= EXT RX 9= +8V
857-VCM485-4	REMOTE, LOCAL, or EXTENSION port selectable with a DIP switch	RS-485 (2- or 4-wire connection)	5-pole screw connector	1= GND 2= R- 3= R+ 4= T- 5= T+
857-VCM fiber PP	REMOTE or LOCAL selectable with a DIP switch	Light, switch for echo/ no-echo and light/ no-light selection	Snap-in connectors	
857-VCM fiber GG (required for 857-RAD)	REMOTE or LOCAL selectable with a DIP switch	Light, switch for echo/ no-echo and light/ no-light selection	ST connectors	Used with 857-VCMFIBER
857-VCM fiber PG	REMOTE or LOCAL selectable with a DIP switch	Light, switch for echo/ no-echo and light/ no-light selection	Snap-in and ST connectors	
857-VCM fiber GP	REMOTE or LOCAL selectable with a DIP switch	Light, switch for echo/ no-echo and light/ no-light selection	ST and Snap-in connectors	

(1) PROFIBUS is supported by the external 857-VPA 3CG module. The module is connected with an 857-VX007-F3 cable to the VCM TTL module (VCM TTL DIP switch must be set to TTL).

Figure 178 - TTL – Module DIP Switches

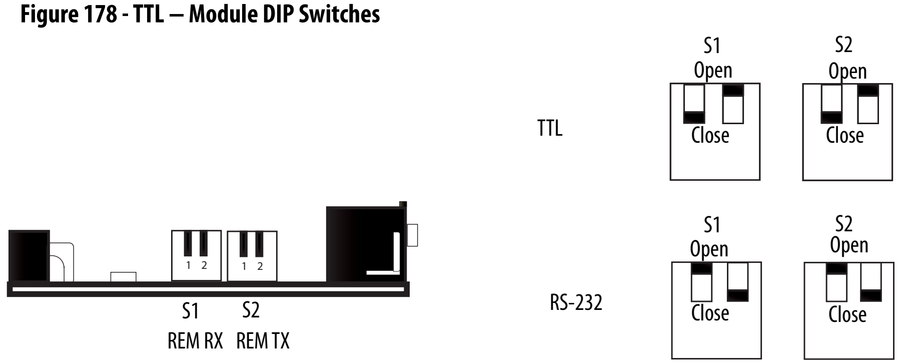


Figure 179 - 857-VCM485-2

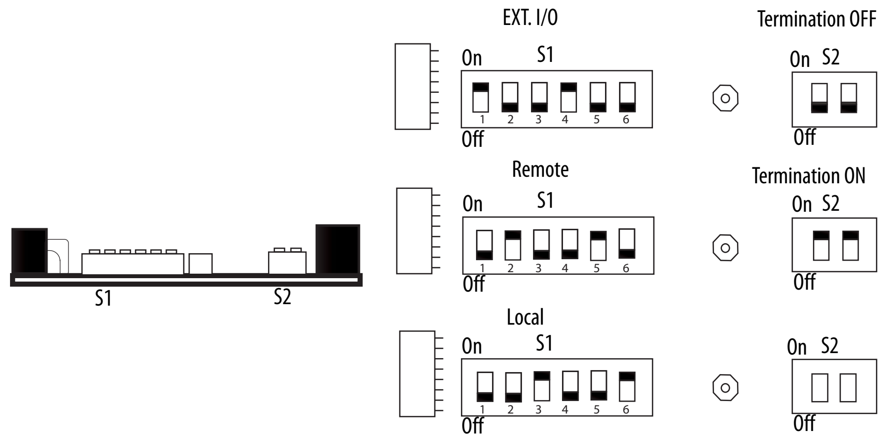


Figure 180 - 857-VCM485-4 — Module DIP Switches

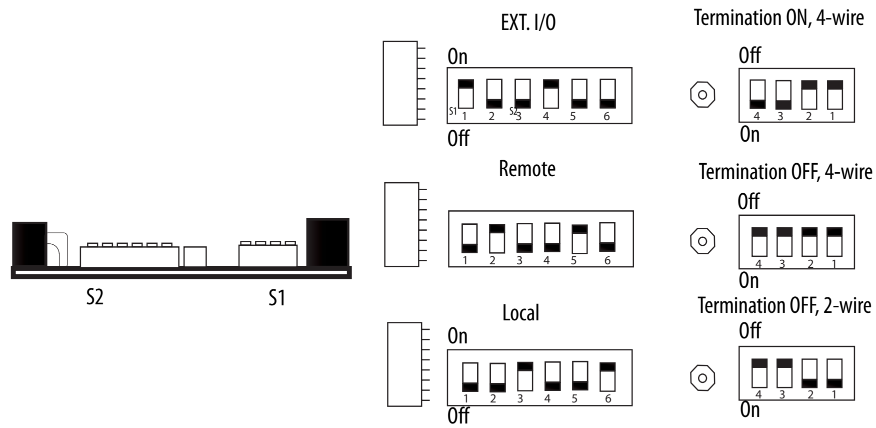
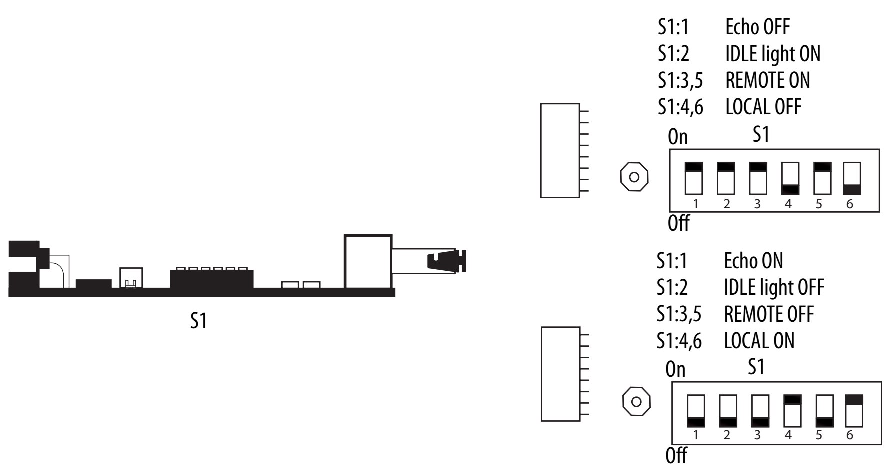


Figure 181 - 857-VCM Fiber — Module DIP Switches



Front Panel Connector

Figure 182 - Pin Numbering of the Front Panel D9S Connector

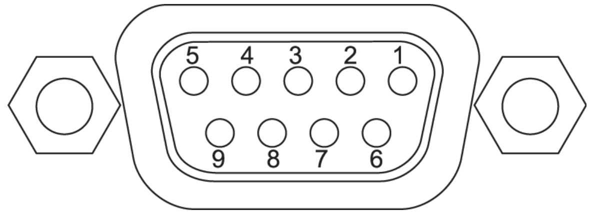


Table 167 - RS-232 Signals

Pin	RS-232 Signal
1	Not connected
2	Rx in
3	Tx out
4	DTR out (+8V)
5	GND
6	DSR in (activates this port and disables the X4 RS-232 port)
7	RTS in (Internally connected to pin 8)
8	CTS out (Internally connected to pin 7)
9	No connected

TIP Connect DSR to DTR to activate the front panel connector and disable the rear panel X4 RS-232 port. The other port in the same X4 connector is not disabled.

Optional Two-channel Arc Protection Card

The optional arc protection card includes two arc sensor channels. The arc sensors are connected to terminals X6: 4-5 and 6-7.

The arc information can be transmitted and/or received through digital input and output channels. A 48V DC signal.

TIP When this option card is installed, the parameter "Arc card type" has value "2Arc+BI/O".

TIP If the slot X6 is occupied with the DI19/DI20 digital input card, this option is not available. There is still one arc sensor channel available (see Optional Digital I/O Card (DI19/DI20) on page 336).

Table 168 - Two-channel Arc Protection Card Connections:

X6: 1	Binary input (BI)
X6: 2	Binary output (BO)
X6: 3	Common for BI and BO.
X6: 4-5	Sensor Channel 1
X6: 6-7	Sensor Channel 2

Activate the binary output of the arc option card by using the arc sensors or by any available signal in the output matrix. The binary output can be connected to an arc binary input of another Allen-Bradley® protection device or other compatible product.

Optional Digital I/O Card (DI19/DI20)

The DI19/DI20 option permits two more digital inputs. These inputs are useful in applications where the contact signals are not potential free. For example, trip circuit supervision is such an application. The inputs are connected to terminals X6:1 – X6:2 and X6:3 – X6:4.

TIP When this option card is installed, the parameter "Arc card type" has value "Arc+2DI". With DI19/DI20 option, only one arc sensor channel is available.

TIP If the slot X6 is occupied with the two-channel arc sensor card, this option is not available.

Table 169 - Digital I/O Card Connections:

1	DI19+
X6:2	DI19-
X6:3	DI20+
X6:4	DI20-
X6:5	NC
X6:6	L+
X6:7	L-

External Input/Output Modules

The 857 device supports optional external input/output modules that are used to extend the system capabilities. A module for analog inputs and outputs is available. These types of devices are supported:

- 12-channel RTD scanner, 857-RAA.
- 12-channel RTD scanner with analog inputs and outputs, and a thermistor input, 857-RAD. See publication 857-UM002.

Block Diagrams

Figure 183 - Block Diagram of Allen-Bradley 857-3C6

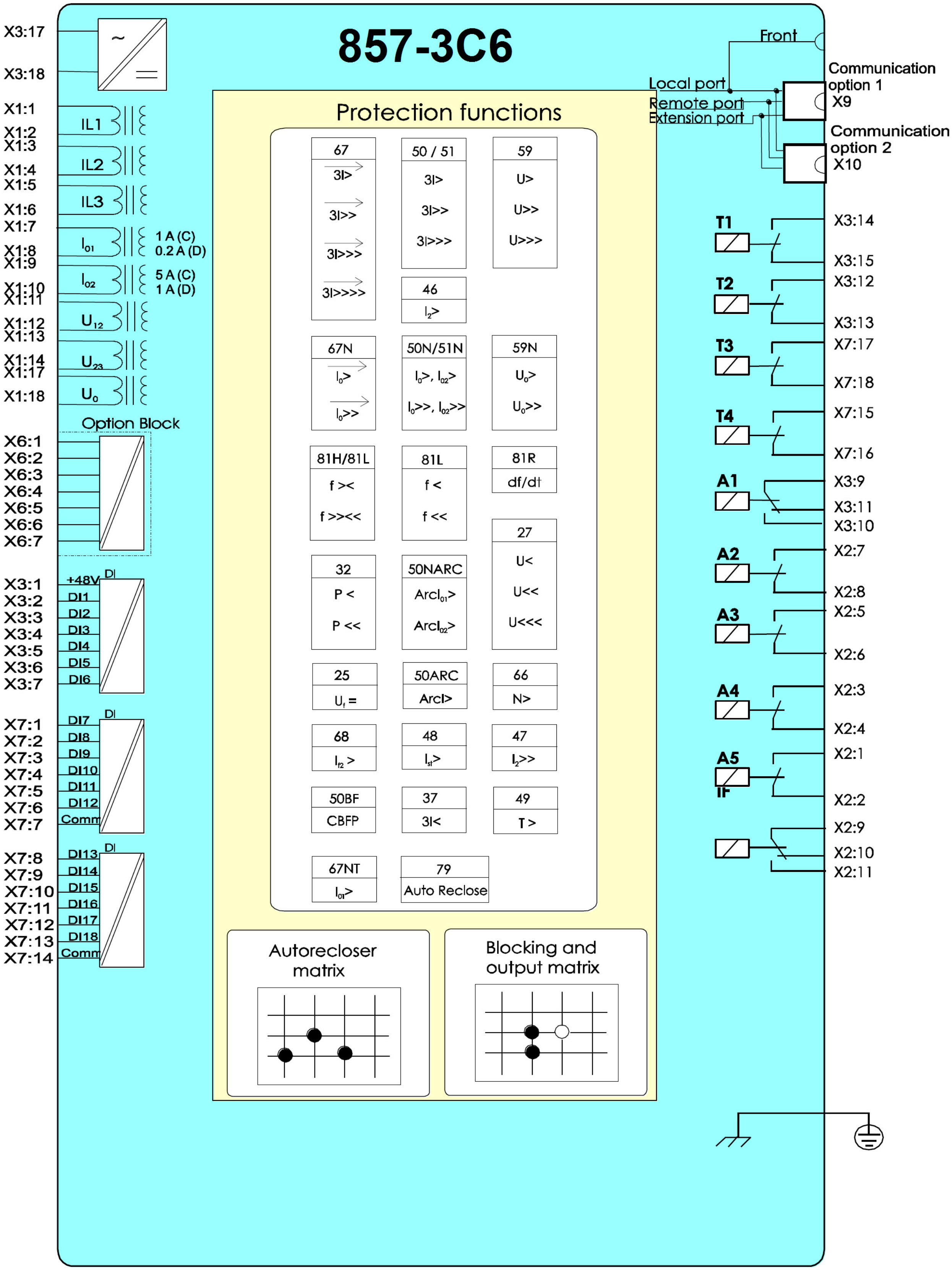


Figure 184 - Block Diagram of Allen-Bradley 857-3C7

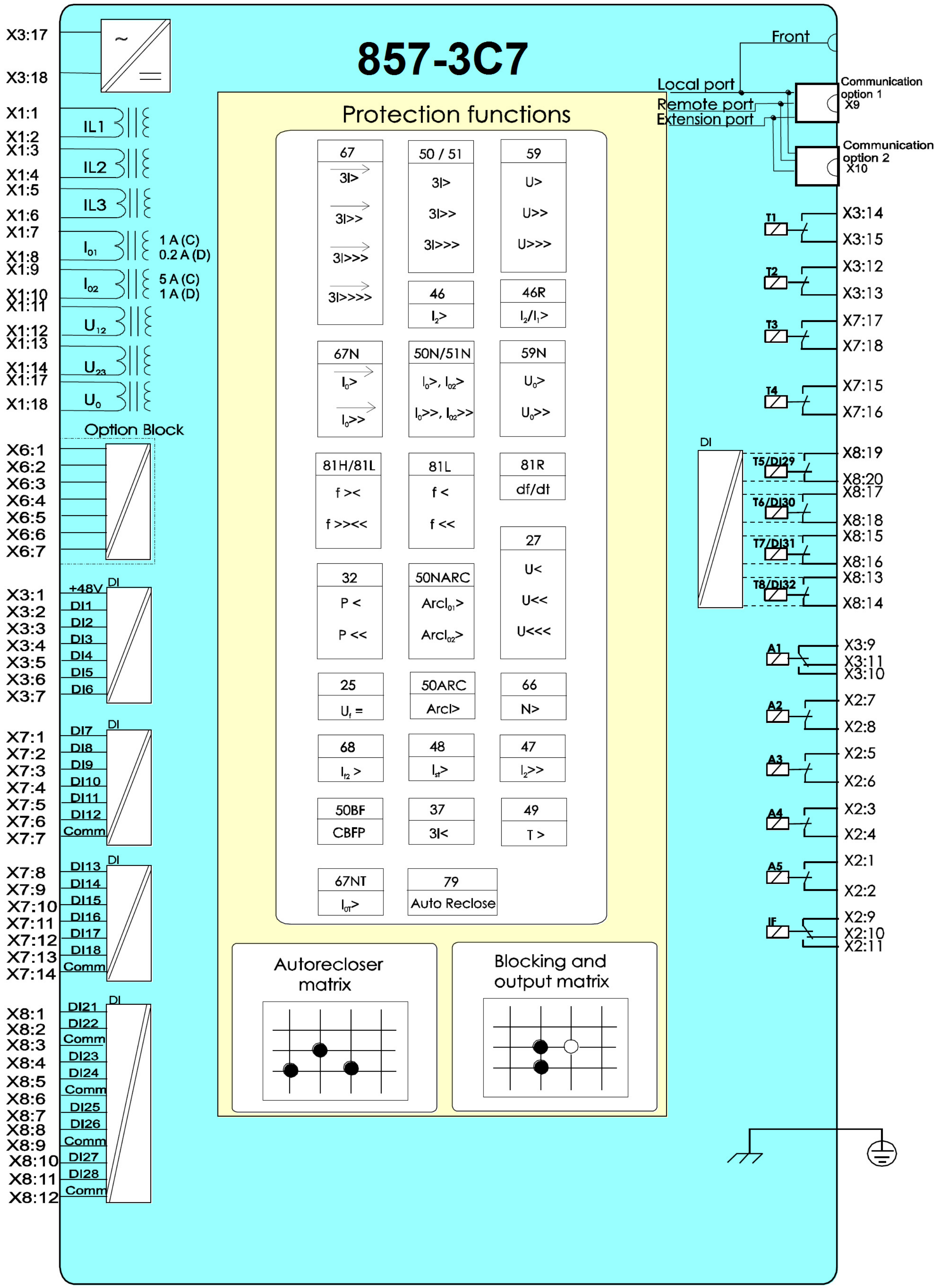
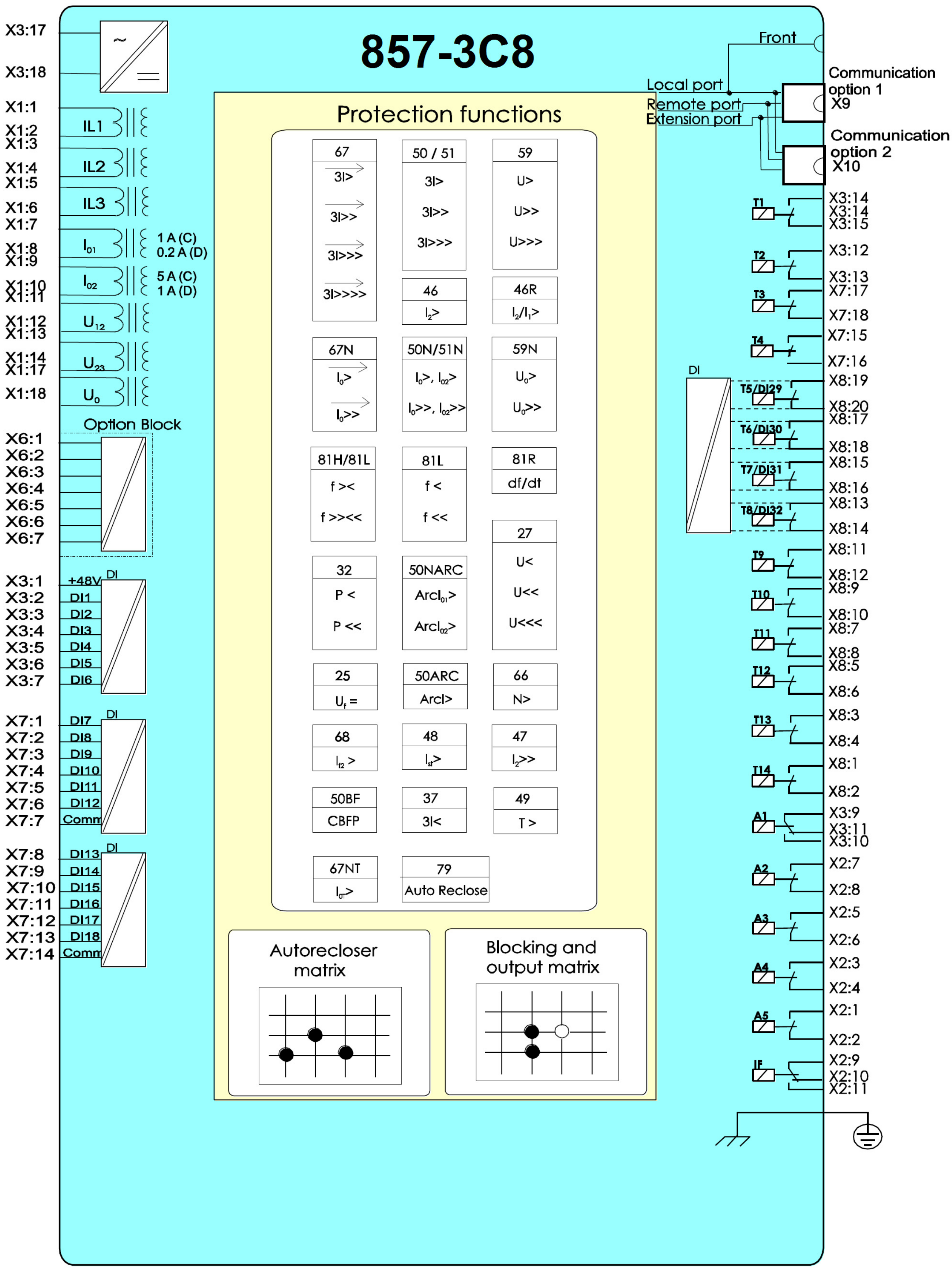


Figure 185 - Block Diagram of Allen-Bradley 857-3C8



Block Diagrams of Option Modules

Optional Arc Protection

Figure 186 - Block Diagram of Optional Arc Protection Module

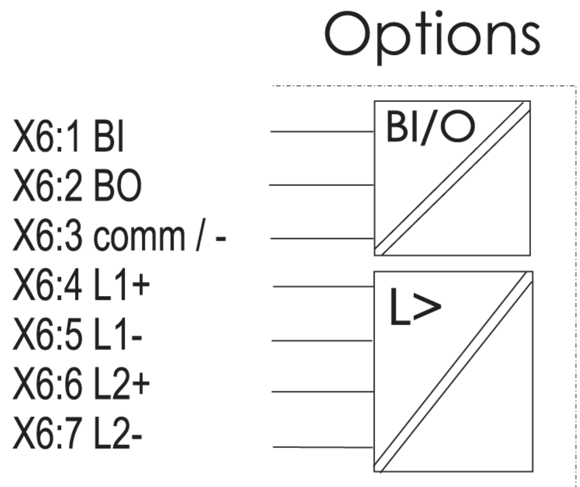
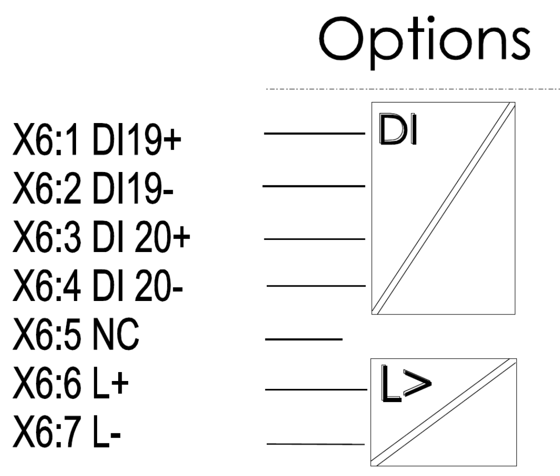


Figure 187 - Block Diagram of Optional D10/D20 Module with One Arc Channel



Connection Examples

The voltage measurement mode is set to "2LL+U_0".

Figure 188 - Connection Example of Allen-Bradley 857-3C7

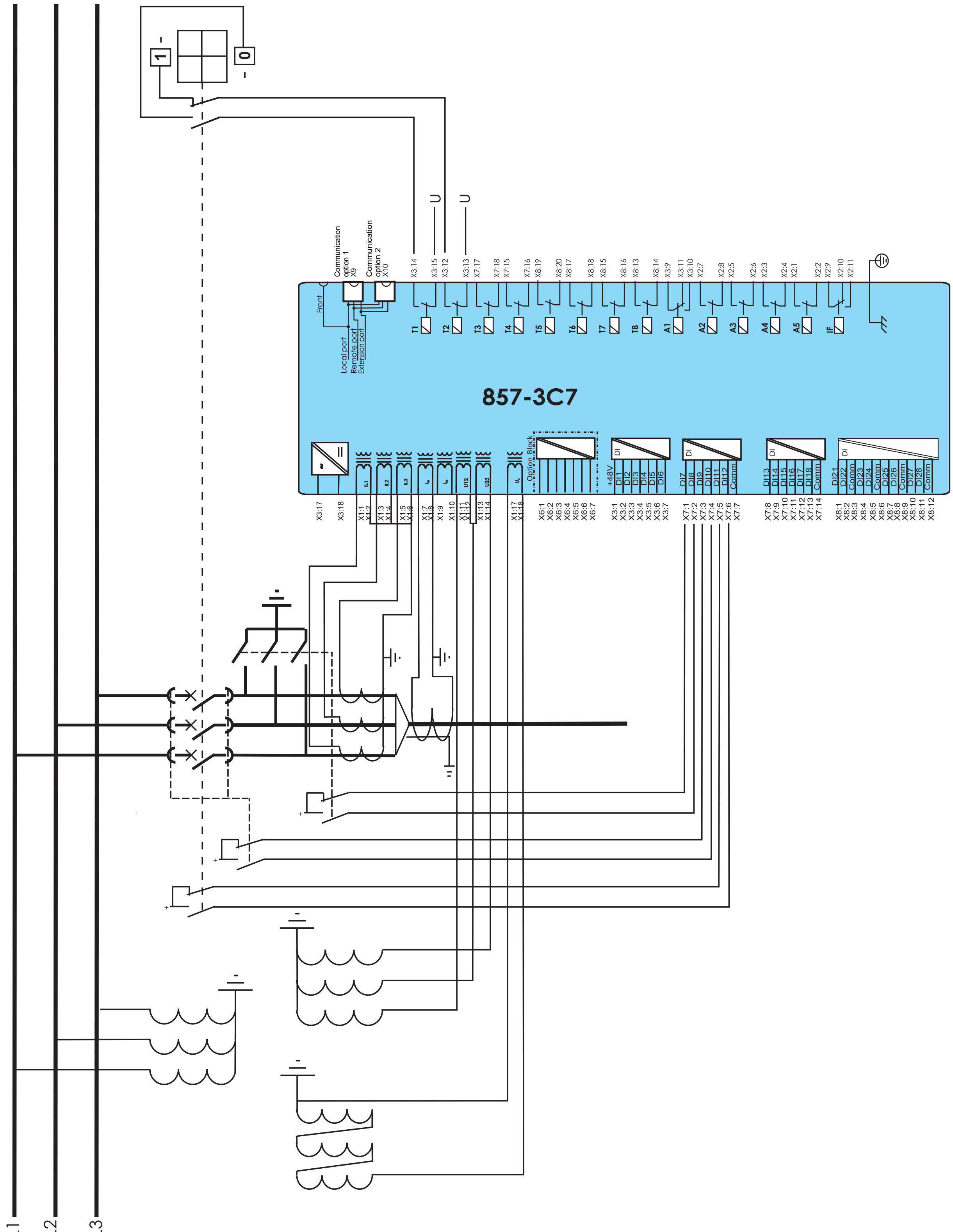
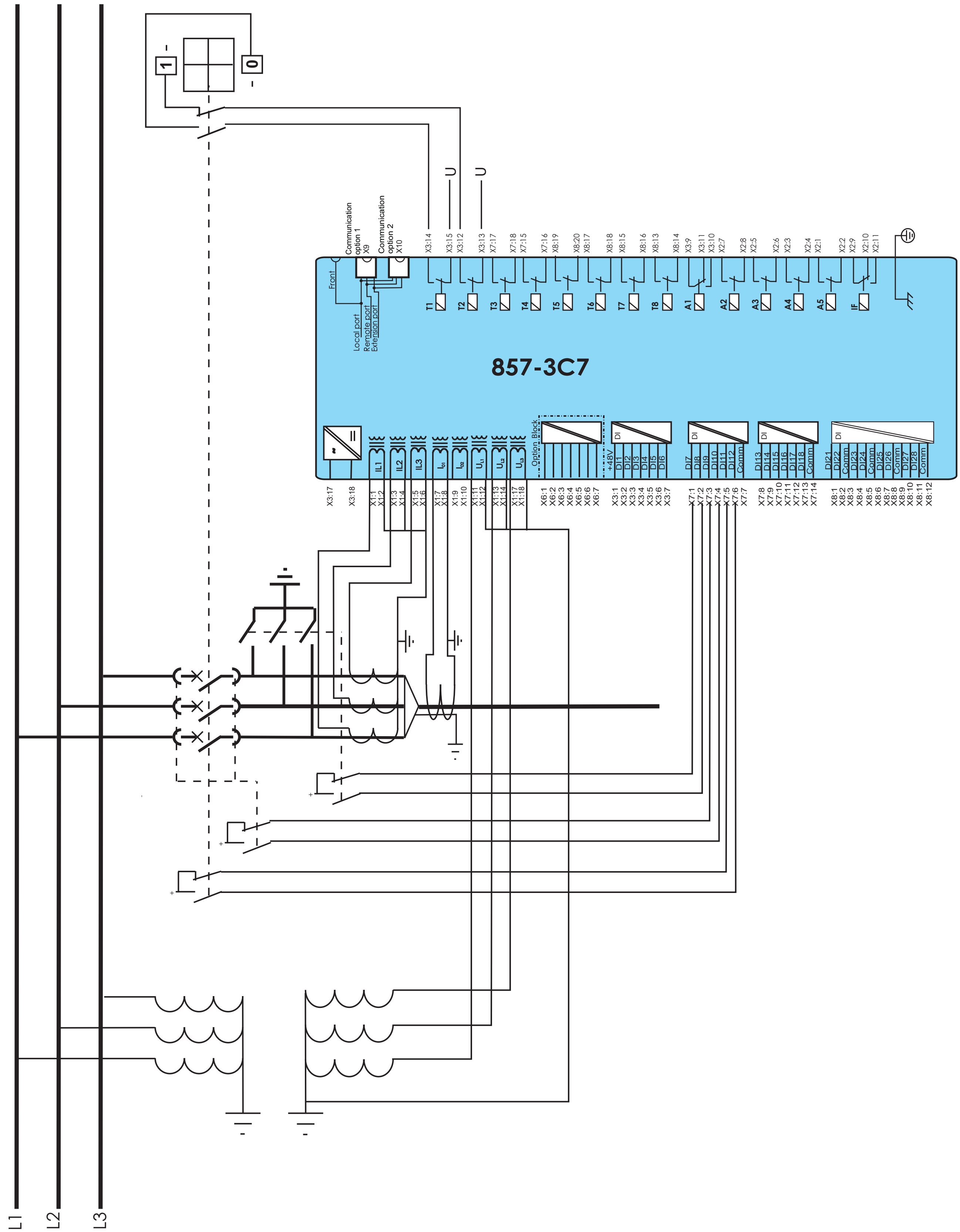


Figure 189 - Connection Example of Allen-Bradley 857-3C7 with Three Voltage Transformers

The device is calculating the residual voltage. The voltage measurement mode is set to "3LN".



The voltage measurement mode is set to "2LL+U_0".
Directional earth-fault stages are not available without the polarizing U_0 voltage.

Figure 190 - Connection Example of Allen-Bradley 857-3C7 with V-connected Voltage Transformer

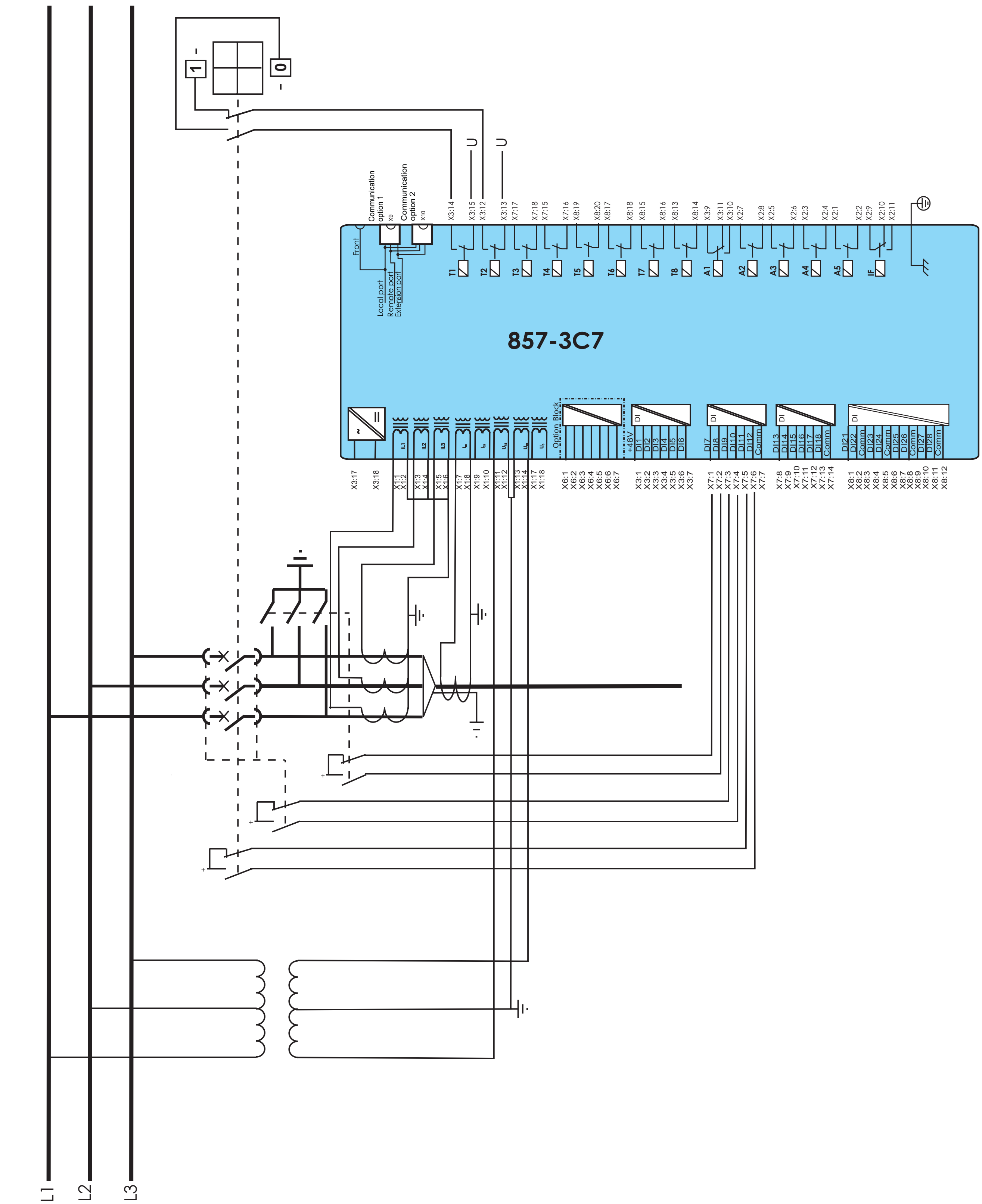
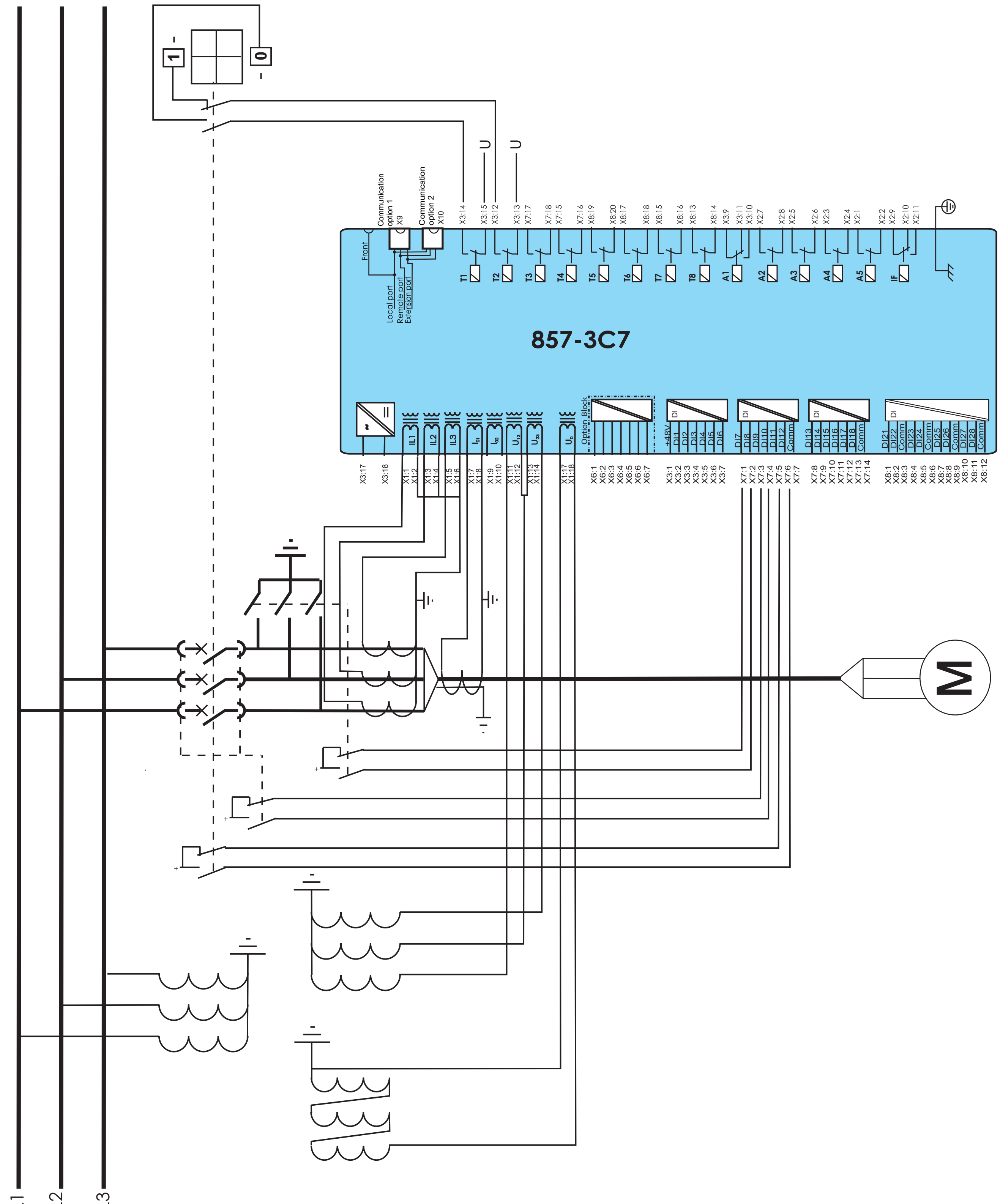


Figure 191 - Connection Example of Allen-Bradley 857-3C7 as a Motor Protection Device

The voltage measurement mode is set to “2LL+U_0”.



Specifications

Connections

Table 170 - Measuring the Circuitry

Rated phase current - Current measurement range - Thermal withstand - Burden - Impedance	5 A (configurable for CT secondaries 1…10 A) 0…250 A 20 A (continuously) 100 A (for 10 s), 500 A (for 1 s) 0.125VA 0.005 Ohms	
I_{02} Input, Option C[1] Rated residual current (optional) - Current measurement range - Thermal withstand - Burden - Impedance	5 A (configurable for CT secondaries 1…10 A) 0…50 A 20 A (continuously) 100 A (for 10 s), 500 A (for 1 s) 0.125VA 0.005 Ohms	
I_{01} Input, Option C / I_{01}2 Input, Option D[1] Rated residual current - Current measurement range - Thermal withstand - Burden - Impedance	1 A (configurable for CT secondaries 0.1…10.0 A) 0…10 A 4 A (continuously) 20 A (for 10 s), 100 A (for 1 s) 0.04VA 0.04 Ohms	
I_{01} Input, Option D[1] Rated residual current (optional) - Current measurement range - Thermal withstand - Burden - Impedance	0.2 A (configurable for CT secondaries 0.1…10.0 A) 0…2 A 0.8 A (continuously) 4 A (for 10 s), 20 A (for 1 s) 0.04VA 0.04 Ohms	
	Serial Numbers < 857-001071	**Serial Numbers > 857-001070**
Rated voltage Un	Configurable for VT Secondaries of 50…120V (110/110V default)	Configurable for VT Secondaries of 50…400V[2] (110/110V default)
Voltage measurement range	0…190V (100/110V)	0…260V (180/215V)[2]
Continuous voltage withstands	250V	250V
Burden	<0.5 A	<0.5 A
Rated frequency fn - Frequency measurement range	45…65 Hz	
Terminal block: - Solid or stranded wire	Maximum wire dimension: 4 mm^2 (10…12 AWG)	

(1) See Catalog Number Explanation on page 20.
(2) For configurable rated voltages greater than 215V (180V), the device must be wired to line-to-neutral voltages. The network neutral must not be ungrounded. The given limit 215V allows 20% overvoltage.

Table 171 - Auxiliary Voltage

Catalog No./ Option	Type A (Standard)	Type B (Option)
Rated voltage U_{aux}	40…265V AC/DC 110/120/220/240V AC 48/60/110/125/220V DC	18…36V DC 24V DC Nominal X3:17= Negative (-) X3:18= Positive (+)
Start Up Peak: 110V 220V	 15 A with a time constant of 1 ms 25 A with a time constant of 1 ms	
Power consumption Max. permitted interruption time	<15 W (normal conditions) < 25 W (output relays activated) < 50 ms (110V DC)	
Terminal Block: - Phoenix MVSTBW or equivalent	Max. wire dimension: 2.5 mm^2 (13…14 AWG)	

Table 172 - Digital Inputs

Internal Operating Voltage	
Number of inputs	6
Internal operating voltage	48V DC
Current drain when active (max.)	Approximately 20 mA
Current drain, average value	< 1 mA
Terminal block: - Phoenix MVSTBW or equivalent	Max. wire dimension: 2.5 mm^2 (13…14 AWG). Maximum torque for removable terminals is 0.5…0.6 N•m
External Operating Voltage	
Number of inputs	12/24/16 (selected by Catalog Number)
External operating voltage	24 V…265V DC Rated voltage selectable in order code: 3: 24V dc/ac (maximum 265V) 5: 24V dc/ac (maximum 265V) (UL) 6: 110V dc/ac (maximum 265V) 7: 220V dc/ac (maximum 265V)
Current drain	Approx. 2 mA
Activation Time dc/ac	< 11 ms/ < 15 ms
Reset time dc/ac	< 11 ms/ < 15 ms
Terminal block: - Phoenix MVSTBW or equivalent	Max. wire dimension: 2.5 mm^2 (13…14 AWG). Maximum torque for removable terminals is 0.5…0.6 N•m.

Table 173 - Trip Contacts

Number of contacts	4/8/14 (depends on the ordering code, or selected by Catalog Number)
Rated voltage	250V AC/DC
Continuous carry	5 A
Make and carry, 0.5 s Make and carry, 3 s	30 A 15 A
Breaking capacity, DC (L/R=40 ms) At 48V DC: At 110V DC: At 220V DC	 5 A 3 A 1 A
Contact material	AgNi 90/10
Terminal block: - Phoenix MVSTBW or equivalent	Maximum wire dimension: 2.5 mm^2 (13…14 AWG). Minimum 1.5 mm2 (15...16 AWG) Maximum torque for removable terminals is 0.5…0.6 N•m.

Table 174 - Alarm Contacts

Number of contacts	3 - Change-over contacts (relays A1, A2, and A3) 2 - Making contacts (relays A4 and A5) 1 - Change-over contact (IF relay)
Rated voltage	250V ac/dc
Max. make current, 4 s at duty cycle 10%	15 A
Continuous carry	5 A
Break capacity, AC	2000VA
Break capacity, DC (L/R=40 ms) At 48V DC At 110V DC At 220V DC	 1.3 A 0.4 A 0.2 A
Contact material	AgNi 0.15 gold plated AgNi 90/10
Terminal Block: - Phoenix MVSTBW or equivalent	Max. wire dimension: 2.5 mm (3/32 in.)^2 (13…14 AWG). Minimum 1.5 mm2 (15...16 AWG) Maximum torque for removable terminals is 0.5…0.6 N•m.

Table 175 - Local Serial Communication Port

Number of ports	1 on front and 1 on rear panel
Electrical connection	RS-232 in the front RS-232 with VCM-TTL (standard) RS-485 with VCM 485-2 or VCM 485-4 Plastic fiber with VCM-fiber (option) Glass fiber with VCM-fiber (option)
Data transfer rate	2400…38,400 kb/s

Table 176 - Remote Control Connection

Number of ports	1 on rear panel
Electrical connection	TTL with VCM TTL (standard) RS-485 with VCM 485 – 4(option) RS-232 with VCM TTL (standard) Plastic fiber connection with VCM fiber (option) Glass fiber connection (option) 100M Ethernet fiber 100M Ethernet copper (RJ-45)
Data transfer rate	1200…19,200 kb/s
Protocols	Modbus, RTU master Modbus, RTU slave SPA-Bus, slave IEC 60870-5-103 IEC 61850 PROFIBUS DP (option, with external module) DNP 3.0 Modbus TCP (internal / external optional module) IEC 60870-5-101 IEC 60870-5-101 TCP DNP 3.0 TCP

Table 177 - Ethernet Connections

Number of Copper Based Ports	One
Electrical Connection	Ethernet RJ45 (Ethernet 10Base-T)
Protocols	SetPointPS Modbus TCP IEC 61850 EtherNet/IP™
Data Transfer Rate	10 Mb/s
Fiber Connection	(Optional)
Type	Multimode
Connector	ST
Physical layer	100 Base-Fx
Maximum cable distance	2 km (3.2 mi.)
Optical wavelength	1300 nm
Cable core / cladding size	50/125 or 62.5/125 µm

Table 178 - Arc Protection Interface (Option)

Number of arc sensor inputs Sensor type to be connected Operating voltage level Current drain, when active Current drain range	2 VA 1 DA 12V DC > 11.9 mA 1.3…31 mA **NOTE:** If the drain is outside the range, either the sensor or the wiring is defected.
Number of binary inputs Operating voltage level	1 (optically isolated) 48V DC
Number of binary outputs Operating voltage level	1 (transistor controlled) 48V DC

IMPORTANT	Maximally three arc binary inputs can be connected to one arc binary output without an external amplifier.

Tests and Environmental Conditions

Table 179 - Disturbance Tests

Test		Standard and Test Class/ Level	Test Value
Emission (EN 61000-6-4/ IEC 60255-25)	Conducted	EN 55011, Class A	0.15…30 MHz
	Emitted	EN 55011, Class A/IEC 60255-25 / CISPR 11	30…1000 MHz
Immunity (EN 61000-6-2/ IEC 60255-26)	1 MHz damped oscillatory wave	IEC 60255-22-1	±2.5 kVp CM, ±1.0 kVp DM
	Static discharge (ESD)	EN 61000-4-2 Level 4 / IEC 60255-22-2 Class 4	8-kV contact discharge 15-kV air discharge
	Emitted HF Field	EN 61000-4-3 Level 3 / IEC 60255-22-3	80…1000 MHz, 10V/m
	Fast transients (EFT)	EN 61000-4-4 Level 3 / IEC 60255-22-4 Class B	2 kV, 5/50 ns, 5 kHz
	Surge	EN 61000-4-5 Level 3 / IEC 60255-22-5	2 kV, 1.2/50 µs, CM 1 kV, 1.2/50 µs, DM
	Conducted HF field	EN 61000-4-6 Level 3 / IEC 60255-22-6	0.15…80 MHz, 10V emf
	Power-frequency magnetic field	EN 61000-4-8	300 A/m (continuous)
	Pulse magnetic field	EN 61000-4-9 Level 5	1000 A/m, 1.2/50 µs
	Voltage interruptions	IEC 60255-11	100 ms / 100%
	Voltage alternative component	IEC 60255-11	12% of operating voltage (DC)
	Voltage dips and short interruptions	EN 61000-4-11	30%/10 ms, 100%/10 ms, 60%/100 ms, >95%/5000 ms

Table 180 - Electrical Safety Tests

Test	Standard and Test Class/ Level	Test Value
Impulse Voltage Withstand	EN60255-5, Class III	5 kV, 1.2/50 µs 1 kV, 1.2/50ms, 0.5 J Communication
Dielectric Test	EN60255-5, Class III	2 kV, 50 Hz 0.5 kV, 50 Hz Communication
Insulation Resistance	EN60255-5	
Protective Bonding Resistance	EN60255-27	
Power Supply Burden	EN60255-1	

Table 181 - Mechanical Tests

Vibration (IEC 60255-21-1)	10…60 Hz, amplitude ±0.035 mm
Class I	60…150 Hz, acceleration 0.5 g Sweep rate 1 octave/min 20 periods in X-, Y-, and Z-axis direction
Shock (IEC 60255-21-1)	Half sine, acceleration 5 g, duration 11 ms
Class I	3 shocks in X-, Y-, and Z-axis direction

Table 182 - Environmental Conditions

Operating temperature	-40…+55 °C (-40…+131°F)
Transport and storage temperature	- 40…+70 °C (-40…+158 °F)
Relative humidity	< 95%
Maximum Altitude, without derating	2000 m (6500 ft)
Cold Performance Warm/Cold Cycle (IEC 60068-2-1:2005)	-40…+55°C (-40…+131°F), 10…98% RH: 3 days
Cold Operational Test (IEC 60068-2-1:2005)	-40°C (-40°F), 16 hours
Cold Storage Test (IEC 60068-2-1:2005)	-40°C (-40°F), 16 hours
Dry Heat Test (IEC 60068-2-2:2007)	70°C, 20 hours followed by 65°C, 16 hours; Total 36 hours

Table 183 - Casing

Degree of protection (IEC 60529)	Standard: IP30 front panel. IP20 rear panel Option Via special order: IP54 front panel, IP 20 rear panel, conformal coated electronic assemblies
Dimensions (W x H x D)	208 x 155 x 225 mm (8.19 x 6.10 x 8.86 in.)
Material	1 mm steel plate
Weight	4.2 kg (9 lb) maximum
Color code	RAL 7032 (Casing) / RAL 7035 (Back plate)

Table 184 - Package

Dimensions (W x H x D)	215 x 160 x 275 mm (8.46 x 6.30 x 10.83 in.)
Weight (Terminal, Package, and Manual)	5.2 kg (11.5 lb) maximum
Cold Performance Warm/Cold Cycle (IEC 60068-2-1:2005)	-40°C…+55°C (-40°F…+131°F) 98% RH: 3 days
Cold Operational Test (IEC 60068-2-1:2005)	-40°C (-40°F) 16 hours
Cold Storage Test (IEC 60068-2-1:2005)	-40°C (-40°F) 16 hours
Dry Heat Test (IEC 60068-2-2:2007)|	70°C, (158°F)20 hours followed by 65°C (149°F), 16 hours; Total 36 hours

Protection Stages

Non-directional Current Protection

Table 185 - Overcurrent Stage I> (50/51)

Pick-up current	0.10…5.00 x I_{MODE}
Definite time function: - Operating time	DT 0.08[1]…300.00 s (step 0.02 s)
IDMT function: - Delay curve family - Curve type - Time multiplier k	 (DT), IEC, IEEE, RI Prg EI, VI, NI, LTI, MI…depends on the family[2] 0.05…20.0, except 0.50…20.0 for RXIDG, IEEE, and IEEE2
Start time Reset time Retardation time Reset ratio	Typically 30 ms <95 ms <50 ms 0.97
Transient over-reach, any τ	<10%
Inaccuracy: - Starting - Operating time at definite time function - Operating time at IDMT function	 ±3% of the set value ±1% or ±25 ms ±5% or at least ±25 ms[1]

(1) The instantaneous time, that is, the minimum total operational-time including the fault detection time and operation time of the trip contacts.

(2) EI = Extremely Inverse, NI = Normal Inverse, VI = Very Inverse, LTI = Long Time Inverse, MI= Moderately Inverse.

Table 186 - Overcurrent Stages I>> and I>>> (50/51)

Pick-up current	0.10…20.00 x I_{MODE} (I>>) 0.10…40.00 x I_{MODE} (I>>>)
Definite time function: - Operating time	DT 0.04[1]…300.00 s (step 0.01 s)
Start time Reset time Retardation time Reset ratio	Typically 30 ms for I>>, 20 ms for I>>> <95 ms <50 ms 0.97
Transient over-reach, any τ	<10%
Inaccuracy: - Starting - Operation time DT (Im/Iset ratio > 1.5) Operational delay DT (Im/Iset ratio 1.03…1.5)	 ±3% of the set value or 5 mA secondary ±1% or ±25 ms

(1) The instantaneous time, that is, the minimum total operational-time including the fault detection time and operation time of the trip contacts.

Table 187 - Stall Protection Stage I_{st} in Motor Protection Mode(48)

Setting range: - Motor start detection current - Nom motor start current	 1.30…10.00 xI_{MOT} (step 0.01) 1.50…10.00 xI_{MOT} (step 0.01)
Delay Type	DT, INV
Definite time characteristic DT: - operating time	 1.0…300.0 s (step 0.1)(1)
Inverse time characteristic INV: - Operational Delay - Inverse Time Efficient (K)	 1.0…300.0 s (step 0.1)(1) 1.0…200.0 s (step 0.1)
- Minimum motor stop time to activate stall protection - Maximum current raise times from motor stop to start	500 ms 200 ms
Motor Stop Limit Motor Running Lower Limit Motor Running Limit after Starting	0.10 x I_{mot}(2) 0.20 x I_{mot}(2) 1.20 x I_{mot}(2)
Start time Reset time Resetting ratio	Typically 60 ms <95 ms 0.95
Inaccuracy: - Starting - Operating time at definite time function - Operating time at IDMT function	 ±3% of the set value ±1% or at ±30 ms ±5% or at least ±30 ms(1)

(1) The instantaneous time, that is, the minimum total operational-time including the fault detection time and operation time of the trip contacts.
(2) Motor is stopped and the running limits are based on the average of the three phase currents.

Table 188 - Thermal Overload Stage T> (49)

Setting range:	0.1…2.40 x I_{MOT} or I_N (step 0.01)
Alarm setting range:	60…99% (step 1%)
Time constant Tau:	2…180 min (step 1)
Cooling time coefficient:	1.0…10.0 x Tau (step 0.1)
Max. overload at 40 °C (104 °F)	70…120%I_{MOT} (step 1)
Max. overload at 70 °C (158 °F)	50…100%I_{MOT} (step 1)
Ambient temperature	-55…125 °C (step 1°)
Resetting ratio (Start and trip)	0.95
Accuracy: - operating time	 ±5% or ±1 s

Table 189 - Unbalance Stage I2> (46)

This stage is operational when all secondary currents are >250 mA.

Setting range: K_2	2…70% (step 1%)
Definite time characteristic: - operating time	 1.0…600.0 s (step 0.1)
Inverse time characteristic: - one characteristic curve - time multiplier K_1 - upper limit for inverse time	 Inv 1…50 s (step 1) 1000 s
Start time Reset time Reset ratio	Typically 300 ms <450 ms 0.95
Inaccuracy: - Starting - Operate time	 ±1% – unit ±5% or ±200 ms

Table 190 - Incorrect Phase Sequence I2>> (46)

Stage is blocked when motor has been running for 2 seconds.

Setting: - Operating time - Reset time	80% (fixed) <120 ms <105 ms

Table 191 - Undercurrent Protection Stage I< (37)

Current setting range:	20…70%I_{MODE} (step 1%)
Definite time characteristic: - operating time	 0.3…300.0 s (step 0.1)
Block limit:	15% (fixed)
Start time Reset time Resetting ratio	Typically 200 ms <450 ms 1.05
Accuracy: - starting - operating time	 ±2% of set value or ±0.5% of the rated value ±1% or ±150 ms

Table 192 - Current Unbalance I_2> (46) in Feeder Mode

Settings: - Setting range of K_2	 2…70%
Definite time function: - Operating time	 1.0…600.0 s (step 0.3 s)
Start time Reset time Reset ratio	Typically 200 ms <450 ms 0.95
Inaccuracy: - Starting - Operate time	 ±1% unit ±5% or ±200 ms

Table 193 - Earth-fault Stage I_0> (50N/51N), (50G/51G)

Input signal	I_{01} (input X1…7 and 8) I_{02} (input X1…9 and 10) I_{0CALC} (= I_{L1}+I_{L2}+I_{L3})
Setting range I_0>	0.005…8.00 When I_{01} or I_{02} 0.05…20.0 When I_{0CALC}
Definite time function: - Operating time	DT 0.04(1)…300.00 s (step 0.01 s)
IDMT function:	
- Delay curve family - Curve type - Time multiplier k	(DT), IEC, IEEE, IEEE2, RI Prg EI, VI, NI, LTI, MI…depends on the family(2) 0.05…20.0, except 0.50…20.0 for RXIDG, IEEE, and IEEE2
Start time Reset time Reset ratio	Typically 30 ms <95 ms 0.95
Inaccuracy: - Starting - Starting (Peak mode) - Operating time at definite time function - Operating time at IDMT function.	 ±2% of the set value or ±0.3% of the rated value ±5% of the set value or ±2% of the rated value (Sine-wave <65 Hz) ±1% or ±25 ms ±5% or at least ±25 ms(1)

(1) The instantaneous time, that is, the total operational-time minimum total operational-time including the fault detection time and operation time of the trip contacts.

(2) EI = Extremely Inverse, NI = Normal Inverse, VI = Very Inverse, LTI = Long Time Inverse, MI= Moderately Inverse.

Table 194 - Earth Fault Stages I_0>>, I_0>>>, I_0>>>> (50N/51N), (50G/51G)

Input signal	I_0 (input X1-7 and 8) I_{02} (input X1-9 and 10) I_{0CALC} (= I_{L1}+I_{L2}+I_{L3})
Setting range I_0>>	0.01…8.00 When I_{01} or I_{02} 0.05…20.0 When I_{0CALC}
Definite time function: - Operating time	 0.08(1)…300.00 s (step 0.01 s)
Start time Reset time Reset ratio	Typically 30 ms <95 ms 0.95
Inaccuracy: - Starting - Starting (Peak mode) - Operate time	 ±2% of the set value or ±0.3% of the rated value ±5% of the set value or ±2% of the rated value (Sine-wave <65 Hz) ±1% or ±25 ms

(1) The instantaneous time, that is, the minimum total operational-time including the fault detection time and operation time of the trip contacts.

Table 195 - Directional Intermittent Transient Earth-fault Stage I_{0int}> (67NI)

Input selection for I_0 peak signal	I_{01} Connectors X1…7 and 8 I_{02} Connectors X1…9 and 10
I_0 peak pickup level (fixed) U_0 pickup level Definite operating time Intermittent time Start time Reset time Reset ratio (hysteresis) for U_0	0.1 x I_{0N} @ 50 Hz 1…60% U_{0N} 0.12…300.00 s (step 0.01) 0.00…300.00 s (step 0.01) <60 ms <60 ms 0.97
Inaccuracy: - starting - time	 ±3% for U_0. No inaccuracy is defined for I_0 transients ±1% or ±30 ms(1)

(1) The actual operation time depends on the intermittent behavior of the fault and the intermittent time setting.

Directional Current Protection

Table 196 - Directional Overcurrent Stages I_φ> and I_φ>> (67)

Pick-up current	0.10…4.00 x I_{MODE}
Mode	Directional/non-directional
Minimum voltage for the direction solving	0.1 $V_{SECONDARY}$
Base angle setting range	-180…179°
Operation angle	±88°
Definite time function: - Operating time	DT(1) 0.06…300.00 s (step 0.02 s)
IDMT function: - Delay curve family - Curve type - Time multiplier k	 (DT), IEC, IEEE, IEEE2, RI Prg EI, VI, NI, LTI, MI, depends on the family(2) 0.05…20.0, except 0.50…20.0 for RXIDG, IEEE, and IEEE2
Start time Reset time Retardation time Reset ratio/angle	Typically 60 ms <95 ms <50 ms 0.95/2 degrees
Transient over-reach, any τ Adjustable voltage memory length	<10% 0.2…3.2 s
Inaccuracy: - Starting (rated value IN= 1…5A) - Angle - Operate time at definite time function - Operate time at IDMT function	 ±3% of the set value or ±0.5% of the rated value ±2° U>5V ±30° U=0.1…5.0V ±1% or ±30 ms ±5% or at least ±30 ms(1)

(1) The instantaneous time, that is, the minimum total operational-time including the fault detection time and operation time of the trip contacts.

(2) EI = Extremely Inverse, NI = Normal Inverse, VI = Very Inverse, LTI = Long Time Inverse, MI= Moderately Inverse.

Table 197 - Directional Overcurrent Stages Iφ>>> and Iφ>>>> (67)

Pick-up current	0.10…20.0 x I_{MODE}
Mode	Directional/non-directional
Minimum voltage for the direction solving	2V $_{SECONDARY}$
Base angle setting range	-180…179°
Operation angle	±88°
Definite time function: - Operating time	DT[1] 0.06…300.00 s (step 0.02 s)
Start time Reset time Retardation time Reset ratio Reset ratio (angle)	Typically 60 ms <95 ms <50 ms 0.95 2 degrees
Transient over-reach, any τ	<10%
Inaccuracy: - Starting (rated value IN= 1…5A) - Angle - Operate time at definite time function	 ±3% of the set value or ±0.5% of the rated value ±2° U>5V ±30° U>0.1…5.0V ±1% or ±30 ms

(1) The instantaneous time, that is the minimum total operational-time including the fault detection time and operation time of the trip contacts.

Table 198 - Directional Intermittent Earth-fault Stages $I_{0φ}$>, $I_{0φ}$>> (67N)

Pick-up current - for $I_{0φ}$> - for $I_{0φ}$>>	0.005…8.0 pu (for $I_{0φ}$>) 0.01…8.0 pu (for $I_{0φ}$>>) 0.005…20.0 pu When I_{DCalc} (for $I_{0φ}$>) 0.01…20.0 pu When I_{DCalc} (for $I_{0φ}$>>) 0.005…8.0 pu (when I_{01} or I_{02}) 0.005…20.0 pu (when I_{DCalc}) 0.01…8.00 pu (when I_{01} or I_{02}) 0.01…20.0 pu (when I_{DCalc})
Start voltage	1…50% U_{0n}
Input signal	I_{01} (input X1-7 and 8) I_{02} (input X1-9 and 10) I_{0Calc} (= I_{L1}+I_{L2}+I_{L3})
Mode	Non-directional/Sector/ResCap
Base angle setting range	-180…179°
Operation angle	±88° (10…170°)
Definite time function: - Operating time	 0.10[1] …300.00 s (step 0.02 s)
IDMT function: - Delay curve family - Curve type - Time multiplier k	 (DT), IEC, IEEE, IEEE2, RI Prg EI, VI, NI, LTI, MI, depends on the family[2] 0.05…20.0, except 0.50…20.0 for RXIDG, IEEE, and IEEE2
Start time Reset time Reset ratio Reset Angle	Typically 60 ms <95 ms 0.95 2°

Table 198 - Directional Intermittent Earth-fault Stages I_0φ>, I_0φ>> (67N) (Continued)

Inaccuracy: - Starting U_0 and I_0 (rated value In= 1…5A) - Starting U_0 and I_0 (Peak Mode when, rated value Ion= 1…10A) - Staring U_0 and I_0 (I_{0calc}) - Angle - Operate time at definite time function - Operate time at IDMT function	 ±3% of the set value or ±0.3% of the rated value ±5% of the set value or ±2% of the rated value (sine-wave <65 Hz) ±3% of the set value or ±0.5% of the rated value ±2° (when U>IV or I_0>5% of rated value I_{ON} ±1% or ±30 ms ±5% or at least ±30 ms(1)

(1) The instantaneous time, that is, the minimum total operational-time including the fault detection time and operation time of the trip contacts.

(2) EI = Extremely Inverse, NI = Normal Inverse, VI = Very Inverse, LTI = Long Time Inverse, MI= Moderately Inverse.

Frequent Start Protection

Table 199 - Frequent Start Protection N> (66)

Settings: - Max motor starts - Min time between motor starts	 1…20 0.0…100 min. (step 0.1 min)
Operation time	<250 ms
Inaccuracy: - Min time between motor starts	 ±5% of the set value

Voltage Protection

Table 200 - Overvoltage Stages U>, U>>, and U>>> (59)

Overvoltage setting range:	50…150%U_n for U>, U>>(1) 50…160% U_n for U>>>(1)
Definite time characteristic: - operating time	 0.08(2)…300.00 s (step 0.01) (U>, U>>) 0.06(2)…300.00 s (step 0.01) (U>>>)
Start time Reset time U> Reset time U>>, U>>> Retardation time Reset ratio	Typically 60 ms 0.06…300.00 s (step 0.01) <95 ms <50 ms 0.99…0.800 (0.1…20.0%, step 0.1%)
Inaccuracy: - starting - operate time	 ±3% of the set value(1) ±1% or ±30 ms

(1) The measurement range is up to 160V to limit the maximum usable setting when rated VT secondary is more than 100V.

(2) The instantaneous time, that is, the minimum total operational-time including the fault detection time and operation time of the trip contacts.

Table 201 - Undervoltage Stages U<, U<<, and U<<< (27)

Setting range	20…120% x U_N
Definite time function: - Operating time U< - Operating time U<< and U<<<	 0.08[1]…300.00 s (step 0.01 s) 0.06[1]…300.00 s (step 0.01 s)
Undervoltage blocking	0…80% x U_N
Start time	Typically 60 ms
Reset time for U< Reset time for U<< and U<<< Retardation time Reset ratio (hysteresis) Reset ratio (Block limit)	0.06…300.00 s (step 0.02 s) <95 ms <50 ms 1.001…1.200 (0.1…20.0%, step 0.1%) 0.5V or 1.03 (3%)
Inaccuracy: - starting - time Operating time	 ±3% of set value ±1% or ±30 ms ±1% or ±30 ms

(1) The total operational-time including the fault detection time and operation time of the trip contacts.

Table 202 - Zero Sequence Voltage Stages U_0> and U_0>> (59N)

Zero sequence voltage setting range	1…60% U_{0n}
Definite time function: - Operating time	 0.3…300.0 s (step 0.1 s)
Start time Reset time Reset ratio	Typically 200 ms <450 ms 0.97
Inaccuracy: - Starting - Starting U_{oCalc} (3LN mode) - Operate time	 ±2% of the set value or ±0.3% of the rated value ±1V ±1% or ±150 ms

Frequency Protection

Table 203 - Overfrequency and Underfrequency Protection Stages f>< and f>><< (81)

Frequency measuring area Current and voltage meas. range Frequency stage setting range Low voltage blocking (range of 45…65 Hz)	16.0…75.0 Hz 45.0…65.0 Hz 40.0…70.0 Hz 10…100%U_n
Definite time function: -operating time	 0.10[1]…300.0 s (step 0.02 s)
Start time Reset time Reset ratio (f> and f>>) Reset ratio (f< and f<<) Reset ratio (LV block)	<100 ms <120 ms 0.998 1.002 0.5V or 1.03 (3%)
Inaccuracy: - starting - starting (LV block) - operating time	 ±20 MHz 3% of the set value ±1% or ±30 ms

(1) The instantaneous time, that is, the minimum total operational-time including the fault detection time and operation time of the trip contacts.

TIP Frequency measurement functions when secondary voltage is over 5V.

f> Low voltage block only freezes the present situation. If start has appeared, block freezes the start signal but there is no trip. A trip cannot be blocked.

f< If device restarts for some reason, there is no trip. Even if the frequency is below the set limit during the start-up (Start and trip is blocked). To cancel this block, frequency must visit above the set limit.

Table 204 - Underfrequency Stages f< and f<< (81L)

Frequency measuring area	16.0…75.0 Hz
Current and voltage meas. range	45.0…65.0 Hz
Frequency stage setting range	40.0…64.0 Hz
Low voltage blocking	10…100%U_n
Definite time function:	
-operating time	0.10(1)…300.0 s (step 0.02 s)
Start time	<100 ms
Reset time	<120 ms
Reset ratio	1.002
Reset ratio (LV block)	Instant
Inaccuracy:	
- starting	±20 MHz
- starting (LV block)	3% of the set value
- operating time	±1% or ±30 ms

(1) The instantaneous time, that is, the minimum total operational-time including the fault detection time and operation time of the trip contacts.

TIP Frequency measurement functions when secondary voltage is over 5V.

f> If device restarts for some reason there is no trip. Even if the frequency is below the set limit during the start-up (Start and trip is blocked). To cancel this block, frequency must visit above the set limit.

Table 205 - Rate of Change of Frequency (ROCOF) Stage df/dt> (81R)

Pick-up setting df/dt	0.2…10.0 Hz/s (step 0.1 Hz/s)
Definite time delay (t> and t_{Min}> are equal):	
- operating time t>	0.14(1)…10.00 s (step 0.02 s)
Inverse time delay (t> is more than t_{Min}>):	
- minimum operating time t_{Min}>	0.14(1)…10.00 s (step 0.02 s)
Start time	140 ms
Reset time	t>
Inaccuracy:	
- starting	±0.1 Hz/s or 10% of set value
- operating time (overshoot ≥ 0.2 Hz/s)	±1% or ±35 ms when area is 0.2…1.0 Hz/s

(1) The instantaneous time, that is, the minimum total operational-time including the fault detection time and operation time of the trip contacts.

Power Protection

Table 206 - Reverse Power and Underpower Stages P<, P<< (32)

Pick-up setting range	-200.0…200.0% of S_N (step 0.5)
Definite time function: - Operating time	 0.3…300.0 s (step 0.1)
Start time Reset time Reset ratio	Typically 200 ms <500 ms 1.05
Inaccuracy: - Starting - Operating time at definite time function	 ± 3% of set value or ± 0.5% of rated value ± 1% or ± 150 ms

TIP When pick-up setting is +1…200%, an internal block is activated if max. voltage of all phases drops below 5% of rated.

Synchrocheck Function Δf, ΔU, Δφ (25)

The Δf must be less than 0.2 Hz.

Table 207 - Synchrocheck Function

Sync mode Voltage check mode CB closing time U_{dead} limit setting U_{live} limit setting	Off; ASync, Sync; DD; DL; LD, DD/DL; DD/LD; DL/LD; DD/DL/LD 0.04…0.6 s 10…120% U_n 10…120% U_n
Frequency difference Voltage difference Phase angle difference Request timeout	0.01…1.00 Hz 1…60% U_n 2…90 deg 0.1…600.0 s
Frequency measurement range Reset ratio (U)	46.0…64.0 Hz 0.97
Inaccuracy: - voltage - frequency - phase angle - operating time	 ± 3% Un ± 20 MHz ± 2 deg when Δf<0.2 Hz, else 5º ± 1% or ± 30 ms

Circuit-breaker Failure Protection

Table 208 - Circuit Breaker Failure Protection CBFP (50BF)

Relay to be supervised	Any assigned output
Definite time function - Operating time	 0.1(1)…10.0 s (step 0.1 s)
Reset time	<95 ms
Inaccuracy - Operating time	 ±20 ms

(1) The instantaneous time, that is, the minimum total operational-time including the fault detection time and operation time of the trip contacts.

Magnetizing Inrush I_{f2} > (68F2)

This stage is used to block other stages. The ratio between the second harmonic component and the fundamental frequency component is measured on all phase currents. When the ratio in any phase exceeds the setting value, the stage gives a start signal.

After a settable delay, the stage gives a trip signal. The start and trip signals can be used for blocking the other stages. The trip delay is irrelevant if only the start signal is used for blocking. The trip delay of the stages to be blocked must be more than 60 ms to help maintain proper blocking.

Table 209 - 2nd Harmonic Overcurrent Protection Stage I_{f2}> (68F2)

Pick up Settings: - Setting range 2.Harmonic - Operation delay	 10…100% 0.05…300.00 s (step 0.01 s)
Inaccuracy: - Starting	 ±1% unit

TIP The amplitude of second harmonic content must be at least 2% of the nominal of CT secondary current. If the nominal current is 5 A, the 100 Hz component is required to exceed 100 mA.

Transformer Over Excitation I_{f5}> (68F5)

Overexciting a transformer creates significant odd harmonics. This stage detects over excitation and can be used to block some other stages.

The ratio between the over excitation component and the fundamental frequency component is measured on all phase currents. When the ratio in any phase exceeds the setting value, the stage gives a start signal. After a settable delay, the stage gives a trip signal.

The trip delay of the stages to be blocked must be more than 60 ms to help maintain proper blocking.

Table 210 - 5th Harmonic Stage I_{f5}> (68F5)

Settings: - Setting range 5th Harmonic - Operating time	 10…100% 0.05…300.00 s (step 0.01 s)
Inaccuracy: - Starting	 ±2% unit

TIP The amplitude of fifth harmonic content must be at least 2% of the nominal of CT secondary current. If the nominal current is 5 A, the 250 Hz component is required to exceed 100 mA.

Arc Fault-protection Stages (Option)

The arc protection operation depends on the setting value of the ArcI>, $ArcI_0$> and $ArcI_{02}$> current limits. The arc current limits cannot be set unless the 857 relay can be provided with the optional arc protection card.

Table 211 - Arc Protection Stage ArcI> (50AR), Option

Setting range	0.5…10.0 x I_n
Arc sensor connection - Operating time (Light only) - Operating time (4xIset + light) - Operating time (BIN) - Operating time (delayed Arc L>) - BO operating time	S1; S2; S1/S2; BI; S1/BI; S2/BI; S1/S2/BI 11 ms 15 ms 10 ms 0.01…0.15 s <3 ms
Reset time Reset time (Delayed ARC L) Reset time (BO) Reset ratio	<95 ms <120 ms <80 ms 0.90
Inaccuracy: - Starting - Operating time - Delayed ARC light	 10% of the set value ±5 ms ±10 ms

Table 212 - Arc Protection Stage ArcI0> (50NARC), Option

Setting range	0.5…1.00 pu
Arc sensor connection - Operating time (Light only) - Operating time (4xIset + light) - Operating time (BIN) - Operating time (delayed Arc L>) - BO operating time	S1; S2; S1/S2; BI; S1/BI; S2/BI; S1/S2/BI 11 ms 15 ms 10 ms 0.01…0.15 s <3 ms
Reset time Reset time (Delayed Arc L) Reset time (BO) Reset ratio	<95 ms <120 ms <80 ms 0.90

Table 212 - Arc Protection Stage ArcI0> (50NARC), Option (Continued)

Inaccuracy: - Starting - Operating time - Delayed ARC light	 10% of the set value ±5 ms ±10 ms

Table 213 - Arc Protection Stage ArcI$_{02}$> (50NARC), Option

Setting range	0.5…1.0 pu
Arc sensor connection - Operating time (Light only) - Operating time (4xIset + light) - Operating time (BIN) - Operating time (delayed Arc L>) - BO operating time	S1; S2; S1/S2; BI; S1/BI; S2/BI; S1/S2/BI 13 ms 17 ms 10 ms 0.01…0.15 s <3 ms
Reset time Reset time (Delayed ARC L) Reset time (BO) Reset ratio	<95 ms <120 ms <80 ms 0.90
Inaccuracy: - Starting - Operating time - Delayed ARC light	 10% of the set value ±5 ms ±10 ms

Supporting Functions

Table 214 - Cold Load/Inrush Current Detection (68)

Settings: - Idle current - Pickup current - Maximum time - Setting range 2.Harmonic	 0.01…0.50 x I_N 0.30…10.00 x I_N 0.01(1)…300.00 s (step 0.01 s) 0…99%

(1) The instantaneous time, that is, the 40°C (104°F)minimum of total operational-time including the fault detection time and operation time of the trip contacts.

Disturbance Recorder (DR)

The operation of disturbance recorder depends on these settings. The recording time and the number of records depend on the time setting and the number of selected channels.

Table 215 - Disturbance Recorder (DR)

Mode of recording	Saturated / Overflow
Sample rate: - Waveform recording - Trend curve recording	 32/cycle, 16/cycle, 8/cycle 10, 20, 200 ms 1, 5, 10, 15, 30 s 1 min
Recording time (one record)	0.1 s…12,000 min (must be shorter than MAX time)
Pre-trigger rate Number of selected channels	0…100% 0…12

Transformer Supervision

Table 216 - Current Transformer Supervision

I_{MAX} > setting I_{MIN} < setting	0.00…10.00 x IN (step 0.01) 0.00…10.00 x IN (step 0.01)
Definite time function: - Operating time	DT 0.04…600.00 s (step 0.01 s)
Reset time Reset ratio I_{max}> Reset ratio I_{min}<	<60 ms 0.97 1.03
Inaccuracy: - Activation - Operating time at definite time function	 ± 3% of the set value ± 1% or ± 30 ms

Table 217 - Voltage Transformer Supervision

Pick-up setting U2>	0.0…200.0%
Pick-up setting I2<	0.0…200.0%
Definite time function: - Operating time	DT 0.04…600.00 s (step 0.01 s)
Reset time Reset ratio	<60 ms 3% of the pick-up value
Inaccuracy: - Activation U2> - Activation I2< - Operating time at definite time function	 ± 3% of the set value ± 1% unit ± 1% or ± 30 ms

Voltage Sag and Swell

Table 218 - Voltage Sag and Swell

Measurement Mode	Default; L-; L-N
Voltage sag limit (L-L; L-N)	10…120%
Voltage swell limit (L-L; L-N)	20…150%
Definite time function: - Operating time	DT 0.06…1.00 s (step 0.01 s)
Low voltage blocking Reset time Reset ration: - Sag - Swell Block limit	0…50%of U_N <60 ms 1.03 0.97 0.5V or 1.03 (3%)
Inaccuracy: - Activation - Activation (block limit) - Operating time at definite time function	 ± 0.5V or 3% of the set value ± 5% of the set value ± 1% or ± 30 ms

IMPORTANT If one of the phase voltages is below sag limit and above block limit but another phase voltage drops below block limit, blocking is disabled.

Voltage Interruptions

Table 219 - Voltage Interruptions

Voltage low limit (U1)	10…120% of U_N (step 1%)
Definite time function: - Operating time	DT <50 ms (Fixed)
Reset time Reset ratio:	<60 ms 1.03
Inaccuracy: - Activation	 3% of the set value

Notes:

Installation

Mounting Instructions

Figure 192 - Mounting Instructions

Dimensions are in millimeters

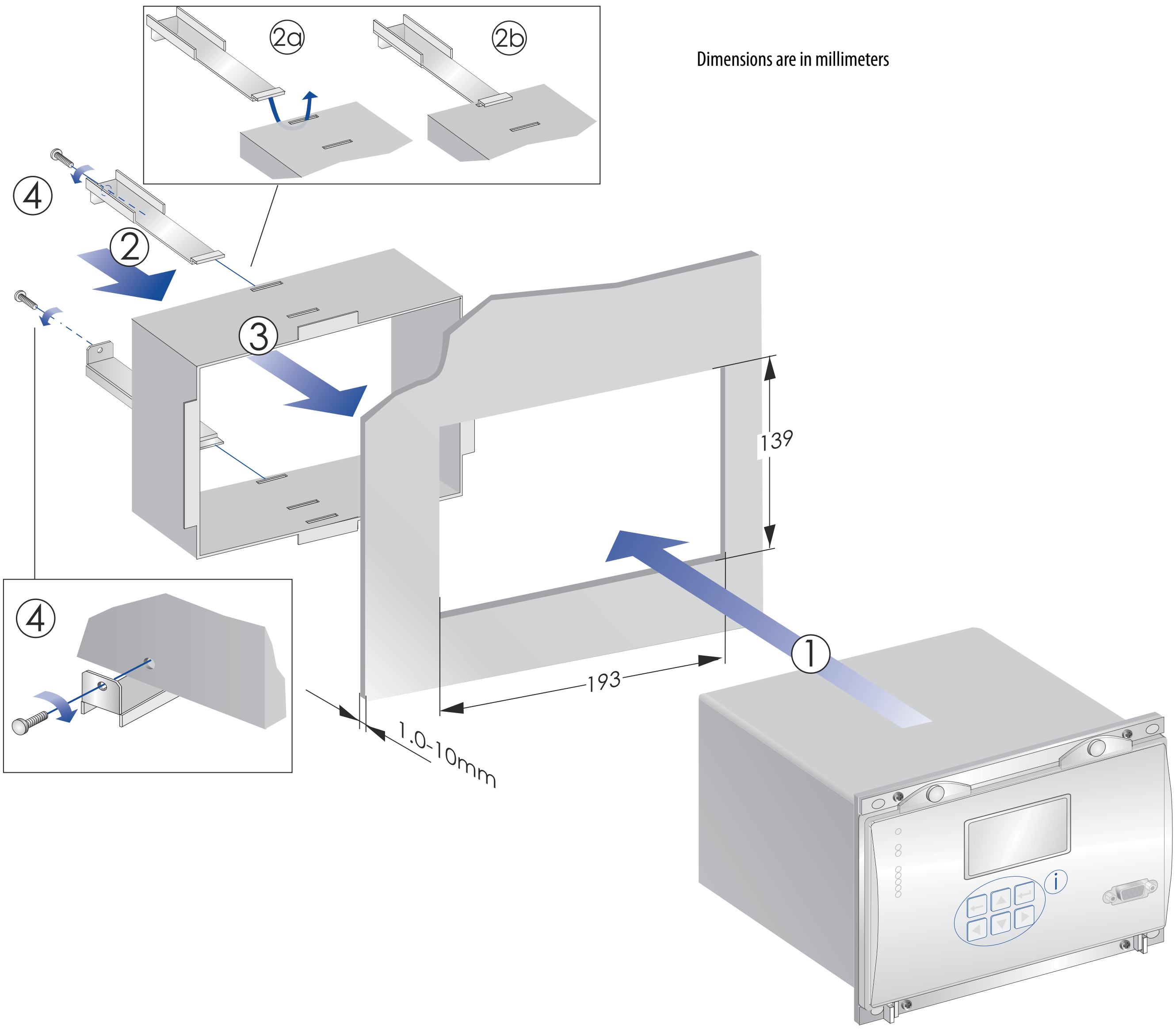
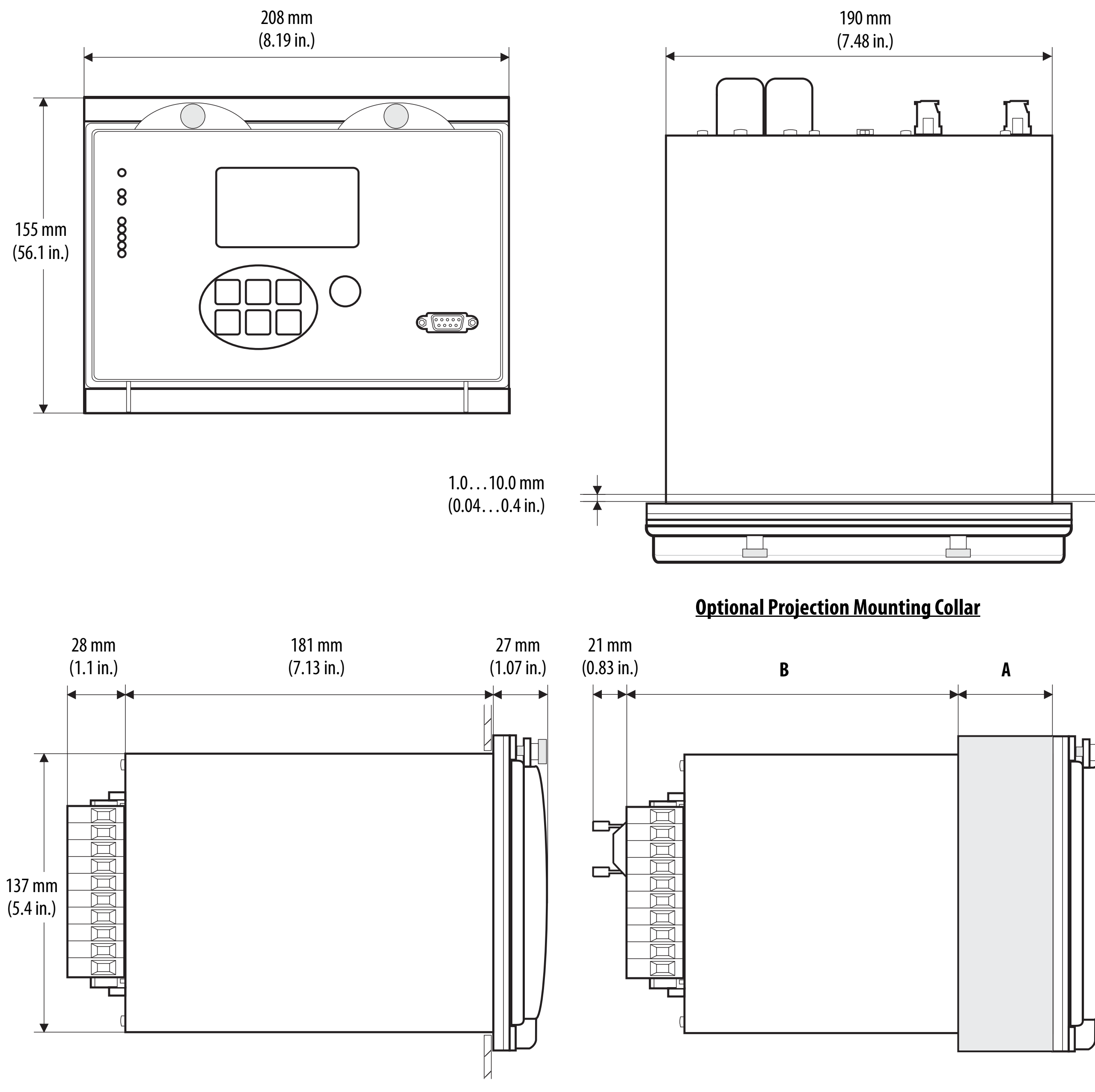


Figure 193 - Dimensions



Collar Part Number	A	B
857-VYX076	40 mm (1.57 in.)	169 mm (6.65 in.)
857-VYX077	60 mm (2.36 in.)	149 mm (5.87 in.)
857-VYX233	100 mm (3.94 in.)	109 mm (4.29 in.)

Parameter List

Overview

This appendix lists all accessible parameters of the Bulletin 857 protection system in numerical order. The setting range for each parameter is provided to assist especially for applications where it is desirable to set values from a logic controller via a network connection. The CIP class codes are provided for troubleshooting purposes.

Information values that are provided are shown in the following table.

Value	Function
Setting Range	Indicated as raw numerical values
Scale Factor	Indicate the decimal precision that is associated with each parameter. Pay close attention to the decimal when writing or reading values
Default	Indicate that the factory pre-programmed values

The mode value determines the ability of the parameter to be read (Get), written (Set) or both (Get/Set).

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
1	Misc.	0x389	1	1 byte padding	1 Byte padding-used when the configuration tool requires assembly data to be word or double-word aligned, to align the assembly contents appropriately.	USINT	1					Set
2	Misc.	0x389	2	2 bytes padding	2 Bytes padding-used when the configuration tool requires assembly data to be word or double-word aligned, to align the assembly contents appropriately.	UINT	2					Set
3	Control Supervisor Object	0x29	3	Run1	Run command from the network is internally blocked. Not used.	BOOL	1	1	1= Running 0= Stopped		0	Get/ Set
4	Control Supervisor Object	0x29	10	Faulted	Relay is in tripped condition Red Trip status indicator illuminated	BOOL	1	1	1 = Trip Occurred (latched in programmed) 0 = No Faults present		0	Get
5	Control Supervisor Object	0x29	11	Warning	Relay is in an Alarm condition Amber Alarm status indicator illuminated	BOOL	1	1	1 = Alarm Occurred (latched in programmed) 0 = N14o Alarm present		0	Get
6	Control Supervisor Object	0x29	12	FaultRst	Fault Reset	BOOL	1	1	1 = Reset Fault 0 = No action		0	Get/ Set
7	Control Supervisor Object	0x29	13	FaultCode	If in Faulted state, FaultCode indicates the fault that caused the transition to Faulted state. If not in Faulted state, Power up state of fault code is 0.	UINT	2	1	CurrTrip=20 ThermOverl=21 PhasImbal=26 GndFault=27 Underload=29 Stall=31, Undervol=51, Overvol=52, Phrevers=54, Freq=55, StHrExceed=73 (limit 65535)		0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
8	Control Supervisor Object	0x29	14	WarnCode	Code word indicating warnings present.	UINT	2	1	CurrTrip=20 ThermOverl=21 PhasImbal=26 GndFault=27 Underload=29 Stall=31, Undervol=51, Overvol=52, Phrevers=54, Freq=55, StHrExceed=73 (limit 65535)		0	Get
9	Control Supervisor Object	0x29	22	CycleCount	Number of operations (motor starts) on the equipment	UDINT	4	1	0	1000000000	0	Get/ Set
10	Over Load Object	0x2C	5	AvgCurrent	Average Running Current	INT	2	1=0.1 A	0	32767	0	Get
11	Over Load Object	0x2C	6	%PhImbal	Percentage Phase Imbalance	USINT	1	1=1%	0	127	0	Get
12	Over Load Object	0x2C	7	%Thermal	Percentage Thermal Capacity	USINT	1	1=1%	0	127	0	Get
13	Over Load Object	0x2C	8	CurrentL1	L1 Current	INT	2	1=1 A	0	32767	0	Get
14	Over Load Object	0x2C	9	CurrentL2	L2 Current	INT	2	1=1 A	0	32767	0	Get
15	Over Load Object	0x2C	10	CurrentL3	L3 Current	INT	2	1=1 A	0	32767	0	Get
16	Over Load Object	0x2C	11	GroundCurrent	Ground Current	INT	2	1=1 A	0	32767	0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
17	Digital Object	0x382	1	Digital inputs	Digital Input State 0 = Input inactive 1 = Input active	UDINT	4	1	Bit0= DI1 Bit1= DI2 Bit2= DI3 Bit3= DI4 Bit4= DI5 Bit5= DI6 Bit6= DI7 Bit7= DI8 Bit8= DI9 Bit9= DI10 Bit10= DI11 Bit11= DI12 Bit12= DI13 Bit13= DI14 Bit14= DI15 Bit15= DI16 Bit16= DI17 Bit17= DI18 Bit18= DI19 Bit19= DI20 Bit20= DI21 Bit21= DI22 Bit22= DI23 Bit23= DI24 Bit24= DI25 Bit25= DI26 Bit26= DI27 Bit27= DI28 Bit28= DI29 Bit29= DI30 Bit30= DI31 Bit31=DI32		0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
18	Digital Object	0x382	2	Output relays	Output Relay State 0 = Output inactive 1 = Output active T1=Trip relay 1, and so forth. A1=Alarm relay 1, and so forth. VO1=Virtual Output 1, and so forth.	UDINT	4	1	Bit0=T1 Bit1=T2 Bit2=T3 Bit3=T4 Bit4=A1 Bit5=A2 Bit6=A3 Bit7=A4 Bit8=A5 Bit9=BO Bit10=T5 Bit11=T6 Bit12=T7 Bit13=T8 Bit14=Not Used Bit15=Not Used Bit16=Alarm status indicator Bit17=Trip status indicator Bit18=status indicator A Bit19=status indicator B Bit20=status indicator C Bit21=Dist. Rec. Bit22=VO1 Bit23=VO2 Bit24=VO3 Bit25=VO4 Bit26=VO5 Bit27=VO6 Bit28=Not Used Bit29=Not Used Bit30=Not Used Bit31=Not Used		0	Get
19	Digital Object	0x382	3	Alive indicator	Alive indicator- Watch Dog OK	USINT	2	1	1=Faulted		0	Get
20	Digital Object	0x382	4	Events	Event Data from the device. FIFO style. Individual reads to obtain sequential data STRUCT- UDINT = sec Since Genesis UINT =milliseconds UINT = event code	UDINT UINT UINT	4	1=1	Bits 0 … 7 Bits 8…11 Bits 12…15	sec Since Genesis milliseconds event code	0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
21	Digital Object	0x382	5	Obj1 state	Object 1 State	USINT	1	1	0=Open 1=Close 2=Undefined		0	Get
22	Digital Object	0x382	6	Obj2 state	Object 2 State	USINT	1	1	0=Open 1=Close 2=Undefined		0	Get
23	Digital Object	0x382	7	Obj3 state	Object 3 State	USINT	1	1	0=Open 1=Close 2=Undefined		0	Get
24	Digital Object	0x382	8	Obj4 state	Object 4 State	USINT	1	1	0=Open 1=Close 2=Undefined		0	Get
25	Digital Object	0x382	9	Obj5 state	Object 5 State	USINT	1	1	0=Open 1=Close 2=Undefined		0	Get
26	Digital Object	0x382	10	Obj6 state	Object 6 State	USINT	1	1	0=Open 1=Close 2=Undefined		0	Get
27	Digital Object	0x382	11	Remote/Local State	Relay Control Mode	BOOL	1	1	0=REMOTE 1=LOCAL		0	Get/ Set
28	Digital Object	0x382	12	Open select Obj1	Open select Obj1 (enabled only in remote mode)	BOOL	1	1	Open=1 Unselected=0		0	Get/ Set
29	Digital Object	0x382	13	Close select Obj1	Close select Obj1 (enabled only in remote mode)	BOOL	1	1	Close=1 Unselected=0		0	Get/ Set
30	Digital Object	0x382	14	Execute operation Obj1	Execute operation Obj1 (enabled only in remote mode)	BOOL	1	1	Execute Selection=1		0	Set
31	Digital Object	0x382	15	Cancel selected operation	Cancel selected operation (enabled only in remote mode)	BOOL	1	1	No Action=0 Cancel=1		0	Set
32	Digital Object	0x382	16	Max ctrl pulse length of Obj1	Maximum control pulse length of Obj1	UDINT	4	1=0.01 s	2	600000	0	Get/ Set
33	Digital Object	0x382	17	Open select Obj2	Open select Obj2 (enabled only in remote mode)	BOOL	1	1	Open=1 Unselected=0		0	Get/ Set
34	Digital Object	0x382	18	Close select Obj2	Close select Obj2 (enabled only in remote mode)	BOOL	1	1	Close=1 Unselected=0		0	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
35	Digital Object	0x382	19	Execute operation Obj2	Execute operation Obj2 (enabled only in remote mode)	BOOL	1	1	Execute Selection=1		0	Set
36	Digital Object	0x382	20	Max ctrl pulse length of Obj2	Maximum control pulse length of Obj2	UDINT	4	1=0.01 s	2	600000	0	Get/ Set
37	Digital Object	0x382	21	OM_MB_ResetLatches	Output Matrix Reset Latches	BOOL	1	1	1=Reset		0	Get/ Set
38	Digital Object	0x382	22	Synchronize minutes	Synchronize minutes	BOOL	1	1	0		0	Get/ Set
39	Digital Object	0x382	23	Open select Obj3	Open select Obj3 (enabled only in remote mode)	BOOL	1	1	Open=1 Unselected=0		0	Get/ Set
40	Digital Object	0x382	24	Close select Obj3	Close select Obj3 (enabled only in remote mode)	BOOL	1	1	Close=1 Unselected=0		0	Get/ Set
41	Digital Object	0x382	25	Execute operation Obj3	Execute operation Obj3 (enabled only in remote mode)	BOOL	1	1	Execute Selection=1		0	Set
42	Digital Object	0x382	26	Max ctrl pulse length of Obj3	Maximum control pulse length of Obj3	UDINT	4	1=0.01 s	0	600000	0	Get/ Set
43	Digital Object	0x382	27	Open select Obj4	Open select Obj4 (enabled only in remote mode)	BOOL	1	1	Open=1 Unselected=0		0	Get/ Set
44	Digital Object	0x382	28	Close select Obj4	Close select Obj4 (enabled only in remote mode)	BOOL	1	1	Close=1 Unselected=0		0	Get/ Set
45	Digital Object	0x382	29	Execute operation Obj4	Execute operation Obj4 (enabled only in remote mode)	BOOL	1	1	Execute Selection=1		0	Set
46	Digital Object	0x382	30	Max ctrl pulse length of Obj4	Maximum control pulse length of Obj4	UDINT	4	1=0.01 s	2	600000	0	Get/ Set
47	Digital Object	0x382	31	Pos. sequence I1	Positive Sequence Current Line 1	INT	4	1 = 1 A	0		0	Get
48	Digital Object	0x382	32	Neg. sequence I2	Negative Sequence Current Line 2	INT	4	1 = 1 A	0		0	Get
49	Digital Object	0x382	33	Current -seq./+seq.	Current -seq./+seq.	INT	4	1=0.01 %	0	10000	0	Get
50	Digital Object	0x382	34	Current phase seq.	Current Phase Sequence	USINT	1	1	0=Unknown State 1=OK 2=Reverse		0	Get
51	Digital Object	0x382	35	Pos. sequence U1	Positive Sequence Voltage Line 1	INT	4	1=1V	0	450000	0	Get
52	Digital Object	0x382	36	Neg. sequence U2	Negative Sequence Voltage Line 2	INT	4	1=1V	0	450000	0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
53	Digital Object	0x382	37	Voltage -seq./+seq.	Voltage -seq./+seq.	INT	4	1=0.01 %	0	10000	0	Get
54	Digital Object	0x382	38	Voltage phase seq.	Voltage Phase Sequence	SINT	1	1	0=Unknown State 1=OK 2=Reverse		0	Get
55	Digital Object	0x382	39	DI1 counter	DI1 counter	UINT	2	1	0	64000	0	Get
56	Digital Object	0x382	40	DI2 counter	DI2 counter	UINT	2	1	0	64000	0	Get
57	Digital Object	0x382	41	DI3 counter	DI3 counter	UINT	2	1	0	64000	0	Get
58	Digital Object	0x382	42	DI4 counter	DI4 counter	UINT	2	1	0	64000	0	Get
59	Digital Object	0x382	43	DI5 counter	DI5 counter	UINT	2	1	0	64000	0	Get
60	Digital Object	0x382	44	DI6 counter	DI6 counter	UINT	2	1	0	64000	0	Get
61	Digital Object	0x382	45	DI19 counter	DI19 counter	UINT	2	1	0	64000	0	Get
62	Digital Object	0x382	46	DI20 counter	DI20 counter	UINT	2	1	0	64000	0	Get
63	Digital Object	0x382	47	Shot1 start counter	Auto Reclose Shot1 start counter	UINT	2	1	0	64000	0	Get
64	Digital Object	0x382	48	Shot2 start counter	Auto Reclose Shot2 start counter	UINT	2	1	0	64000	0	Get
65	Digital Object	0x382	49	Shot3 start counter	Auto Reclose Shot3 start counter	UINT	2	1	0	64000	0	Get
66	Digital Object	0x382	50	Shot4 start counter	Auto Reclose Shot4 start counter	UINT	2	1	0	64000	0	Get
67	Digital Object	0x382	51	Shot5 start counter	Auto Reclose Shot5 start counter	UINT	2	1	0	64000	0	Get
68	Digital Object	0x382	52	AR start counter	AR start counter	UINT	2	1	0	64000	0	Get
69	Digital Object	0x382	53	AR fail counter	AR fails counter	UINT	2	1	0	64000	0	Get
70	Digital Object	0x382	54	Stage start state	Relay in start state	BOOL	1	1	1=Starting 0=Not Starting		0	Get
71	Digital Object	0x382	55	Stage trip state	Stage trip state	BOOL	1	1	1=Trip 0=Not Tripped		0	Get
72	Digital Object	0x382	56	AR shot number	AR shot count number	USINT	1	1	1 2 3 4 5 Last (END)=6		0	Get
73	Digital Object	0x382	57	Critical AR req.	Critical AR request	USINT	2	1	0		0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
74	Digital Object	0x382	58	Reclose locked	Reclose locked	USINT	2	1	1=Locked 0=Not Locked		0	Get
75	Digital Object	0x382	59	Reclose running	Reclose running	USINT	2	1	1=Reclose Running 0=Reclose Not Running		0	Get
76	Digital Object	0x382	60	Final trip	Auto Reclose Final trip	USINT	2	1	0=Open 1=Tripped		0	Get
77	Digital Object	0x382	61	Autoreclose on	Auto reclose on	USINT	2	1	0=Off 1=On		0	Get
78	Digital Object	0x382	62	N> alarm	Number of starts alarm	BOOL	1	1	0=Off 1=Alarm		0	Get
79	Digital Object	0x382	63	Motor start disabled	Motor start disabled	BOOL	1	1	0=Off 1=Disable		0	Get
80	Digital Object	0x382	64	Motor starting	Motor is in start state	BOOL	1	1	1=Motor Starting 0=Motor Not Starting		0	Get
81	Digital Object	0x382	65	Motor running	Motor is in run state	BOOL	1	1	1=Motor Running 0=Motor Not Running		0	Get
82	Digital Object	0x382	66	Voltage interrupt	Indicates a voltage lower than the setpoint condition has occurred	USINT	1	1	0=LOW VOLTAGE 1=OK		0	Get
83	Digital Object	0x382	67	Timer 1 status	Timer 1 status	USINT	1	1	0=Output is inactive 1=Output is active		0	Get
84	Digital Object	0x382	68	Timer 2 status	Timer 2 status	USINT	1	1	0=Output is inactive 1=Output is active		0	Get
85	Digital Object	0x382	69	Timer 3 status	Timer 3 status	USINT	1	1	0=Output is inactive 1=Output is active		0	Get
86	Digital Object	0x382	70	Timer 4 status	Timer 4 status	USINT	1	1	0=Output is inactive 1=Output is active		0	Get
87	Digital Object	0x382	71	Voltage status	Voltage Status	USINT	1	1	0=OK 1=LOW 2=HIGH 3-LOW/HIGH 4=(OK) 5=(LOW) 6=(HIGH) 7=(LOW)/HIGH		0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
88	Digital Object	0x382	72	Logic output states 1…10	State of Logic output 1…8 See parameter 129 for output 9 & 10	USINT	1	1	Bit 0: Logic Output 1 Bit 1: Logic Output 2 Bit 2: Logic Output 3 Bit 3: Logic Output 4 Bit 4: Logic Output 5 Bit 5: Logic Output 6 Bit 6: Logic Output 7 Bit 7: Logic Output 8 0 = Output inactive 1 = Output active		0	Get
89	Digital Object	0x382	73	CBWAlarm 1	CB Wear Alarm 1	BOOL	1	1	0= No Wear Alarm 1=Wear Alarm		0	Get
90	Digital Object	0x382	74	CBWAlarm 2	CB Wear Alarm 2	BOOL	1	1	0= No Wear Alarm 1=Wear Alarm		0	Get
91	Digital Object	0x382	75	Alarm L1..L3	Alarm L1..L3	BOOL	1	1	0= No Line Alarm 1= Line Alarm		0	Get
92	Digital Object	0x382	76	Fault L1..L3	Fault L1..L3	BOOL	1		0= No Line Fault 1= Line Fault		0	Get
93	Digital Object	0x382	77	SetGrp common change	Set Group Common Change	BOOL	1	1	0=Group 1 1=Group 2		0	Get
94	Digital Object	0x382	78	Open select Obj5	Open select Obj5 (enabled only in remote mode)	BOOL	1	1	Open=1 Unselected=0		0	Get/ Set
95	Digital Object	0x382	79	Close select Obj5	Close select Obj5 (enabled only in remote mode)	BOOL	1	1	Close=1 Unselected=0		0	Get/ Set
96	Digital Object	0x382	80	Execute operation Obj5	Execute operation Obj5 (enabled only in remote mode)	BOOL	1	1	Execute Selection=1		0	Set
97	Digital Object	0x382	81	Max ctrl pulse length of Obj5	Maximum Control Pulse Length of Obj5	UDINT	4	1=0.01 s	2	600000	0	Get/ Set
98	Digital Object	0x382	82	Open select Obj6	Open select Obj6 (enabled only in remote mode)	BOOL	1	1	Open=1 Unselected=0		0	Get/ Set
99	Digital Object	0x382	83	Close select Obj6	Close select Obj6 (enabled only in remote mode)	BOOL	1	1	Close=1 Unselected=0		0	Get/ Set
100	Digital Object	0x382	84	Execute operation Obj6	Execute operation Obj6 (enabled only in remote mode)	BOOL	1	1	Execute Selection=1		0	Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
101	Digital Object	0x382	85	Max ctrl pulse length of Obj6	Maximum Control Pulse Length of Obj6	UDINT	4	1=0.01 s	2	600000	0	Get/ Set
102	Digital Object	0x382	86	Sync1 req.	Sync1 request	BOOL	1	1	0= No Sync 1 Request 1=Sync 1 Request		0	Get
103	Digital Object	0x382	87	Sync1 OK	Sync1 OK	BOOL	1	1	0= Sync 1 Not OK 1=Sync 1 OK		0	Get
104	Digital Object	0x382	88	SYNC1 Bypass	SYNC1 Bypass	BOOL	1	1	0= Sync 1 No Bypass 1=Sync 1 Bypass		0	Get
105	Digital Object	0x382	89	Sync1 fail	Sync1 fail	BOOL	1	1	0=Sync 1 OK 1=Sync 1 Failure		0	Get
106	Digital Object	0x382	90	U12/U12y Phase angle difference	U12/U12y Phase angle difference	INT	2	1 = 1°	0	180	0	Get
107	Digital Object	0x382	91	Sync2 req.	Sync2 request	BOOL	1	1	0= No Sync 2 Request 1=Sync 2 Request		0	Get
108	Digital Object	0x382	92	Sync2 OK	Sync2 OK	BOOL	1	1	0= Sync 2 Not OK 1=Sync 2 OK		0	Get
109	Digital Object	0x382	93	SYNC2 Bypass	SYNC2 Bypass	BOOL	1	1	0= Sync 2 No Bypass 1=Sync 2 Bypass		0	Get
110	Digital Object	0x382	94	Sync2 fail	Sync2 fail	BOOL	1	1	0=Sync 2 OK 1=Sync 2 Failure		0	Get
111	Digital Object	0x382	95	Direct01O	Command Direct01 to Open (only in Remote mode)	BOOL	1	1	1=Open		0	Set
112	Digital Object	0x382	96	Direct01C	Command Direct01 to Closed (only in Remote mode)	BOOL	1	1	1=Closed		0	Set
113	Digital Object	0x382	97	Direct02O	Command Direct02 to Open (only in Remote mode)	BOOL	1	1	1=Open		0	Set
114	Digital Object	0x382	98	Direct02C	Command Direct02 to Closed (only in Remote mode)	BOOL	1	1	1=Closed		0	Set
115	Digital Object	0x382	99	Direct03O	Command Direct03 to Open (only in Remote mode)	BOOL	1	1	1=Open		0	Set
116	Digital Object	0x382	100	Direct03C	Command Status of Direct03 Closed (only in Remote mode)	BOOL	1	1	1=Closed		0	Set
117	Digital Object	0x382	101	Direct04O	Command Direct04 to Open (only in Remote mode)	BOOL	1	1	1=Open		0	Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
118	Digital Object	0x382	102	Direct04C	Command Direct04 to Closed (only in Remote mode)	BOOL	1	1	1=Closed		0	Set
119	Digital Object	0x382	103	Direct05O	Command Direct05 to Open (only in Remote mode)	BOOL	1	1	1=Open		0	Set
120	Digital Object	0x382	104	Direct05C	Command Direct05 to Closed (only in Remote mode)	BOOL	1	1	1=Closed		0	Set
121	Digital Object	0x382	105	Direct06O	Command Direct06 to Open (only in Remote mode)	BOOL	1	1	1=Open		0	Set
122	Digital Object	0x382	106	Direct06C	Command Direct06 to Closed (only in Remote mode)	BOOL	1	1	1=Closed		0	Set
123	Digital Object	0x382	107	Virtual input 1	State of Virtual Input 1	BOOL	1	1	Output inactive = 0 Output active = 1		0	Get/ Set
124	Digital Object	0x382	108	Virtual input 2	State of Virtual Input 2	BOOL	1	1	Output inactive = 0 Output active = 1		0	Get/ Set
125	Digital Object	0x382	109	Virtual input 3	State of Virtual Input 3	BOOL	1	1	Output inactive = 0 Output active = 1		0	Get/ Set
126	Digital Object	0x382	110	Virtual input 4	State of Virtual Input 4	BOOL	1	1	Output inactive = 0 Output active = 1		0	Get/ Set
127	Digital Object	0x382	111	Obj7 state	Object 7 state	USINT	1	1	Open=0 Close=1 Undef=2		0	Get
128	Digital Object	0x382	112	Obj8 state	Object 8 State	USINT	1	1	Open=0 Close=1 Undef=2		0	Get
129	Digital Object	0x382	113	Logic output states 9…16	Logic output states 9…16	USINT	1	1	Bit 0= Logic Output 9 Bit 1= Logic Output 10 Bit 2= Logic Output 11 Bit 3= Logic Output 12 Bit 4= Logic Output 13 Bit 5= Logic Output 14 Bit 6= Logic Output 15 Bit 7= Logic Output 16 Output inactive = 0 Output active = 1		0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
130	Digital Object	0x382	114	Logic output states 17...20	Logic output states 17...20	USINT	1	1	Bit 0= Logic output 17 Bit 1= Logic Output 18 Bit 2= Logic Output 19 Bit 3= Logic Output 20 Bit 4…7= not used Output inactive = 0 Output active = 1		0	Get
131	Digital Object	0x382	115	Virtual outputs	Virtual outputs	USINT	1	0	Bit 0= Virtual Output 1 Bit 1= Virtual Output 2 Bit 2= Virtual Output 3 Bit 3= Virtual Output 4 Bit 4= Virtual Output 5 Bit 5= Virtual Output 6 Bit 6…7= not used Output inactive = 0 Output active = 1		0	Get
132	Digital Object	0x382	116	Diagnostic register 1	Potential output relay problem	UINT	2	1	Bit 0: T1 Bit 1: T2 Bit 2: T3 Bit 3: T4 Bit 4: A1 Bit 5: A2 Bit 6: A3 Bit 7: A4 Bit 8: A5 Bit 9: Bit 10: T5 Bit 11: T6 Bit 12: T7 Bit 13: T8 Bit 14: T9 Bit 15: No fault = 0 Fault = 1		0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
133	Digital Object	0x382	117	Diagnostic register 2	Diagnostic register 2	UINT	2	1	Bit 0: Trip relay 10 Bit 1: Trip relay 11 Bit 2: Trip relay 12 Bit 3: Trip relay 13 Bit 4: Trip relay 14 Bit 5: Trip relay 15 Bit 6: Trip relay 16 Bit 7: Trip relay 17 Bit 8: Trip relay 18 Bit 9: Trip relay 19 Bit 10: Trip relay 20 Bit 11: Trip relay 21 Bit 12: Trip relay 22 Bit 13: Trip relay 23 Bit 14: Trip relay 24 Bit 15: [not used] No fault = 0 Fault = 1		0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
134	Digital Object	0x382	118	Diagnostic register 3	Diagnostic register 3	UINT	2	1	Bit 0= DAC Potential mA-output problem Bit 1= STACK Potential stack problem Bit 2= MemChk Potential memory problem Bit 3 = BGTask Potential background task timeout Bit 4= DI Potential input problem (Remove DI1, DI2) Bit 5= Reserved Bit 6 = Arc Potential arc card problem Bit 7= SecPulse Potential hardware problem Bit 8= RangeChk DB: Setting outside range Bit 9= CPULoad CPU Overloaded Bit 10= +24V Potential internal voltage problem Bit 11= -15V Potential internal voltage problem Bit 12= ITemp Internal temperature too high Bit 13= ADChk1 Potential A/D converter problem Bit 14= ADChk2 Potential A/D converter problem Bit 15= E2prom Potential E^2Prom problem		0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
135	Digital Object	0x382	119	Diagnostic register 4	Diagnostic register 4	UINT	2	1	Bit 0: +12V Bit 1: COM buffer Bit 2: Not used Bit 3: Not used Bit 4: Not used Bit 5: Not used Bit 6: Not used Bit 7: Not used Bit 8: Not used Bit 9: Low AUX Bit 10: Not used Bit 11: [not used] Bit 12: [not used] Bit 13: [not used] Bit 14: [not used] Bit 15: [not used] No fault = 0 Fault = 1		0	Get
136	Digital Object	0x382	120	Engine running hours	Engine running hours	UDINT	4	1= 1 h	0	876000	0	Get
137	Digital Object	0x382	121	Engine running seconds	Engine running seconds	UINT	2	1 = 1 s	0	3599	0	Get
138	Digital Object	0x382	122	Start counter	Start counter	UINT	2	1	0	65535	0	Get
139	Digital Object	0x382	123	Reset diagnostics	Reset diagnostics	BOOL	1	1	Reset=1		0	Get/ Set
140	Digital Object	0x382	124	Clear min & max	Minimum and maximum clear	BOOL	1	1	Clear=1		0	Get
141	Digital Object(2)	0x382	125	Pos. sequence I'_1	I'L Positive sequence current	INT	4	1 = 1 A	0		0	Get
142	Digital Object(2)	0x382	126	Neg. sequence I'_2	I'2 Negative sequence current	INT	4	1 = 1 A	0		0	Get
143	Digital Object(2)	0x382	127	Current I' -seq./+seq.	Current I' -seq./+seq. (I'2/I'1)	INT	4	1 = 0.1%	0	1000	0	Get
144	Digital Object(2)	0x382	128	Current I' phase seq.	Current I' phase sequence	SINT	1	1	??=0 OK=1 Reverse=2		0	Get
145	Digital Object	0x382	129	External DI1	External DI1	BOOL	1	1	Open=0 Close=1		0	Get
146	Digital Object	0x382	130	External DI2	External DI2	BOOL	1	1	Open=0 Close=1		0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
147	Digital Object	0x382	131	External DI3	External DI3	BOOL	1	1	Open=0 Close=1		0	Get
148	Digital Object	0x382	132	External DI4	External DI4	BOOL	1	1	Open=0 Close=1		0	Get
149	Digital Object	0x382	133	External DI5	External DI5	BOOL	1	1	Open=0 Close=1		0	Get
150	Digital Object	0x382	134	External DI6	External DI6	BOOL	1	1	Open=0 Close=1		0	Get
151	Digital Object	0x382	135	External DI7	External DI7	BOOL	1	1	Open=0 Close=1		0	Get
152	Digital Object	0x382	136	External DI8	External DI8	BOOL	1	1	Open=0 Close=1		0	Get
153	Digital Object	0x382	137	External DI9	External DI9	BOOL	1	1	Open=0 Close=1		0	Get
154	Digital Object	0x382	138	External DI10	External DI10	BOOL	1	1	Open=0 Close=1		0	Get
155	Digital Object	0x382	139	External DI11	External DI11	BOOL	1	1	Open=0 Close=1		0	Get
156	Digital Object	0x382	140	External DI12	Condition of External DI12	BOOL	1	1	Open=0 Close=1		0	Get
157	Digital Object	0x382	141	External DI13	Condition of External DI13	BOOL	1	1	Open=0 Close=1		0	Get
158	Digital Object	0x382	142	External DI14	Condition of External DI14	BOOL	1	1	Open=0 Close=1		0	Get
159	Digital Object	0x382	143	External DI15	Condition of External DI15	BOOL	1	1	Open=0 Close=1		0	Get
160	Digital Object	0x382	144	External DI16	Condition of External DI16	BOOL	1	1	Open=0 Close=1		0	Get
161	Digital Object	0x382	145	External DI17	Condition of External DI17	BOOL	1	1	Open=0 Close=1		0	Get
162	Digital Object	0x382	146	External DI18	Condition of External DI18	BOOL	1	1	Open=0 Close=1		0	Get
163	Digital Object	0x382	147	Event Code	Event Buffer Event Code	UINT	2	1	Bits 0…5 Bits 6…15	Code Channel	0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
164	Digital Object	0x382	148	Event Millisec And Sec	Event Millisecond And Second	UINT	2	1	Bits 0…5 Bits 6…15	secs milliseconds	0	Get
165	Digital Object	0x382	149	Event Min And Hour	Event Minute And Hour	UINT	2	1	Bits 0…7 Bits 8…15	minutes hour	0	Get
166	Digital Object	0x382	150	Event Day And Month	Event Day And Month	UINT	2	1	Bits 0…7 Bits 8…15	Day Month	0	Get
167	Digital Object	0x382	151	Event Year	Event Year	UINT	2	1	Bits 0…15	Year	0	Get
168	Digital Object	0x382	152	Event Ack	Event Acknowledgement	BOOL	1	1	Ack Read=1		0	Get
169	Digital Object	0x382	153	External D01	Condition of External D01	BOOL	1	1	Open=0 Close=1		0	Get
170	Digital Object	0x382	154	External D02	Condition of External D02	BOOL	1	1	Open=0 Close=1		0	Get
171	Digital Object	0x382	155	External D03	Condition of External D03	BOOL	1	1	Open=0 Close=1		0	Get
172	Digital Object	0x382	156	External D04	Condition of External D04	BOOL	1	1	Open=0 Close=1		0	Get
173	Digital Object	0x382	157	External D05	Condition of External D05	BOOL	1	1	Open=0 Close=1		0	Get
174	Digital Object	0x382	158	External D06	Condition of External D06	BOOL	1	1	Open=0 Close=1		0	Get
175	Digital Object	0x382	159	External D07	Condition of External D07	BOOL	1	1	Open=0 Close=1		0	Get
176	Digital Object	0x382	160	External D08	Condition of External D08	BOOL	1	1	Open=0 Close=1		0	Get
177	Digital Object	0x382	161	External D09	Condition of External D09	BOOL	1	1	Open=0 Close=1		0	Get
178	Digital Object	0x382	162	External D010	Condition of External D010	BOOL	1	1	Open=0 Close=1		0	Get
179	Digital Object	0x382	163	External D011	Condition of External D011	BOOL	1	1	Open=0 Close=1		0	Get
180	Digital Object	0x382	164	External D012	Condition of External D012	BOOL	1	1	Open=0 Close=1		0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
181	Digital Object	0x382	165	External DO13	Condition of External DO13	BOOL	1	1	Open=0 Close=1		0	Get
182	Digital Object	0x382	166	External DO14	Condition of External DO14	BOOL	1	1	Open=0 Close=1		0	Get
183	Digital Object	0x382	167	External DO15	Condition of External DO15	BOOL	1	1	Open=0 Close=1		0	Get
184	Digital Object	0x382	168	External DO16	Condition of External DO16	BOOL	1	1	Open=0 Close=1		0	Get
185	Digital Object	0x382	169	Device status	Device Status Codes	USINT	1	1	Motor Running=0 Warning=1 Fault=2		0	Get
186	Analog Object	0x383	1	Phase current IL1	Phase current IL1	INT	2	1 = 1 A	0		0	Get
187	Analog Object	0x383	2	Phase current IL2	Phase current IL2	INT	2	1 = 1 A	0		0	Get
188	Analog Object	0x383	3	Phase current IL3	Phase current IL3	INT	2	1 = 1 A	0		0	Get
189	Analog Object	0x383	4	Frequency	Frequency	INT	2	1 = 0.01 Hz	0		0	Get
190	Analog Object	0x383	5	Io1 residual current	Io1 residual current	INT	2	1 = 0.001 pu	0		0	Get
191	Analog Object	0x383	6	Io2 residual current	Io2 residual current	INT	2	1 = 0.001 pu	0		0	Get
192	Analog Object	0x383	7	Zero sequence voltage	Zero sequence voltage	INT	2	1 = 0.1%	0	1000	0	Get
193	Analog Object	0x383	8	Active power	Active power	INT	2	1 = 1 kW	-65000	65000	0	Get
194	Analog Object	0x383	9	Reactive power	Reactive power	INT	2	1 = 1 kVAR	-65000	65000	0	Get
195	Analog Object	0x383	10	Apparent power	Apparent power	INT	2	1 = 1 kVA	-65000	65000	0	Get
196	Analog Object	0x383	11	Line-to-line voltage U12	Line-to-line voltage U12	UINT	2	1 = 1V	0	450000	0	Get
197	Analog Object	0x383	12	Line-to-line voltage U23	Line-to-line voltage U23	UINT	2	1 = 1V	0	450000	0	Get
198	Analog Object	0x383	13	Line-to-line voltage U31	Line-to-line voltage U31	UINT	2	1 = 1V	0	450000	0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
199	Analog Object	0x383	14	Exported energy	Exported energy	UDINT	4	1 = 0.001 MWh	0	999999	0	Get
200	Analog Object	0x383	15	Imported energy	Imported energy	UDINT	4	1 = 0.001 MWh	0	999999	0	Get
201	Analog Object	0x383	16	Exp. reactive energy	Exported Reactive Energy	UDINT	4	1 = 0.001 Mvarh	0	999999	0	Get
202	Analog Object	0x383	17	Imp. reactive energy	Imported Reactive Energy	UDINT	4	1 = 0.001 Mvarh	0	999999	0	Get
203	Analog Object	0x383	18	Power factor	Power factor Range -1 to +1 (Internal range to 65000)	UDINT	4	1 = 0.01	-100	+100	0	Get
204	Analog Object	0x383	19	Phase-to-earth voltage UL1	Phase-to-earth voltage UL1	UINT	2	1 = 1V	0	999999	0	Get
205	Analog Object	0x383	20	Phase-to-earth voltage UL2	Phase-to-earth voltage UL2	UINT	2	1 = 1V	0	999999	0	Get
206	Analog Object	0x383	21	Phase-to-earth voltage UL3	Phase-to-earth voltage UL3	UINT	2	1 = 1V	0	999999	0	Get
207	Analog Object	0x383	22	Tan phi	Tan phi Use parameter 853 for higher accuracy	INT	2	1 = 0.001	-99999	99999	0	Get
208	Analog Object	0x383	23	Phase current IL	Phase current IL	INT	2	1 A = 1	0		0	Get
209	Analog Object	0x383	24	Average line voltage	Average line voltage	UINT	2	1 = 1V	0		0	Get
210	Analog Object	0x383	25	Average phase voltage	Average phase voltage	UINT	2	1 = 1V	0		0	Get
211	Analog Object	0x383	26	Phase current THD	Phase current total harmonic distortion	DINT	4	1= 0.1%	0		0	Get
212	Analog Object	0x383	27	IL1 THD	IL1 total harmonic distortion	DINT	4	1= 1%	0		0	Get
213	Analog Object	0x383	28	IL2 THD	IL2 total harmonic distortion	DINT	4	1= 1%	0		0	Get
214	Analog Object	0x383	29	IL3 THD	IL3 total harmonic distortion	DINT	4	1= 1%	0		0	Get
215	Analog Object	0x383	30	HARMONICS of IL1	Harmonics of IL1	UDINT	4	1=1% [5]	0		0	Get
216	Analog Object	0x383	31	HARMONICS of IL2	Harmonics of IL2	UDINT	4	1=1% [5]	0		0	Get
217	Analog Object	0x383	32	HARMONICS of IL3	Harmonics of IL3	SINT	4	1=1% [5]	0		0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
218	Analog Object	0x383	33	Min. of IL1 IL2 IL3	Minimum Current of L1,L2,L3	INT	2	1 = 1 A	0		0	Get
219	Analog Object	0x383	34	Max. of IL1 IL2 IL3	Maximum Current of L1,L2,L3	INT	2	1 = 1 A	0		0	Get
220	Analog Object	0x383	35	Phase current ILRMS	Phase current ILRMS	INT	2	1 = 1 A_{rms}	0		0	Get
221	Analog Object	0x383	36	Phase current IL1RMS	Phase current IL1RMS	INT	2	1 = 1 A_{rms}	0		0	Get
222	Analog Object	0x383	37	Phase current IL2RMS	Phase current IL2RMS	INT	2	1 = 1 A_{rms}	0		0	Get
223	Analog Object	0x383	38	Phase current IL3RMS	Phase current IL3RMS	INT	2	1 = 1 A_{rms}	0		0	Get
224	Analog Object	0x383	39	Temperature rise	Temperature rise	UDINT	4	1=0.1 %	0	8000	100	Get
225	Analog Object	0x383	40	Ambient temperature	Ambient temperature	SINT	1	1 = 1°	0		0	Get/ Set
226	Analog Object	0x383	41	IL1da demand	IL1da demand amps	INT	2	1 = 1 A	0		0	Get
227	Analog Object	0x383	42	IL2da demand	IL2da demand amps	INT	2	1 = 1 A	0		0	Get
228	Analog Object	0x383	43	IL3da demand	IL3da demand amps	INT	2	1 = 1 A	0		0	Get
229	Analog Object	0x383	44	IoCalc demand	Io Calculated demand amps	INT	2	1 = 0.01 pu	0		0	Get
230	Analog Object	0x383	45	Io1 demand	Io1 demand	INT	2	1 = 0.001 pu	0		0	Get
231	Analog Object	0x383	46	Io2 demand	Io2 demand	INT	2	1 = 0.001 pu	0		0	Get
232	Analog Object	0x383	47	Voltage THD	Voltage Total Harmonic Distortion	UINT	2	1= 1%	0		0	Get
233	Analog Object	0x383	48	Ua THD	Ua Total Harmonic Distortion	UINT	2	1= 1%	0		0	Get
234	Analog Object	0x383	49	Ub THD	Ub Total Harmonic Distortion	UINT	2	1= 1%	0		0	Get
235	Analog Object	0x383	50	Uc THD	Uc Total Harmonic Distortion	UINT	2	1= 0.1%	0		0	Get
236	Analog Object	0x383	51	HARMONICS of UL1	Harmonics of UL1	USINT	4	1[5] = 1%	0		0	Get
237	Analog Object	0x383	52	HARMONICS of UL2	Harmonics of UL2	USINT	4	1[5] = 1%	0		0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
238	Analog Object	0x383	53	HARMONICS of UL3	Harmonics of UL3	USINT	4	1 = 1% [5]	0		0	Get
239	Analog Object	0x383	54	Min. of line voltages	Minimum of line voltages	UINT	2	1 = 1V	0		0	Get
240	Analog Object	0x383	55	Max. of line voltages	Maximum of line voltages	UINT	2	1 = 1V	0		0	Get
241	Analog Object	0x383	56	Min. of phase voltages	Minimum of phase voltages	UINT	2	1 = 1V	0		0	Get
242	Analog Object	0x383	57	Max. of phase voltages	Maximum of phase voltages	UINT	2	1 = 1V	0		0	Get
243	Analog Object	0x383	58	RMS voltage mean	Mean RMS voltage	UINT	2	1 = 1V rms	0		0	Get
244	Analog Object	0x383	59	Input voltage UL1RMS	Input voltage UL1RMS	UINT	2	1 = $1V_{rms}$	0		0	Get
245	Analog Object	0x383	60	Input voltage UL2RMS	Input voltage UL2RMS	UINT	2	1 = 1V rms	0		0	Get
246	Analog Object	0x383	61	Input voltage UL3RMS	Input voltage UL3RMS	UINT	2	1 = 1V rms	0		0	Get
247	Analog Object	0x383	62	U12 demand	U12 demand	UINT	2	1 = 1V	0		0	Get
248	Analog Object	0x383	63	U23 demand	U23 demand	UINT	2	1 = 1V	0		0	Get
249	Analog Object	0x383	64	U31 demand	U31 demand	UINT	2	1 = 1V	0		0	Get
250	Analog Object	0x383	65	UL1 demand	UL1 demand	UINT	2	1 = 1V	0		0	Get
251	Analog Object	0x383	66	UL2 demand	UL2 demand	UINT	2	1 = 1V	0		0	Get
252	Analog Object	0x383	67	UL3 demand	UL3 demand	UINT	2	1 = 1V	0		0	Get
253	Analog Object	0x383	68	Cosine phi	Cosine phi	INT	2	1= 0.01			0	Get
254	Analog Object	0x383	69	Cosine of phase L1	Cosine of phase L1	INT	2	1= 0.01			0	Get
255	Analog Object	0x383	70	Cosine of phase L2	Cosine of phase L2	INT	2	1= 0.01			0	Get
256	Analog Object	0x383	71	Cosine of phase L3	Cosine of phase L3	INT	2	1= 0.01			0	Get
257	Analog Object	0x383	72	Power angle	Power angle	INT	2	1= 1°	0		0	Get
258	Analog Object	0x383	73	Phase L1 active power	Phase L1 active power	INT	2	1= 1 kW	0		0	Get
259	Analog Object	0x383	74	Phase L2 active power	Phase L2 active power	INT	2	1 = 1 kW	0		0	Get
260	Analog Object	0x383	75	Phase L3 active power	Phase L3 active power	INT	2	1 = 1 kW	0		0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
261	Analog Object	0x383	76	Phase L1 reactive power	Phase L1 reactive power	INT	2	1 = 1 kVAR	0		0	Get
262	Analog Object	0x383	77	Phase L2 reactive power	Phase L2 reactive power	INT	2	1 = 1kVAR	0		0	Get
263	Analog Object	0x383	78	Phase L3 reactive power	Phase L3 reactive power	INT	2	1 = 1 kVAR	0		0	Get
264	Analog Object	0x383	79	Phase L1 apparent power	Phase L1 apparent power	INT	2	1 = 1 kVA	0		0	Get
265	Analog Object	0x383	80	Phase L2 apparent power	Phase L2 apparent power	INT	2	1 = 1 kVA	0		0	Get
266	Analog Object	0x383	81	Phase L3 apparent power	Phase L3 apparent power	INT	2	1 = 1 kVA	0		0	Get
267	Analog Object	0x383	82	RMS active power	RMS active power	INT	2	1 = 1 kW	0		0	Get
268	Analog Object	0x383	83	RMS reactive power	RMS reactive power	INT	2	1 = 1kVAR	0		0	Get
269	Analog Object	0x383	84	RMS apparent power	RMS apparent power	INT	2	1 = 1 kVA	0		0	Get
270	Analog Object	0x383	85	Active power demand	Active power demand	INT	2	1 = 1 kW	0		0	Get
271	Analog Object	0x383	86	Reactive power demand	Reactive power demand	INT	2	1 = 1 kVAR	0		0	Get
272	Analog Object	0x383	87	Apparent power demand	Apparent power demand	INT	2	1 = 1 kVA	0		0	Get
273	Analog Object	0x383	88	Power factor demand	Demand Power factor Range -1 to +1 (Internal range to 65000)	INT	2	1 = 0.01	-100	+100	0	Get
274	Analog Object	0x383	89	RMS active power demand	RMS active power demand	INT	2	1 = 1 kW	0		0	Get
275	Analog Object	0x383	90	RMS reactive power demand	RMS reactive power demand	INT	2	1 = 1kVAR	0		0	Get
276	Analog Object	0x383	91	RMS apparent power demand	RMS apparent power demand	INT	2	1 = 1 kVA	0		0	Get
277	Analog Object	0x383	92	Calculated Io	Calculated Io	INT	2	1 = 0.001 pu	0		0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
278	Analog Object	0x383	93	Fault current of I>	Fault current level of I>	INT	2	1 = 0.01	0		0	Get
279	Analog Object	0x383	94	Fault current of I>>	Fault current level of I>>	INT	2	1 = 0.01	0		0	Get
280	Analog Object	0x383	95	Fault current of I>>>	Fault current level of I>>>	INT	2	1 = 0.01	0		0	Get
281	Analog Object	0x383	96	Fault reactance	Fault reactance	UINT	2	1 = 0.01 ohm	0		0	Get
282	Analog Object	0x383	97	Frequency fy	Frequency fy	UINT	2	1 = 0.01 Hz	0		0	Get
283	Analog Object	0x383	98	Line-to-line voltage U12y	Line-to-line voltage U12y	INT	2	1 = 1V	0		0	Get
284	Analog Object	0x383	99	Frequency fz	Frequency fz	UINT	2	1 = 0.01 Hz	0		0	Get
285	Analog Object	0x383	100	Line-to-line voltage U12z	Line-to-line voltage U12z	INT	2	1 = 1V	0		0	Get
286	Analog Object	0x383	101	U12/U12z Phase angle difference	U12/U12z Phase angle difference	INT	2	1° = 1	0		0	Get
287	Analog Object	0x383	102	Minimum frequency	Minimum frequency	INT	2	1 = 0.01 Hz	0		0	Get/ Set
288	Analog Object	0x383	103	Minimum active power	Minimum active power	INT	2	1 = 1 kW	0		0	Get/ Set
289	Analog Object	0x383	104	Minimum react. power	Minimum react. power	INT	2	1 = 1kVAR	0		0	Get/ Set
290	Analog Object	0x383	105	Minimum apparent power	Minimum apparent power	INT	2	1 = 1 kVA	0		0	Get/ Set
291	Analog Object	0x383	106	Min power factor	Minimum Power factor Range -1 to +1 (Internal range to 65000)	INT	2	1 = 0.01	-100	+100	0	Get/ Set
292	Analog Object	0x383	107	Minimum of Io	Minimum of Io	INT	2	1 = 0.1%	0		0	Get/ Set
293	Analog Object	0x383	108	Minimum of Io2	Minimum of Io2	INT	2	1 = 0.1%	0		0	Get/ Set
294	Analog Object	0x383	109	Minimum active power demand	Minimum active power demand	INT	2	1 = 1 kW	0		0	Get/ Set
295	Analog Object	0x383	110	Minimum react. power demand	Minimum react. power demand	INT	2	1= 1 kVAR	0		0	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
296	Analog Object	0x383	111	Minimum apparent power demand	Minimum apparent power demand	INT	2	1 = 1 kVA	0		0	Get/Set
297	Analog Object	0x383	112	15 min minimum power factor	15 Min Minimum Power factor Range -1 to +1 (Internal range to 65000)	INT	2	1 = 0.01	-100	+100	0	Get/Set
298	Analog Object	0x383	113	Minimum active power RMS demand	Minimum active power RMS demand	INT	2	1 = 1 kW	0		0	Get/Set
299	Analog Object	0x383	114	Minimum react. power RMS demand	Minimum react. power RMS demand	INT	2	1 = 1 kVAR	0		0	Get/Set
300	Analog Object	0x383	115	Minimum apparent power RMS demand	Minimum apparent power RMS demand	INT	2	1 = 1 kVA	0		0	Get/Set
301	Analog Object	0x383	116	Minimum of IL1	Minimum of IL1	INT	2	1 A = 1	0		0	Get/Set
302	Analog Object	0x383	117	Minimum of IL2	Minimum of IL2	INT	2	1 = 1 A	0		0	Get/Set
303	Analog Object	0x383	118	Minimum of IL3	Minimum of IL3	INT	2	1 = 1 A	0		0	Get/Set
304	Analog Object	0x383	119	RMS minimum of IL1	RMS minimum of IL1	INT	2	1 = 1 A_{rms}	0		0	Get/Set
305	Analog Object	0x383	120	RMS minimum of IL2	RMS minimum of IL2	INT	2	1 = 1 A_{rms}	0		0	Get/Set
306	Analog Object	0x383	121	RMS minimum of IL3	RMS minimum of IL3	INT	2	1 = 1 A_{rms}	0		0	Get/Set
307	Analog Object	0x383	122	Minimum of IL1 demand	Minimum of IL1 demand	INT	2	1 = 1 A	0		0	Get/Set
308	Analog Object	0x383	123	Minimum of IL2 demand	Minimum of IL2 demand	INT	2	1 = 1 A	0		0	Get/Set
309	Analog Object	0x383	124	Minimum of IL3 demand	Minimum of IL3 demand	INT	2	1 = 1 A	0		0	Get/Set
310	Analog Object	0x383	125	RMS minimum of IL1 demand	RMS minimum of IL1 demand	INT	2	1 = 1 A_{rms}	0		0	Get/Set
311	Analog Object	0x383	126	RMS minimum of IL2 demand	RMS minimum of IL2 demand	INT	2	1 = 1 A_{rms}	0		0	Get/Set
312	Analog Object	0x383	127	RMS minimum of IL3 demand	RMS minimum of IL3 demand	INT	2	1 = 1 A_{rms}	0		0	Get/Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
313	Analog Object	0x383	128	Minimum of U12	Minimum of U12	INT	2	1 = 1V	0		0	Get/ Set
314	Analog Object	0x383	129	Minimum of U23	Minimum of U23	INT	2	1 = 1V	0		0	Get/ Set
315	Analog Object	0x383	130	Minimum of U31	Minimum of U31	INT	2	1 = 1V	0		0	Get/ Set
316	Analog Object	0x383	131	Maximum frequency	Maximum frequency	INT	2	1 = 0.01 Hz	0		0	Get/ Set
317	Analog Object	0x383	132	Maximum active power	Maximum active power	INT	2	1 = 1 kW	0		0	Get/ Set
318	Analog Object	0x383	133	Maximum react. power	Maximum react. power	INT	2	1= 1 kVAR	0		0	Get/ Set
319	Analog Object	0x383	134	Maximum apparent power	Maximum apparent power	INT	2	1 = 1 kVA	0		0	Get/ Set
320	Analog Object	0x383	135	Max power factor	Maximum Power factor Range -1 to +1 (Internal range to 65000)	INT	2	1 = 0.01	-100	+100	0	Get/ Set
321	Analog Object	0x383	136	Maximum of Io	Maximum of Io	INT	2	1 = 0.1%	0		0	Get/ Set
322	Analog Object	0x383	137	Maximum of Io2	Maximum of Io2	INT	2	1 = 0.1%	0		0	Get/ Set
323	Analog Object	0x383	138	Maximum active power demand	Maximum active power demand	INT	2	1 = 1 kW	0		0	Get/ Set
324	Analog Object	0x383	139	Maximum react. power demand	Maximum react. power demand	INT	2	1= 1 kVAR	0		0	Get/ Set
325	Analog Object	0x383	140	Maximum apparent power demand	Maximum apparent power demand	INT	2	1 = 1 kVA	0		0	Get/ Set
326	Analog Object	0x383	141	15 min maximum power factor	15 Min Maximum Power factor Range -1 to +1 (Internal range to 65000)	INT	2	1 = 0.01	-100	+100	0	Get/ Set
327	Analog Object	0x383	142	Maximum active power RMS demand	Maximum active power RMS demand	INT	2	1 = 1 kW	0		0	Get/ Set
328	Analog Object	0x383	143	Maximum react. power RMS demand	Maximum reactive power RMS demand	INT	2	1= 1 kVAR	0		0	Get/ Set
329	Analog Object	0x383	144	Maximum apparent power RMS demand	Maximum apparent power RMS demand	INT	2	1 = 1 kVA	0		0	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
330	Analog Object	0x383	145	Maximum of IL1	Maximum of IL1	INT	2	1 = 1 A	0		0	Get/ Set
331	Analog Object	0x383	146	Maximum of IL2	Maximum of IL2	INT	2	1 = 1 A	0		0	Get/ Set
332	Analog Object	0x383	147	Maximum of IL3	Maximum of IL3	INT	2	1 = 1 A	0		0	Get/ Set
333	Analog Object	0x383	148	RMS maximum of IL1	RMS maximum of IL1	INT	2	1 = 1 A_{rms}	0		0	Get/ Set
334	Analog Object	0x383	149	RMS maximum of IL2	RMS maximum of IL2	INT	2	1 = 1 A_{rms}	0		0	Get/ Set
335	Analog Object	0x383	150	RMS maximum of IL3	RMS maximum of IL3	INT	2	1 = 1 A_{rms}	0		0	Get/ Set
336	Analog Object	0x383	151	Maximum of IL1 demand	Maximum of IL1 demand	INT	2	1 = 1 A	0		0	Get/ Set
337	Analog Object	0x383	152	Maximum of IL2 demand	Maximum of IL2 demand	INT	2	1 = 1 A	0		0	Get/ Set
338	Analog Object	0x383	153	Maximum of IL3 demand	Maximum of IL3 demand	INT	2	1 = 1 A	0		0	Get/ Set
339	Analog Object	0x383	154	RMS maximum of IL1 demand	RMS maximum of IL1 demand	INT	2	1 = 1 A_{rms}	0		0	Get/ Set
340	Analog Object	0x383	155	RMS maximum of IL2 demand	RMS maximum of IL2 demand	INT	2	1 = 1 A_{rms}	0		0	Get/ Set
341	Analog Object	0x383	156	RMS maximum of IL3 demand	RMS maximum of IL3 demand	INT	2	1 = 1 A_{rms}	0		0	Get/ Set
342	Analog Object	0x383	157	Maximum of U12	Maximum of U12	INT	2	1 = 1V	0		0	Get/ Set
343	Analog Object	0x383	158	Maximum of U23	Maximum of U23	INT	2	1 = 1V	0		0	Get/ Set
344	Analog Object	0x383	159	Maximum of U31	Maximum of U31	INT	2	1 = 1V	0		0	Get/ Set
345	Analog Object	0x383	160	Z12 primary impedance	Z12 primary impedance	INT	2	1 = 0.01 ohm	0		0	Get
346	Analog Object	0x383	161	Z23 primary impedance	Z23 primary impedance	INT	2	1 = 0.01 ohm	0		0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
347	Analog Object	0x383	162	Z31 primary impedance	Z31 primary impedance	INT	2	1 = 0.01 ohm	0		0	Get
348	Analog Object	0x383	163	Z12 secondary impedance	Z12 secondary impedance	INT	2	1 = 0.01 ohm	0		0	Get
349	Analog Object	0x383	164	Z23 secondary impedance	Z23 secondary impedance	INT	2	1 = 0.01 ohm	0		0	Get
350	Analog Object	0x383	165	Z31 secondary impedance	Z31 secondary impedance	INT	2	1 = 0.01 ohm	0		0	Get
351	Analog Object	0x383	166	Z12 angle	Z12 angle	INT	2	1= 1 °	0		0	Get
352	Analog Object	0x383	167	Z23 angle	Z23 angle	INT	2	1= 1 °	0		0	Get
353	Analog Object	0x383	168	Z31 angle	Z31 angle	INT	2	1= 1 °	0		0	Get
354	Analog Object(2)	0x383	169	Phase current I'_{L1}	I'L1 current	INT	2	1 = 1 A	0		0	Get
355	Analog Object(2)	0x383	170	Phase current I'_{L2}	I'L2 current	INT	2	1 = 1 A	0		0	Get
356	Analog Object(2)	0x383	171	Phase current I'_{L3}	I'L3 current	INT	2	1 = 1 A	0		0	Get
357	Analog Object(2)	0x383	172	IL1 difference	IL1 differential current	INT	2	1 = 0.01 x xIn	0		0	Get
358	Analog Object(2)	0x383	173	IL2 difference	IL2 differential current	INT	2	1 = 0.01 x xIn	0		0	Get
359	Analog Object(2)	0x383	174	IL3 difference	IL3 differential current	INT	2	1 = 0.01 x xIn	0		0	Get
360	Analog Object(2)	0x383	175	Phase current I'THD	Phase current I'THD	INT	2	1= 0.1%	0		0	Get
361	Analog Object(2)	0x383	176	I'_{L1} THD	I'L1 total harmonic distortion	INT	2	1= 0.1%	0		0	Get
362	Analog Object(2)	0x383	177	I'_{L2} THD	I'L2 total harmonic distortion	INT	2	1= 0.1%	0		0	Get
363	Analog Object(2)	0x383	178	I'_{L3} THD	I'L3 total harmonic distortion	INT	2	1= 0.1%	0		0	Get
364	Analog Object(2)	0x383	179	Harmonics of I'_{L1}	Harmonics of I'L1	USINT	1	1 = 1%	0		0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
365	Analog Object[2]	0x383	180	Harmonics of I'_{L2}	Harmonics of I'L2	USINT	1	1 = 1%	0		0	Get
366	Analog Object[2]	0x383	181	Harmonics of I'_{L3}	Harmonics of I'L3	USINT	1	1 = 1%	0		0	Get
367	Analog Object[2]	0x383	182	Min. of $I'_{L1} I'_{L2} I'_{L3}$	I'L minimum	INT	2	1 = 1 A	0		0	Get
368	Analog Object[2]	0x383	183	Max. of $I'_{L1} I'_{L2} I'_{L3}$	I'L maximum	INT	2	1 = 1 A	0		0	Get
369	Analog Object[2]	0x383	184	Phase current I'_{LRMS}	I'L RMS current	INT	2	1 = 1 A_{rms}	0		0	Get
370	Analog Object[2]	0x383	185	Phase current I'_{L1RMS}	I'L1 RMS	INT	2	1 = 1 A_{rms}	0		0	Get
371	Analog Object[2]	0x383	186	Phase current I'_{L2RMS}	I'L2 RMS	INT	2	1 = 1 A_{rms}	0		0	Get
372	Analog Object[2]	0x383	187	Phase current I'_{L3RMS}	I'L3 RMS	INT	2	1 = 1 A_{rms}	0		0	Get
373	Analog Object	0x383	188	External AI1	External AI1	UDINT	4	1 = 0.01	-25000	+25000	0	Get
374	Analog Object	0x383	189	External AI2	External AI2	UDINT	4	1 = 0.01	-25000	+25000	0	Get
375	Analog Object	0x383	190	External AI3	External AI3	UDINT	4	1 = 0.01	-25000	+25000	0	Get
376	Analog Object	0x383	191	External AI4	External AI4	UDINT	4	1 = 0.01	-25000	+25000	0	Get
377	Analog Object	0x383	192	External AI5	External AI5	UDINT	4	1 = 0.01	-25000	+25000	0	Get
378	Analog Object	0x383	193	External AI6	External AI6	UDINT	4	1 = 0.01	-25000	+25000	0	Get
379	Analog Object	0x383	194	External AI7	External AI7	UDINT	4	1 = 0.01	-25000	+25000	0	Get
380	Analog Object	0x383	195	External AI8	External AI8	UDINT	4	1 = 0.01	-25000	+25000	0	Get
381	Analog Object	0x383	196	External AI9	External AI9	UDINT	4	1 = 0.01	-25000	+25000	0	Get
382	Analog Object	0x383	197	External AI10	External AI10	UDINT	4	1 = 0.01	-25000	+25000	0	Get
383	Analog Object	0x383	198	External AI11	External AI11	UDINT	4	1 = 0.01	-25000	+25000	0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
384	Analog Object	0x383	199	External AI12	External AI12	UDINT	4	1 = 0.01	-25000	+25000	0	Get
385	Analog Object	0x383	200	External AI13	External AI13	UDINT	4	1 = 0.01 mA	0	2000	0	Get
386	Analog Object	0x383	201	External AI14	External AI14	UDINT	4	1 = 0.01 mA	0	2000	0	Get
387	Analog Object	0x383	202	External AI15	External AI15	UDINT	4	1 = 0.01 mA	0	2000	0	Get
388	Analog Object	0x383	203	External AI16	External AI16	UDINT	4	1 = 0.01 mA	0	2000	0	Get
389	Analog Object	0x383	204	External AI Alarm State > 1	External AI Input Status	BOOL	1	1	Channel 1 Alarm=1		0	Get
390	Analog Object	0x383	205	External AI Alarm State > 2	External AI Input Status	BOOL	1	1	Channel 2 Alarm=1		0	Get
391	Analog Object	0x383	206	External AI Alarm State > 3	External AI Input Status	BOOL	1	1	Channel 3 Alarm=1		0	Get
392	Analog Object	0x383	207	External AI Alarm State > 4	External AI Input Status	BOOL	1	1	Channel 4 Alarm=1		0	Get
393	Analog Object	0x383	208	External AI Alarm State > 5	External AI Input Status	BOOL	1	1	Channel 5 Alarm=1		0	Get
394	Analog Object	0x383	209	External AI Alarm State > 6	External AI Input Status	BOOL	1	1	Channel 6 Alarm=1		0	Get
395	Analog Object	0x383	210	External AI Alarm State > 7	External AI Input Status	BOOL	1	1	Channel 7 Alarm=1		0	Get
396	Analog Object	0x383	211	External AI Alarm State > 8	External AI Input Status	BOOL	1	1	Channel 8 Alarm=1		0	Get
397	Analog Object	0x383	212	External AI Alarm State > 9	External AI Input Status	BOOL	1	1	Channel 9 Alarm=1		0	Get
398	Analog Object	0x383	213	External AI Alarm State > 10	External AI Input Status	BOOL	1	1	Channel 10 Alarm=1		0	Get
399	Analog Object	0x383	214	External AI Alarm State > 11	External AI Input Status	BOOL	1	1	Channel 11 Alarm=1		0	Get
400	Analog Object	0x383	215	External AI Alarm State > 12	External AI Input Status	BOOL	1	1	Channel 12 Alarm=1		0	Get
401	Analog Object	0x383	216	External AI Alarm State > 13	External AI Input Status	BOOL	1	1	Channel 13 Alarm=1		0	Get
402	Analog Object	0x383	217	External AI Alarm State > 14	External AI Input Status	BOOL	1	1	Channel 14 Alarm=1		0	Get
403	Analog Object	0x383	218	External AI Alarm State > 15	External AI Input Status	BOOL	1	1	Channel 15 Alarm=1		0	Get
404	Analog Object	0x383	219	External AI Alarm State > 16	External AI Input Status	BOOL	1	1	Channel 16 Alarm=1		0	Get
405	Analog Object	0x383	220	External AI Alarm State >> 1	External AI Input Status	BOOL	1	1	Channel 1 Trip=1		0	Get
406	Analog Object	0x383	221	External AI Alarm State >> 2	External AI Input Status	BOOL	1	1	Channel 2 Trip=1		0	Get
407	Analog Object	0x383	222	External AI Alarm State >> 3	External AI Input Status	BOOL	1	1	Channel 3 Trip =1		0	Get
408	Analog Object	0x383	223	External AI Alarm State >> 4	External AI Input Status	BOOL	1	1	Channel 4 Trip =1		0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
409	Analog Object	0x383	224	External AI Alarm State >> 5	External AI Input Status	BOOL	1	1	Channel 5 Trip =1		0	Get
410	Analog Object	0x383	225	External AI Alarm State >> 6	External AI Input Status	BOOL	1	1	Channel 6 Trip =1		0	Get
411	Analog Object	0x383	226	External AI Alarm State >> 7	External AI Input Status	BOOL	1	1	Channel 7 Trip =1		0	Get
412	Analog Object	0x383	227	External AI Alarm State >> 8	External AI Input Status	BOOL	1	1	Channel 8 Trip =1		0	Get
413	Analog Object	0x383	228	External AI Alarm State >> 9	External AI Input Status	BOOL	1	1	Channel 9 Trip =1		0	Get
414	Analog Object	0x383	229	External AI Alarm State >> 10	External AI Input Status	BOOL	1	1	Channel 10 Trip =1		0	Get
415	Analog Object	0x383	230	External AI Alarm State >> 11	External AI Input Status	BOOL	1	1	Channel 11 Trip =1		0	Get
416	Analog Object	0x383	231	External AI Alarm State >> 12	External AI Input Status	BOOL	1	1	Channel 12 Trip =1		0	Get
417	Analog Object	0x383	232	External AI Alarm State >> 13	External AI Input Status	BOOL	1	1	Channel 13 Trip =1		0	Get
418	Analog Object	0x383	233	External AI Alarm State >> 14	External AI Input Status	BOOL	1	1	Channel 14 Trip =1		0	Get
419	Analog Object	0x383	234	External AI Alarm State >> 15	External AI Input Status	BOOL	1	1	Channel 15 Trip =1		0	Get
420	Analog Object	0x383	235	External AI Alarm State >> 16	External AI Input Status	BOOL	1	1	Channel 16 Trip =1		0	Get
421	Analog Object	0x383	236	External A01	External Analog Output Channel 1	UDINT	4	1 = 0.01	-2100000000 [6]	+2100000000 [6]	0	Get
422	Analog Object	0x383	237	External A02	External Analog Output Channel 2	UDINT	4	1 = 0.01	-2100000000 [6]	+2100000000 [6]	0	Get
423	Analog Object	0x383	238	External A03	External Analog Output Channel 3	UDINT	4	1 = 0.01	-2100000000 [6]	+2100000000 [6]	0	Get
424	Analog Object	0x383	239	External A04	External Analog Output Channel 4	UDINT	4	1 = 0.01	-2100000000 [6]	+2100000000 [6]	0	Get
425	Analog Object	0x383	240	External A05	External Analog Output Channel 5	UDINT	4	1 = 0.01	-2100000000 [6]	+2100000000 [6]	0	Get
426	Analog Object	0x383	241	External A06	External Analog Output Channel 6	UDINT	4	1 = 0.01	-2100000000 [6]	+2100000000 [6]	0	Get
427	Analog Object	0x383	242	External A07	External Analog Output Channel 7	UDINT	4	1 = 0.01	-2100000000 [6]	+2100000000 [6]	0	Get
428	Analog Object	0x383	243	External A08	External Analog Output Channel 8	UDINT	4	1 = 0.01	-2100000000 [6]	+2100000000 [6]	0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
429	Analog Object	0x383	244	External A09	External Analog Output Channel 9	UDINT	4	1 = 0.01	-2100000000 [6]	+2100000000 [6]	0	Get
430	Analog Object	0x383	245	External A010	External Analog Output Channel 10	UDINT	4	1 = 0.01	-2100000000 [6]	+2100000000 [6]	0	Get
431	Analog Object	0x383	246	External A011	External Analog Output Channel 11	UDINT	4	1 = 0.01	-2100000000 [6]	+2100000000 [6]	0	Get
432	Analog Object	0x383	247	External A012	External Analog Output Channel 12	UDINT	4	1 = 0.01	-2100000000 [6]	+2100000000 [6]	0	Get
433	Analog Object	0x383	248	External A013	External Analog Output Channel 13	UDINT	4	1 = 0.01	-2100000000 [6]	+2100000000 [6]	0	Get
434	Analog Object	0x383	249	External A014	External Analog Output Channel 14	UDINT	4	1 = 0.01	-2100000000 [6]	+2100000000 [6]	0	Get
435	Analog Object	0x383	250	External A015	External Analog Output Channel 15	UDINT	4	1 = 0.01	-2100000000[6]	+2100000000 [6]	0	Get
436	Analog Object	0x383	251	External A016	External Analog Output Channel 16	UDINT	4	1 = 0.01	-2100000000 [6]	+2100000000 [6]	0	Get
437	StgProt CurrentObject	0x385	1	I> Enable for I>	Protection Enable	BOOL	1	1	0=Off 1=On		1	Get/ Set
438	StgProtCurrentObject	0x385	2	I> Group	Setting Group Enable	USINT	1	1	0=Group 1 1=Group 2		0	Get/ Set
439	StgProtCurrentObject	0x385	3	I> Pick-up setting 1	I> Pick-up setting 1	UDINT	4	1 = 0.01 x Imot	10	500	120	Get/ Set
440	StgProtCurrentObject	0x385	4	I> Pick-up setting 2	I> Pick-up setting 2	UDINT	4	1 = 0.01 x Imot	10	500	120	Get/ Set
441	StgProtCurrentObject	0x385	5	I> Delay curve family 1	Delay Curve Type Selected DT=Definite time RI=Old ASEA type	USINT	1	1	0=DT 1=IEC 2=IEEE 3=IEEE2 4=RI 5=Prg1 6=Prg2 7=Prg3		1	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
442	StgProtCurrentObject	0x385	6	I> Delay curve family 2	Delay Curve Type Selected DT=Definite time RI=Old ASEA type	USINT	1	1	0=DT 1=IEC 2=IEEE 3=IEEE2 4=RI 5=Prg1 6=Prg2 7=Prg3		1	Get/ Set
443	StgProtCurrentObject	0x385	7	I> Delay type 1	Delay Curve Type Selected DT=Definite time NI=Normal inverse VI=Very inverse EI=Extremely inverse LTI=Long time inverse LTEI=Long time extremely inverse LTVI=Long time very inverse MI=Moderately inverse STI=Short time inverse STEI=Short time extremely inverse RI=Old ASEA type RXIDG=Old ASEA type	USINT	1	1	0=DT 1=NI 2=VI 3=EI 4=LTI 5=LTEI 6=LTVI 7=MI 8=STI 9=STEI 10=RI		1	Get/ Set
444	StgProtCurrentObject	0x385	8	I> Delay type 2	Delay Curve Type Selected DT=Definite time NI=Normal inverse VI=Very inverse EI=Extremely inverse LTI=Long time inverse LTEI=Long time extremely inverse LTVI=Long time very inverse MI=Moderately inverse STI=Short time inverse STEI=Short time extremely inverse RI=Old ASEA type RXIDG=Old ASEA type	USINT	1	1	0=DT 1=NI 2=VI 3=EI 4=LTI 5=LTEI 6=LTVI 7=MI 8=STI 9=STEI 10=RI		1	Get/ Set
445	StgProtCurrentObject	0x385	9	I> Inv. time coefficient k 1	I> Inv. time coefficient k 1	UDINT	4	1 = 0.01	5	2000	100	Get/ Set
446	StgProtCurrentObject	0x385	10	I> Inv. time coefficient k 2	I> Inv. time coefficient k 2	UDINT	4	1 = 0.01	5	2000	100	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
447	StgProtCurrentObject	0x385	11	I> Include harmonics	I> Include harmonics	BOOL	1	1	0=No 1=Yes		0	Get/ Set
448	StgProtCurrentObject	0x385	12	I> Constant A	I> Constant A	UDINT	4	1 = 0.001	0	200000	1	Get/ Set
449	StgProtCurrentObject	0x385	13	I> Constant B	I> Constant B	UDINT	4	1 = 0.001	0	5000	1	Get/ Set
450	StgProtCurrentObject	0x385	14	I> Constant C	I> Constant C	UDINT	4	1 = 0.001	0	5000	1	Get/ Set
451	StgProtCurrentObject	0x385	15	I> Constant D	I> Constant D	UDINT	4	1 = 0.001	0	5000	1	Get/ Set
452	StgProtCurrentObject	0x385	16	I> Constant E	I> Constant E	UDINT	4	1 = 0.001	0	20000	1	Get/ Set
453	StgProtCurrentObject	0x385	17	I>> Enable for I>>	I>> Enable for I>>	BOOL	1	1	0=Off 1=On		1	Get/ Set
454	StgProtCurrentObject	0x385	18	I>> Group	I>> Setting Group	USINT	1	1	0=Group 1 1=Group 2		0	Get/ Set
455	StgProtCurrentObject	0x385	19	I>> Pick-up setting 1	I>> Pick-up setting 1	UDINT	4	1 = 0.01 x Imot	10	2000	250	Get/ Set
456	StgProtCurrentObject	0x385	20	I>> Pick-up setting 2	I>> Pick-up setting 2	UDINT	4	1 = 0.01 x Imot	10	2000	250	Get/ Set
457	StgProtCurrentObject	0x385	21	I>> Operation delay 1	I>> Operation delay 1	UDINT	4	1 = 0.01 s	4	180000	60	Get/ Set
458	StgProtCurrentObject	0x385	22	I>> Operation delay 2	I>> Operation delay 2	UDINT	4	1 = 0.01 s	4	180000	60	Get/ Set
459	StgProtCurrentObject	0x385	23	I>>> Enable for I>>>	I>>> Enable for I>>>	BOOL	1	1	Off=0 On=1		0	Get/ Set
460	StgProtCurrentObject	0x385	24	I>>> Group	I>>> Setting Group	USINT	1	1	0=Group 1 1=Group 2		0	Get/ Set
461	StgProtCurrentObject	0x385	25	I>>> Pick-up setting 1	I>>> Pick-up setting 1	UDINT	4	1 = 0.01 x Imot	10	4000	500	Get/ Set
462	StgProtCurrentObject	0x385	26	I>>> Pick-up setting 2	I>>> Pick-up setting 2	UDINT	4	1 = 0.01 x Imot	10	4000	500	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
463	StgProtCurrentObject	0x385	27	I>>> Operation delay 1	I>>> Operation delay 1	UDINT	4	1 = 0.01 s	3	30000	10	Get/ Set
464	StgProtCurrentObject	0x385	28	I>>> Operation delay 2	I>>> Operation delay 2	UDINT	4	1 = 0.01 s	3	30000	10	Get/ Set
465	StgProtCurrentObject	0x385	29	Idir> Enable for Idir>	Idir> Enable for Idir>	BOOL	1	1	Off=0 On=1		0	Get/ Set
466	StgProtCurrentObject	0x385	30	Idir> Group	Idir> Setting Group	USINT	1	1	0=Group1 1=Group 2		0	Get/ Set
467	StgProtCurrentObject	0x385	31	Idir> Pick-up setting 1	Idir> Pick-up setting 1	UDINT	4	1 = 0.01 x Imot	10	400	120	Get/ Set
468	StgProtCurrentObject	0x385	32	Idir> Pick-up setting 2	Idir> Pick-up setting 2	UDINT	4	1 = 0.01 x Imot	10	400	120	Get/ Set
469	StgProtCurrentObject	0x385	33	Idir> Direction mode 1	Idir> Direction mode 1	USINT	1	1	0=Directional + Backup 1=Unidirectional 2= Directional		0	Get/ Set
470	StgProtCurrentObject	0x385	34	Idir> Direction mode 2	Idir> Direction mode 2	USINT	1	1	0=Directional + Backup 1=Unidirectional 2= Directional		0	Get/ Set
471	StgProtCurrentObject	0x385	35	Idir> Angle offset 1	Idir> Angle offset 1	INT	2	1= 1 °	-180	179	8192	Get/ Set
472	StgProtCurrentObject	0x385	36	Idir> Angle offset 2	Idir> Angle offset 2	INT	2	1= 1 °	-180	179	8192	Get/ Set
473	StgProtCurrentObject	0x385	37	Idir> Delay curve family 1	Idir> Delay curve family 1 DT=Definite time RI=Old ASEA type	USINT	1	1	0=DT 1=IEC 2=IEEE 3=IEEE2 4=RI 5=Prg1 6=Prg2 7=Prg3		1	Get/ Set
474	StgProtCurrentObject	0x385	38	Idir> Delay curve family 2	Idir> Delay curve family 2 DT=Definite time RI=Old ASEA type	USINT	1	1	0=DT 1=IEC 2=IEEE 3=IEEE2 4=RI 5=Prg1 6=Prg2 7=Prg3		1	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
475	StgProtCurrentObject	0x385	39	Idir> Delay type 1	Idir> Delay type 1 DT=Definite time NI=Normal inverse VI=Very inverse EI=Extremely inverse LTI=Long time inverse LTEI=Long time extremely inverse LTVI=Long time very inverse MI=Moderately inverse STI=Short time inverse STEI=Short time extremely inverse RI=Old ASEA type RXIDG=Old ASEA type	USINT	1	1	0=DT 1=NI 2=VI 3=EI 4=LTI 5=LTEI 6=LTVI 7=MI 8=STI 9=STEI 10=RI		1	Get/ Set
476	StgProtCurrentObject	0x385	40	Idir> Delay type 2	Idir> Delay type 2 DT=Definite time NI=Normal inverse VI=Very inverse EI=Extremely inverse LTI=Long time inverse LTEI=Long time extremely inverse LTVI=Long time very inverse MI=Moderately inverse STI=Short time inverse STEI=Short time extremely inverse RI=Old ASEA type RXIDG=Old ASEA type	USINT	1	1	0=DT 1=NI 2=VI 3=EI 4=LTI 5=LTEI 6=LTVI 7=MI 8=STI 9=STEI 10=RI		1	Get/ Set
477	StgProtCurrentObject	0x385	41	Idir> Inv. time coefficient k 1	Idir> Inv. time coefficient k 1	UDINT	4	1 = 0.01	5	2000	20	Get/ Set
478	StgProtCurrentObject	0x385	42	Idir> Inv. time coefficient k 2	Idir> Inv. time coefficient k 2	UDINT	4	1 = 0.01	5	2000	20	Get/ Set
479	StgProtCurrentObject	0x385	43	Idir> Constant A	Idir> Constant A	UDINT	4	1 = 0.001	0	200000	1	Get/ Set
480	StgProtCurrentObject	0x385	44	Idir> Constant B	Idir> Constant B	UDINT	4	1 = 0.001	0	5000	1	Get/ Set
481	StgProtCurrentObject	0x385	45	Idir> Constant C	Idir> Constant C	UDINT	4	1 = 0.001	0	5000	1	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
482	StgProtCurrentObject	0x385	46	Idir> Constant D	Idir> Constant D	DINT	4	1 = 0.001	0	200000	1	Get/ Set
483	StgProtCurrentObject	0x385	47	Idir> Constant E	Idir> Constant E	UDINT	4	1 = 0.001	0	20000	1	Get/ Set
484	StgProtCurrentObject	0x385	48	Idir>> Enable for Idir>>	Idir>> Enable for Idir>>	BOOL	1	0	0=Off 1=On		0	Get/ Set
485	StgProtCurrentObject	0x385	49	Idir>> Group	Idir>> Setting Group	USINT	1	1	0=Group 1 1=Group 2		0	Get/ Set
486	StgProtCurrentObject	0x385	50	Idir>> Pick-up setting 1	Idir>> Pick-up setting 1	UDINT	4	1 = 0.01 x Imot	10	400	120	Get/ Set
487	StgProtCurrentObject	0x385	51	Idir>> Pick-up setting 2	Idir>> Pick-up setting 2	UDINT	4	1 = 0.01 x Imot	10	400	120	Get/ Set
488	StgProtCurrentObject	0x385	52	Idir>> Direction mode 1	Idir>> Direction mode 1 ResCap=High impedance earthed network Sector= Low impedance earthed network Undir = Undirectional mode network	USINT	1	1	0=ResCap 1=Sector 2=Undir		0	Get/ Set
489	StgProtCurrentObject	0x385	53	Idir>> Direction mode 2	Idir>> Direction mode 2 ResCap=High impedance earthed network Sector= Low impedance earthed network Undir = Undirectional mode network	USINT	1	1	0=ResCap 1=Sector 2=Undir		0	Get/ Set
490	StgProtCurrentObject	0x385	54	Idir>> Angle offset 1	Idir>> Angle offset 1	INT	2	1 = 1 °	-180	179	0	Get/ Set
491	StgProtCurrentObject	0x385	55	Idir>> Angle offset 2	Idir>> Angle offset 2	INT	2	1 = 1 °	-180	179	0	Get/ Set
492	StgProtCurrentObject	0x385	56	Idir>> Delay curve family 1	Delay Curve Idir>> Delay curve family 1 DT=Definite time RI=Old ASEA type	USINT	1	1	0=DT 1=IEC 2=IEEE 3=IEEE2 4=RI 5=Prg1 6=Prg2 7=Prg3		1	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
493	StgProtCurrentObject	0x385	57	Idir>> Delay curve family 2	Delay Curve Idir>> Delay curve family 2 DT=Definite time RI=Old ASEA type	USINT	1	1	0=DT 1=IEC 2=IEEE 3=IEEE2 4=RI 5=Prg1 6=Prg2 7=Prg3		1	Get/ Set
494	StgProtCurrentObject	0x385	58	Idir>> Delay type 1	Delay Curve Idir>> Delay type 1 DT=Definite time NI=Normal inverse VI=Very inverse EI=Extremely inverse LTI=Long time inverse LTEI=Long time extremely inverse LTVI=Long time very inverse MI=Moderately inverse STI=Short time inverse STEI=Short time extremely inverse RI=Old ASEA type RXIDG=Old ASEA type	USINT	1	1	0=DT 1=NI 2=VI 3=EI 4=LTI 5=LTEI 6=LTVI 7=MI 8=STI 9=STEI 10=RI		1	Get/ Set
495	StgProtCurrentObject	0x385	59	Idir>> Delay type 2	Delay Curve Idir>> Delay type 2 DT=Definite time NI=Normal inverse VI=Very inverse EI=Extremely inverse LTI=Long time inverse LTEI=Long time extremely inverse LTVI=Long time very inverse MI=Moderately inverse STI=Short time inverse STEI=Short time extremely inverse RI=Old ASEA type RXIDG=Old ASEA type	USINT	1	1	0=DT 1=NI 2=VI 3=EI 4=LTI 5=LTEI 6=LTVI 7=MI 8=STI 9=STEI 10=RI		1	Get/ Set
496	StgProtCurrentObject	0x385	60	Idir>> Inv. time coefficient k 1	Idir>> Inv. time coefficient k 1	UDINT	4	1 = 0.01	5	2000	20	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
497	StgProtCurrentObject	0x385	61	Idir>> Inv. time coefficient k 2	Idir>> Inv. time coefficient k 2	UDINT	4	1 = 0.01	5	2000	20	Get/ Set
498	StgProtCurrentObject	0x385	62	Idir>> Constant A	Idir>> Constant A	UDINT	4	1 = 0.001	0	200000	1	Get/ Set
499	StgProtCurrentObject	0x385	63	Idir>> Constant B	Idir>> Constant B	UDINT	4	1 = 0.001	0	5000	1	Get/ Set
500	StgProtCurrentObject	0x385	64	Idir>> Constant C	Idir>> Constant C	UDINT	4	1 = 0.001	0	5000	1	Get/ Set
501	StgProtCurrentObject	0x385	65	Idir>> Constant D	Idir>> Constant D	DINT	4	1 = 0.001			1	Get/ Set
502	StgProtCurrentObject	0x385	66	Idir>> Constant E	Idir>> Constant E	UDINT	4	1 = 0.001	0	20000	1	Get/ Set
503	StgProtCurrentObject	0x385	67	Idir>>> Enable for Idir>>>	Idir>>> Enable for Idir>>>	BOOL	1	1	0=Off 1=On		0	Get/ Set
504	StgProtCurrentObject	0x385	68	Idir>>> Group	Idir>>> Setting Group	USINT	1	1	0=Group 1 1=Group 2		0	Get/ Set
505	StgProtCurrentObject	0x385	69	Idir>>> Pick-up setting 1	Idir>>> Pick-up setting 1	UDINT	4	1 = 0.01 x Imot	10	2000	120	Get/ Set
506	StgProtCurrentObject	0x385	70	Idir>>> Pick-up setting 2	Idir>>> Pick-up setting 2	UDINT	4	1 = 0.01 x Imot	10	2000	120	Get/ Set
507	StgProtCurrentObject	0x385	71	Idir>>> Direction mode 1	Idir>>> Direction mode 1 ResCap=High impedance earthed network Sector= Low impedance earthed network Undir = Undirectional mode network	USINT	1	1	0=ResCap 1=Sector 2=Undir		0	Get/ Set
508	StgProtCurrentObject	0x385	72	Idir>>> Direction mode 2	Idir>>> Direction mode 2 ResCap=High impedance earthed network Sector= Low impedance earthed network Undir = Undirectional mode network	USINT	1	1	0=ResCap 1=Sector 2=Undir		0	Get/ Set
509	StgProtCurrentObject	0x385	73	Idir>>> Angle offset 1	Idir>>> Angle offset 1	INT	2	1= 1 °	-180	179	0	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
510	StgProtCurrentObject	0x385	74	Idir>>> Angle offset 2	Idir>>> Angle offset 2	INT	2	1= 1 °	-180	179	0	Get/ Set
511	StgProtCurrentObject	0x385	75	Idir>>> Operation delay 1	Idir>>> Operation delay 1	UDINT	4	1 = 0.01 s	4	30000	30	Get/ Set
512	StgProtCurrentObject	0x385	76	Idir>>> Operation delay 2	Idir>>> Operation delay 2	UDINT	4	1 = 0.01 s	4	30000	30	Get/ Set
513	StgProtCurrentObject	0x385	77	Idir>>>> Enable for Idir>>>>	Idir>>>> Enable for Idir>>>>	BOOL	1	1	0=Off 1=On		0	Get/ Set
514	StgProtCurrentObject	0x385	78	Idir>>>> Group	Idir>>>> Setting Group	USINT	1	1	0=Group 1 1=Group 2		0	Get/ Set
515	StgProtCurrentObject	0x385	79	Idir>>>> Pick-up setting 1	Idir>>>> Pick-up setting 1	UDINT	4	1 = 0.01 x Imot	10	2000	120	Get/ Set
516	StgProtCurrentObject	0x385	80	Idir>>>> Pick-up setting 2	Idir>>>> Pick-up setting 2	UDINT	4	1 = 0.01 x Imot	10	2000	120	Get/ Set
517	StgProtCurrentObject	0x385	81	Idir>>>> Direction mode 1	Idir>>>> Direction mode 1 ResCap=High impedance earthed network Sector= Low impedance earthed network Undir = Undirectional mode network	USINT	1	0	0=ResCap 1=Sector 2=Undir		0	Get/ Set
518	StgProtCurrentObject	0x385	82	Idir>>>> Direction mode 2	Idir>>>> Direction mode 2 ResCap=High impedance earthed network Sector= Low impedance earthed network Undir = Undirectional mode network	USINT	1		0=ResCap 1=Sector 2=Undir		0	Get/ Set
519	StgProtCurrentObject	0x385	83	Idir>>>> Angle offset 1	Idir>>>> Angle offset 1	INT	2	1 = 1°	-180	179	0	Get/ Set
520	StgProtCurrentObject	0x385	84	Idir>>>> Angle offset 2	Idir>>>> Angle offset 2	INT	2	1 = 1°	-180	179	0	Get/ Set
521	StgProtCurrentObject	0x385	85	Idir>>>> Operation delay 1	Idir>>>> Operation delay 1	UDINT	4	1 = 0.01 s	4	30000	30	Get/ Set
522	StgProtCurrentObject	0x385	86	Idir>>>> Operation delay 2	Idir>>>> Operation delay 2	UDINT	4	1 = 0.01 s	4	30000	30	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
523	StgProtCurrentObject	0x385	87	I2> Enable for I2>	I2> Enable for I2>	BOOL	1	1	0=Off 1=On		1	Get/ Set
524	StgProtCurrentObject	0x385	88	I2> Group	I2> Setting Group	USINT	1	1	0=Group 1 1=Group 2		0	Get/ Set
525	StgProtCurrentObject	0x385	89	I2> Pick-up setting K2 1	I2> K2 Pick-up setting 1	UDINT	4	1 = 1%	2	70	6554	Get/ Set
526	StgProtCurrentObject	0x385	90	I2> Pick-up setting K2 2	I2> K2 Pick-up setting 2	UDINT	4	1 = 1%	2	70	6554	Get/ Set
527	StgProtCurrentObject	0x385	91	I2> Delay type 1	I2> Delay type 1	USINT	1	0	0=DT 1=INV		0	Get/ Set
528	StgProtCurrentObject	0x385	92	I2> Delay type 2	I2> Delay type 2	USINT	1	0	0=DT 1=INV		0	Get/ Set
529	StgProtCurrentObject	0x385	93	I2> Operation delay 1	I2> Operation delay 1	UDINT	4	1 = 0.1 s	10	6000	100	Get/ Set
530	StgProtCurrentObject	0x385	94	I2> Operation delay 2	I2> Operation delay 2	UDINT	4	1 = 0.1 s	10	6000	100	Get/ Set
531	StgProtCurrentObject	0x385	95	I2>> Enable for I2>>	I2>> Enable for I2>>	BOOL	1	1	0=Off 1=On		0	Get/ Set
532	StgProtCurrentObject	0x385	96	Ist> Enable for Ist>	Ist> Enable for Ist>	BOOL	1	1	0=Off 1=On		1	Get/ Set
533	StgProtCurrentObject	0x385	97	Ist> Motor start detection current	Ist> Motor start detection current	UDINT	4	1 = 0.01 x Imot	130	1000	150	Get/ Set
534	StgProtCurrentObject	0x385	98	Ist> Nom motor start current	Ist> Nominal motor start current	UDINT	4	1 = 0.01 x Imot	150	1000	600	Get/ Set
535	StgProtCurrentObject	0x385	99	Ist> Delay type	Ist> Delay type DT=0 INV=1	USINT	1	1			0	Get/ Set
536	StgProtCurrentObject	0x385	100	Ist> Operation delay	Ist> Operation delay	UDINT	4	1 = 0.1 s	10	3000	100	Get/ Set
537	StgProtCurrentObject	0x385	101	N> Enable for N>	Enable for N>	BOOL	1	1	0=Off 1=Enable		0	Get/ Set
538	StgProtCurrentObject	0x385	102	N> Max motor starts/hour	N> Maximum motor starts/hour	UDINT	4	1	1	20	6	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
539	StgProtCurrentObject	0x385	103	N> Min time between motor starts	N> Minimum time between motor starts	UDINT	4	1 = 0.1 min	0	1000	600000	Get/ Set
540	StgProtCurrentObject	0x385	104	N> Alarm on event	N> Alarm on event	BOOL	1	1	0=Off 1=On		0	Get/ Set
541	StgProtCurrentObject	0x385	105	N> Alarm off event	N> Alarm off event	BOOL	1	1	0=Off 1=On		0	Get/ Set
542	StgProtCurrentObject	0x385	106	N> Motor start disabled	N> Motor start disabled	BOOL	1	1	0=Off 1=On		0	Get/ Set
543	StgProtCurrentObject	0x385	107	N> Motor start enabled	N> Motor start enabled	BOOL	1	1	0=Off 1=On		0	Get/ Set
544	StgProtCurrentObject	0x385	108	I< Enable for I<	I< Enable for I<	BOOL	1	1	0=Off 1=On		0	Get/ Set
545	StgProtCurrentObject	0x385	109	I< Group	I< Setting Group	USINT	1	1	0=Group 1 1=Group 2		0	Get/ Set
546	StgProtCurrentObject	0x385	110	I< Pick-up setting 1	I< Pick-up setting 1	UDINT	4	1 = 1% Imot	20	70	50	Get/ Set
547	StgProtCurrentObject	0x385	111	I< Pick-up setting 2	I< Pick-up setting 2	UDINT	4	1 = 1% Imot	20	70	50	Get/ Set
548	StgProtCurrentObject	0x385	112	I< Operation delay 1	I< Operation delay 1	UDINT	4	1 = 0.1s	3	3000	10	Get/ Set
549	StgProtCurrentObject	0x385	113	I< Operation delay 2	I< Operation delay 2	UDINT	4	1 = 0.1s	3	3000	10	Get/ Set
550	StgProtCurrentObject(1)	0x385	114	ArcI> Enable	ArcI> Enable	BOOL	1	1	0=Off 1=On		0	Get/ Set
551	StgProtCurrentObject(1)	0x385	115	ArcI> Pick-up setting	ArcI> Pick-up setting	UDINT	4	1 = 0.1 pu	5	100	10	
552	StgProtCurrentObject(1)	0x385	116	ArcI> Arc inputs in use	ArcI> Arc inputs in use	USINT	1	1	1=S1 2=S2 3=S1/S2 4=BI 5=S1/BI 6=S2/BI S1/S2/BI=7		15	Get/ Set
553	StgProtCurrentObject	0x385	117	dI> Enable	dI> Enable	BOOL	1	1	0=Off 1=On		1	Get/ Set
554	StgProtCurrentObject	0x385	118	dI> pick-up (Ibias < 0.5Ign)	dI> pick-up (Ibias < 0.5Ign)	UDINT	4	1 = 1% Imot	5	50	20	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
555	StgProtCurrentObject	0x385	119	dI> Slope1	dI> Slope1	UDINT	4	1 = 1%	5	100	50	Get/ Set
556	StgProtCurrentObject	0x385	120	dI> Ibias for start of slope 2	dI> Ibias for start of slope 2	UDINT	4	1 = 0.01 x Imot	100	300	200	Get/ Set
557	StgProtCurrentObject	0x385	121	dI> Slope2	dI> Slope2	UDINT	4	1 = 1%	50	200	150	Get/ Set
558	StgProtCurrentObject	0x385	122	dI> dI> 2.harm. block enable	dI> dI> 2.harm. block enable	BOOL	1	1	0=Off 1=On		1	Get/ Set
559	StgProtCurrentObject	0x385	123	dI> 2.harm. block limit	dI> 2.harm. block limit	UDINT	4	1 = 1%			6553	Get/ Set
560	StgProtCurrentObject	0x385	124	dI>> Enable	dI>> Enable	BOOL	1	1	0=Off 1=On		1	Get/ Set
561	StgProtCurrentObject	0x385	125	dI>> Pick-up setting	dI>> Pick-up setting	UDINT	4	1 = 0.1 x Imot	50	400	200	Get/ Set
562	StgProtCurrentObject(2)	0x385	126	I'2> Enable for I'2	I'2> Enable for I'2>	BOOL	1	1	0=Off 1=On		0	Get/ Set
563	StgProtCurrentObject(2)	0x385	127	I'2> Group	I'2> Group	USINT	1	1	0=Group 1 1=Group 2		0	Get/ Set
564	StgProtCurrentObject(2)	0x385	128	I'2> Pick-up setting 1	I'2> Pick-up setting 1	UDINT	4	1 = 1%			6554	Get/ Set
565	StgProtCurrentObject(2)	0x385	129	I'2> Pick-up setting 2	I'2> Pick-up setting 2	UDINT	4	1 = 1%			6554	Get/ Set
566	StgProtCurrentObject(2)	0x385	130	I'2> Delay Type 1	I'2> Delay type 1	USINT	1	1	0=DT 1=INV		0	Get/ Set
567	StgProtCurrentObject(2)	0x385	131	I'2> Delay Type 2	I'2> Delay type 2	USINT	1	1	0=DT 1=INV		0	Get/ Set
568	StgProtCurrentObject(2)	0x385	132	I'2> Operational delay 1	I'2> Operation delay 1	UDINT	4	1 = 0.1 s	10	6000	100	Get/ Set
569	StgProtCurrentObject(2)	0x385	133	I'2> Operational delay 2	I'2> Operation delay 2	UDINT	4	1 = 0.1 s	10	6000	100	Get/ Set
570	StgProtCurrentObject(2)	0x385	134	I'> enable for I'>	I'> Enable for I'>	BOOL	1	1	0=Off 1=On		1	Get/ Set
571	StgProtCurrentObject(2)	0x385	135	I'> Group	I'> Group	USINT	1	1	0=Group 1 1=Group 2		0	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
572	StgProtCurrentObject[2]	0x385	136	I'> Pick-up setting 1	I'> Pick-up setting 1	UDINT	4	1 = 0.01 x Imot	10	500	120	Get/ Set
573	StgProtCurrentObject[2]	0x385	137	I'> Pick-up setting 2	I'> Pick-up setting 2	UDINT	4	1 = 0.01 x Imot	10	500	120	Get/ Set
574	StgProtCurrentObject[2]	0x385	138	I'> Delay curve family 1	I'> Delay curve family 1 DT=Definite time RI=Old ASEA type	USINT	1	1	0=DT 1=IEC 2=IEEE 3=IEEE2 4=RI 5=Prg1 6=Prg2 7=Prg3		1	Get/ Set
575	StgProtCurrentObject[2]	0x385	139	I'> Delay curve family 2	I'> Delay curve family 2 DT=Definite time RI=Old ASEA type	USINT	1	1	0=DT 1=IEC 2=IEEE 3=IEEE2 4=RI 5=Prg1 6=Prg2 7=Prg3		1	Get/ Set
576	StgProtCurrentObject[2]	0x385	140	I'> Delay type 1	I'> Delay type 1 DT=Definite time NI=Normal inverse VI=Very inverse EI=Extremely inverse LTI=Long time inverse LTEI=Long time extremely inverse LTVI=Long time very inverse MI=Moderately inverse STI=Short time inverse STEI=Short time extremely inverse RI=Old ASEA type RXIDG=Old ASEA type	USINT	1	1	0=DT 1=NI 2=VI 3=EI 4=LTI 5=LTEI 6=LTVI 7=MI 8=STI 9=STEI 10=RI		1	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
577	StgProtCurrentObject(2)	0x385	141	I'> Delay type 2	I'> Delay type 2 DT=Definite time NI=Normal inverse VI=Very inverse EI=Extremely inverse LTI=Long time inverse LTEI=Long time extremely inverse LTVI=Long time very inverse MI=Moderately inverse STI=Short time inverse STEI=Short time extremely inverse RI=Old ASEA type RXIDG=Old ASEA type	USINT	1	1	0=DT 1=NI 2=VI 3=EI 4=LTI 5=LTEI 6=LTVI 7=MI 8=STI 9=STEI 10=RI		1	Get/ Set
578	StgProtCurrentObject(2)	0x385	142	I’> Inv. time coefficient k 1	I’> Inv. time coefficient k 1	UDINT	4	1 = 0.01	5	2000	100	Get/ Set
579	StgProtCurrentObject(2)	0x385	143	I’> Inv. time coefficient k 2	I’> Inv. time coefficient k 2	UDINT	4	1 = 0.01	5	2000	100	Get/ Set
580	StgProtCurrentObject(2)	0x385	144	I’> Constant A	I’> Constant A	UDINT	4	1 = 0.001	0	200000	1	Get/ Set
581	StgProtCurrentObject(2)	0x385	145	I’> Constant B	I’> Constant B	UDINT	4	1 = 0.001	0	5000	1	Get/ Set
582	StgProtCurrentObject(2)	0x385	146	I’> Constant C	I’> Constant C	UDINT	4	1 = 0.001	0	5000	1	Get/ Set
583	StgProtCurrentObject(2)	0x385	147	I’> Constant D	I’> Constant D	DINT	4	1 = 0.001			1	Get/ Set
584	StgProtCurrentObject(2)	0x385	148	I’> Constant E	I’> Constant E	UDINT	4	1 = 0.001	0	20000	1	Get/ Set
585	StgProtCurrentObject(2)	0x385	149	I’>> Enable for I’>>	I’>> Enable for I’>>	BOOL	1	1	0=Off 1=On		1	Get/ Set
586	StgProtCurrentObject(2)	0x385	150	I’>> Group	I’>> Setting Group	USINT	1	1	0=Off 1=On		0	Get/ Set
587	StgProtCurrentObject(2)	0x385	151	I’>> Pick-up setting 1	I’>> Pick-up setting 1	UDINT	4	1 = 0.01 x Imot	10	2000	250	Get/ Set
588	StgProtCurrentObject(2)	0x385	152	I’>> Pick-up setting 2	I’>> Pick-up setting 2	UDINT	4	1 = 0.01 x Imot	10	2000	250	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
589	StgProtCurrentObject(2)	0x385	153	I’>> Operation delay 1	I’>> Operation delay 1	UDINT	4	1 =0.01 s	4	30000	60	Get/ Set
590	StgProtCurrentObject(2)	0x385	154	I’>> Operation delay 2	I’>> Operation delay 2	UDINT	4	1 =0.01 s	4	30000	60	Get/ Set
591	StgProtEFObject	0x386	1	Io> Enable for Io>	Enable for Io>	BOOL	1	1	0=Off 1=On		1	Get/ Set
592	StgProtEFObject	0x386	2	Io> Group	Io> Setting Group	USINT	1	1	0=Group 1 1=Group 2		0	Get/ Set
593	StgProtEFObject	0x386	3	Io> Pick-up setting 1	Io> Pick-up setting 1	UDINT	4	1 = 0.001 pu	5	20000	50	Get/ Set
594	StgProtEFObject	0x386	4	Io> Pick-up setting 2	Io> Pick-up setting 2	UDINT	4	1 = 0.001 pu	5	20000	50	Get/ Set
595	StgProtEFObject	0x386	5	Io> Delay curve family 1	Io> Delay curve family 1 DT=Definite time RI=Old ASEA type	USINT	1	1	0=DT 1=IEC 2=IEEE 3=IEEE2 4=RI 5=Prg1 6=Prg2 7=Prg3		1	Get/ Set
596	StgProtEFObject	0x386	6	Io> Delay curve family 2	Io> Delay curve family 2 DT=Definite time RI=Old ASEA type	USINT	1	1	0=DT 1=IEC 2=IEEE 3=IEEE2 4=RI 5=Prg1 6=Prg2 7=Prg3		1	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
597	StgProtEFObject	0x386	7	Io> Delay type 1	Io> Delay type 1 DT=Definite time NI=Normal inverse VI=Very inverse EI=Extremely inverse LTI=Long time inverse LTEI=Long time extremely inverse LTVI=Long time very inverse MI=Moderately inverse STI=Short time inverse STEI=Short time extremely inverse RI=Old ASEA type RXIDG=Old ASEA type	USINT	1	1	0=DT 1=NI 2=VI 3=EI 4=LTI 5=LTEI 6=LTVI 7=MI 8=STI 9=STEI 10=RI		0	Get/ Set
598	StgProtEFObject	0x386	8	Io> Delay type 2	Io> Delay type 2 DT=Definite time NI=Normal inverse VI=Very inverse EI=Extremely inverse LTI=Long time inverse LTEI=Long time extremely inverse LTVI=Long time very inverse MI=Moderately inverse STI=Short time inverse STEI=Short time extremely inverse RI=Old ASEA type RXIDG=Old ASEA type	USINT	1	1	0=DT 1=NI 2=VI 3=EI 4=LTI 5=LTEI 6=LTVI 7=MI 8=STI 9=STEI 10=RI		0	
599	StgProtEFObject	0x386	9	Io> Operation delay 1	Io> Operation delay 1	UDINT	4	1 = 0.01 s	4	30000	100	Get/ Set
600	StgProtEFObject	0x386	10	Io> Operation delay 2	Io> Operation delay 2	UDINT	4	1 = 0.01 s	4	30000	100	Get/ Set
601	StgProtEFObject	0x386	11	Io> Intermittent time	Io> Intermittent time	UDINT	4	1 = 0.01 s	0	30000	0	Get/ Set
602	StgProtEFObject	0x386	12	Io> Constant A	Io> Constant A	UDINT	4	1 = 0.001	0	200000	1	Get/ Set
603	StgProtEFObject	0x386	13	Io> Constant B	Io> Constant B	UDINT	4	1 = 0.001	0	5000	1	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
604	StgProtEFObject	0x386	14	Io> Constant C	Io> Constant C	UDINT	4	1 = 0.001	0	5000	1	Get/ Set
605	StgProtEFObject	0x386	15	Io> Constant D	Io> Constant D	DINT	4	1 = 0.001	-10000	10000	1	Get/ Set
606	StgProtEFObject	0x386	16	Io> Constant E	Io> Constant E	UDINT	4	1 = 0.001	0	20000	1	Get/ Set
607	StgProtEFObject	0x386	17	Io>> Enable for Io>>	Io>> Enable for Io>>	BOOL	1	1	0=Off 1= On		1	Get/ Set
608	StgProtEFObject	0x386	18	Io>> Group	Io>> Setting Group	USINT	1	1	0=Group 1 1=Group 2		0	Get/ Set
609	StgProtEFObject	0x386	19	Io>> Pick-up setting 1	Io>> Pick-up setting 1	UDINT	4	1 = 0.01 pu	1	2000	10	Get/ Set
610	StgProtEFObject	0x386	20	Io>> Pick-up setting 2	Io>> Pick-up setting 2	UDINT	4	1 = 0.01 pu	1	2000	10	Get/ Set
611	StgProtEFObject	0x386	21	Io>> Operation delay 1	Io>> Operation delay 1	UDINT	4	1 = 0.01 s	4	30000	100	Get/ Set
612	StgProtEFObject	0x386	22	Io>> Operation delay 2	Io>> Operation delay 2	UDINT	4	1 = 0.01 s	4	30000	100	Get/ Set
613	StgProtEFObject	0x386	23	Iodir> Enable for Iodir>	Iodir> Enable for Iodir>	BOOL	1	1	0=Off 1=On		1	Get/ Set
614	StgProtEFObject	0x386	24	Iodir> Group	Iodir> Setting Group	USINT	1	1	0=Group 1 1=Group 2		0	Get/ Set
615	StgProtEFObject	0x386	25	Iodir> Direction mode 1	Iodir> Direction mode 1 ResCap=High impedance earthed network Sector= Low impedance earthed network Undir = Undirectional mode network	USINT	1	1	0=ResCap 1=Sector 2=Undir		0	Get/ Set
616	StgProtEFObject	0x386	26	Iodir> Direction mode 2	Iodir> Direction mode 2 ResCap=High impedance earthed network Sector= Low impedance earthed network Undir = Undirectional mode network	USINT	1	1	0=ResCap 1=Sector 2=Undir		0	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
617	StgProtEFObject	0x386	27	Iodir> Char ctrl. in ResCap mode 1	Iodir> Character control in ResCap mode 1 Res= resistive Cap = capacitive	USINT	1	1	0=Res 1=Cap 2=DI1 3=DI2 4=DI3 5=DI4 6=DI5 7=DI6 8=DI7 9=DI8 10=DI9		0	Get/ Set
618	StgProtEFObject	0x386	28	Iodir> Char ctrl. in ResCap mode 2	Iodir> Character control in ResCap mode 2 Res= resistive Cap = capacitive	USINT	1	1	0=Res 1=Cap 2=DI1 3=DI2 4=DI3 5=DI4 6=DI5 7=DI6 8=DI7 9=DI8 10=DI9		0	Get/ Set
619	StgProtEFObject	0x386	29	Iodir> Pick-up setting 1	Iodir> Pick-up setting 1	UDINT	4	1 = 0.001 pu	5	20000	200	Get/ Set
620	StgProtEFObject	0x386	30	Iodir> Pick-up setting 2	Iodir> Pick-up setting 2	UDINT	4	1 = 0.001 pu	5	20000	200	Get/ Set
621	StgProtEFObject	0x386	31	Iodir> Uo setting for IoDir> stage 1	Iodir> Uo setting for IoDir> stage 1	UDINT	4	1 = 1%	1	50	10	Get/ Set
622	StgProtEFObject	0x386	32	Iodir> Uo setting for IoDir> stage 2	Iodir> Uo setting for IoDir> stage 2	UDINT	4	1 = 1%	1	50	10	Get/ Set
623	StgProtEFObject	0x386	33	Iodir> Angle offset 1	Iodir> Angle offset 1	INT	2	1= 1 °	0	170	0	Get/ Set
624	StgProtEFObject	0x386	34	Iodir> Angle offset 2	Iodir> Angle offset 2	INT	2	1= 1 °	0	170	0	Get/ Set
625	StgProtEFObject	0x386	35	Iodir> Pick up sector size 1	Iodir> Pick up sector size 1	UINT	2	1 = 1±°	0	170	88	Get/ Set
626	StgProtEFObject	0x386	36	Iodir> Pick up sector size 2	Iodir> Pick up sector size 2	UINT	2	1 = 1±°	0	170	88	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
627	StgProtEFObject	0x386	37	Iodir> Delay curve family 1	Iodir> Delay curve family 1 DT= Definite Time RI=Old ASEA type	USINT	1	1	0=DT 1=IEC 2=IEEE 3=IEEE2 4=RI 5=Prg1 6=Prg2 7=Prg3		1	Get/ Set
628	StgProtEFObject	0x386	38	Iodir> Delay curve family 2	Iodir> Delay curve family 2	USINT	1	1	0=DT 1=IEC 2=IEEE 3=IEEE2 4=RI 5=Prg1 6=Prg2 7=Prg3		1	Get/ Set
629	StgProtEFObject	0x386	39	Iodir> Delay type 1	Iodir> Delay type 1 DT=Definite time NI=Normal inverse VI=Very inverse EI=Extremely inverse LTI=Long time inverse LTEI=Long time extremely inverse LTVI=Long time very inverse MI=Moderately inverse STI=Short time inverse STEI=Short time extremely inverse RI=Old ASEA type RXIDG=Old ASEA type	USINT	1	1	0=DT 1=NI 2=VI 3=EI 4=LTI 5=LTEI 6=LTVI 7=MI 8=STI 9=STEI 10=RI		0	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
630	StgProtEFObject	0x386	40	Iodir> Delay type 2	Iodir> Delay type 2 DT=Definite time NI=Normal inverse VI=Very inverse EI=Extremely inverse LTI=Long time inverse LTEI=Long time extremely inverse LTVI=Long time very inverse MI=Moderately inverse STI=Short time inverse STEI=Short time extremely inverse RI=Old ASEA type RXIDG=Old ASEA type	USINT	1	1	0=DT 1=NI 2=VI 3=EI 4=LTI 5=LTEI 6=LTVI 7=MI 8=STI 9=STEI 10=RI		0	Get/ Set
631	StgProtEFObject	0x386	41	Iodir> Operation delay 1	Iodir> Operation delay 1	UDINT	4	1 =0.01 s	10	30000	50	Get/ Set
632	StgProtEFObject	0x386	42	Iodir> Operation delay 2	Iodir> Operation delay 2	UDINT	4	1 =0.01 s	10	30000	50	Get/ Set
633	StgProtEFObject	0x386	43	Iodir> Constant A	Iodir> Constant A	UDINT	4	1 = 0.001	0	200000	1	Get/ Set
634	StgProtEFObject	0x386	44	Iodir> Constant B	Iodir> Constant B	UDINT	4	1 = 0.001	0	5000	1	Get/ Set
635	StgProtEFObject	0x386	45	Iodir> Constant C	Iodir> Constant C	UDINT	4	1 = 0.001	0	5000	1	Get/ Set
636	StgProtEFObject	0x386	46	Iodir> Constant D	Iodir> Constant D	DINT	4	1 = 0.001	-10000	10000	1	Get/ Set
637	StgProtEFObject	0x386	47	Iodir> Constant E	Iodir> Constant E	UDINT	4	1 = 0.001	0	20000	1	Get/ Set
638	StgProtEFObject	0x386	48	Iodir>> Enable for Iodir>>	Iodir>> Enable for Iodir>>	BOOL	1	1	0=Off 1=On		0	Get/ Set
639	StgProtEFObject	0x386	49	Iodir>> Group	Iodir>> Setting Group	USINT	1	1	0=Group 1 1=Group 2		0	Get/ Set
640	StgProtEFObject	0x386	50	Iodir>> Direction mode 1	Iodir>> Direction mode 1	USINT	1	1	0=ResCap 1=Sector 2=Undir		0	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
641	StgProtEFObject	0x386	51	Iodir>> Direction mode 2	Iodir>> Direction mode 2	USINT	1	1	0=ResCap 1=Sector 2=Undir		0	Get/ Set
642	StgProtEFObject	0x386	52	Iodir>> Char ctrl. in ResCap mode 1	Iodir>> Character control in ResCap mode 1	USINT	1	1	0=Res 1=Cap 2=DI1 3=DI2 4=DI3 5=DI4 6=DI5 7=DI6 8=DI7 9=DI8 10=DI9		0	Get/ Set
643	StgProtEFObject	0x386	53	Iodir>> Char ctrl. in ResCap mode 2	Iodir>> Character control in ResCap mode 2	USINT	1	1	0=Res 1=Cap 2=DI1 3=DI2 4=DI3 5=DI4 6=DI5 7=DI6 8=DI7 9=DI8 10=DI9		0	Get/ Set
644	StgProtEFObject	0x386	54	Iodir>> Pick-up setting 1	Iodir>> Pick-up setting 1	UDINT	4	1 = 0.01 pu	1	2000	20	Get/ Set
645	StgProtEFObject	0x386	55	Iodir>> Pick-up setting 2	Iodir>> Pick-up setting 2	UDINT	4	1 = 0.01 pu	1	2000	20	Get/ Set
646	StgProtEFObject	0x386	56	Iodir>> Uo setting for IoDir>> stage 1	Iodir>> Uo setting for IoDir>> stage 1	UDINT	4	1 = 1%	1	50	10	Get/ Set
647	StgProtEFObject	0x386	57	Iodir>> Uo setting for IoDir>> stage 2	Iodir>> Uo setting for IoDir>> stage 2	UDINT	4	1 = 1%	1	50	10	Get/ Set
648	StgProtEFObject	0x386	58	Iodir>> Angle offset 1	Iodir>> Angle offset 1	INT	2	1= 1°	0	170	0	Get/ Set
649	StgProtEFObject	0x386	59	Iodir>> Angle offset 2	Iodir>> Angle offset 2	INT	2	1= 1°	0	170	0	Get/ Set
650	StgProtEFObject	0x386	60	Iodir>> Pick up sector size 1	Iodir>> Pick up sector size 1	UINT	2	1= 1±°	0	170	88	Get/ Set
651	StgProtEFObject	0x386	61	Iodir>> Pick up sector size 2	Iodir>> Pick up sector size 2	UINT	2	1 = 1±°	0	170	88	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
652	StgProtEFObject	0x386	62	Iodir>> Delay curve family 1	Iodir>> Delay curve family 1 DT=Definite time RI=Old ASEA type	USINT	1	1	0=DT 1=IEC 2=IEEE 3=IEEE2 4=RI 5=Prg1 6=Prg2 7=Prg3		1	Get/ Set
653	StgProtEFObject	0x386	63	Iodir>> Delay curve family 2	Iodir>> Delay curve family 2 DT=Definite time RI=Old ASEA type	USINT	1	1	0=DT 1=IEC 2=IEEE 3=IEEE2 4=RI 5=Prg1 6=Prg2 7=Prg3		1	Get/ Set
654	StgProtEFObject	0x386	64	Iodir>> Delay type 1	Iodir>> Delay type 1 DT=Definite time NI=Normal inverse VI=Very inverse EI=Extremely inverse LTI=Long time inverse LTEI=Long time extremely inverse LTVI=Long time very inverse MI=Moderately inverse STI=Short time inverse STEI=Short time extremely inverse RI=Old ASEA type RXIDG=Old ASEA type	USINT	1	1	0=DT 1=NI 2=VI 3=EI 4=LTI 5=LTEI 6=LTVI 7=MI 8=STI 9=STEI 10=RI		0	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
655	StgProtEFObject	0x386	65	Iodir>> Delay type 2	Iodir>> Delay type 2 DT=Definite time NI=Normal inverse VI=Very inverse EI=Extremely inverse LTI=Long time inverse LTEI=Long time extremely inverse LTVI=Long time very inverse MI=Moderately inverse STI=Short time inverse STEI=Short time extremely inverse RI=Old ASEA type RXIDG=Old ASEA type	USINT	1	1	0=DT 1=NI 2=VI 3=EI 4=LTI 5=LTEI 6=LTVI 7=MI 8=STI 9=STEI 10=RI		0	Get/ Set
656	StgProtEFObject	0x386	66	Iodir>> Operation delay 1	Iodir>> Operation delay 1	UDINT	4	1 =0.01 s	10	30000	50	Get/ Set
657	StgProtEFObject	0x386	67	Iodir>> Operation delay 2	Iodir>> Operation delay 2	UDINT	4	1 =0.01 s	10	30000	50	Get/ Set
658	StgProtEFObject	0x386	68	Iodir>> Constant A	Iodir>> Constant A	UDINT	4	1 = 0.001	0	200000	1	Get/ Set
659	StgProtEFObject	0x386	69	Iodir>> Constant B	Iodir>> Constant B	UDINT	4	1 = 0.001	0	5000	1	Get/ Set
660	StgProtEFObject	0x386	70	Iodir>> Constant C	Iodir>> Constant C	UDINT	4	1 = 0.001	0	5000	1	Get/ Set
661	StgProtEFObject	0x386	71	Iodir>> Constant D	Iodir>> Constant D	DINT	4	1 = 0.001			1	Get/ Set
662	StgProtEFObject	0x386	72	Iodir>> Constant E	Iodir>> Constant E	UDINT	4	1 = 0.001	0	20000	1	Get/ Set
663	StgProtEFObject	0x386	73	Io>>> Enable for Io>>>	Io>>> Enable for Io>>>	BOOL	1	1	0=Off 1=On		1	Get/ Set
664	StgProtEFObject	0x386	74	Io>>> Group	Io>>> Setting Group	USINT	1	1	0=Group 1 1=Group 2		0	Get/ Set
665	StgProtEFObject	0x386	75	Io>>> Pick-up setting 1	Io>>> Pick-up setting 1	UDINT	4	1 = 0.01 pu	1	2000	10	Get/ Set
666	StgProtEFObject	0x386	76	Io>>> Pick-up setting 2	Io>>> Pick-up setting 2	UDINT	4	1 = 0.01 pu	1	2000	10	Get/ Set
667	StgProtEFObject	0x386	77	Io>>> Operation delay 1	Io>>> Operation delay 1	UDINT	4	1 =0.01 s	4	30000	50	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
668	StgProtEFObject	0x386	78	Io>>> Operation delay 2	Io>>> Operation delay 2	UDINT	4	1 =0.01 s	4	30000	50	Get/ Set
669	StgProtEFObject	0x386	79	Io>>> Compensation mode	Io>>> Compensation mode	USINT	1	1	0=Off 1=On		0	Get/ Set
670	StgProtEFObject	0x386	80	Io>>> Compensation current	Io>>> Compensation current	UDINT	4	1 = 0.001 pu	10	3000	50	Get/ Set
671	StgProtEFObject	0x386	81	Io>>> Save unbalance current	Io>>> Save unbalance current	USINT	1	1	1=Get		0	Get/ Set
672	StgProtEFObject	0x386	82	Io>>> Saving unbal event	Io>>> Saving unbalance event	BOOL	1	1	0=Off 1=On		0	Get/ Set
673	StgProtEFObject	0x386	83	Io>>> Unbal saved event	Io>>> Unbalance saved event	BOOL	1	1	0=Off 1=On		0	Get/ Set
674	StgProtEFObject	0x386	84	Io>>>> Enable for Io>>>>	Io>>>> Enable for Io>>>>	BOOL	1	1	0=Off 1=On		1	Get/ Set
675	StgProtEFObject	0x386	85	Io>>>> Group	Io>>>> Setting Group	USINT	1	1	0=Group 1 1=Group 2		0	Get/ Set
676	StgProtEFObject	0x386	86	Io>>>> Pick-up setting 1	Io>>>> Pick-up setting 1	UDINT	4	1 = 0.01 pu	1	2000	20	Get/ Set
677	StgProtEFObject	0x386	87	Io>>>> Pick-up setting 2	Io>>>> Pick-up setting 2	UDINT	4	1 = 0.01 pu	1	2000	20	Get/ Set
678	StgProtEFObject	0x386	88	Io>>>> Operation delay 1	Io>>>> Operation delay 1	UDINT	4	1 =0.01 s	4	30000	100	Get/ Set
679	StgProtEFObject	0x386	89	Io>>>> Operation delay 2	Io>>>> Operation delay 2	UDINT	4	1 =0.01 s	4	30000	100	Get/ Set
680	StgProtEFObject	0x386	90	Io>>>> Compensation mode	Io>>>> Compensation mode	USINT	1	1	Off=0 Normal=1 Location=2		0	Get/ Set
681	StgProtEFObject	0x386	91	Io>>>> Compensation current	Io>>>> Compensation current	UDINT	4	1 = 0.001 pu	10	3000	50	Get/ Set
682	StgProtEFObject	0x386	92	Io>>>> Save unbalance current	Io>>>> Save unbalance current	USINT	1	1	1=Get		0	Get/ Set
683	StgProtEFObject	0x386	93	Io>>>> Max allowed faults	Io>>>> Max allowed faults	UINT	2	1	0	10	0	Get/ Set
684	StgProtEFObject	0x386	94	Io>>>> Clear location counters	Io>>>> Clear location counters	USINT	1	1	1=Clear		0	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
685	StgProtEFObject	0x386	95	Io>>>> Saving unbal event	Io>>>> Saving unbalance event	BOOL	1	1	0=Off 1=On		0	Get/ Set
686	StgProtEFObject	0x386	96	Io>>>> Unbal saved event	Io>>>> Unbalance saved event	BOOL	1	1	0=Off 1=On		0	Get/ Set
687	StgProtEFObject	0x386	97	IoInt> Enable for IoInt>	IoInt> Enable for IoInt>	BOOL	1	1	0=Off 1=On		0	Get/ Set
688	StgProtEFObject	0x386	98	IoInt> Group	IoInt> Setting Group	USINT	1	1	0=Off 1=On		0	Get/ Set
689	StgProtEFObject	0x386	99	IoInt> Uo pick-up 1	IoInt> Uo pick-up 1	UDINT	4	1 = 1%	1	60	10	Get/ Set
690	StgProtEFObject	0x386	100	IoInt> Uo pick-up 2	IoInt> Uo pick-up 2	UDINT	4	1 = 1%	1	60	10	Get/ Set
691	StgProtEFObject	0x386	101	IoInt> Operation delay 1	IoInt> Operation delay 1	UDINT	4	1 =0.01 s	2	30000	50	Get/ Set
692	StgProtEFObject	0x386	102	IoInt> Operation delay 2	IoInt> Operation delay 2	UDINT	4	1 =0.01 s	2	30000	50	Get/ Set
693	StgProtEFObject	0x386	103	IoInt> Intermittent time	IoInt> Intermittent time	UDINT	4	1 =0.01 s	0	30000	100	Get/ Set
694	StgProtEFObject	0x386	104	Uo> Enable for Uo>	Uo> Enable for Uo>	BOOL	1	1	0=Off 1=On		1	Get/ Set
695	StgProtEFObject	0x386	105	Uo> Group	Uo> Setting Group	USINT	1	1	0=Group 1 1=Group 2		0	Get/ Set
696	StgProtEFObject	0x386	106	Uo> Pick-up setting 1	Uo> Pick-up setting 1	UDINT	4	1 = 1%	1	60	10	Get/ Set
697	StgProtEFObject	0x386	107	Uo> Pick-up setting 2	Uo> Pick-up setting 2	UDINT	4	1 = 1%	1	60	10	Get/ Set
698	StgProtEFObject	0x386	108	Uo> Operation delay 1	Uo> Operation delay 1	UDINT	4	1 = 0.1 s	3	3000	20	Get/ Set
699	StgProtEFObject	0x386	109	Uo> Operation delay 2	Uo> Operation delay 2	UDINT	4	1 = 0.1 s	3	3000	20	Get/ Set
700	StgProtEFObject	0x386	110	Uo>> Enable for Uo>>	Uo>> Enable for Uo>>	BOOL	1	1	0=Off 1=On		1	Get/ Set
701	StgProtEFObject	0x386	111	Uo>> Group	Uo>> Setting Group	USINT	1	1	0=Group 1 1=Group 2		0	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
702	StgProtEFObject	0x386	112	Uo>> Pick-up setting 1	Uo>> Pick-up setting 1	UDINT	4	1 = 1%	1	60	20	Get/ Set
703	StgProtEFObject	0x386	113	Uo>> Pick-up setting 2	Uo>> Pick-up setting 2	UDINT	4	1 = 1%	1	60	20	Get/ Set
704	StgProtEFObject	0x386	114	Uo>> Operation delay 1	Uo>> Operation delay 1	UDINT	4	1 = 0.1s	3	3000	5	Get/ Set
705	StgProtEFObject	0x386	115	Uo>> Operation delay 2	Uo>> Operation delay 2	UDINT	4	1 = 0.1s	3	3000	5	Get/ Set
706	StgProtEFObject(1)	0x386	116	Arclo1> Enable for Arclo1>	Arclo1> Enable for Arclo1>	BOOL	1	1	0=Off 1=On		0	Get/ Set
707	StgProtEFObject(1)	0x386	117	Arclo1> Pick-up setting	Arclo1> Pick-up setting	UDINT	4	1 = 0.01 pu	5	100	10	Get/ Set
708	StgProtEFObject(1)	0x386	118	Arclo1> Arc inputs in use	Arclo1> Arc inputs in use	USINT	1	1	S1=1 S2=2 S1/S2=3 BI=4 S1/BI=5 S2/BI=6 S1/S2/BI=7		15	Get/ Set
709	StgProtEFObject(1)	0x386	119	Arclo2> Enable for Arclo2>	Enable for Arclo2>	BOOL	1	1	0=Off 1=On		0	Get/ Set
710	StgProtEFObject(1)	0x386	120	Arclo2> Pick-up setting	Arclo2> Pick-up setting	UDINT	4	1 = 0.01 pu	5	100	10	Get/ Set
711	StgProtEFObject(1)	0x386	121	Arclo2> Arc inputs in use	Arclo2> Arc inputs in use	USINT	1	1	S1=1 S2=2 S1/S2=3 BI=4 S1/BI=5 S2/BI=6 S1/S2/BI=7		15	Get/ Set
712	StgProtOtherObject	0x387	1	U> Enable for U>	U> Enable for U>	BOOL	1	1	0=Off 1=On		1	Get/ Set
713	StgProtOtherObject	0x387	2	U> Group	U> Setting Group	USINT	1	1	0=Group 1 1=Group 2		0	Get/ Set
714	StgProtOtherObject	0x387	3	U> Pick-up setting 1	U> Pick-up setting 1	UDINT	4	1 = 1%Un	50	150	120	Get/ Set
715	StgProtOtherObject	0x387	4	U> Pick-up setting 2	U> Pick-up setting 2	UDINT	4	1 = 1%Un	50	150	120	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
716	StgProtOtherObject	0x387	5	U> Operation delay 1	U> Operation delay 1	UDINT	4	1 =0.01 s	8	30000	10	Get/ Set
717	StgProtOtherObject	0x387	6	U> Operation delay 2	U> Operation delay 2	UDINT	4	1 =0.01 s	8	30000	10	Get/ Set
718	StgProtOtherObject	0x387	7	U> Release delay	U> Release delay	UDINT	4	1 =0.01 s	6	300000	0	Get/ Set
719	StgProtOtherObject	0x387	8	U> Hysteresis	U> Hysteresis	UDINT	4	1 = 0.1%	1	200	30	Get/ Set
720	StgProtOtherObject	0x387	9	U>> Enable for U>>	U>> Enable for U>>	BOOL	1	1	0=Off 1=On		1	Get/ Set
721	StgProtOtherObject	0x387	10	U>> Group	U>> Setting Group	USINT	1	1	0=Group 1 1=Group 2		0	Get/ Set
722	StgProtOtherObject	0x387	11	U>> Pick-up setting 1	U>> Pick-up setting 1	UDINT	4	1 = 1%Un	50	150	130	Get/ Set
723	StgProtOtherObject	0x387	12	U>> Pick-up setting 2	U>> Pick-up setting 2	UDINT	4	1 = 1%Un	50	150	130	Get/ Set
724	StgProtOtherObject	0x387	13	U>> Operation delay 1	U>> Operation delay 1	UDINT	4	1 =0.01 s	6	300000	5	Get/ Set
725	StgProtOtherObject	0x387	14	U>> Operation delay 2	U>> Operation delay 2	UDINT	4	1 =0.01 s	6	300000	5	Get/ Set
726	StgProtOtherObject	0x387	15	U>> Hysteresis	U>> Hysteresis	UDINT	4	1 = 0.1%	1	200	30	Get/ Set
727	StgProtOtherObject	0x387	16	U>>> Enable for U>>>	U>>> Enable for U>>>	BOOL	1	1	0=Off 1=On		1	Get/ Set
728	StgProtOtherObject	0x387	17	U>>> Group	U>>> Setting Group	USINT	1	1	0=Group 1 1=Group 2		0	Get/ Set
729	StgProtOtherObject	0x387	18	U>>> Pick-up setting 1	U>>> Pick-up setting 1	UDINT	4	1 = 1%Un	50	160	135	Get/ Set
730	StgProtOtherObject	0x387	19	U>>> Pick-up setting 2	U>>> Pick-up setting 2	UDINT	4	1 = 1%Un	50	160	135	Get/ Set
731	StgProtOtherObject	0x387	20	U>>> Operation delay 1	U>>> Operation delay 1	UDINT	4	1 =0.01 s	4	300000	5	Get/ Set
732	StgProtOtherObject	0x387	21	U>>> Operation delay 2	U>>> Operation delay 2	UDINT	4	1 =0.01 s	4	300000	5	Get/ Set
733	StgProtOtherObject	0x387	22	U>>> Hysteresis	U>>> Hysteresis	UDINT	4	1 = 0.1%	1	200	30	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
734	StgProtOtherObject	0x387	23	U< Enable for U<	U< Enable for U<	BOOL	1	1	0=Off 1=On		1	Get/Set
735	StgProtOtherObject	0x387	24	U< Group	U< Setting Group	USINT	1	1	0=Group 1 1=Group 2		0	Get/Set
736	StgProtOtherObject	0x387	25	U< Pick-up setting 1	U< Pick-up setting 1	UDINT	4	1 = 1%Un	20	120	80	Get/Set
737	StgProtOtherObject	0x387	26	U< Pick-up setting 2	U< Pick-up setting 2	UDINT	4	1 = 1%Un	20	120	80	Get/Set
738	StgProtOtherObject	0x387	27	U< Operation delay 1	U< Operation delay 1	UDINT	4	1 =0.01 s	8	30000	1000	Get/Set
739	StgProtOtherObject	0x387	28	U< Operation delay 2	U< Operation delay 2	UDINT	4	1 =0.01 s	8	30000	1000	Get/Set
740	StgProtOtherObject	0x387	29	U< Low voltage blocking 1	U< Low voltage blocking 1	UDINT	4	1 = 1%Un	0	80	10	Get/Set
741	StgProtOtherObject	0x387	30	U< Low voltage blocking 2	U< Low voltage blocking 2	UDINT	4	1 = 1%Un	0	80	10	Get/Set
742	StgProtOtherObject	0x387	31	U< Release delay	U< Release delay	UDINT	4	1 =0.01 s	6	300000	0	Get/Set
743	StgProtOtherObject	0x387	32	U< Hysteresis	U< Hysteresis	UDINT	4	1 = 0.1%	1	200	30	Get/Set
744	StgProtOtherObject	0x387	33	U<< Enable for U<<	U<< Enable for U<<	BOOL	1	1	0=Off 1=On		1	Get/Set
745	StgProtOtherObject	0x387	34	U<< Group	U<< Setting Group	USINT	1	1	0=Group 1 1=Group 2		0	Get/Set
746	StgProtOtherObject	0x387	35	U<< Pick-up setting 1	U<< Pick-up setting 1	UDINT	4	1 = 1%Un	20	120	70	Get/Set
747	StgProtOtherObject	0x387	36	U<< Pick-up setting 2	U<< Pick-up setting 2	UDINT	4	1 = 1%Un	20	120	70	Get/Set
748	StgProtOtherObject	0x387	37	U<< Operation delay 1	U<< Operation delay 1	UDINT	4	1 =0.01 s	6	30000	100	Get/Set
749	StgProtOtherObject	0x387	38	U<< Operation delay 2	U<< Operation delay 2	UDINT	4	1 =0.01 s	6	30000	100	Get/Set
750	StgProtOtherObject	0x387	39	U<< Low voltage blocking 1	U<< Low voltage blocking 1	UDINT	4	1 = 1%Un	0	80	10	Get/Set
751	StgProtOtherObject	0x387	40	U<< Low voltage blocking 2	U<< Low voltage blocking 2	UDINT	4	1 = 1%Un	0	80	10	Get/Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
752	StgProtOtherObject	0x387	41	U<< Hysteresis	U<< Hysteresis	UDINT	4	1 = 0.1%	1	200	30	Get/ Set
753	StgProtOtherObject	0x387	42	U<<< Enable for U<<<	U<<< Enable for U<<<	BOOL	1	1	0=Off 1=On		1	Get/ Set
754	StgProtOtherObject	0x387	43	U<<< Group	U<<< Setting Group	USINT	1	1	0=Group 1 1=Group 2		0	Get/ Set
755	StgProtOtherObject	0x387	44	U<<< Pick-up setting 1	U<<< Pick-up setting 1	UDINT	4	1 = 1%Un	20	120	70	Get/ Set
756	StgProtOtherObject	0x387	45	U<<< Pick-up setting 2	U<<< Pick-up setting 2	UDINT	4	1 = 1%Un	20	120	70	Get/ Set
757	StgProtOtherObject	0x387	46	U<<< Operation delay 1	U<<< Operation delay 1	UDINT	4	1 =0.01 s	6	30000	50	Get/ Set
758	StgProtOtherObject	0x387	47	U<<< Operation delay 2	U<<< Operation delay 2	UDINT	4	1 =0.01 s	6	30000	50	Get/ Set
759	StgProtOtherObject	0x387	48	U<<< Low voltage blocking 1	U<<< Low voltage blocking 1	UDINT	4	1 = 1%Un	0	80	10	Get/ Set
760	StgProtOtherObject	0x387	49	U<<< Low voltage blocking 2	U<<< Low voltage blocking 2	UDINT	4	1 = 1%Un	0	80	10	Get/ Set
761	StgProtOtherObject	0x387	50	U<<< Hysteresis	U<<< Hysteresis	UDINT	4	1 = 0.1%	1	200	30	Get/ Set
762	StgProtOtherObject	0x387	51	fX Enable for fX	fX Enable for fX	BOOL	1	1	0=Off 1=On		1	Get/ Set
763	StgProtOtherObject	0x387	52	fX Group	fX Setting Group	USINT	1	1	0=Group 1 1=Group 2		0	Get/ Set
764	StgProtOtherObject	0x387	53	fX Pick-up setting 1	fX Pick-up setting 1	UDINT	4	1 = 0.01 Hz	4000	7000	19608	Get/ Set
765	StgProtOtherObject	0x387	54	fX Pick-up setting 2	fX Pick-up setting 2	UDINT	4	1 = 0.01 Hz	4000	7000	19608	Get/ Set
766	StgProtOtherObject	0x387	55	fX Operation delay 1	fX Operation delay 1	UDINT	4	1 =0.01 s	10	30000	10	Get/ Set
767	StgProtOtherObject	0x387	56	fX Operation delay 2	fX Operation delay 2	UDINT	4	1 =0.01 s	10	30000	10	Get/ Set
768	StgProtOtherObject	0x387	57	Low voltage blocking 1st inst.	Low (Under) voltage blocking 1st instance	UDINT	4	1 = 1%Un	10	100	40	Get/ Set
769	StgProtOtherObject	0x387	58	fXX Enable for fXX	fXX Enable for fXX	BOOL	1	1	0=Off 1=On		0	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
770	StgProtOtherObject	0x387	59	fXX Group	fXX Setting Group	USINT	1	1	0=Group 1 1=Group 2		0	Get/ Set
771	StgProtOtherObject	0x387	60	fXX Pick-up setting 1	fXX Pick-up setting 1	UDINT	4	1 = 0.01 Hz	4000	7000	19231	Get/ Set
772	StgProtOtherObject	0x387	61	fXX Pick-up setting 2	fXX Pick-up setting 2	UDINT	4	1 = 0.01 Hz	4000	7000	19231	Get/ Set
773	StgProtOtherObject	0x387	62	fXX Operation delay 1	fXX Operation delay 1	UDINT	4	1 =0.01 s	10	300000	5	Get/ Set
774	StgProtOtherObject	0x387	63	fXX Operation delay 2	fXX Operation delay 2	UDINT	4	1 =0.01 s	10	300000	5	Get/ Set
775	StgProtOtherObject	0x387	64	Low voltage blocking 2nd inst.	Low (Under) voltage blocking 2nd instance	UDINT	4	1 = 1%Un	10	100	40	Get/ Set
776	StgProtOtherObject	0x387	65	f< Enable for f<	f< Enable for f<	BOOL	1	1	0=Off 1=On		1	Get/ Set
777	StgProtOtherObject	0x387	66	f< Group	f< Setting Group	USINT	1	1	0=Group 1 1=Group 2		0	Get/ Set
778	StgProtOtherObject	0x387	67	f< Pick-up setting 1	f< Pick-up setting 1	UDINT	4	1 = 0.01 Hz	4000	6400	20833	Get/ Set
779	StgProtOtherObject	0x387	68	f< Pick-up setting 2	f< Pick-up setting 2	UDINT	4	1 = 0.01 Hz	4000	6400	20833	Get/ Set
780	StgProtOtherObject	0x387	69	f< Operation delay 1	f< Operation delay 1	UDINT	4	1 =0.01 s	10	30000	150	Get/ Set
781	StgProtOtherObject	0x387	70	f< Operation delay 2	f< Operation delay 2	UDINT	4	1 =0.01 s	10	30000	150	Get/ Set
782	StgProtOtherObject	0x387	71	Low voltage blocking 3rd inst.	Low (Under) voltage blocking 3rd instance	UDINT	4	1 = 1%Un	10	100	40	Get/ Set
783	StgProtOtherObject	0x387	72	f<< Enable for f<<	f<< Enable for f<<	BOOL	1	1	0=Off 1=On		0	Get/ Set
784	StgProtOtherObject	0x387	73	f<< Group	f<< Setting Group	USINT	1	1	0=Group 1 1=Group 2		0	Get/ Set
785	StgProtOtherObject	0x387	74	f<< Pick-up setting 1	f<< Pick-up setting 1	UDINT	4	1 = 0.01 Hz	4000	6400	20833	Get/ Set
786	StgProtOtherObject	0x387	75	f<< Pick-up setting 2	f<< Pick-up setting 2	UDINT	4	1 = 0.01 Hz	4000	6400	20833	Get/ Set
787	StgProtOtherObject	0x387	76	f<< Operation delay 1	f<< Operation delay 1	UDINT	4	1 = 0.01 s	10	300000	5	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
788	StgProtOtherObject	0x387	77	f<< Operation delay 2	f<< Operation delay 2	UDINT	4	1 =0.01 s	10	300000	5	Get/ Set
789	StgProtOtherObject	0x387	78	Low voltage blocking 4th inst.	Low (Under) voltage blocking 4th instance	UDINT	4	1 = 1%Un	10	100	40	Get/ Set
790	StgProtOtherObject	0x387	79	df/dt Enable for df/dt	Enable for df/dt	BOOL	1	1	0=Off 1=On		0	Get/ Set
791	StgProtOtherObject	0x387	80	df/dt Group	df/dt Setting Group	USINT	1	1	0=Group 1 1=Group 2		0	Get/ Set
792	StgProtOtherObject	0x387	81	df/dt Pick-up setting 1	df/dt Pick-up setting 1	UDINT	4	1= 0.1Hz/s	2	100	50	Get/ Set
793	StgProtOtherObject	0x387	82	df/dt Pick-up setting 2	df/dt Pick-up setting 2	UDINT	4	1= 0.1Hz/s	2	100	50	Get/ Set
794	StgProtOtherObject	0x387	83	df/dt Operation delay 1	df/dt Operation delay 1	UDINT	4	1 = 0.01 s	14	1000	25	Get/ Set
795	StgProtOtherObject	0x387	84	df/dt Operation delay 2	df/dt Operation delay 2	UDINT	4	1 = 0.01 s	14	1000	25	Get/ Set
796	StgProtOtherObject	0x387	85	df/dt Minimum delay 1	df/dt Minimum delay 1	UDINT	4	1 = 0.01 s	14	1000	25	Get/ Set
797	StgProtOtherObject	0x387	86	df/dt Minimum delay 2	df/dt Minimum delay 2	UDINT	4	1 = 0.01 s	14	1000	25	Get/ Set
798	StgProtOtherObject	0x387	87	P< Enable for P<	P< Enable for P<	BOOL	1	1	0=Off 1=On		0	Get/ Set
799	StgProtOtherObject	0x387	88	P< Group	P< Setting Group	USINT	1	1	0=Group 1 1=Group 2		0	Get/ Set
800	StgProtOtherObject	0x387	89	P< Pick-up setting 1	P< Pick-up setting 1	DINT	4	1 = 0.1%Sn	-2000	2000	-40	Get/ Set
801	StgProtOtherObject	0x387	90	P< Pick-up setting 2	P< Pick-up setting 2	DINT	4	1 = 0.1%Sn	-2000	2000	-40	Get/ Set
802	StgProtOtherObject	0x387	91	P< Operation delay 1	P< Operation delay 1	UDINT	4	1 = 0.1 s	3	3000	10	Get/ Set
803	StgProtOtherObject	0x387	92	P< Operation delay 2	P< Operation delay 2	UDINT	4	1 = 0.1 s	3	3000	10	Get/ Set
804	StgProtOtherObject	0x387	93	P<< Enable for P<<	P<< Enable for P<<1	BOOL	1	1	0=Off 1=On		0	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
805	StgProtOtherObject	0x387	94	P<< Group	P<< Setting Group	USINT	1	1	0=Group 1 1=Group 2		0	Get/ Set
806	StgProtOtherObject	0x387	95	P<< Pick-up setting 1	P<< Pick-up setting 1	DINT	4	1 = 0.1%Sn	-2000	2000	-20	Get/ Set
807	StgProtOtherObject	0x387	96	P<< Pick-up setting 2	P<< Pick-up setting 2	DINT	4	1 = 0.1%Sn	-2000	2000	-20	Get/ Set
808	StgProtOtherObject	0x387	97	P<< Operation delay 1	P<< Operation delay 1	UDINT	4	1 = 0.1s	3	3000	10	Get/ Set
809	StgProtOtherObject	0x387	98	P<< Operation delay 2	P<< Operation delay 2	UDINT	4	1 = 0.1s	3	3000	10	Get/ Set
810	StgProtOtherObject	0x387	99	T> Enable for T>	T> Enable for T>	BOOL	1	1	0=Off 1=On		1	Get/ Set
811	StgProtOtherObject	0x387	100	T> Maximum continuous current	T> Maximum continuous current	UDINT	4	1 = 0.01 x Imot	10	240	106	Get/ Set
812	StgProtOtherObject	0x387	101	T> Alarm setting	T> Alarm setting	UDINT	4	1 = 1%	60	99	80	Get/ Set
813	StgProtOtherObject	0x387	102	T> Time constant tau	T> Time constant tau	UINT	2	1 min = 1	2	180	60	Get/ Set
814	StgProtOtherObject	0x387	103	T> Rel. cooling time constant	T> Relative cooling time constant	UDINT	4	1=0.1 x tau	10	100	10	Get/ Set
815	StgProtOtherObject	0x387	104	T> Max overload at +40°C	T> Max overload at +40°C	UDINT	4	1 = 1% Imot	70	120	100	Get/ Set
816	StgProtOtherObject	0x387	105	T> Max overload at +70°C	T> Max overload at +70°C	UDINT	4	1 = 1%Imot	50	100	78	Get/ Set
817	StgProtOtherObject	0x387	106	T> Ambient temperature	T> Ambient temperature	INT	2	1 = 1 °	-55	125	40	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
818	StgProtOtherObject	0x387	107	T> Ambient temp. sensor	T> Ambient temperature sensor selection	USINT	1	1	1=ExtAI1 2=ExtAI2 3=ExtAI3 4=ExtAI4 5=ExtAI5 6=ExtAI6 7=ExtAI7 8=ExtAI8 9=ExtAI9 10=ExtAI10 11=ExtAI11 12=ExtAI12 13=ExtAI13 14=ExtAI14 15=ExtAI15, 16=ExtAI16		0	Get/ Set
819	StgProtOtherObject	0x387	108	Enable for CBFP	Enable for Circuit Breaker Failure Protection	BOOL	1	1	0=Off 1=On		0	Get/ Set
820	StgProtOtherObject	0x387	109	CBFP Monitored Trip relay	Circuit Breaker Failure Protection Monitored Trip relay	USINT	1	1	1=T1 2=T2 3=T3 4=T4 5=T5 6=T6 7=T7 8=T8 9=T9 10=T10 11=T11 12=T12 13=T13		0	Get/ Set
821	StgProtOtherObject	0x387	110	CBFP Operation delay	Circuit Breaker Failure Protection Operation delay	UDINT	4	1 = 0.01 s	10	1000	25	Get/ Set
822	StgGeneralObject	0x388	1	CT primary	Current transformer primary	UDINT	4	1 = 1 A	10	20000	500	Get/ Set
823	StgGeneralObject	0x388	2	CT secondary	Current transformer secondary	UINT	2	1 = 1 A	1	10	5	Get/ Set
824	StgGeneralObject	0x388	3	I Nominal input	I Nominal input	UINT	2	1 = 1 A	1	5	5	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
825	StgGeneralObject	0x388	4	Io1 CT primary	Io1 CT primary	UDINT	4	1 = 1 A	1	20000	50	Get/ Set
826	StgGeneralObject	0x388	5	Io1 CT secondary	Io1 CT secondary	UDINT	4	1 = 0.1 A	1	100	50	Get/ Set
827	StgGeneralObject	0x388	6	Nominal Io1 input	Nominal Io1 input	UDINT	4	1= 0.1 A	1	50	10	Get
828	StgGeneralObject	0x388	7	Io2 CT primary	Io2 CT primary	UDINT	4	1 = 1 A	1	20000	50	Get/ Set
829	StgGeneralObject	0x388	8	Io2 CT secondary	Io2 CT secondary	UDINT	4	1 = 0.1 A	1	100	50	Get/ Set
830	StgGeneralObject	0x388	9	Nominal Io2 input	Nominal Io2 input	UDINT	4	1 = 0.1 A	1	50	50	Get
831	StgGeneralObject	0x388	10	VT primary	Voltage transformer primary	UDINT	4	1 = 1V	50	450000	11000	Get/ Set
832	StgGeneralObject	0x388	11	VT secondary	Voltage transformer secondary	UINT	2	1 = 1V	50	400	100	Get/ Set
833	StgGeneralObject	0x388	12	VTo secondary	VTo secondary	UDINT	4	1 = 0.001V	25000	240000	100000	Get/ Set
834	StgGeneralObject	0x388	13	Motor nom current	Nominal Motor Current	UDINT	4	1 = 0.1 A	50	20000	4000	Get
835	StgGeneralObject	0x388	14	Generator nom voltage	Nominal Generator Current	UINT	2	1 = 1V	50	65000	11400	Get/ Set
836	StgGeneralObject	0x388	15	Nominal power	Nominal power	UDINT	4	1 = 1 kVA	100	400000	8000	Get/ Set
837	StgGeneralObject	0x388	16	Nominal shaft power Pm	Nominal shaft power Pm	UDINT	4	1 = 1 kW	100	400000	6400	Get/ Set
838	StgGeneralObject	0x388	17	Reserved	Reserved	BOOL	1	-	-	-	-	Get/ Set
839	StgGeneralObject(2)	0x388	18	High side voltage (IL) voltage	IL side nominal voltage	UDINT	4	1 = 1V	50	450000	100	Get/ Set
840	StgGeneralObject(2)	0x388	19	Low side voltage (I'L) voltage	I'L side nominal voltage	UDINT	4	1 = 1V	50	65000	100	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
841	StgGeneralObject(2)	0x388	20	Connection group	Transformer connection group	USINT	1	1	Yy0=0 Yy6=1 Yd1=2 Yd5=3 Yd7=4 Yd11=5 Dy1=6 Dy5=7 Dy7=8 Dy11=9 Dd0=10		0	Get/ Set
842	Analog2Object	0x384	1	Frequency	Frequency	DINT	4	1 = 0.01 Hz	4500	6500	0	Get
843	Analog2Object	0x384	2	Active power	Active power	DINT	4	1 = 1 kW	-999999	999999	0	Get
844	Analog2Object	0x384	3	Reactive power	Reactive power	DINT	4	1 = 1 kVAR	-999999	999999	0	Get
845	Analog2Object	0x384	4	Apparent power	Apparent power	DINT	4	1 = 1 kVA	-999999	999999	0	Get
846	Analog2Object	0x384	5	Line-to-line voltage U12	Line-to-line voltage U12	UDINT	4	1 = 1V	0	999999	0	Get
847	Analog2Object	0x384	6	Line-to-line voltage U23	Line-to-line voltage U23	UDINT	4	1 = 1V	0	999999	0	Get
848	Analog2Object	0x384	7	Line-to-line voltage U31	Line-to-line voltage U31	UDINT	4	1 = 1V	0	999999	0	Get
849	Analog2Object	0x384	8	Power factor	Power factor Range -1 to +1 (Internal range to 65000)	DINT	4	1 = 0.01	-100	+100	0	Get
850	Analog2Object	0x384	9	Phase-to-earth voltage UL1	Phase-to-earth voltage UL1	UDINT	4	1 = 1V	0	999999	0	Get
851	Analog2Object	0x384	10	Phase-to-earth voltage UL2	Phase-to-earth voltage UL2	UDINT	4	1 = 1V	0	999999	0	Get
852	Analog2Object	0x384	11	Phase-to-earth voltage UL3	Phase-to-earth voltage UL3	UDINT	4	1 = 1V	0	999999	0	Get
853	Analog2Object	0x384	12	Tan phi	Tan phi	DINT	4	1 = 0.001	-99999	99999	0	Get
854	Analog2Object	0x384	13	Average line voltage	Average line voltage	UDINT	4	1 = 1V	0	450000	0	Get
855	Analog2Object	0x384	14	Average phase voltage	Average phase voltage	UDINT	4	1 = 1V	0	450000	0	Get
856	Analog2Object	0x384	15	Pos. sequence U1	Positive sequence U1	UDINT	4	1 = 1V	0	450000	0	Get
857	Analog2Object	0x384	16	Neg. sequence U2	Negative sequence U2	UDINT	4	1 = 1V	0	450000	0	Get
858	Analog2Object	0x384	17	Min of line voltages	Minimum of line voltages	UDINT	4	1 = 1V	0	450000	0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
859	Analog2Object	0x384	18	Max of line voltages	Maximum of line voltages	UDINT	4	1 = 1V	0	450000	0	Get
860	Analog2Object	0x384	19	Min. of phase voltages	Minimum of phase voltages	UDINT	4	1 = 1V	0	450000	0	Get
861	Analog2Object	0x384	20	Max. of phase voltages	Maximum of phase voltages	UDINT	4	1 = 1V	0	450000	0	Get
862	Analog2Object	0x384	21	RMS voltage mean	Mean RMS voltage	UDINT	4	$1 = 1V_{rms}$	0	450000	0	Get
863	Analog2Object	0x384	22	Input voltage UL1RMS	Input voltage UL1RMS	UDINT	4	$1 = 1V_{rms}$	0	450000	0	Get
864	Analog2Object	0x384	23	Input voltage UL2RMS	Input voltage UL2RMS	UDINT	4	$1 = 1V_{rms}$	0	450000	0	Get
865	Analog2Object	0x384	24	Input voltage UL3RMS	Input voltage UL3RMS	UDINT	4	$1 = 1V_{rms}$	0	450000	0	Get
866	Analog2Object	0x384	25	U12 demand	U12 demand	UDINT	4	1 = 1V	0	450000	0	Get
867	Analog2Object	0x384	26	U23 demand	U23 demand	UDINT	4	1 = 1V	0	450000	0	Get
868	Analog2Object	0x384	27	U31 demand	U31 demand	UDINT	4	1 = 1V	0	450000	0	Get
869	Analog2Object	0x384	28	UL1 demand	UL1 demand	UDINT	4	1 = 1V	0	450000	0	Get
870	Analog2Object	0x384	29	UL2 demand	UL2 demand	UDINT	4	1 = 1V	0	450000	0	Get
871	Analog2Object	0x384	30	UL3 demand	UL3 demand	UDINT	4	1 = 1V	0	450000	0	Get
872	Analog2Object	0x384	31	Cosine phi	Cosine phi	DINT	4	1 = 0.01	0		767	Get
873	Analog2Object	0x384	32	Cosine of phase L1	Cosine of phase L1	DINT	4	1 = 0.01	0		32767	Get
874	Analog2Object	0x384	33	Cosine of phase L2	Cosine of phase L2	DINT	4	1 = 0.01	0		32767	Get
875	Analog2Object	0x384	34	Cosine of phase L3	Cosine of phase L3	DINT	4	1 = 0.01	0		32767	Get
876	Analog2Object	0x384	35	Phase L1 active power	Phase L1 active power	DINT	4	1 = 1 kW	0	999999.999	0	Get
877	Analog2Object	0x384	36	Phase L2 active power	Phase L2 active power	DINT	4	1 = 1 kW	0	999999.999	0	Get
878	Analog2Object	0x384	37	Phase L3 active power	Phase L3 active power	DINT	4	1 = 1 kW	0	999999.999	0	Get
879	Analog2Object	0x384	38	Phase L1 reactive power	Phase L1 reactive power	DINT	4	1 = 1 kVAR	0	999999.999	0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
880	Analog2Object	0x384	39	Phase L2 reactive power	Phase L2 reactive power	DINT	4	1 = 1 kVAR	0	999999.999	0	Get
881	Analog2Object	0x384	40	Phase L3 reactive power	Phase L3 reactive power	DINT	4	1 = 1 kVAR	0	999999.999	0	Get
882	Analog2Object	0x384	41	Phase L1 apparent power	Phase L1 apparent power	DINT	4	1 = 1 kVA	0	999999.999	0	Get
883	Analog2Object	0x384	42	Phase L2 apparent power	Phase L2 apparent power	DINT	4	1 = 1 kVA	0	999999.999	0	Get
884	Analog2Object	0x384	43	Phase L3 apparent power	Phase L3 apparent power	DINT	4	1 = 1 kVA	0	999999.999	0	Get
885	Analog2Object	0x384	44	RMS active power	RMS active power	DINT	4	1 = 1 kW	0	999999.999	0	Get
886	Analog2Object	0x384	45	RMS reactive power	RMS reactive power	DINT	4	1 = 1 kVAR	0	999999.999	0	Get
887	Analog2Object	0x384	46	RMS apparent power	RMS apparent power	DINT	4	1 = 1 kVA	0	999999.999	0	Get
888	Analog2Object	0x384	47	Active power demand	Active power demand	DINT	4	1 = 1 kW	0	999999.999	0	Get
889	Analog2Object	0x384	48	Reactive power demand	Reactive power demand	DINT	4	1 = 1 kVAR	0	999999.999	0	Get
890	Analog2Object	0x384	49	Apparent power demand	Apparent power demand	DINT	4	1 = 1 kVA	0	999999.999	0	Get
891	Analog2Object	0x384	50	Power factor demand	Demand Power factor Range -1 to +1 (Internal range to 65000)	DINT	4	1 = 0.01	-100	+100	0	Get
892	Analog2Object	0x384	51	RMS active power demand	RMS active power demand	DINT	4	1 = 1 kW	0	999999.999	0	Get
893	Analog2Object	0x384	52	RMS reactive power demand	RMS reactive power demand	DINT	4	1 = 1 kVAR	0	999999.999	0	Get
894	Analog2Object	0x384	53	RMS apparent power demand	RMS apparent power demand	DINT	4	1 = 1 kVA	0	999999.999	0	Get
895	Analog2Object	0x384	54	T> Estimated time to trip	T> Estimated time to trip	UDINT	4	1	0	4294967296	0	Get
896	Digital Object(2)	0x385	170	Virtual output 1	Virtual output 1	BOOL	1	1	0=Off 1=On		0	Get/ Set
897	Digital Object(2)	0x385	171	Virtual output 2	Virtual output 2	BOOL	1	1	0=Off 1=On		0	Get/ Set

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
898	Digital Object(2)	0x385	172	Virtual output 3	Virtual output 3	BOOL	1	1	0=Off 1=On		0	Get/ Set
899	Digital Object(2)	0x385	173	Virtual output 4	Virtual output 4	BOOL	1	1	0=Off 1=On		0	Get/ Set
900	Digital Object(2)	0x385	174	Virtual output 5	Virtual output 5	BOOL	1	1	0=Off 1=On		0	Get/ Set
901	Digital Object(2)	0x385	175	Virtual output 6	Virtual output 6	BOOL	1	1	0=Off 1=On		0	Get/ Set
902	Analog2Object	0x384	55	Phase current IL1	Phase current IL1	UDINT	4	1 = 1 A	0	2000	0	Get
903	Analog2Object	0x384	56	Phase current IL2	Phase current IL2	UDINT	4	1 = 1 A	0	2000	0	Get
904	Analog2Object	0x384	57	Phase current IL3	Phase current IL3	UDINT	4	1 = 1 A	0	2000	0	Get
905	Analog2Object	0x384	58	Pos. sequence I1	Positive Sequence I1 current	UDINT	4	1 = 1 A	0	2000	0	Get
906	Analog2Object	0x384	59	Neg. sequence I2	Negative Sequence I2 current	UDINT	4	1 = 1 A	0	2000	0	Get
907	Analog2Object	0x384	60	Current -seq./+seq.	Current -seq./+seq.	UDINT	4	1 = 0.1%	0	1000	0	Get
908	Analog2Object	0x384	61	Voltage -seq./+seq.	Voltage -seq./+seq.	DINT	4	1 = 0.1%	0	1000	0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
909	Analog2Object	0x384	62	AI_AlarmStateMisc	AI Alarm State Miscellaneous	UDINT	4	1	Bit 0: Sensor 1 Short Circuited Bit 1: Sensor 2 Short Circuited Bit 2: Sensor 3 Short Circuited Bit 3: Sensor 4 Short Circuited Bit 4: Sensor 5 Short Circuited Bit 5: Sensor 6 Short Circuited Bit 6: Sensor 7 Short Circuited Bit 7: Sensor 8 Short Circuited Bit 8: Sensor 9 Short Circuited Bit 9: Sensor 10 Short Circuited Bit 10: Sensor 11 Short Circuited Bit 11: Sensor 12 Short Circuited Bit 12: Sensor 13 Short Circuited Bit 13: Sensor 14 Short Circuited Bit 14: Sensor 15 Short Circuited Bit 15: Sensor 16 Short Circuited Bit 16: Sensor 1 Open Circuit Bit 17: Sensor 2 Open Circuit Bit 18: Sensor 3 Open Circuit Bit 19: Sensor 4 Open Circuit Bit 20: Sensor 5 Open Circuit Bit 21: Sensor 6 Open Circuit Bit 22: Sensor 7 Open Circuit Bit 23: Sensor 8 Open Circuit Bit 24: Sensor 9 Open Circuit Bit 25: Sensor 10 Open Circuit Bit 26: Sensor 11 Open Circuit Bit 27: Sensor 12 Open Circuit Bit 28: Sensor 13 Open Circuit Bit 29: Sensor 14 Open Circuit Bit 30: Sensor 15 Open Circuit Bit 31: Sensor 16 Open Circuit 0=Off 1=On		0	Get
910	Analog2Object	0x384	63	Harmonics of IL1, 2	Harmonic content of IL1, 2nd harmonic	UDINT	4	1%=1	0	500	0	Get
911	Analog2Object	0x384	64	Harmonics of IL1, 3	Harmonic content of IL1, 3rd harmonic	UDINT	4	1%=1	0	500	0	Get
912	Analog2Object	0x384	65	Harmonics of IL1, 4	Harmonic content of IL1, 4th harmonic	UDINT	4	1%=1	0	500	0	Get
913	Analog2Object	0x384	66	Harmonics of IL1, 5	Harmonic content of IL1, 5th harmonic	UDINT	4	1%=1	0	500	0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
914	Analog2Object	0x384	67	Harmonics of IL1, 6	Harmonic content of IL1, 6th harmonic	UDINT	4	1%=1	0	500	0	Get
915	Analog2Object	0x384	68	Harmonics of IL1, 7	Harmonic content of IL1, 7th harmonic	UDINT	4	1%=1	0	500	0	Get
916	Analog2Object	0x384	69	Harmonics of IL1, 8	Harmonic content of IL1, 8th harmonic	UDINT	4	1%=1	0	500	0	Get
917	Analog2Object	0x384	70	Harmonics of IL1, 9	Harmonic content of IL1, 9th harmonic	UDINT	4	1%=1	0	500	0	Get
918	Analog2Object	0x384	71	Harmonics of IL1, 10	Harmonic content of IL1, 10th harmonic	UDINT	4	1%=1	0	500	0	Get
919	Analog2Object	0x384	72	Harmonics of IL1, 11	Harmonic content of IL1, 11th harmonic	UDINT	4	1%=1	0	500	0	Get
920	Analog2Object	0x384	73	Harmonics of IL1, 12	Harmonic content of IL1, 12th harmonic	UDINT	4	1%=1	0	500	0	Get
921	Analog2Object	0x384	74	Harmonics of IL1, 13	Harmonic content of IL1, 13th harmonic	UDINT	4	1%=1	0	500	0	Get
922	Analog2Object	0x384	75	Harmonics of IL1, 14	Harmonic content of IL1, 14th harmonic	UDINT	4	1%=1	0	500	0	Get
923	Analog2Object	0x384	76	Harmonics of IL1, 15	Harmonic content of IL1, 15th harmonic	UDINT	4	1%=1	0	500	0	Get
924	Analog2Object	0x384	77	Harmonics of IL2, 2	Harmonic content of IL2, 2nd harmonic	UDINT	4	1%=1	0	500	0	Get
925	Analog2Object	0x384	78	Harmonics of IL2, 3	Harmonic content of IL2, 3rd harmonic	UDINT	4	1%=1	0	500	0	Get
926	Analog2Object	0x384	79	Harmonics of IL2, 4	Harmonic content of IL2, 4th harmonic	UDINT	4	1%=1	0	500	0	Get
927	Analog2Object	0x384	80	Harmonics of IL2, 5	Harmonic content of IL2, 5th harmonic	UDINT	4	1%=1	0	500	0	Get
928	Analog2Object	0x384	81	Harmonics of IL2, 6	Harmonic content of IL2, 6th harmonic	UDINT	4	1%=1	0	500	0	Get
929	Analog2Object	0x384	82	Harmonics of IL2, 7	Harmonic content of IL2, 7th harmonic	UDINT	4	1%=1	0	500	0	Get
930	Analog2Object	0x384	83	Harmonics of IL2, 8	Harmonic content of IL2, 8th harmonic	UDINT	4	1%=1	0	500	0	Get
931	Analog2Object	0x384	84	Harmonics of IL2, 9	Harmonic content of IL2, 9th harmonic	UDINT	4	1%=1	0	500	0	Get
932	Analog2Object	0x384	85	Harmonics of IL2, 10	Harmonic content of IL2, 10th harmonic	UDINT	4	1%=1	0	500	0	Get
933	Analog2Object	0x384	86	Harmonics of IL2, 11	Harmonic content of IL2, 11th harmonic	UDINT	4	1%=1	0	500	0	Get
934	Analog2Object	0x384	87	Harmonics of IL2, 12	Harmonic content of IL2, 12th harmonic	UDINT	4	1%=1	0	500	0	Get
935	Analog2Object	0x384	88	Harmonics of IL2, 13	Harmonic content of IL2, 13th harmonic	UDINT	4	1%=1	0	500	0	Get
936	Analog2Object	0x384	89	Harmonics of IL2, 14	Harmonic content of IL2, 14th harmonic	UDINT	4	1%=1	0	500	0	Get
937	Analog2Object	0x384	90	Harmonics of IL2, 15	Harmonic content of IL2, 15th harmonic	UDINT	4	1%=1	0	500	0	Get
938	Analog2Object	0x384	91	Harmonics of IL3, 2	Harmonic content of IL3, 2nd harmonic	UDINT	4	1%=1	0	500	0	Get
939	Analog2Object	0x384	92	Harmonics of IL3, 3	Harmonic content of IL3, 3rd harmonic	UDINT	4	1%=1	0	500	0	Get
940	Analog2Object	0x384	93	Harmonics of IL3, 4	Harmonic content of IL3, 4th harmonic	UDINT	4	1%=1	0	500	0	Get
941	Analog2Object	0x384	94	Harmonics of IL3, 5	Harmonic content of IL3, 5th harmonic	UDINT	4	1%=1	0	500	0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
942	Analog2Object	0x384	95	Harmonics of IL3, 6	Harmonic content of IL3, 6th harmonic	UDINT	4	1%=1	0	500	0	Get
943	Analog2Object	0x384	96	Harmonics of IL3, 7	Harmonic content of IL3, 7th harmonic	UDINT	4	1%=1	0	500	0	Get
944	Analog2Object	0x384	97	Harmonics of IL3, 8	Harmonic content of IL3, 8th harmonic	UDINT	4	1%=1	0	500	0	Get
945	Analog2Object	0x384	98	Harmonics of IL3, 9	Harmonic content of IL3, 9th harmonic	UDINT	4	1%=1	0	500	0	Get
946	Analog2Object	0x384	99	Harmonics of IL3, 10	Harmonic content of IL3, 10th harmonic	UDINT	4	1%=1	0	500	0	Get
947	Analog2Object	0x384	100	Harmonics of IL3, 11	Harmonic content of IL3, 11th harmonic	UDINT	4	1%=1	0	500	0	Get
948	Analog2Object	0x384	101	Harmonics of IL3, 12	Harmonic content of IL3, 12th harmonic	UDINT	4	1%=1	0	500	0	Get
949	Analog2Object	0x384	102	Harmonics of IL3, 13	Harmonic content of IL3, 13th harmonic	UDINT	4	1%=1	0	500	0	Get
950	Analog2Object	0x384	103	Harmonics of IL3, 14	Harmonic content of IL3, 14th harmonic	UDINT	4	1%=1	0	500	0	Get
951	Analog2Object	0x384	104	Harmonics of IL3, 15	Harmonic content of IL3, 15th harmonic	UDINT	4	1%=1	0	500	0	Get
952	Analog2Object	0x384	105	Harmonics of U12, 2	Harmonic content of U12, 2nd harmonic	UDINT	4	1%=1	0	500	0	Get
953	Analog2Object	0x384	106	Harmonics of U12, 3	Harmonic content of U12, 3rd harmonic	UDINT	4	1%=1	0	500	0	Get
954	Analog2Object	0x384	107	Harmonics of U12, 4	Harmonic content of U12, 4th harmonic	UDINT	4	1%=1	0	500	0	Get
955	Analog2Object	0x384	108	Harmonics of U12, 5	Harmonic content of U12, 5th harmonic	UDINT	4	1%=1	0	500	0	Get
956	Analog2Object	0x384	109	Harmonics of U12, 6	Harmonic content of U12, 6th harmonic	UDINT	4	1%=1	0	500	0	Get
957	Analog2Object	0x384	110	Harmonics of U12, 7	Harmonic content of U12, 7th harmonic	UDINT	4	1%=1	0	500	0	Get
958	Analog2Object	0x384	111	Harmonics of U12, 8	Harmonic content of U12, 8th harmonic	UDINT	4	1%=1	0	500	0	Get
959	Analog2Object	0x384	112	Harmonics of U12, 9	Harmonic content of U12, 9th harmonic	UDINT	4	1%=1	0	500	0	Get
960	Analog2Object	0x384	113	Harmonics of U12, 10	Harmonic content of U12, 10th harmonic	UDINT	4	1%=1	0	500	0	Get
961	Analog2Object	0x384	114	Harmonics of U12, 11	Harmonic content of U12, 11th harmonic	UDINT	4	1%=1	0	500	0	Get
962	Analog2Object	0x384	115	Harmonics of U12, 12	Harmonic content of U12, 12th harmonic	UDINT	4	1%=1	0	500	0	Get
963	Analog2Object	0x384	116	Harmonics of U12, 13	Harmonic content of U12, 13th harmonic	UDINT	4	1%=1	0	500	0	Get
964	Analog2Object	0x384	117	Harmonics of U12, 14	Harmonic content of U12, 14th harmonic	UDINT	4	1%=1	0	500	0	Get
965	Analog2Object	0x384	118	Harmonics of U12, 15	Harmonic content of U12, 15th harmonic	UDINT	4	1%=1	0	500	0	Get
966	Analog2Object	0x384	119	Harmonics of U23, 2	Harmonic content of U23, 2nd harmonic	UDINT	4	1%=1	0	500	0	Get
967	Analog2Object	0x384	120	Harmonics of U23, 3	Harmonic content of U23, 3rd harmonic	UDINT	4	1%=1	0	500	0	Get
968	Analog2Object	0x384	121	Harmonics of U23, 4	Harmonic content of U23, 4th harmonic	UDINT	4	1%=1	0	500	0	Get
969	Analog2Object	0x384	122	Harmonics of U23, 5	Harmonic content of U23, 5th harmonic	UDINT	4	1%=1	0	500	0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
970	Analog2Object	0x384	123	Harmonics of U23, 6	Harmonic content of U23, 6th harmonic	UDINT	4	1%=1	0	500	0	Get
971	Analog2Object	0x384	124	Harmonics of U23, 7	Harmonic content of U23, 7th harmonic	UDINT	4	1%=1	0	500	0	Get
972	Analog2Object	0x384	125	Harmonics of U23, 8	Harmonic content of U23, 8th harmonic	UDINT	4	1%=1	0	500	0	Get
973	Analog2Object	0x384	126	Harmonics of U23, 9	Harmonic content of U23, 9th harmonic	UDINT	4	1%=1	0	500	0	Get
974	Analog2Object	0x384	127	Harmonics of U23, 10	Harmonic content of U23, 10th harmonic	UDINT	4	1%=1	0	500	0	Get
975	Analog2Object	0x384	128	Harmonics of U23, 11	Harmonic content of U23, 11th harmonic	UDINT	4	1%=1	0	500	0	Get
976	Analog2Object	0x384	129	Harmonics of U23, 12	Harmonic content of U23, 12th harmonic	UDINT	4	1%=1	0	500	0	Get
977	Analog2Object	0x384	130	Harmonics of U23, 13	Harmonic content of U23, 13th harmonic	UDINT	4	1%=1	0	500	0	Get
978	Analog2Object	0x384	131	Harmonics of U23, 14	Harmonic content of U23, 14th harmonic	UDINT	4	1%=1	0	500	0	Get
979	Analog2Object	0x384	132	Harmonics of U23, 15	Harmonic content of U23, 15th harmonic	UDINT	4	1%=1	0	500	0	Get
980	Analog2Object	0x384	133	Harmonics of Uo, 2	Harmonic content of Uo, 2nd harmonic	UDINT	4	1%=1	0	500	0	Get
981	Analog2Object	0x384	134	Harmonics of Uo, 3	Harmonic content of Uo, 3rd harmonic	UDINT	4	1%=1	0	500	0	Get
982	Analog2Object	0x384	135	Harmonics of Uo, 4	Harmonic content of Uo, 4th harmonic	UDINT	4	1%=1	0	500	0	Get
983	Analog2Object	0x384	136	Harmonics of Uo, 5	Harmonic content of Uo, 5th harmonic	UDINT	4	1%=1	0	500	0	Get
984	Analog2Object	0x384	137	Harmonics of Uo, 6	Harmonic content of Uo, 6th harmonic	UDINT	4	1%=1	0	500	0	Get
985	Analog2Object	0x384	138	Harmonics of Uo, 7	Harmonic content of Uo, 7th harmonic	UDINT	4	1%=1	0	500	0	Get
986	Analog2Object	0x384	139	Harmonics of Uo, 8	Harmonic content of Uo, 8th harmonic	UDINT	4	1%=1	0	500	0	Get
987	Analog2Object	0x384	140	Harmonics of Uo, 9	Harmonic content of Uo, 9th harmonic	UDINT	4	1%=1	0	500	0	Get
988	Analog2Object	0x384	141	Harmonics of Uo, 10	Harmonic content of Uo, 10th harmonic	UDINT	4	1%=1	0	500	0	Get
989	Analog2Object	0x384	142	Harmonics of Uo, 11	Harmonic content of Uo, 11th harmonic	UDINT	4	1%=1	0	500	0	Get
990	Analog2Object	0x384	143	Harmonics of Uo, 12	Harmonic content of Uo, 12th harmonic	UDINT	4	1%=1	0	500	0	Get
991	Analog2Object	0x384	144	Harmonics of Uo, 13	Harmonic content of Uo, 13th harmonic	UDINT	4	1%=1	0	500	0	Get
992	Analog2Object	0x384	145	Harmonics of Uo, 14	Harmonic content of Uo, 14th harmonic	UDINT	4	1%=1	0	500	0	Get
993	Analog2Object	0x384	146	Harmonics of Uo, 15	Harmonic content of Uo, 15th harmonic	UDINT	4	1%=1	0	500	0	Get
994	Analog2Object[2]	0x384	147	Harmonics of I'L1, 2	Harmonic content of I'L1, 2nd harmonic	UDINT	4	1%=1	0	500	0	Get
995	Analog2Object[2]	0x384	148	Harmonics of I'L1, 3	Harmonic content of I'L1, 3rd harmonic	UDINT	4	1%=1	0	500	0	Get
996	Analog2Object[2]	0x384	149	Harmonics of I'L1, 4	Harmonic content of I'L1, 4th harmonic	UDINT	4	1%=1	0	500	0	Get
997	Analog2Object[2]	0x384	150	Harmonics of I'L1, 5	Harmonic content of I'L1, 5th harmonic	UDINT	4	1%=1	0	500	0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
998	Analog2Object(2)	0x384	151	Harmonics of I'L1, 6	Harmonic content of I'L1, 6th harmonic	UDINT	4	1%=1	0	500	0	Get
999	Analog2Object(2)	0x384	152	Harmonics of I'L1, 7	Harmonic content of I'L1, 7th harmonic	UDINT	4	1%=1	0	500	0	Get
1000	Analog2Object(2)	0x384	153	Harmonics of I'L1, 8	Harmonic content of I'L1, 8th harmonic	UDINT	4	1%=1	0	500	0	Get
1001	Analog2Object(2)	0x384	154	Harmonics of I'L1, 9	Harmonic content of I'L1, 9th harmonic	UDINT	4	1%=1	0	500	0	Get
1002	Analog2Object(2)	0x384	155	Harmonics of I'L1, 10	Harmonic content of I'L1, 10th harmonic	UDINT	4	1%=1	0	500	0	Get
1003	Analog2Object(2)	0x384	156	Harmonics of I'L1, 11	Harmonic content of I'L1, 11th harmonic	UDINT	4	1%=1	0	500	0	Get
1004	Analog2Object(2)	0x384	157	Harmonics of I'L1, 12	Harmonic content of I'L1, 12th harmonic	UDINT	4	1%=1	0	500	0	Get
1005	Analog2Object(2)	0x384	158	Harmonics of I'L1, 13	Harmonic content of I'L1, 13th harmonic	UDINT	4	1%=1	0	500	0	Get
1006	Analog2Object(2)	0x384	159	Harmonics of I'L1, 14	Harmonic content of I'L1, 14th harmonic	UDINT	4	1%=1	0	500	0	Get
1007	Analog2Object(2)	0x384	160	Harmonics of I'L1, 15	Harmonic content of I'L1, 15th harmonic	UDINT	4	1%=1	0	500	0	Get
1008	Analog2Object(2)	0x384	161	Harmonics of I'L2, 2	Harmonic content of I'L2, 2nd harmonic	UDINT	4	1%=1	0	500	0	Get
1009	Analog2Object(2)	0x384	162	Harmonics of I'L2, 3	Harmonic content of I'L2, 3rd harmonic	UDINT	4	1%=1	0	500	0	Get
1010	Analog2Object(2)	0x384	163	Harmonics of I'L2, 4	Harmonic content of I'L2, 4th harmonic	UDINT	4	1%=1	0	500	0	Get
1011	Analog2Object(2)	0x384	164	Harmonics of I'L2, 5	Harmonic content of I'L2, 5th harmonic	UDINT	4	1%=1	0	500	0	Get
1012	Analog2Object(2)	0x384	165	Harmonics of I'L2, 6	Harmonic content of I'L2, 6th harmonic	UDINT	4	1%=1	0	500	0	Get
1013	Analog2Object(2)	0x384	166	Harmonics of I'L2, 7	Harmonic content of I'L2, 7th harmonic	UDINT	4	1%=1	0	500	0	Get
1014	Analog2Object(2)	0x384	167	Harmonics of I'L2, 8	Harmonic content of I'L2, 8th harmonic	UDINT	4	1%=1	0	500	0	Get
1015	Analog2Object(2)	0x384	168	Harmonics of I'L2, 9	Harmonic content of I'L2, 9th harmonic	UDINT	4	1%=1	0	500	0	Get
1016	Analog2Object(2)	0x384	169	Harmonics of I'L2, 10	Harmonic content of I'L2, 10th harmonic	UDINT	4	1%=1	0	500	0	Get
1017	Analog2Object(2)	0x384	170	Harmonics of I'L2, 11	Harmonic content of I'L2, 11th harmonic	UDINT	4	1%=1	0	500	0	Get
1018	Analog2Object(2)	0x384	171	Harmonics of I'L2, 12	Harmonic content of I'L2, 12th harmonic	UDINT	4	1%=1	0	500	0	Get
1019	Analog2Object(2)	0x384	172	Harmonics of I'L2, 13	Harmonic content of I'L2, 13th harmonic	UDINT	4	1%=1	0	500	0	Get
1020	Analog2Object(2)	0x384	173	Harmonics of I'L2, 14	Harmonic content of I'L2, 14th harmonic	UDINT	4	1%=1	0	500	0	Get
1021	Analog2Object(2)	0x384	174	Harmonics of I'L2, 15	Harmonic content of I'L2, 15th harmonic	UDINT	4	1%=1	0	500	0	Get
1022	Analog2Object(2)	0x384	175	Harmonics of I'L3, 2	Harmonic content of I'L3, 2nd harmonic	UDINT	4	1%=1	0	500	0	Get
1023	Analog2Object(2)	0x384	176	Harmonics of I'L3, 3	Harmonic content of I'L3, 3rd harmonic	UDINT	4	1%=1	0	500	0	Get
1024	Analog2Object(2)	0x384	177	Harmonics of I'L3, 4	Harmonic content of I'L3, 4th harmonic	UDINT	4	1%=1	0	500	0	Get
1025	Analog2Object(2)	0x384	178	Harmonics of I'L3, 5	Harmonic content of I'L3, 5th harmonic	UDINT	4	1%=1	0	500	0	Get

Par. No.	Group	CIP Class Code (Hexadecimal)	Attribute ID Number (Decimal)	Parameter Name	Description	Type	Data Size (bytes)	Scale Factor	Min	Max	Default	Mode
1026	Analog2Object[2]	0x384	179	Harmonics of I'L3, 6	Harmonic content of I'L3, 6th harmonic	UDINT	4	1%=1	0	500	0	Get
1027	Analog2Object[2]	0x384	180	Harmonics of I'L3, 7	Harmonic content of I'L3, 7th harmonic	UDINT	4	1%=1	0	500	0	Get
1028	Analog2Object[2]	0x384	181	Harmonics of I'L3, 8	Harmonic content of I'L3, 8th harmonic	UDINT	4	1%=1	0	500	0	Get
1029	Analog2Object[2]	0x384	182	Harmonics of I'L3, 9	Harmonic content of I'L3, 9th harmonic	UDINT	4	1%=1	0	500	0	Get
1030	Analog2Object[2]	0x384	183	Harmonics of I'L3, 10	Harmonic content of I'L3, 10th harmonic	UDINT	4	1%=1	0	500	0	Get
1031	Analog2Object[2]	0x384	184	Harmonics of I'L3, 11	Harmonic content of I'L3, 11th harmonic	UDINT	4	1%=1	0	500	0	Get
1032	Analog2Object[2]	0x384	185	Harmonics of I'L3, 12	Harmonic content of I'L3, 12th harmonic	UDINT	4	1%=1	0	500	0	Get
1033	Analog2Object[2]	0x384	186	Harmonics of I'L3, 13	Harmonic content of I'L3, 13th harmonic	UDINT	4	1%=1	0	500	0	Get
1034	Analog2Object[2]	0x384	187	Harmonics of I'L3, 14	Harmonic content of I'L3, 14th harmonic	UDINT	4	1%=1	0	500	0	Get
1035	Analog2Object[2]	0x384	188	Harmonics of I'L3, 15	Harmonic content of I'L3, 15th harmonic	UDINT	4	1%=1	0	500	0	Get
1100	Ethernet	NA	NA	Requested packet interval time	Requested packet interval time	UDINT	4	1	50000	5000000	100000	Get/ Set
1101	Ethernet	NA	NA	Controller Output Image 100 Size	Controller Output Image 100 Size	UDINT	4	1=1 bytes				Get
1102	Ethernet	NA	NA	Controller Input Image 150 Size	Controller Input Image 150 Size	UDINT	4	1=1 bytes				Get
1003	DeviceNet[3] [4]	NA	NA	Controller Output Image 100 Size	Controller Output Image 100 Size	UDINT	4	1=1 bytes				Get
1004	DeviceNet[3] [4]	NA	NA	Controller Input Image 150 Size	Controller Input Image 150 Size	UINT	2	1=1 bytes				Get

(1) Only available with Arc flash option.
(2) Only used on Bulletin 865.
(3) DeviceNet® not available.
(4) Not used with EtherNet.
(5) Indexed values, Bit 0 = DC component, Bit 1 = Fundamental wave, Bits 2…15 = Harmonic component active.
(6) Range and 1 = 0.01 < scaling vary by linked parameter that is selected. See publication 857-UM002.

Notes:

Modbus Parameter List

Overview

This appendix lists all Modbus parameters that are associated with the Bulletin 857 protection system. The parameters are listed in the numerical order of the holding register. This table includes all holding registers. Depending on the model and options enabled, some registers are not be available in the device.

Table 220 - Modbus Parameters

Name	Scaling	Setting for Scaling	Read	Write	The Holding Register	Note
Reread event	1 = 1	—	1	0	401991…401995	Mirror of registers 402490…402494
Events	1 = 1	—	1	0	401996…402000	Mirror of registers 402101…4021 05
Alive indicator (0…255 increments once per second)	1 = 1	—	1	0	402001	
Digital Inputs	1 = 1	—	1	0	402007	
Dis after DI16 for Modbus	1 = 1	—	1	0	402008	
Phase current IL1	1 A= 1	—	1	0	402009	
Phase current IL2	1 A= 1	—	1	0	402010	
Phase current IL3	1 A = 1	—	1	0	402011	
Io1 residual current	1.00 A = 100	—	1	0	402012	
Io2 residual current	1.000 A = 100	—	1	0	402013	
Line-to-line voltage U12	1000V = 1000	Voltage Scaling	1	0	402014	
Line-to-line voltage U23	1000V = 1000	Voltage Scaling	1	0	402015	
Line-to-line voltage U31	1000V = 1000	Voltage Scaling	1	0	402016	
Phase-to-earth voltage UL1	1000V = 1000	Voltage Scaling	1	0	402017	
Phase-to-earth voltage UL2	1000V = 1000	Voltage Scaling	1	0	402018	
Phase-to-earth voltage UL3	1000V = 1000	Voltage Scaling	1	0	402019	
Zero sequence voltage	1.0% = 10	—	1	0	402020	
Frequency	50.000 Hz= 5000	Frequency Scaling	1	0	402021	
Active power	1 000 Kw = 1000	Power Scaling	1	0	402022	
Reactive power	1 000 kVAR = 1000	Power Scaling	1	0	402023	
Apparent power	1000 kVA = 1000	Power Scaling	1	0	402024	
Power factor	1.00 = 100	PF and cosine Scaling	1	0	402025	
Energy Eexp	1 = 1	—	1	0	402026	
Eexp/1 0^4	10^4 = 1	—	1	0	402027	
Eexp/1 0^8	10^8 = 1	—	1	0	402028	
Energy EqExp	1 = 1	—	1	0	402029	

Table 220 - Modbus Parameters (Continued)

Name	Scaling	Setting for Scaling	Read	Write	The Holding Register	Note
EqExp/10^4	10^4 = 1	—	1	0	402030	
EqExp/10^8	10^8 = 1	—	1	0	402031	
Energy Eimp	1 = 1	—	1	0	402032	
Eimp/10^4	10^4 = 1	—	1	0	402033	
Eimp/10^8	10^8 = 1	—	1	0	402034	
Energy EqImp	1 = 1	—	1	0	402035	
EqImp/10^4	10^4 = 1	—	1	0	402036	
EqImp/10^8	10^8 = 1	—	1	0	402037	
Tan phi	1.000 = 1000	Tan phi Scaling	1	0	402038	
Phase current IL	1 A = 1	—	1	0	402039	
Average line voltage	1000V = 1000	Voltage Scaling	1	0	402040	
Average phase voltage	1000V = 1000	Voltage Scaling	1	0	402041	
Obj1 state	Open = 0, Close = 1, Undef = 2	—	1	0	402042	
Obj2 state	Open = 0, Close = 1, Undef = 2	—	1	0	402043	
Obj3 state	Open = 0, Close = 1, Undef = 2	—	1	0	402044	
Obj4 state	Open = 0, Close = 1, Undef = 2	—	1	0	402045	
Obj5 state	Open = 0, Close = 1, Undef = 2	—	1	0	402046	
Obj6 state	Open = 0, Close = 1, Undef = 2	—	1	0	402047	
Remote/Local State	Remote = 0 Local = 1	—	1	1	402048	
Output relays	1 = 1	—	1	0	402049	
Obj7 state	Open = 0, Close = 1, Undef = 2	—	1	0	402050	
Obj8 state	Open = 0, Close = 1, Undef = 2	—	1	0	402051	
Digital inputs 21…32	1 = 1		1	0	402052	
Run hours/10^0 to Modbus	1 = 1	—	1	0	402057	
Run hours/10^4 to Modbus	1 = 1	—	1	0	402058	
Engine running seconds	1 s = 1	—	1	1	402059	
Start counter	1 = 1	—	1	1	402060	
Phase current I'L1	1 A = 1	—	1	0	402061	
Phase current I'L2	1 A = 1	—	1	0	402062	
Phase current I'L3	1 A = 1	—	1	0	402063	
IL1 difference	1.00 x In = 100	—	1	0	402064	
IL2 difference	1.00 x In = 100	—	1	0	402065	
IL3 difference	1.00 x In = 100	—	1	0	402066	
Events	1 = 1	—	1	0	402101…402105	
Event code		—			402101	

Table 220 - Modbus Parameters (Continued)

Name	Scaling	Setting for Scaling	Read	Write	The Holding Register	Note
Event Time Stamp: bits 15…6 = milliseconds, bits 5…0 = seconds		—			402102	
Event Time Stamp: upper byte = minutes, lower byte = hours		—			402103	
Event Time Stamp: upper byte = days, lower byte = month		—			402104	
Event Time Stamp		—			402105	
Last fault current	1.00 x In = 100	—	1	1	402110	
Fault current	1.00 x In = 100	—	1	0	402111	
Fault current	1.00 x In = 100	—	1	0	402112	
Fault current	1.00 x In = 100	—	1	0	402113	
Fault reactance	1.00 ohm = 100	—	1	0	402115	
Algorithm condition	OK = 0, NegX = 1 BigX = 2, LongFlt =3 NoDI = 4, NoPreFlt = 5 NoPostFlt = 6, ShrtFlt = 7	—	1	0	402116	
Alarm L1…L3: bit 0 = L1 bit 1 = L2 bit 2 = L3	1 = 1	—	1	0	402121	
Fault L1…L3: bit 0 = L1 bit 1 = L2 bit 2 = L3	1 = 1	—	1	0	402122	
Last fault Io current	1.00 pu = 100	—	1	0	402130	
Fault current	1.00 pu = 100	—	1	0	402131	
Fault current	1.00 pu = 100	—	1	0	402132	
Fault current	1.00 pu = 100	—	1	0	402133	
Fault current	1.00 pu = 100	—	1	0	402134	
Diagnostic register 1	1 = 1	—	1	0	402191	
Diagnostic register 2	1 = 1	—	1	0	402192	
Diagnostic register 3	1 = 1	—	1	0	402193	
Diagnostic register 4	1 = 1	—	1	0	402194	
HARMONICS of IL1: 402201 = DC component, 402202 = 1. Harmonic, … 402216 = 15. Harmonic	1% = 1	—	1	0	402201…402216	
HARMONICS of IL2	1% = 1	—	1	0	402221…402236	Format same as 402201…402216
HARMONICS of IL3	1% = 1	—	1	0	402241…402256	Format same as 402201…402216
HARMONICS of Ua	1% = 1	—	1	0	402301…402316	Format same as 402201…402216

Table 220 - Modbus Parameters (Continued)

Name	Scaling	Setting for Scaling	Read	Write	The Holding Register	Note
HARMONICS of Ub	1% = 1	—	1	0	402321…402336	Format same as 402201…402216
HARMONICS of Uc	1% = 1	—	1	0	402341…402356	Format same as 402201…402216
HARMONICS of I'L1	1% = 1	—	1	0	402401…402416	Format same as 402201…402216
HARMONICS of I'L2	1% = 1	—	1	0	402421…402436	Format same as 402201…4022166
HARMONICS of I'L3	1% = 1	—	1	0	402441…402456	Format same as 402201…402216
Reread event	1 = 1	—	1	0	402490…402494	
Release latches	Release = 1	—	1	1	402501	
Synchronize minutes	1 = 1	—	1	1	402502	
Grp. 2 remote Scaling	1% = 1	—	1	1	402503	
Set RTC: 402504 = seconds, 402505 upper byte =minutes 402505 lower byte = hours 402506 upper byte = day 402506 lower byte = month 402507 = year	1 = 1	—	0	1	402504…402507	
Open select Obj1	1 = 1	—	1	1	402508	
Close select Obj1	1 = 1	—	1	1	402509	
Execute operation Obj1	1 = 1	—	0	1	402510	
Max ctrl pulse length of Obj1	1.00 s = 100	—	1	1	402511	
Open select Obj2	1 = 1	—	1	1	402512	
Close select Obj2	1 = 1	—	1	1	402513	
Execute operation Obj2	1 = 1	—	0	1	402514	
Max ctrl pulse length of Obj2	1.00 s = 100	—	1	1	402515	
Cancel selected operation	1 = 1	—	0	1	402516	
Open select Obj3	1 = 1	—	1	1	402517	
Close select Obj3	1 = 1	—	1	1	402518	
Execute operation Obj3	1 = 1	—	0	1	402519	
Max ctrl pulse length of Obj3	1.00 s = 100	—	1	1	402520	
Open select Obj4	1 = 1	—	1	1	402521	
Close select Obj4	1 = 1	—	1	1	402522	
Execute operation Obj4	1 = 1	—	0	1	402523	
Max ctrl pulse length of Obj4	1.00 s = 100	—	1	1	402524	
Ambient temperature	1 °C (33.8 °F)= 100	—	1	1	402525	
SetGrp common change	1 = 0, 2 = 1	—	1	1	402526	
Open select Obj5	1 = 1	—	1	1	402527	
Close select Obj5	1 = 1	—	1	1	402528	
Execute operation Obj5	1 = 1	—	0	1	402529	

Table 220 - Modbus Parameters (Continued)

Name	Scaling	Setting for Scaling	Read	Write	The Holding Register	Note
Max ctrl pulse length of Obj5	1.00 s = 100	—	1	1	402530	
Open select Obj6	1 = 1	—	1	1	402531	
Close select Obj6	1 = 1	—	1	1	402532	
Execute operation Obj6	1 = 1	—	0	1	402533	
Max ctrl pulse length of Obj6	1.00 s = 100	—	1	1	402534	
Reset diagnostics	Reset = 1	—	1	1	402535	
Clear min and max	Clear = 1	—	1	1	402536	
Pos. sequence I1	1 A = 1	—	1	0	403001	
Neg. sequence I2	1 A = 1	—	1	0	403002	
Current -seq./+seq.	1.0% = 10	—	1	0	403003	
Current phase seq.	?? = 0, OK = 1, Reverse = 2	—	1	0	403004	
Phase current THD	1.0% = 10	—	1	0	403005	
IL1 THD	1.0% = 10	—	1	0	403006	
IL2 THD	1.0% = 10	—	1	0	403007	
IL3 THD	1.0% = 10	—	1	0	403008	
Phase current IL	1 A = 1	—	1	0	403009	
Min. of IL1 IL2 IL3	1 A = 1	—	1	0	403010	
Max. of IL1 IL2 IL3	1 A = 1	—	1	0	403011	
Phase current ILRMS	1 A rms = 1	—	1	0	403012	
Phase current IL1RMS	1 A rms = 1	—	1	0	403015	
Phase current IL2RMS	1 A rms = 1	—	1	0	403016	
Phase current IL3RMS	1 A rms = 1	—	1	0	403017	
Temperature rise	1.0% = 10	—	1	1	403018	
Ambient temperature	1 °C = 100	—	1	1	403019	
IL1da demand	1 A = 1	—	1	0	403020	
IL2da demand	1 A = 1	—	1	0	403021	
IL3da demand	1 A = 1	—	1	0	403022	
IoCalc demand	1.00 pu = 100	—	1	0	403023	
Io1 demand	1.000 pu = 1000	—	1	0	403024	
Io2 demand	1.000 pu = 1000	—	1	0	403025	
Pos. sequence U1	1000V = 1000	Voltage Scaling	1	0	403031	
Neg. sequence U2	1000V = 1000	Voltage Scaling	1	0	403032	
Voltage -seq./+seq.	1.0% = 10	—	1	0	403033	
Voltage phase seq.	?? = 0, OK = 1, Reverse = 2	—	1	0	403034	
Voltage THD	1.0% = 10	—	1	0	403035	
Ua THD	1.0% = 10	—	1	0	403036	
Ub THD	1.0% = 10	—	1	0	403037	
Uc THD	1.0% = 10	—	1	0	403038	
Average line voltage	1000V = 1000	Voltage Scaling	1	0	403039	

Table 220 - Modbus Parameters (Continued)

Name	Scaling	Setting for Scaling	Read	Write	The Holding Register	Note
Min of line voltages	1000V = 1000	Voltage Scaling	1	0	403040	
Max of line voltages	1000V = 1000	Voltage Scaling	1	0	403041	
Average phase voltage	1000V = 1000	Voltage Scaling	1	0	403042	
Min. of phase voltages	1000V = 1000	Voltage Scaling	1	0	403043	
Max. of phase voltages	1000V = 1000	Voltage Scaling	1	0	403044	
Voltage mean	1000V rms = 1000	Voltage Scaling	1	0	403045	
Input voltage Ua	1000V rms = 1000	Voltage Scaling	1	0	403048	
Input voltage Ub	1000V rms = 1000	Voltage Scaling	1	0	403049	
Input voltage Uc	1000V rms = 1000	Voltage Scaling	1	0	403050	
U12 demand	1000V = 1000	Voltage Scaling	1	0	403051	
U23 demand	1000V = 1000	Voltage Scaling	1	0	403052	
U31 demand	1000V = 1000	Voltage Scaling	1	0	403053	
UL1 demand	1000V = 1000	Voltage Scaling	1	0	403054	
UL2 demand	1000V = 1000	Voltage Scaling	1	0	403055	
UL3 demand	1000V = 1000	Voltage Scaling	1	0	403056	
Cosine phi	1.00 = 100	PF and cos Scaling	1	0	403058	
Tan phii	1.000 = 1000	Tan phi Scaling	1	0	403059	
Power angle	1° = 1	—	1	0	403060	
RMS active power	1000 kW = 1000	Power Scaling	1	0	403061	
RMS reactive power	1000 kVAR = 1000	Power Scaling	1	0	403062	
RMS apparent power	1000 kVA = 1000	Power Scaling	1	0	403063	
Active power demand	1000 kW = 1000	Power Scaling	1	0	403066	
Reactive power demand	1000 kVAR = 1000	Power Scaling	1	0	403067	
Apparent power demand	1000 kVA = 1000	Power Scaling	1	0	403068	
Power factor demand	1.00 = 100	PF and cos Scaling	1	0	403069	
RMS active power demand	1000 kW = 1000	Power Scaling	1	0	403071	
RMS reactive power demand	1000 kVAR = 1000	Power Scaling	1	0	403072	
RMS apparent power demand	1000 kVA = 1000	Power Scaling	1	0	403073	
Phase L1 active power	1000 kW = 1000	Power Scaling	1	0	403081	
Phase L2 active power	1000 kW = 1000	Power Scaling	1	0	403082	
Phase L3 active power	1000 kW = 1000	Power Scaling	1	0	403083	
Phase L1 reactive power	1000 kVAR = 1000	Power Scaling	1	0	403084	
Phase L2 reactive power	1000 kVAR = 1000	Power Scaling	1	0	403085	
Phase L3 reactive power	1000 kVAR = 1000	Power Scaling	1	0	403086	
Phase L1 apparent power	1000 kVA = 1000	Power Scaling	1	0	403087	
Phase L2 apparent power	1000 kVA = 1000	Power Scaling	1	0	403088	
Phase L3 apparent power	1000 kVA = 1000	Power Scaling	1	0	403089	
Cosine of phase L1	1.00 = 100	PF and cos Scaling	1	0	403090	
Cosine of phase L2	1.00 = 100	PF and cos Scaling	1	0	403091	

Table 220 - Modbus Parameters (Continued)

Name	Scaling	Setting for Scaling	Read	Write	The Holding Register	Note
Cosine of phase L3	1.00 = 100	PF and cos Scaling	1	0	403092	
Frequency fy	50.000 Hz = 5000	Frequency Scaling	1	0	403101	Synchrocheck
Line-to-line voltage U12y	1000V = 1000	Voltage Scaling	1	0	403102	Synchrocheck
Synchrocheck 1-Phase angle difference	1° = 1	—	1	0	403103	Synchrocheck
Frequency fz	50.000 Hz = 5000	Frequency Scaling	1	0	403111	Synchrocheck
Line-to-line voltage U12z	1000V = 1000	Voltage Scaling	1	0	403112	Synchrocheck
Synchrocheck 2-Phase angle difference	1° = 1	—	1	0	403113	Synchrocheck
Positive sequence I'1	1 A = 1	—	1	0	403151	
Negative sequence I'1	1 A = 1	—	1	0	403152	
Current I' -seq./+seq.	1.0% = 10	—	1	0	403153	
Current I' phase sequence	?? = 0, OK = 1, Reverse = 2	—	1	0	403154	
Phase current I'THD	1.0% = 10	—	1	0	403155	
I'L1 THD	1.0% = 10	—	1	0	403156	
I'L2 THD	1.0% = 10	—	1	0	403157	
I'L3 THD	1.0% = 10	—	1	0	403158	
Phase current I'L	1 A = 1	—	1	0	403159	
Min. of I'L1, I'L2, I'L3	1 A = 1	—	1	0	403160	
Max. of I'L1, I'L2, I'L3	1 A = 1	—	1	0	403161	
Phase current I'Lrms	1 A rms = 1	—	1	0	403162	
Phase current I'L1rms	1 A rms = 1	—	1	0	403165	
Phase current I'L2rms	1 A rms = 1	—	1	0	403166	
Phase current I'L3rms	1 A rms = 1	—	1	0	403167	
DI1 counter	1 = 1	—	1	1	403301	
DI2 counter	1 = 1	—	1	1	403302	
DI3 counter	1 = 1	—	1	1	403303	
DI4 counter	1 = 1	—	1	1	403304	
DI5 counter	1 = 1	—	1	1	403305	
DI6 counter	1 = 1	—	1	1	403306	
DI7 counter	1 = 1	—	1	1	403307	
DI8 counter	1 = 1	—	1	1	403308	
DI9 counter	1 = 1	—	1	1	403309	
DI10 counter	1 = 1	—	1	1	403310	
DI11 counter	1 = 1	—	1	1	403311	
DI12 counter	1 = 1	—	1	1	403312	
DI13 counter	1 = 1	—	1	1	403313	
DI14 counter	1 = 1	—	1	1	403314	
DI15 counter	1 = 1	—	1	1	403315	
DI16 counter	1 = 1	—	1	1	403316	
DI17 counter	1 = 1	—	1	1	403317	

Table 220 - Modbus Parameters (Continued)

Name	Scaling	Setting for Scaling	Read	Write	The Holding Register	Note
DI18 counter	1 = 1	—	1	1	403318	
DI19 counter	1 = 1	—	1	1	403319	Optional DI19/DI20 card
DI20 counter	1 = 1	—	1	1	403320	Optional DI19/DI20 card
DI21 counter	1 = 1	—	1	1	403350	
DI22 counter	1 = 1	—	1	1	403351	
DI23 counter	1 = 1	—	1	1	403352	
DI24 counter	1 = 1	—	1	1	403353	
DI25 counter	1 = 1	—	1	1	403354	
DI26 counter	1 = 1	—	1	1	403355	
DI27 counter	1 = 1	—	1	1	403356	
DI28 counter	1 = 1	—	1	1	403357	
DI29 counter	1 = 1	—	1	1	403358	
DI30 counter	1 = 1	—	1	1	403359	
DI31 counter	1 = 1	—	1	1	403360	
DI32 counter	1 = 1	—	1	1	403361	
Shot1 start counter	1 = 1	—	1	1	403331	
Shot2 start counter	1 = 1	—	1	1	403332	
Shot3 start counter	1 = 1	—	1	1	403333	
Shot4 start counter	1 = 1	—	1	1	403334	
Shot5 start counter	1 = 1	—	1	1	403335	
AR start counter	1 = 1	—	1	1	403336	
AR fail counter	1 = 1	—	1	1	403337	
AR shot number	1, 2, 3, 4, 5, END = 6	—	1	0	403402	
Critical AR req.	1 = 1	—	1	0	403403	
Reclose locked	1 = 1	—	1	0	403404	
Reclose running	1 = 1	—	1	0	403405	
Final trip	1 = 1	—	1	0	403406	
Autoreclose on	1 = 1	—	1	0	403407	
Motor Starting	1 = 1		1	0	403411	
Motor Running	1 = 1		1	0	403412	
Voltage interrupt	LOW = 0, OK = 1	—	1	0	403413	
Voltage status	OK = 0, LOW = 1, HIGH = 3, (OK) = 4 (LOW) = 5 (HIGH) = 6 (LOW)/(HIGH) = 7	—	1	0	403414	
Timer 1 status	0 = 1, 1 = 2	—	1	1	403415	
Timer 2 status	0 = 1, 1 = 2	—	1	1	403416	
Timer 3 status	0 = 1, 1 = 2	—	1	1	403417	
Timer 4 status	0 = 1, 1 = 2	—	1	1	403418	
Logic output states 1…10	1 = 1	—	1	0	403419	

Table 220 - Modbus Parameters (Continued)

Name	Scaling	Setting for Scaling	Read	Write	The Holding Register	Note
CBWAlarm 1	1 = 1	—	1	0	403420	
CBWAlarm 2	1 = 1	—	1	0	403421	
Logic output states 9…16	1 = 1	—	1	0	403422	
Logic output states 17…20	1 = 1	—	1	0	403423	
Virtual outputs	0, 1	—	1	0	403426	
Virtual input 1	0, 1	—	1	1	403427	
Virtual input 2	0, 1	—	1	1	403428	
Virtual input 3	0, 1	—	1	1	403429	
Virtual input 4	0, 1	—	1	1	403430	
Synchrocheck 1 request	1 = 1	—	1	0	403431	
Synchrocheck 1 OK	1 = 1	—	1	0	403432	
Synchrocheck 1 bypass	1 = 1	—	1	1	403433	
Synchrocheck 1 fail	1 = 1	—	1	0	403434	
Synchrocheck 2 request	1 = 1	—	1	0	403441	
Synchrocheck 2 OK	1 = 1	—	1	0	403442	
Synchrocheck 2 bypass	1 = 1	—	1	1	403443	
Synchrocheck 2 fail	1 = 1	—	1	0	403444	
Logic Cntr1	1 = 1	—	1	0	403451	
Logic Cntr2	1 = 1	—	1	0	403452	
Logic Cntr3	1 = 1	—	1	0	403453	
Logic Cntr4	1 = 1	—	1	0	403454	
Logic Cntr5	1 = 1	—	1	0	403455	
Logic Cntr6	1 = 1	—	1	0	403456	
External AI1	1.00 °C (33.8 °F) = 100	—	1	0	403500	External I/O must be active
External AI2	1.00 °C (33.8 °F) = 100	—	1	0	403501	External I/O must be active
External AI3	1.00 °C (33.8 °F) = 100	—	1	0	403502	External I/O must be active
External AI4	1.00 °C (33.8 °F) = 100	—	1	0	403503	External I/O must be active
External AI5	1.00 °C (33.8 °F) = 100	—	1	0	403504	External I/O must be active
External AI6	1.00 °C (33.8 °F) = 100	—	1	0	403505	External I/O must be active
External AI7	1.00 °C (33.8 °F) = 100	—	1	0	403506	External I/O must be active
External AI8	1.00 °C (33.8 °F) = 100	—	1	0	403507	External I/O must be active
External AI9	1.00 °C (33.8 °F) = 100	—	1	0	403508	External I/O must be active
External AI10	1.00 °C (33.8 °F) = 100	—	1	0	403509	External I/O must be active

Table 220 - Modbus Parameters (Continued)

Name	Scaling	Setting for Scaling	Read	Write	The Holding Register	Note
External AI11	1.00 °C (33.8 °F) = 100	—	1	0	403510	External I/O must be active
External AI12	1.00 °C (33.8 °F) = 100	—	1	0	403511	External I/O must be active
External AI13	1.00 °C (33.8 °F) = 100	—	1	0	403512	External I/O must be active
External AI14	1.00 °C (33.8 °F) = 100	—	1	0	403513	External I/O must be active
External AI15	1.00 °C (33.8 °F) = 100	—	1	0	403514	External I/O must be active
External AI16	1.00 °C (33.8 °F) = 100	—	1	0	403515	External I/O must be active
External DI1	1 = 1	—	1	0	403600	
External DI2	1 = 1	—	1	0	403601	
External DI3	1 = 1	—	1	0	403602	
External DI4	1 = 1	—	1	0	403603	
External DI5	1 = 1	—	1	0	403604	
External DI6	1 = 1	—	1	0	403605	
External DI7	1 = 1	—	1	0	403606	
External DI8	1 = 1	—	1	0	403607	
External DI9	1 = 1	—	1	0	403608	
External DI10	1 = 1	—	1	0	403609	
External DI11	1 = 1	—	1	0	403610	
External DI12	1 = 1	—	1	0	403611	
External DI13	1 = 1	—	1	0	403612	
External DI14	1 = 1	—	1	0	403613	
External DI15	1 = 1	—	1	0	403614	
External DI16	1 = 1	—	1	0	403615	
External DI17	1 = 1	—	1	0	403616	
External DI18	1 = 1	—	1	0	403617	
Minimum frequency	50.000 Hz = 50000	—	1	1	404001	
Minimum active power	1 kW = 1	—	1	1	404002	
Minimum react. power	1 kVAR = 1	—	1	1	404003	
Minimum apparent power	1 kVA = 1	—	1	1	404004	
Min power factor	1.000 = 1000	—	1	1	404005	
Minimum of Io	1.0% = 10	—	1	1	404006	
Minimum of Io2	1.0% = 10	—	1	1	404007	
Minimum active power	1 kW = 1	—	1	1	404008	
Minimum react. power	1 kVAR = 1	—	1	1	404009	
Minimum apparent power	1 kVA = 1	—	1	1	404010	
15 min minimum power factor	1.000 = 1000	—	1	1	404011	
Minimum active power	1 kW = 1	—	1	1	404012	

Table 220 - Modbus Parameters (Continued)

Name	Scaling	Setting for Scaling	Read	Write	The Holding Register	Note
Minimum react. power	1 kVAR = 1	—	1	1	404013	
Minimum apparent power	1 kVA = 1	—	1	1	404014	
Minimum of IL1	1 A = 1	—	1	1	404015	
Minimum of IL2	1 A = 1	—	1	1	404016	
Minimum of IL3	1 A = 1	—	1	1	404017	
RMS minimum of IL1	1 A rms = 1	—	1	1	404018	
RMS minimum of IL2	1 A rms = 1	—	1	1	404019	
RMS minimum of IL3	1 A rms = 1	—	1	1	404020	
Minimum of IL1	1 A = 1	—	1	1	404021	
Minimum of IL2	1 A = 1	—	1	1	404022	
Minimum of IL3	1 A = 1	—	1	1	404023	
RMS minimum of IL1	1 A rms = 1	—	1	1	404024	
RMS minimum of IL2	1 A rms = 1	—	1	1	404025	
RMS minimum of IL3	1 A rms = 1	—	1	1	404026	
Minimum of U12	1V = 1	—	1	1	404030	
Minimum of U23	1V = 1	—	1	1	404031	
Minimum of U31	1V = 1	—	1	1	404032	
Maximum frequency	50.000 Hz = 50000	—	1	1	404101	
Maximum active power	1 kW = 1	—	1	1	404102	
Maximum react. power	1 kVAR = 1	—	1	1	404103	
Maximum apparent power	1 kVA = 1	—	1	1	404104	
Max power factor	1.000 = 1000	—	1	1	404105	
Maximum of Io	1.0% = 10	—	1	1	404106	
Maximum of Io2	1.0% = 10	—	1	1	404107	
Maximum active power	1 kW = 1	—	1	1	404108	
Maximum react. power	1 kVAR = 1	—	1	1	404109	
Maximum apparent power	1 kVA = 1	—	1	1	404110	
15 min Maximum power factor	1.000 = 1000	—	1	1	404111	
Maximum active power	1 kW = 1	—	1	1	404112	
Maximum react. power	1 kVAR = 1	—	1	1	404113	
Maximum apparent power	1 kVA = 1	—	1	1	404114	
Maximum of IL1	1 A = 1	—	1	1	404115	
Maximum of IL2	1 A = 1	—	1	1	404116	
Maximum of IL3	1 A = 1	—	1	1	404117	
RMS Maximum of IL1	1 A rms = 1	—	1	1	404118	
RMS Maximum of IL2	1 A rms = 1	—	1	1	404119	
RMS Maximum of IL3	1 A rms = 1	—	1	1	404120	
Maximum of IL1	1 A = 1	—	1	1	404121	
Maximum of IL2	1 A = 1	—	1	1	404122	

Table 220 - Modbus Parameters (Continued)

Name	Scaling	Setting for Scaling	Read	Write	The Holding Register	Note
Maximum of IL3	1 A = 1	—	1	1	404123	
RMS Maximum of IL1	1 A rms = 1	—	1	1	404124	
RMS Maximum of IL2	1 A rms = 1	—	1	1	404125	
RMS Maximum of IL3	1 A rms = 1	—	1	1	404126	
Maximum of U12	1V = 1	—	1	1	404130	
Maximum of U23	1V = 1	—	1	1	404131	
(Maximum of U31	1V = 1	—	1	1	404132	
Z12 primary impedance	1.00 Ω = 100	—	1	0	404201	
Z23 primary impedance	1.00 Ω = 100	—	1	0	404202	
Z31 primary impedance	1.00 Ω = 100	—	1	0	404203	
Z12 secondary impedance	1.00 Ω = 100	—	1	0	404204	
Z23 secondary impedance	1.00 Ω = 100	—	1	0	404205	
Z31 secondary impedance	1.00 Ω = 100	—	1	0	404206	
Z12 angle	1° = 1	—	1	0	404207	
Z23 angle	1° = 1	—	1	0	404208	
Z31 angle	1° = 1	—	1	0	404209	
Diagnostics Registers	1 = 1		1	0	404372…404379	

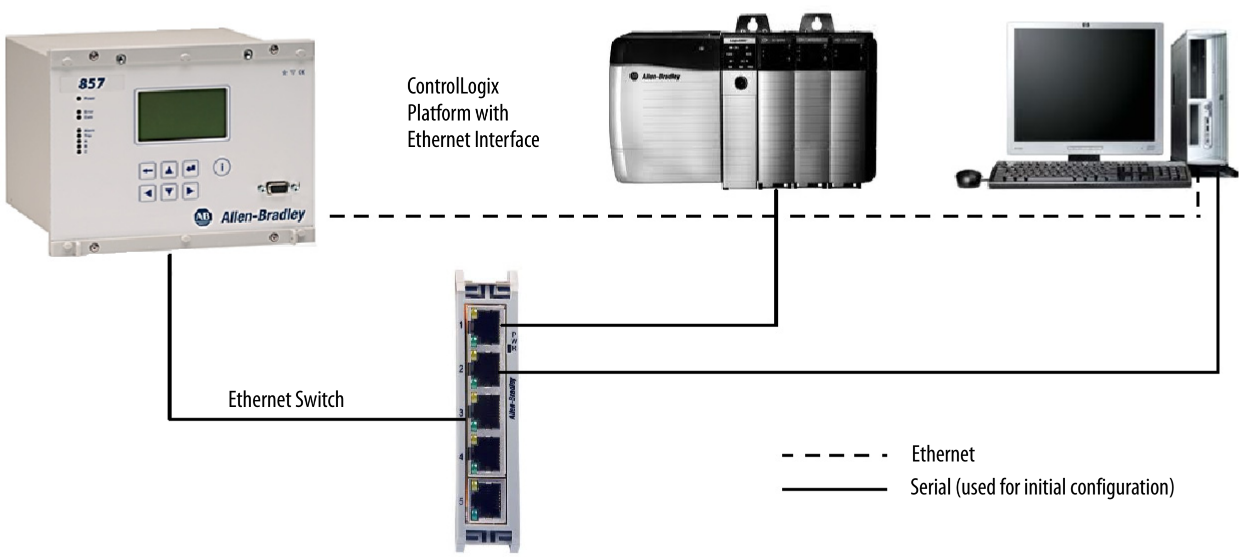
Configuring the 857 Relay in Studio 5000

There are two primary ways to connect to the relay using EtherNet I/P in combination with a ControlLogix™ or CompactLogix™ platform using Studio5000™ software.

1. Use a predefined static assembly in the 857 relay and apply an EDS AOP within Studio 5000.
2. Create a custom input output assembly within the 857 in combination with the use of a generic Ethernet module within Studio 5000.

Typical Hardware Configuration

A basic hardware setup is shown in Figure .



Configuring an I/O Profile Using an EDS AOP

Starting with version 13.01 firmware for the 857, an EDS AOP has been defined to streamline the integration of the 857 within your EtherNet/IP™ network using Studio 5000 software. The use of an EDS AOP approach provides a level of automation regarding the automatic configuration of the input and output assembly in the 857 relay and the automatic configuration of the tag information in the Logix environment.

To use the added functionality of an EDS AOP for the 857 relay, you must determine which of the predefined static assemblies works best for your specific application of the 857. The selection of the predefined static assembly relates to the three basic criteria:

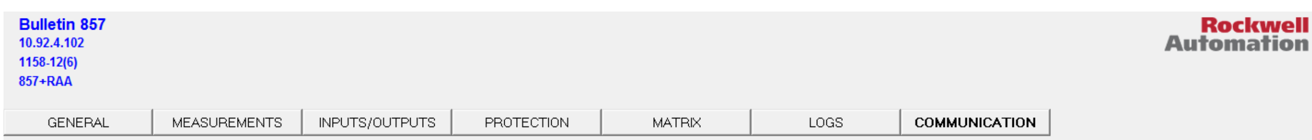
- What configuration are the devices providing three phase voltage configured
- Is an 857-RAA RTD Scanner being used and,
- Is the protection mode either Motor Protection or Feeder Protection.

Table 146 provides information to determine which predefined static assembly to use.

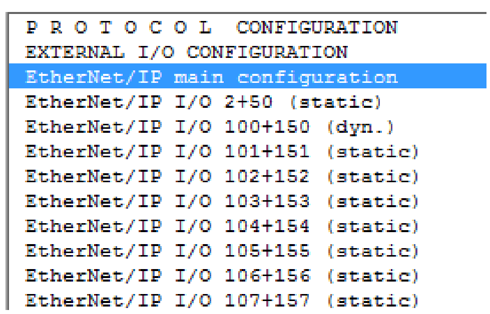
Select a Static Assembly

Follow these steps to select a predefined static assembly.

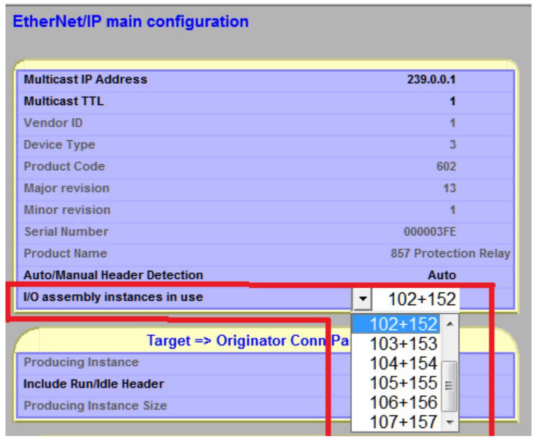
1. From the SetPointPS main screen, press the Communication button.

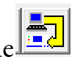


2. In the left pane, select EtherNet/IP main configuration.



3. Click the value next to I/O assembly instances in use.
4. From the pulldown menu, choose your desired static assembly.

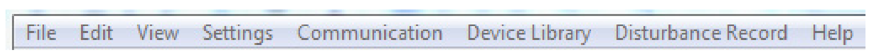


5. Press the  button to write changes to the device.

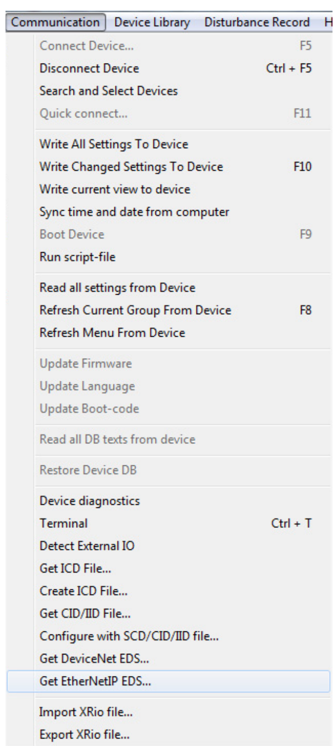
Download the EDS File from the 857 Relay

Follow these steps to download the EDS file using SetPointPS.

1. In the SetPointPS toolbar, click Communication.



2. Select Get EtherNetIP EDS....



SetPointPS will read the EDS file from the device.

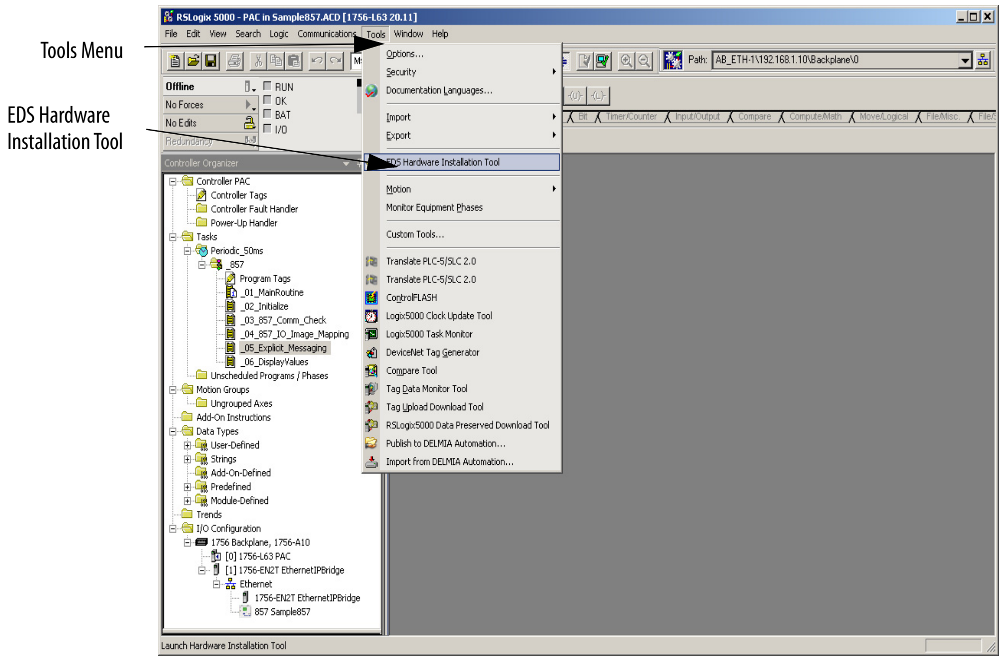
3. Save the EDS file to a desired location on your computer.

Register the EDS-based Device into Studio 5000

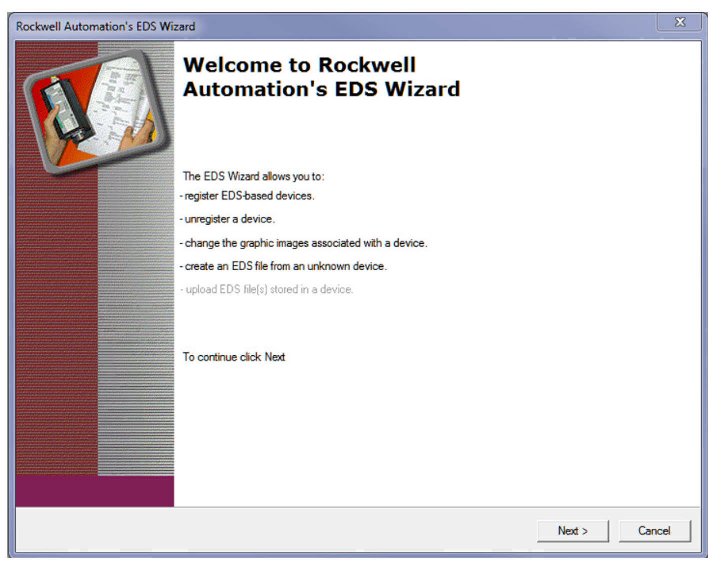
Follow these steps to install the EDS file into the Studio 5000 software.

1. In Studio 5000, click the Tool menu and select EDS Hardware Installation Tool.

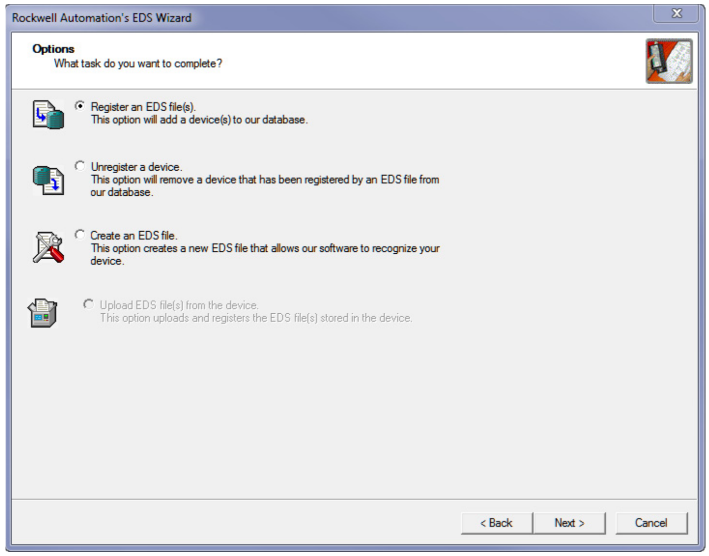
   The Rockwell Automation® EDS Wizard opens.



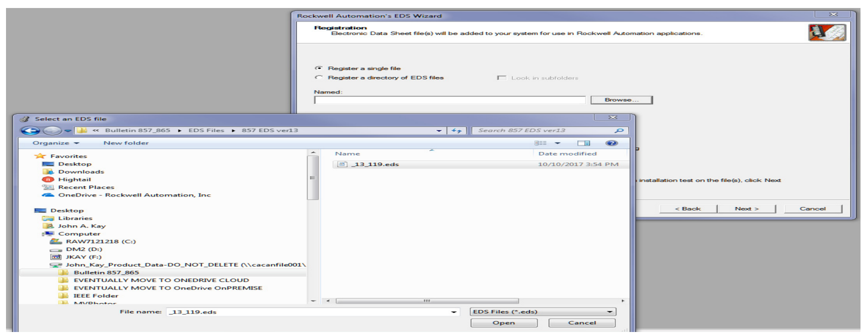
2. In the Rockwell Automation EDS Wizard home screen, click Next.



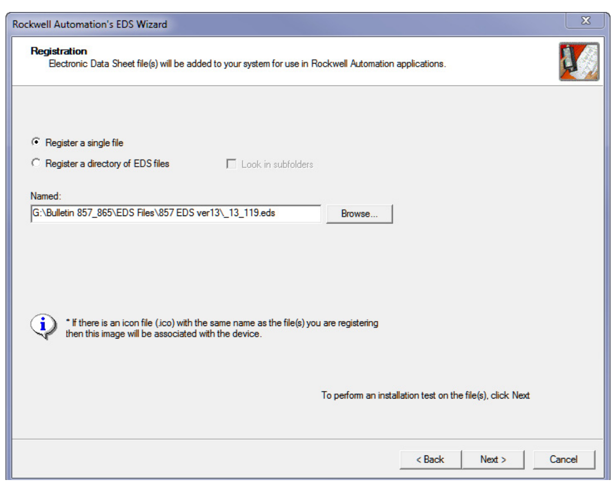
3. Select the Register an EDS file(s) radio button, and click Next.



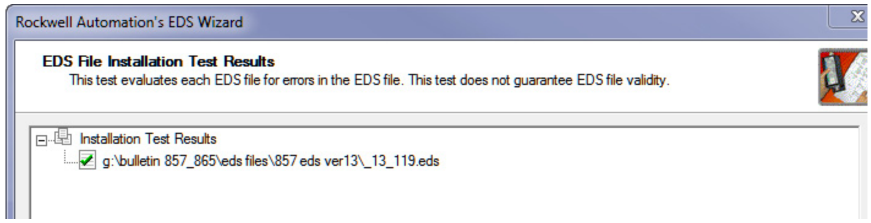
4. Select Register a single file.
5. Click Browse and locate and select the EDS file you created in [Download the EDS File from the 857 Relay on page 459](#).



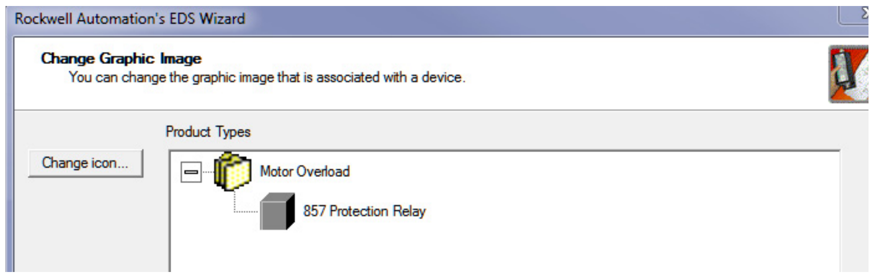
6. Click Next.



7. Verify a green check is next to your EDS file, and click Next.

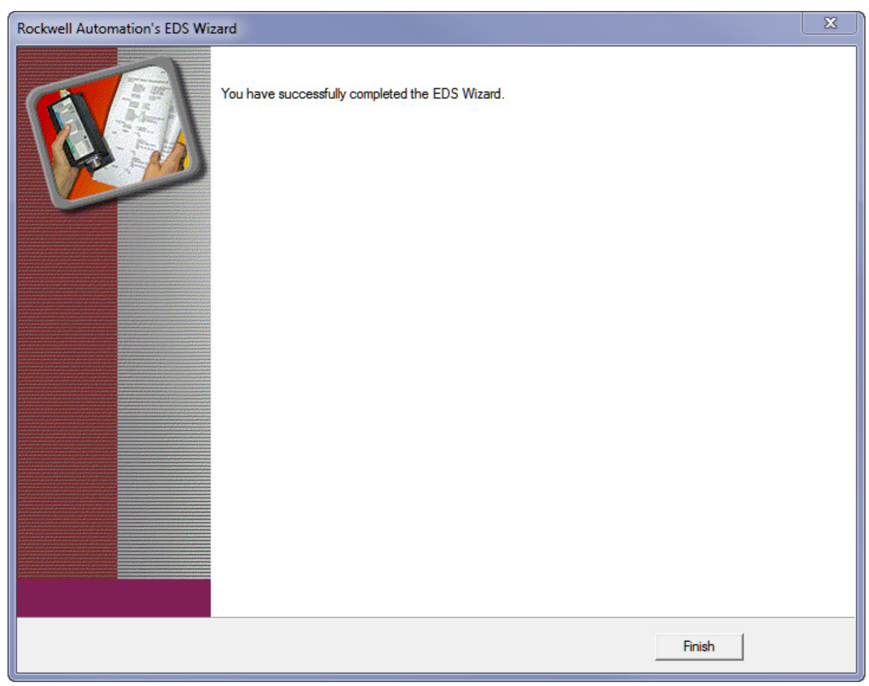


8. In the Change Graphic Image dialog, click Next.



9. In the Final Task Summary Dialog, click Next.

10. Click Finish to complete the EDS Wizard.



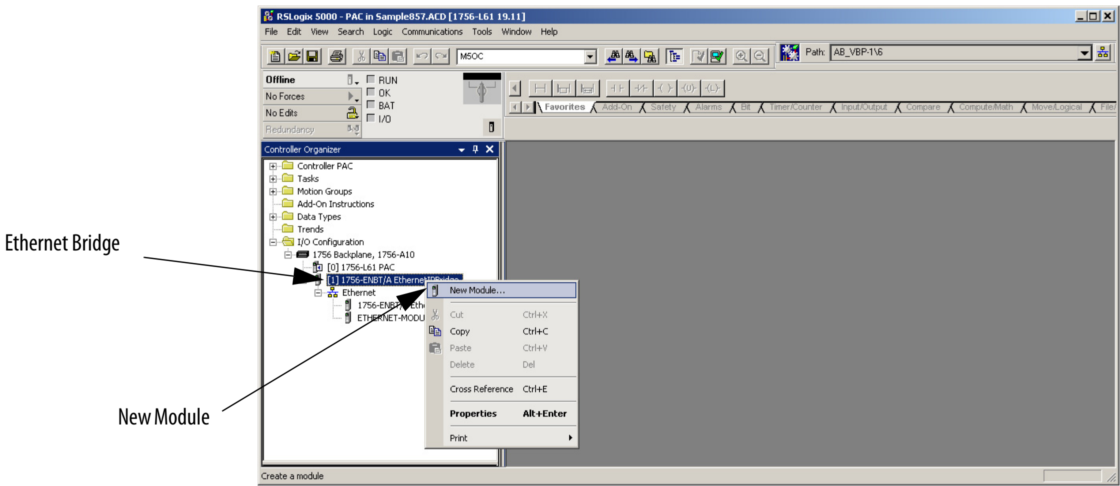
Configure Device Properties in Studio 5000

After the EDS device is registered per the procedure in Register the EDS-based Device into Studio 5000 on page 460, you must configure the device properties to match the static assembly selected in the 857 relay.

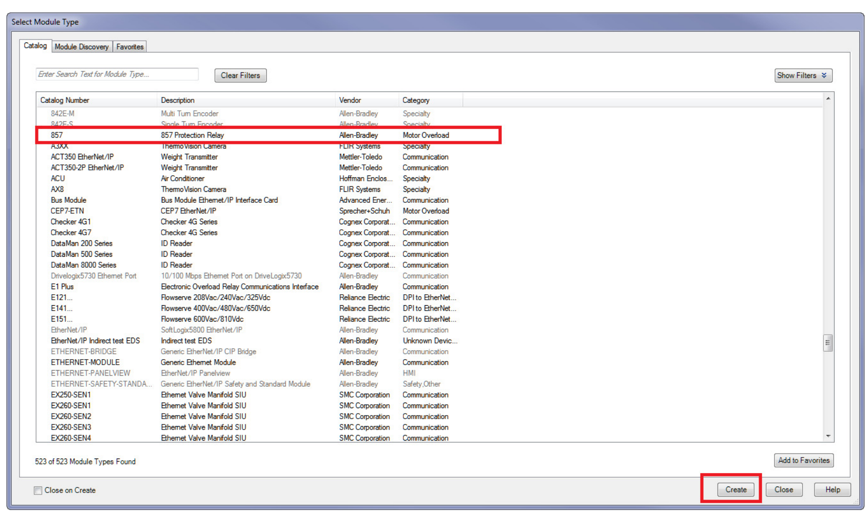
Follow these steps to configure the device properties.

1. In the RSLogix 5000 window, right-click the EtherNet/IP bridge.
2. Select New Module from the pop-up menu.

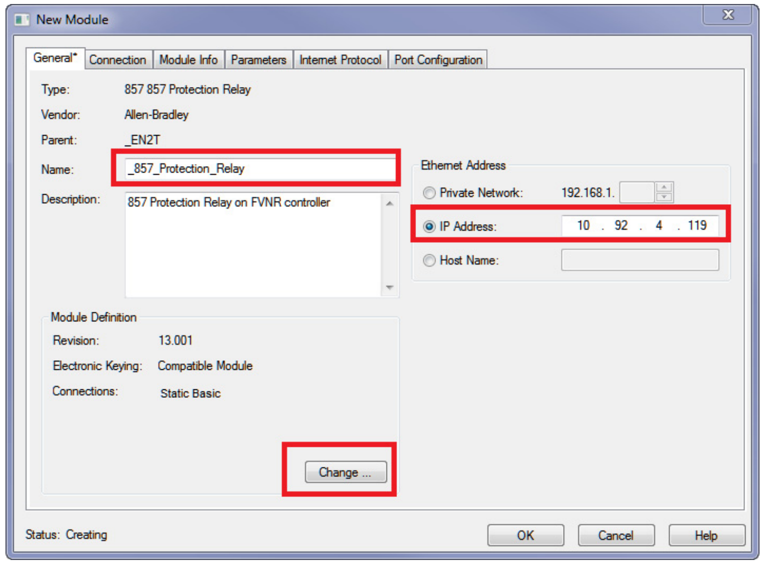
   The New Module dialog opens.



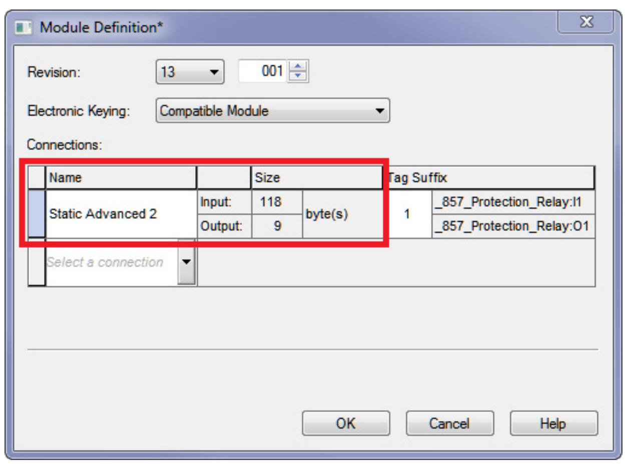
3. In the Select Module Type dialog, select 857 in the Catalog Number column.
4. Click Create.



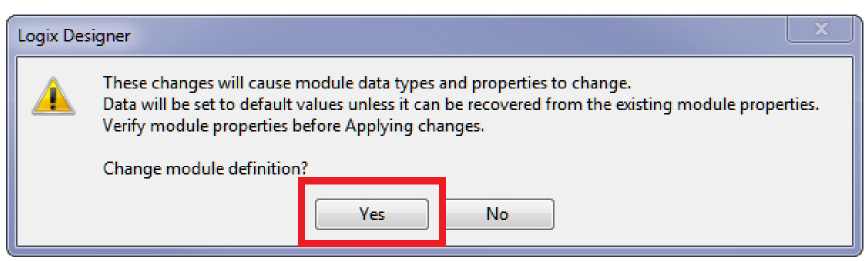
5. In the New Module dialog:
   a. Verify the module name is 857 Protection Relay
   b. Verify the IP address is correct
   c. Click Change in the Module Definition section.



6. In the Module Definition dialog, click the pulldown menu and choose Static Advanced 2.



7. In the Logix Designer dialog, select Yes.



8. Click OK to create the module and complete the procedure.

Configuring the 857 I/O Profile Using the Ethernet /IP Bridge

No Custom AOP exists for the 857 protection relay when using RSLogix 5000®. If the 857 has firmware version13 or higher, an EDS AOP is available. See Electronic Data Sheet (EDS) File on page 292 for more details.

If used in a dynamic assembly (fully configurable), use the following steps. A basic RSLogix 5000 Generic Profile is required.

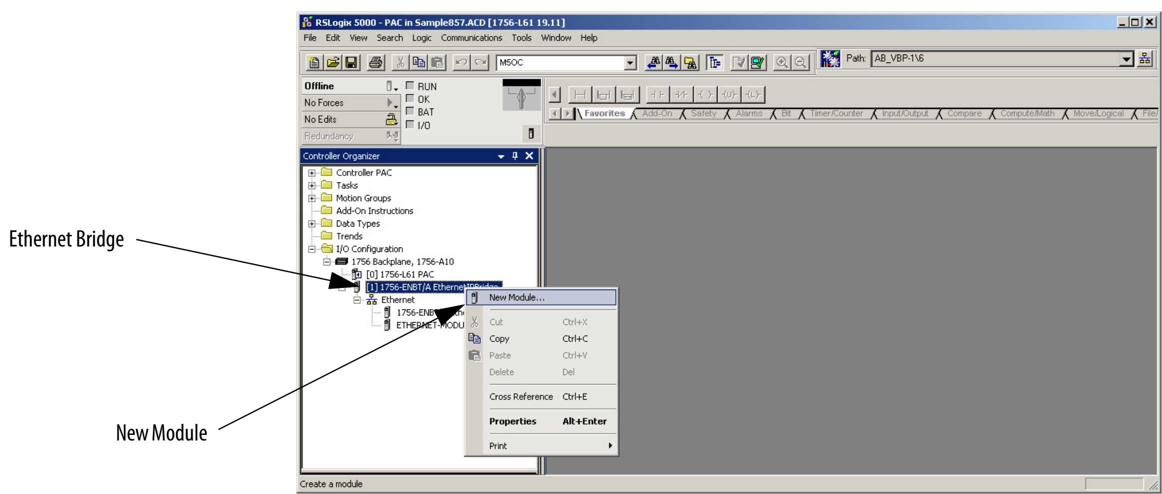
There are four main tasks to configure the 857 relay using the EtherNet/IP bridge.

Section	Page
Set Connection Parameters in RSLogix 5000	465
Configuring the 857 for EtherNet/IP Using the Front Panel	468
Configuring the 857 for Ethernet/IP Using SetpointPS	470
Configure Produced/Consumed (CIP I/O) Image	473
Produced and Consuming Assemblies (CIP I/O) Data Table Alignment	474

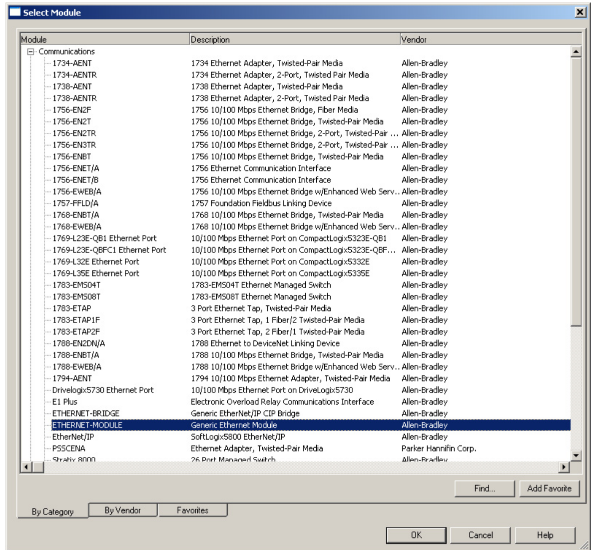
Set Connection Parameters in RSLogix 5000

1. In the RSLogix 5000 window, right-click the EtherNet/IP bridge.
2. Select New Module from the pop-up menu.

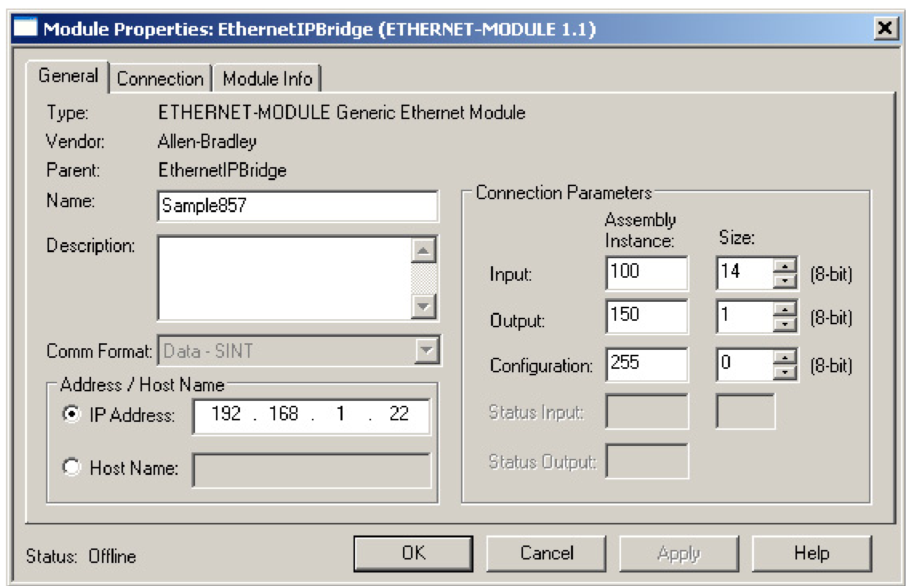
   The New Module dialog opens.



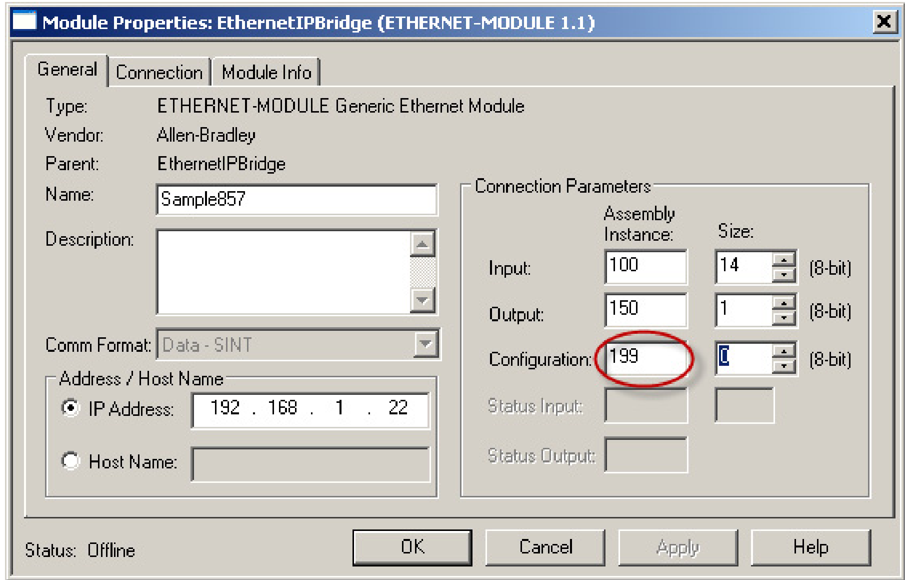
3. Expand the New Module tree and select ETHERNET-MODULE (Generic Ethernet Module).



4. If 857 relay firmware less than release 10.96 is used, set connection parameters as they appear in this graphic.

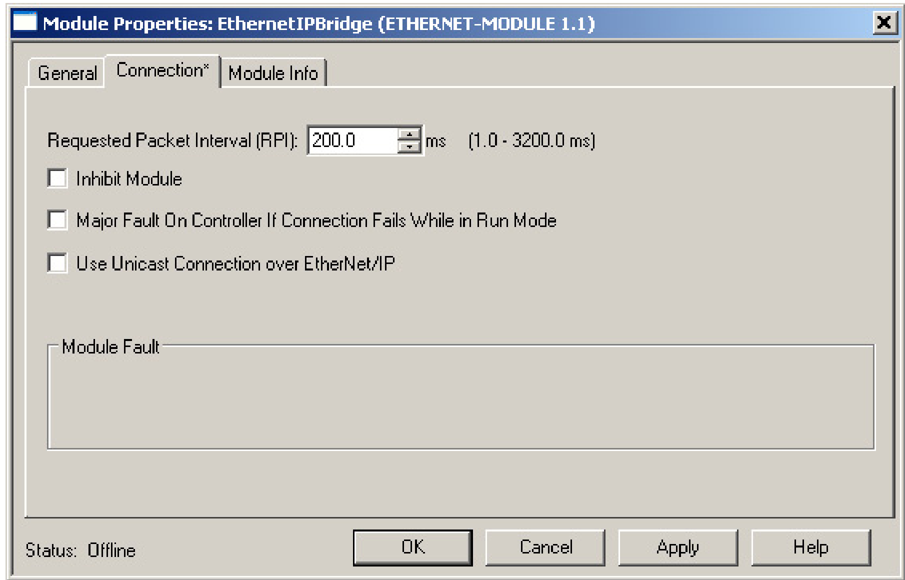


5. If 857 relay firmware release 10.96 or greater is used, set connection parameters as they appear in this graphic. Note the Assembly Instance (high lighted in red) for the configuration parameter changes to 199.



Use SetpointPS programming software to determine input and output sizes as defined by the CIP I/O configuration set. They can be set only when offline with the processor. See Configuring the 857 for Ethernet/IP Using SetpointPS on page 470.

Connection (RPI) time in the sample program is 200 ms. An I/O connection with any 857 relay must be no less than 50 ms. To change the RPI value, click the Connection tab in the Module Properties: EthernetIPBridge dialog.

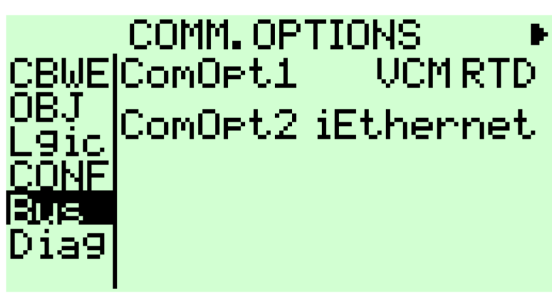


Configuring the 857 for EtherNet/IP Using the Front Panel

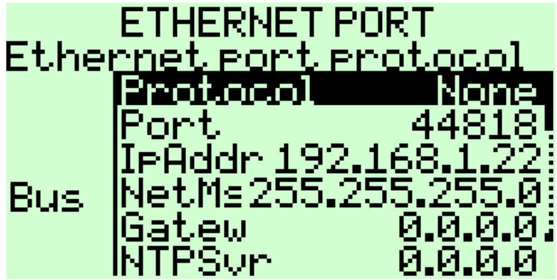
The 857 relay is delivered without the EtherNet/IP protocol enabled. To become familiar with the front panel and its operation see 857 Protection System Front Panel on page 23. To enable the EtherNet/IP port, use the front panel.

1. Press the info Key and enter key on the front panel
2. Enter the Relay password.

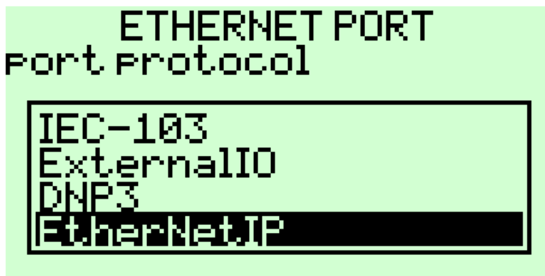
3. Navigate by using the up/down arrows to the COMM. OPTIONS level

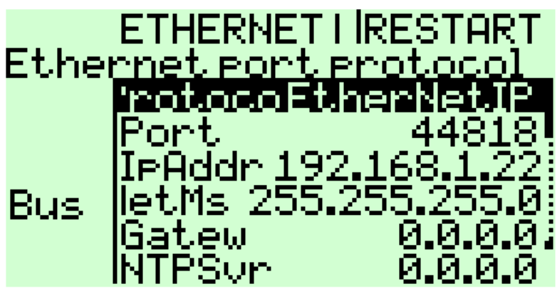


4. Navigate (use right/left arrows) to the ETHERNET PORT screen and select Protocol (use the enter key).

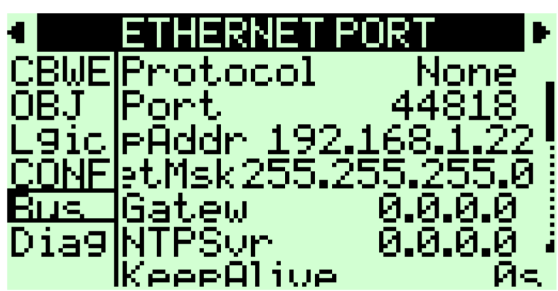


5. Change Protocol to EtherNet/IP (bottom of list). Restart the relay (shown by RESTART and progress bar at the top right corner). The alternative to the RESTART function is to cycle power on the unit.

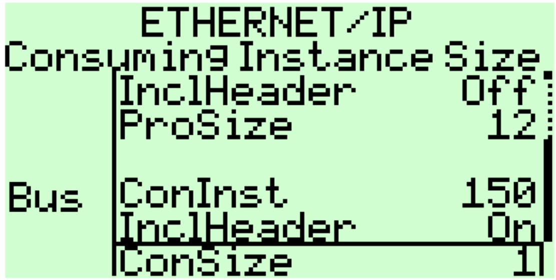




6. Set the desired IP address, subnet mask, and any other required Ethernet attributes (specific to site network). Restart the relay.



7. Navigate (use right/left arrows) to the ETHERNET/IP screen to view protocol-specific settings. The produced/consumed image sizes (in bytes) can be viewed from this screen.



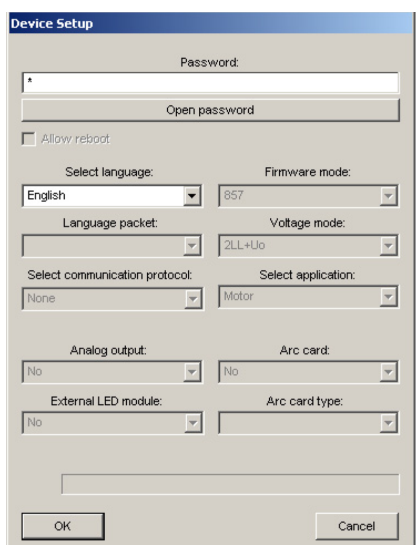
Configuring the 857 for Ethernet/IP Using SetpointPS

If SetpointPS programming software is the selected configuration method, it is recommended to use the front serial port to connect to a computer. When produced/consumed messaging is running between the 857 and controller, it is not possible to establish a connection from the 857 to a computer through EtherNet/IP.

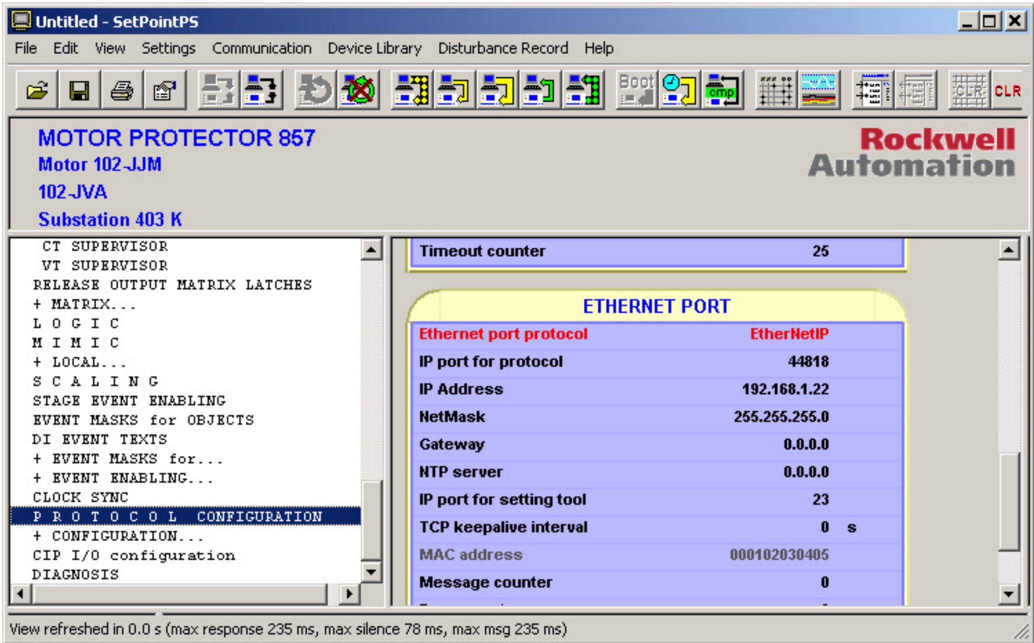
For more information on how to use SetpointPS programming software see Rockwell Publication 857-PM001.

To enable the EtherNet/IP port using SetpointPS:

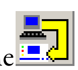
1. Connect to the relay. Use the  icon
2. Enter the password (default configuration is 2) and click OK to allow access to the SetPointPS window.



3. Scroll down the list and select PROTOCOL CONFIGURATION. Change the Ethernet port protocol to EtherNet/IP, and change other network values as required.

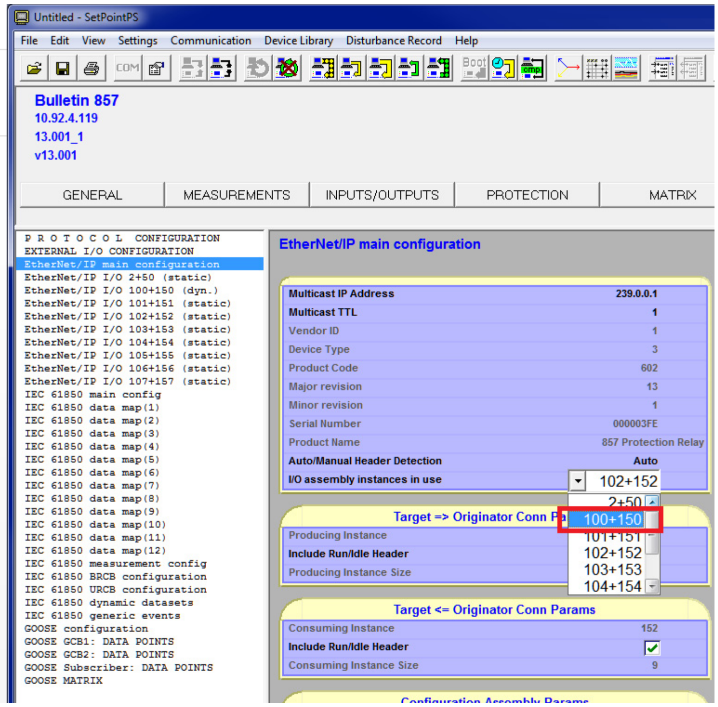


IMPORTANT	When a parameter is shown as red in SetpointPS, it means that the offline (project file) value is set but online it is not.

4. To (download) set new values in the relay, use the  icon. A restart of the relay can be required, depending on the values that are changed. If it is, the following dialog appears.

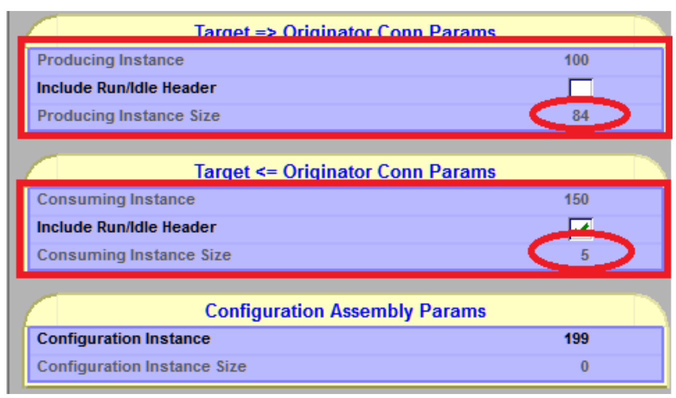
The other method to restart is to cycle control power to the unit.

5. Scroll down to Ethernet/IP MAIN CONFIGURATION and view protocol-specific parameters.



6. Select I/O assembly instances in use to 100+150. The relay will ask to be rebooted again, (unless the assembly was already set to 100+150).

   After the relay re-boots, the size (byte count) for each assembly is show in this location.

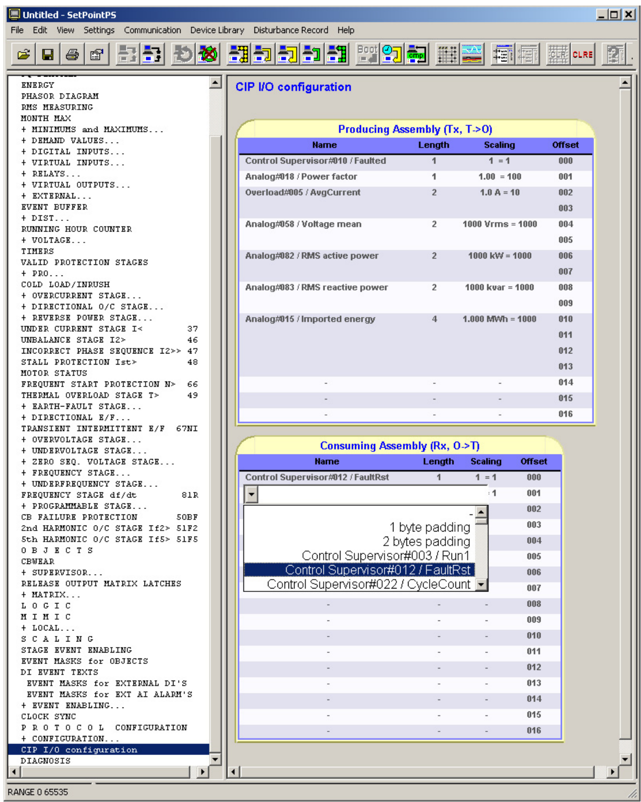


IMPORTANT	The producing and consuming instance sizes are shown in grey font, indicating that they cannot be configured from this screen. The size for each instance is dictated by the selections made in the input/output assembly. You can configure the content of these assemblies. It is also recommended that the Run/Idle Header selections remain with their default values (Producing Assembly, de-selected, Consuming Assembly, Selected).

Configure Produced/Consumed (CIP I/O) Image

Use the SetpointPS programming software to configure the CIP I/O image. Scroll to CIP I/O configuration to view the image parameters. The factory default only shows one parameter in each assembly. You must add or remove items that you want packaged in either assembly.

The valid parameters within each assembly are selectable by clicking in the area below the Name area and by using a pull-down menu as shown below. The parameters can be single word, double word, or 4 word elements (8, 16, or 32 bits).

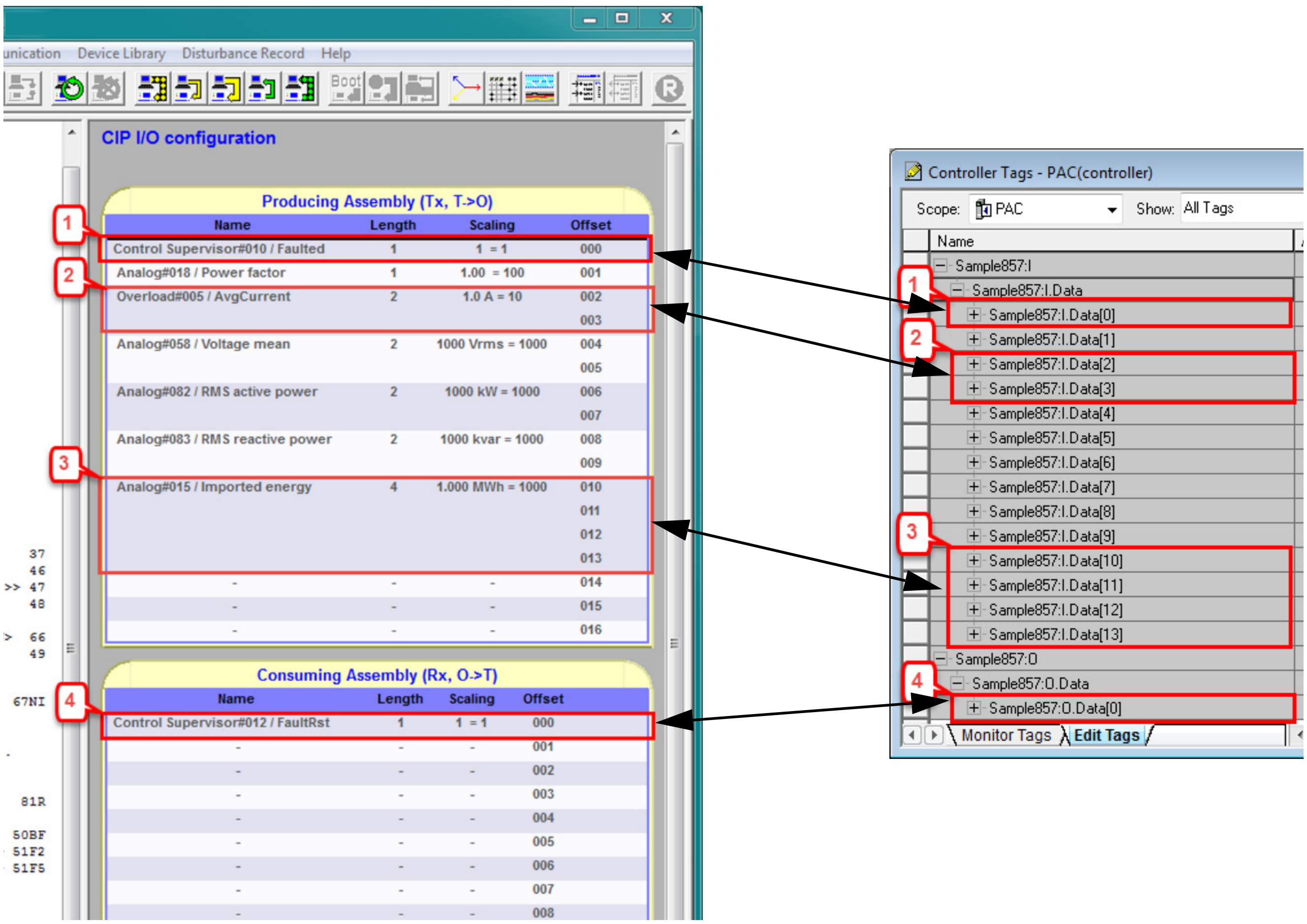


Single and double byte pad words are available as required to allow for correct word or double-word alignment in the image.

Produced and Consuming Assemblies (CIP I/O) Data Table Alignment

Once the 100+150 CIP I/O image is configured in the 857 the Logix/Studio 5000 program, it is necessary to align the data words from the relay with the data table in the controller. The offset value provides the byte count offset value for that parameter.

The example below shows how the CIP I/O configuration Offset value aligns with the single integer (SINT) array element in the controller data table.



Once the data is transferred into the Logix controller, it is recommended that you move the data into controller defined tags for further use, such that tag naming can identify the purpose of the data. This image uses the following tag names to identify their purposes, and Logix 5000 instructions to transfer the data to them.

Figure 194 - Controller Tags

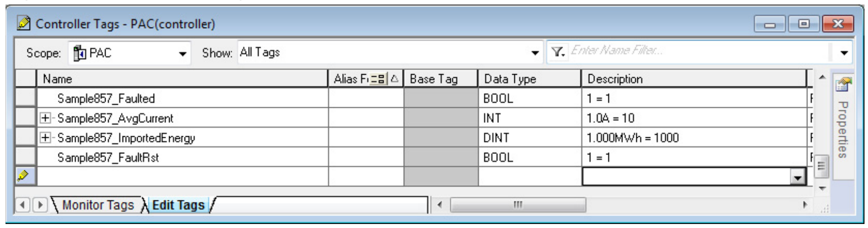
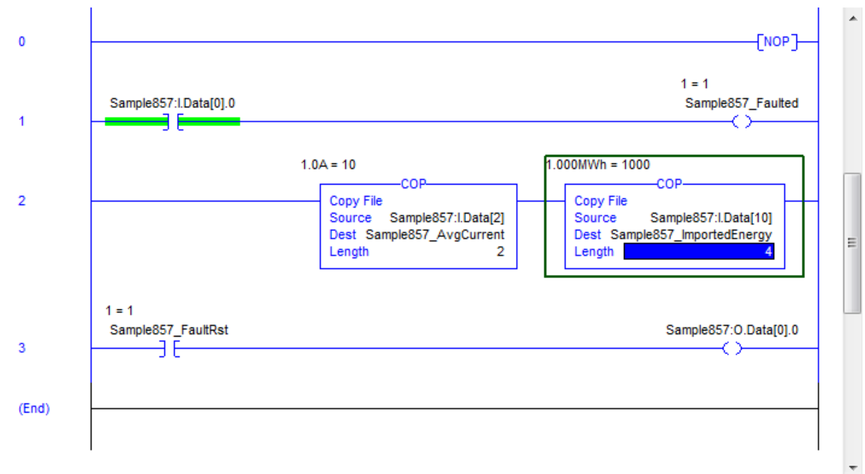


Figure 195 - Logix 5000 Ladder Logic Instructions



Notes:

History of Changes

This appendix contains the new or updated information for each revision of this publication. These lists include substantive updates only and are not intended to reflect all changes. Translated versions are not always available for each revision.

857-UM001C-EN-P, June 2019

Change
Changed all references from 47 to 46, where applicable
Corrected catalog number
Added Cycle control power
Added Incorrect Phase Sequence (Voltage Based) section
Adjusted signal relay operating time
Added Decimal and Hexadecimal to column headings
Indicated which parameters are Bulletin 865 only.

Notes:

The following terms and abbreviations are used throughout this manual. For definitions of terms that are not listed here, see the Allen-Bradley® Industrial Automation Glossary, publication AG-7.1.

AC contactor An alternating current (AC) contactor establishes or interrupts an AC power circuit.

Altitude The atmospheric altitude (height above sea level) at which the motor is operating; NEMA standards call for an altitude not to exceed1000 m (3300 ft). As the altitude increases above 1000 m (3300 ft) and the air density decreases, the ability for the air to cool the motor decreases. For higher altitudes, higher grades of insulation or motor derating are required. DC motors require special brushes for operation at high altitudes.

Ambient temperature The temperature of the surrounding cooling medium, such as gas or liquid, which comes into contact with the heated parts of the motor. The cooling medium is usually the air that surrounds the motor. The standard NEMA rating for ambient temperature is not to exceed 40 °C (104 °F).

American National Standards Institute (ANSI) American National Standards Institute. An organization that develops and publishes voluntary industry standards in the United States.

American Wire Gauge (AWG) A standard system that is used for designating the size of electrical conductors. Gauge numbers have an inverse relationship to size; larger numbers have a smaller cross-sectional area. However, a single-strand conductor has a larger cross-sectional area than a multi-strand conductor of the same gauge, so that they have the same current-carrying specification.

ANSI American National Standards Institute. A standardization organization.

Approved Use of this term indicated that the device has been found acceptable by the authority having jurisdiction.

Architecture Specific configuration of hardware and software elements in a system.

Authority Having Jurisdiction The entity that has authority to enforce the requirements of a code or standard, or to approve equipment, materials, installations, or procedures.

Branch circuit The conductors and components following the last overcurrent protective device protecting a load (as defined in UL 508A, December 28, 2007).

Branch circuit protection Overcurrent protection with an ampere rating that is selected to help protect the branch circuit. For a motor branch circuit, the overcurrent protection is required for overcurrents due to short circuits and faults to ground only (as defined in UL 508A, December 28, 2007).

Branch circuit protective device A fuse or circuit breaker that has been evaluated to a safety standard for providing overcurrent protection (as defined in UL 508A, December 28, 2007).

CBFP Circuit breaker failure protection.

Circuit Breaker (CB) A device that is designed to open and close a circuit by non-automatic means. And to open the circuit automatically on a pre-determined overcurrent, without damage to itself when properly applied within its rating.

Class 1 circuit A control circuit on the load side of overcurrent protective device where the voltage does not exceed 600 volts. Where the power available is not limited, or control circuit on the load side of power is limiting the supply. Such as a transformer (as defined in UL 508A, December 28, 2007).

Class 1 wiring Conductors of a Class 1 Circuit (as defined in UL 508A, December 28, 2007).

Class 2 circuit A control circuit that is supplied from a source having limited voltage (30V rms or less0. And current capacity, such as from the secondary of a Class 2 transformer, and rated for use with Class 2 remote-control or signaling circuits (as defined in UL 508A, December 28, 2007).

Coil 1. The electrical conductors wound into the core slot of a motor, electrically insulated from the iron core. A group of coils is connected into circuits, or windings, which carry independent current. These coils carry and produce a magnetic field when a current pass through them.

2. A ladder diagram symbol that represents an output instruction.

Combination motor controller One or more devices that are assembled to provide a means to disconnect, the branch circuit protection, motor control, and motor overload protection for a motor circuit. As defined in UL 508A, December 28, 2007.

Compensation Adjustment or alteration of a control system to improve performance. A compensator can be an electrical, mechanical, hydraulic, or pneumatic device.

Conductor A material, such as copper or aluminum, which offers low resistance or opposition to the flow of electric current.

Conduit box The metal container usually on the side of the motor, where the stator (the winding) leads are attached to leads that go to the power supply.

Control circuit A circuit that carries the electric signals that direct the performance of a controller, and which does not carry the main power circuit. A control circuit is, in most cases, limited to 15 amperes (as defined in UL 508A, December 28, 2007).

Control circuit transformer A transformer whose secondary supplies power to control circuit devices only (excluding loads). As defined in UL 508A, December 28, 2007.

Controller A device or group of devices that serves to govern, in some predetermined manner, the electric power that is delivered to the apparatus to which it is connected. As defined in UL 508A, December 28, 2007).

cosφ Active power that is divided by apparent power = P/S. (See Chapter 5). Negative sign indicates reverse power.

CT Current transformer.

CT_{PRI} Nom primary value of current transformer.

CT_{SEC} Nom secondary value of current transformer.

DC contactor A contactor that is designed to establish or interrupt a direct current (DC) power circuit.

DC motor A motor that uses generated or rectified DC power. A DC motor is often used when variable-speed operation is required.

Dead band See Hysteresis.

DI Digital input.

Disconnecting means A device that disconnects all ungrounded conductors of a circuit from their electrical supply (as defined in UL 508A, December 28, 2007).

DO Digital output, output relay.

DSR Data set ready. An RS-232 signal. Input in front panel port of Allen-Bradley relays to disable rear-panel local port.

Dry Potential free.

DST Daylight Savings Time. Adjusting the official local time forward by 1 hour for summer time.

DT Definite Time.

DTR Data terminal ready. An RS232 signal. Output and always true (8 V DC) in front panel port of Allen-Bradley relays.

FFT Fast Fourier transform. Algorithm to convert time domain signals to frequency domain or to phasors.

Feeder circuit The conductors and circuitry on the supply side of the branch-circuit overcurrent protective device (as defined in UL 508A, December 28, 2007).

Field installed equipment Devices to be installed after an industrial control panel is built/ labeled (as defined in UL 508A, December 28, 2007).

Field wiring terminal A terminal that is provided in an industrial control panel to terminate field wiring (as defined in UL 508A, December 28, 2007).

Frame 1. The supporting structure for the stator parts of an AC motor. In a DC motor, the frame usually forms a part of the magnetic coil. The frame also determines mounting dimensions.

2. The unit that is exchanged at the data link layer of a communication network.

Frame size Refers to a set of physical dimensions of motors as established by NEMA. These dimensions include critical mounting dimensions. NEMA 48 and 56 frame motors are considered fractional horsepower sizes even though they can exceed 1 horsepower. NEMA 143T to 449T is considered integral horsepower AC motors and 5000 series and above are called large motors. (For definition of letters following frame number, see "Suffixes to NEMA frames" on page 489.

Frequency The rate at which the alternating current makes a complete cycle of reversals. It is expressed in cycles per second. In the U.S., 60 cycles (Hz) are the standard while in other countries 50 Hz (cycles) is common. The frequency of the AC current affects the speed of a motor.

Full-load current (FLC); Full-load Amperage (FLA) The current flowing through the line when the motor is operating at full-load torque and full-load speed with rated frequency and voltage that is applied to the motor terminals.

Full load torque The torque necessary to produce the rated horsepower at full-load speed.

General-purpose motor A general-purpose motor is any motor having a NEMA "B" design, which is listed and offered in standard ratings, with standard operating characteristics and mechanical construction for use under usual service conditions without restriction to a particular application or type of application (NEMA).

General-use rating A rating, expressed in volts and amperes, which are assigned to a device that is intended to control the following:

a. A load with a continuous or inrush ampere rating that does not exceed the ampere rating of the device.
b. When AC rated, a load that has a power factor of 0.75…0.80 (inductive).
c. When DC rated, a load that is resistive (noninductive) (as defined in UL 508A, December 28, 2007).

Hardware 1. Any mechanical, electrical, and electronic components and assemblies.

2. All physical components of a control system – including the controller, peripherals, and the interconnecting wiring – as opposed to the software components that control its operation. Compare with software (programming).

Horsepower (Hp) 1. Unit of power that represents the amount of work done per unit of time. 1 horsepower (Hp) is equivalent to the lifting of 33,000 pounds to a height of 1 foot in 1 minute. It is equal to 746 watts.

2. The horsepower of a motor is expressed as a function of torque and speed. Where torque is measured in units of ft•lbs and speed is measured in units of RPM. Calculated as (torque x speed) / 5252.

Hysteresis Used to avoid oscillation when comparing two near by values.

I_{01N} Nominal current of the I_{01} input of the device.

I_{02N} Nominal current of the I_{02} input of the device.

I_{0N} Nominal current of I_0 input in general.

I_{MODE} Nominal current of the selected mode. In feeder mode, I_{mode} = $CT_{primary}$. In motor mode, I_{mode} = I_{MOT}.

I_{MOT} Nominal motor current, in motor protective mode.

I_N Nominal current. Rating of CT primary or secondary.

I_{SET} Another name for pick up setting value I>

I_{oSET} Another name for pick up setting value I_O>

I_{ON} Nominal current of I0 input in general

I_{O1N} Nominal current of I01 input in general

I_{O2N} Nominal current of I02 input in general

IEC-101 Abbreviation for communication protocol that is defined in standard IEC 60870-5-101.

IEC-103 Abbreviation for communication protocol that is defined in standard IEC 60870-5-103.

IED Intelligent Electronic Device.

IEEE Institute of Electrical and Electronics Engineers.

Induction motor AC motor that has no electrical connection to the rotor. The current that is supplied to the primary winding on the stator produces a rotating magnetic field in the stator. This rotating magnetic field induces current in the rotor windings. The induced current in the rotor windings creates a magnetic field in the rotor. The interaction of the magnetic field of the stator and the magnetic field of the rotor causes motion. It runs close to synchronous speed.

Instantaneous trip circuit breaker A circuit breaker in which no delay is introduced into the tripping action of the circuit breaker. These circuit breakers are able to provide motor branch circuit protection when evaluated as a part of a combination motor controller as in 31.1.1 (as defined in UL 508A, December 28, 2007).

Insulation 1. Material that tends to resist the flow of electric current and reduce heat loss.

2. In a motor, insulation allows high voltage in the system for current flow and for motor torque production.

International Electrotechnical Commission (IEC) Global organization that prepares and publishes international standards for all electrical, electronic, and related technologies. These standards serve as a basis for national standardization and as references when drafting international tenders and contracts. The IEC promotes international cooperation on all questions of electrotechnical standardization and related matters. Such as the assessment of conformity to standards, in the fields of electricity, electronics, and related technologies.

Interrupting Rating The highest current, at rated voltage, which a device is intended to interrupt under standard test conditions.

Inverse-time circuit breaker A circuit breaker in which a delay is introduced into the tripping action of the circuit breaker. The delay decreases as the magnitude of the current increases. These circuit breakers are able to provide branch circuit protection (as defined in UL 508A, December 28, 2007).

Isolated secondary circuit A circuit that is derived from an isolating source and having no direct connection back to the primary circuit, other than through the grounding means. Such as a transformer, optical isolator, a limiting impedance, or electromechanical relay. A secondary circuit that has a direct connection back to the primary circuit is evaluated as part of the primary circuit (as defined in UL 508A, December 28, 2007).

LAN Local area network. based network for computers and relays.

Latching Output relays and status indicators can be latched, which means that they are not released when the control signal is releasing. The releasing of latched devices is done with a separate action.

Listed Equipment, materials, or services included in a list that is acceptable to the authority having jurisdiction.

Load 1. Burden that is imposed on a motor by the driven machine. It is often stated as the torque required to overcome the resistance of the machine it drives. Sometimes synonymous with "required power."

2. Share of work that is demanded of a machine or system. It is the external force that is applied to a machine or system. Or the sum of the external forces and the weight of the structure moved by the machine or system.

3. Amount of power or current required to start or maintain motion in a power-driven machine or apparatus.

4. External mechanical resistance against which a machine acts.

5. Machine characteristics that are moved from one place to another.

6. Robot supported function of mass, moment of inertia, static and dynamic forces. It is expressed as the force and torque at the mechanical interface, which can be exerted along the various axes of motion under specified conditions of velocity and acceleration.

Locked-rotor current Amount of current drawn at the instant a motor is energized. It is the steady-state current that is taken from a line with a rotor that is at standstill with rated voltage and frequency. In most cases, it is much higher than the current required for running a motor. It is also known as starting current.

Local HMI IED front panel with display and push buttons

Low-voltage limited energy circuit A control circuit that involves a peak open-circuit potential of not more than 42.4 volts (DC or peak) supplied by a primary battery or by an isolated secondary circuit. Where the current capacity is limited by an overcurrent device, such as a fuse. Or by the inherent capacity of the secondary transformer or power supply, or a combination of a secondary winding and an impedance. A low-voltage limited energy circuit is not derived from a line-voltage circuit by connecting a resistance in series with the supply circuit to limit the voltage and current. As defined in UL 508A, December 28, 2007.

Motor A device that takes electrical energy and converts it into mechanical energy to turn a shaft.

Motor overload Electrical overload, a situation where an electrical machine or system is subjected to a greater load its design.

Motor rating The operational capabilities of a motor. They are specifications or performance limits that are measured at defined temperatures.

Nameplate The plate on the outside of the motor that describes the motor horsepower, voltage, speed efficiency, design, enclosure, and so forth.

National Electrical Code® (*NEC®*) National Fire Protection Association, regulations that govern the construction and installation of electrical wiring and apparatus. The regulations are suitable for mandatory application by governing bodies that exercise legal jurisdiction. It is widely used by state and local authorities within the United States.

National Electrical Manufacturers Association (NEMA) A non-profit association of manufacturers of electric equipment and supplies. NEMA has set standards for the following: horsepower ratings, speeds, frame sizes and dimensions, standard voltages and frequencies with allowable variations, service factors, torque, the starting current and KVA, enclosures.

NTP Network time protocol for LAN and WWW.

Original Equipment Manufacturer (OEM) The maker of a piece of equipment. For example, a machine tool manufacturer buys programmable controller components, sensors, and actuators. Then integrates them with their machine tool to produce the complete system for sale to the end user.

Overcurrent protection A device that is designed to open a circuit when the current through it exceeds a predetermined value. The ampere rating of the device is selected for a circuit to terminate a condition. When the current exceeds the rating of conductors and equipment due to overloads, short circuits, and faults to ground. As defined in UL 508A, December 28, 2007).

Overload An electrical load that exceeds the available electrical power.

Overload protection Protection that is required for motor circuits that will operate to prohibit excessive heat due to running overloads and failure to start (as defined in UL 508A, December 28, 2007).

P Active power. Units =[W].

PF Power factor. The absolute value is equal to cos φ, but the sign is "+" for inductive, which is lagging current and "-" for capacitive, that is leading current.

Phase 1. Indicates the space relationships of windings and the changing values of the recurring cycles of AC voltages and currents. Due to the positioning (or the phase relationship) of the windings, the various voltages and currents are not similar in all aspects at any given instant. Each winding leads or lags another in position. Each voltage leads or lags another voltage in time. Each current leads or lags another current in time. The most common power supplies are single- or three-phase (with 120 electrical degrees between the three-phases).

2. The separation in electrical degrees between any specified transitions of any two channels in an encoder.

P_M Nominal current of prime mover (used by reverse/under power protection elements).

Power The work done per unit of time. Measured in horsepower or watts: 1 Hp= 33,000 ft•lb/min. = 746 W.

Power factor The ratio of the active power (W) to the apparent power (VA) expressed as a percentage. It is numerically equal to the cosine of the angle of lag of the input current regarding its voltage, which is multiplied by 100.

Power transformer A transformer whose secondary winding supplies power to loads or a combination of loads and control circuit devices operating at the secondary voltage (as defined in UL 508A, December 28, 2007).

PT See VT.

pu Per unit. Depending on the context, the per unit refers to any nom value. For example, for overcurrent setting 1 pu = 1 x I_{MODE}.

Q Reactive power. Units = [var] acc. IEC.

Qualified person A person who has the skills, knowledge, and training that is related to the construction, installation, and operation of electrical equipment. With safety training to recognize and avoid the hazards that are involved.

Rated horsepower The maximum or allowable power output of a motor or other prime mover under normal, continuous operating conditions.

RMS Root mean square.

S Apparent Power. Unit = [VA].

Safe working procedure A method of work that reduces risk.

Service Factor (SF) 1. When used on a motor nameplate, a number that indicates how much above the nameplate rating a motor can be loaded without causing serious degradation. For example, a 1.15 SF can produce 15% greater torque than the 1.0 SF rating of the same motor).

2. When used in the applying motors or gearmotors, a figure of merit, which is used to “adjust”, measured loads to compensate for conditions, which are difficult to measure or define. Typically, measured loads are multiplied by service factors (experience factors) and the result in an “equivalent required torque” rating of a motor or gearmotor.

Shall Indicates a mandatory requirement in regulatory standards.

Short-circuit current An overcurrent that results from a short circuit due to a fault or an incorrect connection.

Short-circuit current rating (SCCR) The prospective symmetrical fault current at a nom voltage to which an apparatus or system can be connected without damage that exceeds the defined acceptance criteria. As defined in UL 508A, December 28, 2007.

SNTP Simple Network Time Protocol for LAN and WWW.

Suffixes to NEMA frames Letter suffixes sometimes follow the NEMA frame size designations. Some of these suffixes, according to NEMA standards, have these meanings:

Fractional Horsepower Motors.

C - Face mounting.
G - Gasoline pump motor.
H - Indicates a frame having a larger “F” dimension.
J - Jet pump motor.
Y - Special mounting dimensions *(see manufacturer).*
Z - All mounting dimensions are standard except the shaft extension.

Integral Horsepower Motors.

A - DC motor or generator.
C - Face mounting on drive end.
D - Flange mounting on drive end.
P - Vertical hollow and solid shaft motors with P-Base flange.
HP - Vertical solid shaft motors with P-Base flange (normal thrust).
JM - Close-coupled pump motor with C-Face mounting and special shaft extensions.
JP - Close-coupled pump motor with C-Face mounting and special long shaft extension.
LP - Vertical solid shaft motors with P-Base flange (medium thrust).
S - Standard short shaft for direct connection.
T - Standardized shaft -“T” frame.
V - Vertical mounting.
Y - Special mounting dimensions.
Z - All mounting dimensions standard except shaft extension.

Supplementary protection A device that is intended to provide additional protection subsequent to branch circuit protection. They have not been evaluated for providing branch circuit protection (as defined in UL 508A, December 28, 2007).

Supplementary protector A manually resettable device that is designed to open the circuit automatically on a predetermined value of time versus current or voltage within an appliance or other electrical equipment. It can be provided with manual means to open or close the circuit. These devices provide supplementary protection only (as defined in UL 508A, December 28, 2007).

TCS Trip circuit supervision.

THD Total harmonic distortion.

U_{0SEC} Voltage for input U_c at zero-ohm earth-fault (in mode 2LL $+U_0$).

U_A Voltage at input U_{12} or U_1, depending on voltage measurement mode.

U_B Voltage at input U_{23} or U_2, depending on voltage measurement mode.

U_C Voltage at input U_{31} or U_3, depending on voltage measurement mode.

U_N Normal voltage. Rating of VT9PT) primary or secondary.

UL (Underwriter's Laboratory) An independent testing organization, which examines and tests devices, systems and materials with particular reference to life, fire, and casualty hazards. It develops standards for motors and controls that are used in hazardous locations through cooperation with manufacturers. UL has standards and tests for explosion-proof and dust ignition-proof motors, which must be met and passed before application of the UL label.

UTC Coordinated Universal Time (used to be called GMT = Greenwich Mean Time).

VT Voltage or primary transformer.

VT_{pri} Nom primary value of VT or PT.

VT_{sec} Nom secondary value of VT or PT.

Voltage, Nom A Nom value that is assigned to a circuit or system for conveniently designating its voltage class.

Watt The amount of power that is required to maintain a current of 1 ampere at a pressure of 1 volt. Most motors are rated in kW equal to 1000 watts. 1 horsepower is equal to 746 watts.

Webset Http base configuration tool.

Numerics

A

B

C

E

F

G

H

I

K

L

P

Rockwell Automation Support

Use these resources to access support information.

Technical Support Center	Find help with how-to videos, FAQs, chat, user forums, and product notification updates.	rok.auto/support
Knowledgebase	Access Knowledgebase articles.	rok.auto/knowledgebase
Local Technical Support Phone Numbers	Locate the telephone number for your country.	rok.auto/phonesupport
Literature Library	Find installation instructions, manuals, brochures, and technical data publications.	rok.auto/literature
Product Compatibility and Download Center (PCDC)	Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes.	rok.auto/pcdc

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Waste Electrical and Electronic Equipment (WEEE)

At the end of life, this equipment should be collected separately from any unsorted municipal waste.

Rockwell Automation maintains current product environmental information on its website at rok.auto/pec.

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